TM5-5023

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

GENERATOR SET

ELECTRIC, PORTABLE DIESEL DRIVEN SKID MOUNTED

100 KW, 127-220 VOLT 3 PHASE, 60 CYCLE OR 230-400 VOLT, 3 PHASE, 50 CYCLE, BUDA MODEL 8DCS-1125

DEPARTMENT OF THE ARMY • *NOVEMBER 1956*

AGO 10082B—Dec

SAFETY PRECAUTIONS

Do not make any electrical connections or changes until after the circuit breaker has been placed in the OFF position and the engine stopped.

When operating two or more generator sets in parallel, do not remove any of the sets from the line if the load exceeds the combined wattage ratings of the remaining sets.

In case of fire, extinguish flames quickly and avoid exposure to smoke and fumes.

Do not try to crank the engine electrically for more than 15 seconds at a time. Allow two-minute intervals between cranking attempts.

Do not operate the generator set in an inclosure unless the exhaust gases are piped to the outside. The exhaust gases contain carbon monoxide, a colorless, odorless, deadly poison.

Provide sufficient ventilation for proper cooling if the generator set is operated in an inclosure.

Keep the engine cooling system filled with clean coolant. Always neutralize the cooling system after a cleaning solution has been used.

Never add coolant to an overheated engine; allow the engine to cool first, then add coolant.

If freezing temperatures prevail, do not add water to the batteries unless the generator set is to be operated or the batteries are to be charged immediately.

Do not use emery cloth or emery paper on commutators, slip rings, or brushes. The abrasive material will become imbedded and cause short circuits.

Be certain that identification marking on wires and terminal points are legible before disconnecting any wires. If any markings are illegible, refer to the wiring diagram for the proper markings.

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 set or components, do not allow them to swing and damage equipment or injure personnel.

Never use acid flux or acid core solder when soldering electrical connections.

Do not allow bearings to spin when drying with compressed air. Do not spin a dry bearing.

TECHNICAL MANUAL
No. 5–5023

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *1 November 1956*

GENERATOR SET, ELECTRIC, PORTABLE, DIESEL DRIVEN, SKID MOUNTED, 100 KW, 127–220 VOLT, 3 PHASE, 60 CYCLE, OR 230–400 VOLT, 3 PHASE, 50 CYCLE, BUDA MODEL 8DCS–1125

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. These instructions are published for the use of the personnel to whom this generator set is issued. They contain information on the operation, organizational maintenance, and field and depot maintenance of the generator set as well as a description of the major units and their functions in relation to other components of the materiel. They apply only to the Buda Company Model 8DCS–1125.

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

c. Any errors, or suggestions for improvement of this manual should be brought to the attention of the Commanding General, The Engineer Maintenance Center, Corps of Engineers, U. S. Army, Columbus, Ohio, ATTN: Chief, Maintenance Engineering Division. Direct communication is authorized.

2. Record and Report Forms

The record and report forms listed below will be used in the maintenance of this equipment.

a. DA Form 5–13 (Spot Check Inspection Report of Organizational Maintenance of Engineer Equipment).

b. DA Form 5–14 (Annual Technical Inspection Report of Engineer Equipment).

c. DA Form 9–71 (Locator and Inventory Control Card).

d. DA Form 9–77 (Job Order Register).

e. DA Form 9–79 (Parts Requisition).

f. DA Form 5–22 (Exchange Part of Unit Identification Tag).

g. DA Form 446 (Issue Slip).

h. DA Form 447 (Turn-in Slip).

i. DA Form 460 (Work Sheet for Preventive Maintenance Roster).

j. DA Form 464 (Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment).

k. DA Form 468 (Unsatisfactory Equipment Report).

l. DA Form 478 (Organizational Equipment File).

m. DD Form 518 (Accident-Identification Card).

n. DA Form 811 (Work Request and Job Order).

o. DA Form 867 (Status of Modification Work Order).

p. DD Form 110 (Vehicle and Equipment Operational Record).

Note. Refer to TM 5–505 for detailed instructions on the use of the above record and report forms.

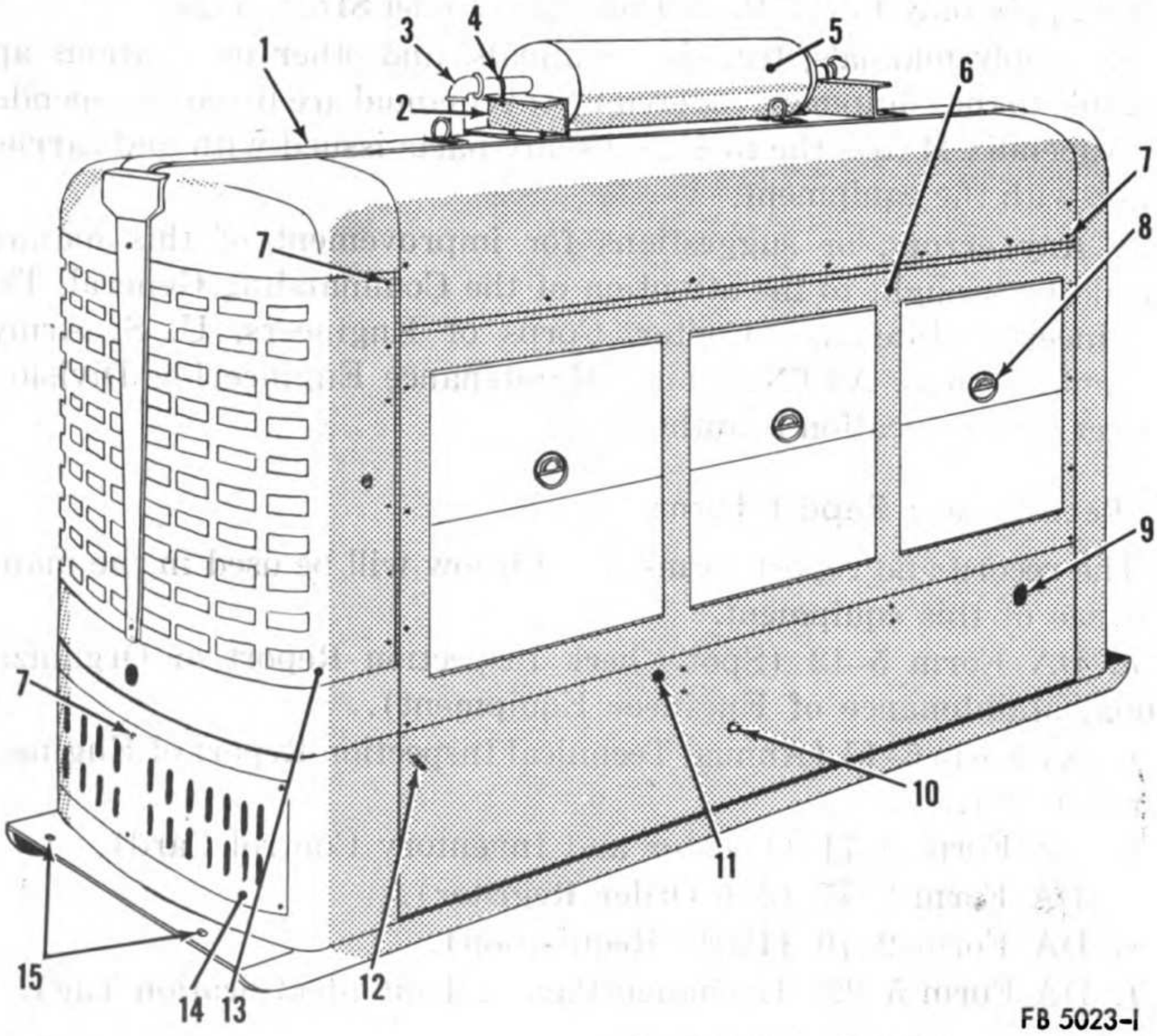
q. DA Form 285 (Accident Report of Personal or Property Damage).

r. DD Form 6 (Report of Damaged or Improper Shipment).

Section II. DESCRIPTION AND DATA

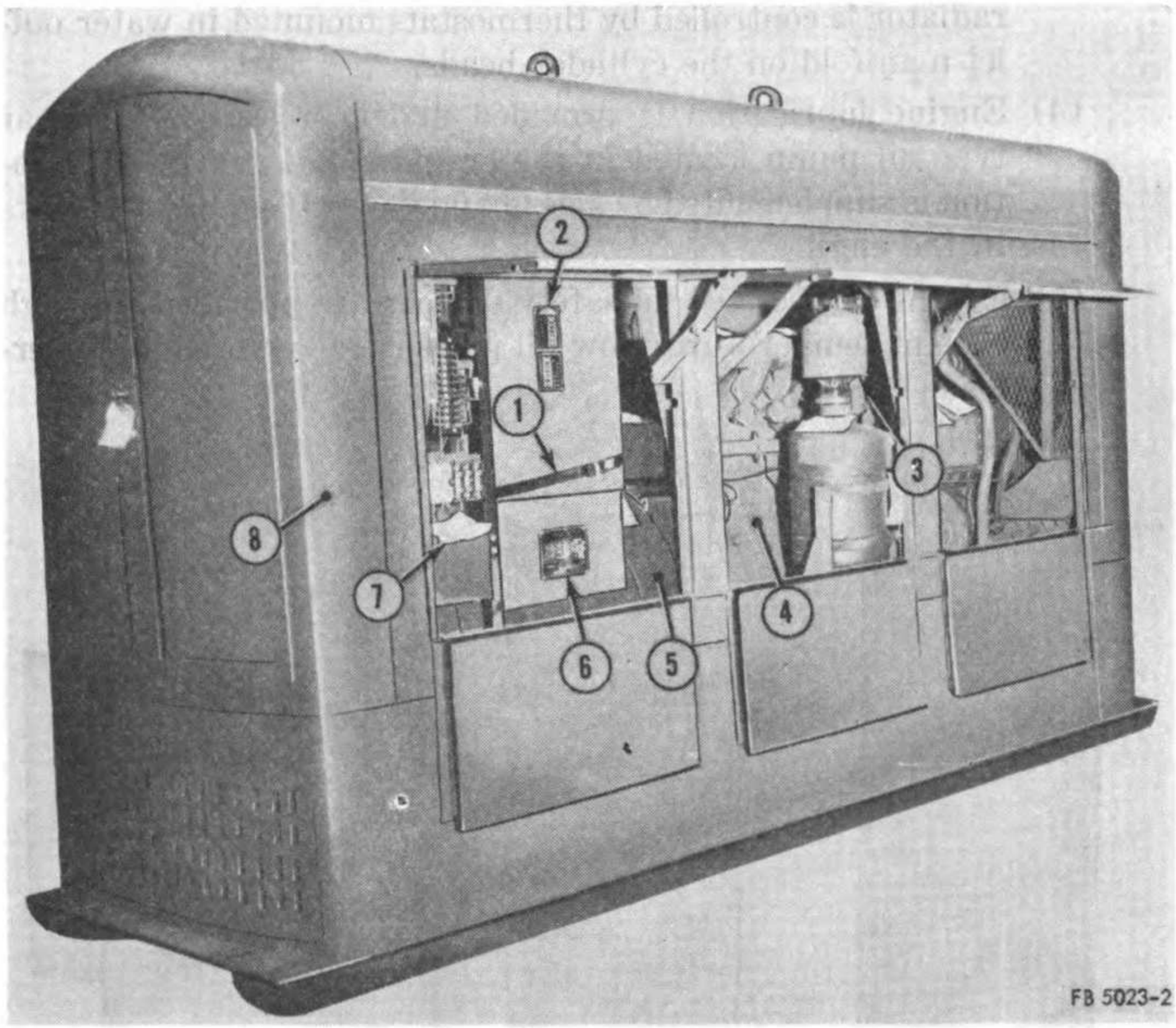
3. Description

a. General. The Buda Company Model 8DCS–1125 generator set (fig. 1) is a portable, skid-mounted, canopy-covered unit. It is powered by an eight-cylinder, full diesel engine (4, fig. 2), direct



1 Top panel
2 Support
3 Elbow
4 Muffler clamp
5 Muffler
6 Side panel
7 Screw, rd-hd, ⅜ x 1 NC (62 rqr)
8 Door latch handle
9 Load line access hole
10 Crankcase drain pipe
11 Auxiliary fuel line hole
12 Radiator overflow line
13 Front panel
14 Gas tank access cover
15 Towing eyes

Figure 1. Generator set, right front three-quarter view.



1 Strap
2 Terminal changeover diagram
3 Preservative tape
4 Engine
5 Generator
6 Generator identification plate
7 Desiccant
8 Rear panel

Figure 2. Generator set with access doors opened, right rear three-quarter view.

coupled to a 100 kw (kilowatt), ac (alternating current) generator (5). The unit is complete with all controls and instruments necessary for operation.

b. Engine.

(1) The engine (4, fig. 2) is a Buda Model 8DCS–1125, eight-cylinder, four-stroke-cycle, supercharged, solid injection, cold starting, full diesel.

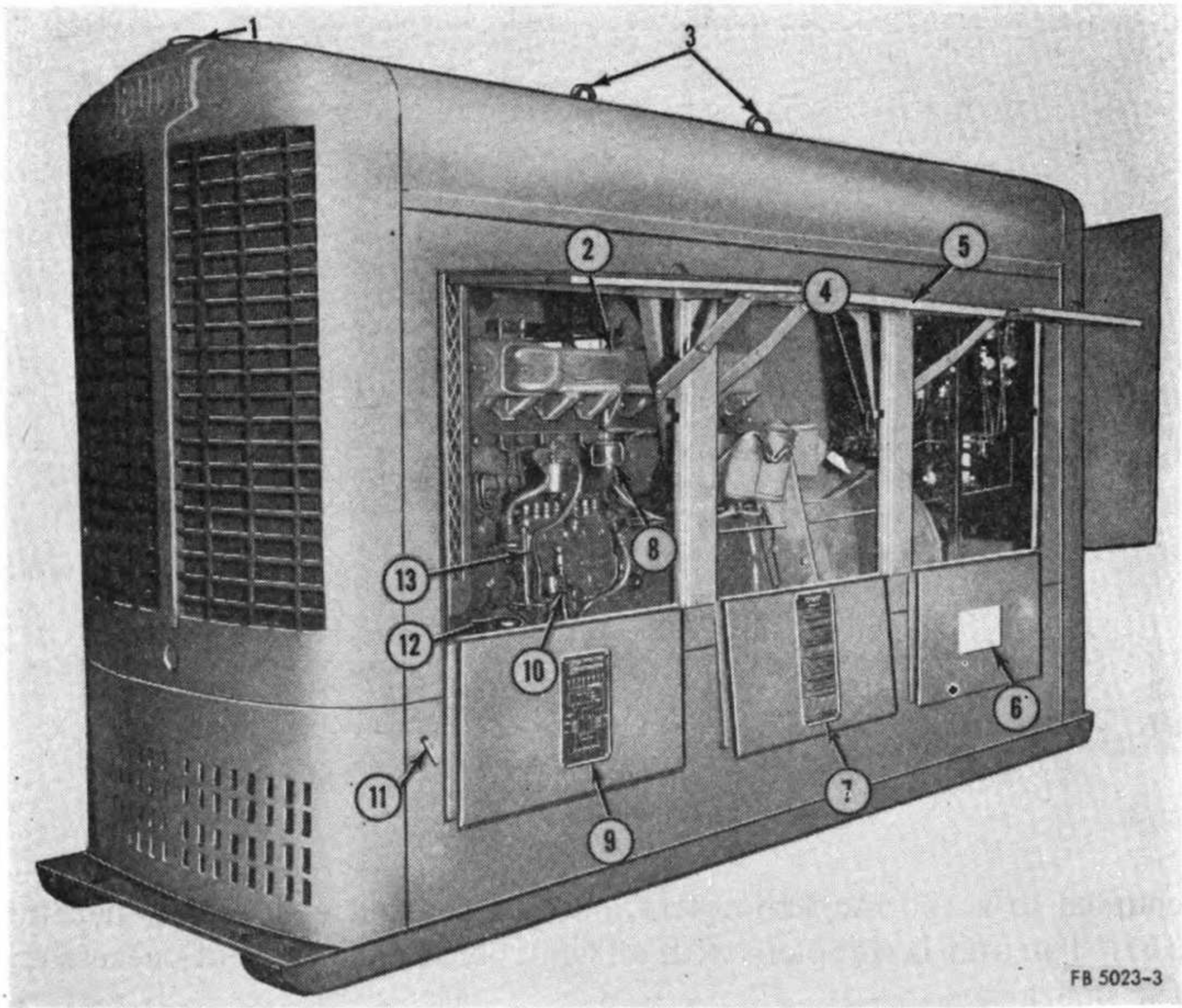
(2) The engine develops 300 hp (horse power) at 1,800 rpm (revolutions per minute). The positive displacement, multiple plunger, fuel injection pump (13, fig. 3), and engine speed governor (10, fig. 4), regulate engine speed from idle to full load.

(3) A water pump at the right front side of the engine block, circulates coolant under definite pressure, through the block and radiator. The coolant flow through the block and

radiator is controlled by thermostats mounted in water outlet manifold on the cylinder heads.

(4) Engine lubrication is provided under pressure by a gear type oil pump located in the crankcase. Pressure lubrication is supplemented by splash and vapor from moving parts in the engine.

(5) Engine protective and safety devices are provided for high coolant temperatures, low oil pressure, overspeed and overload.

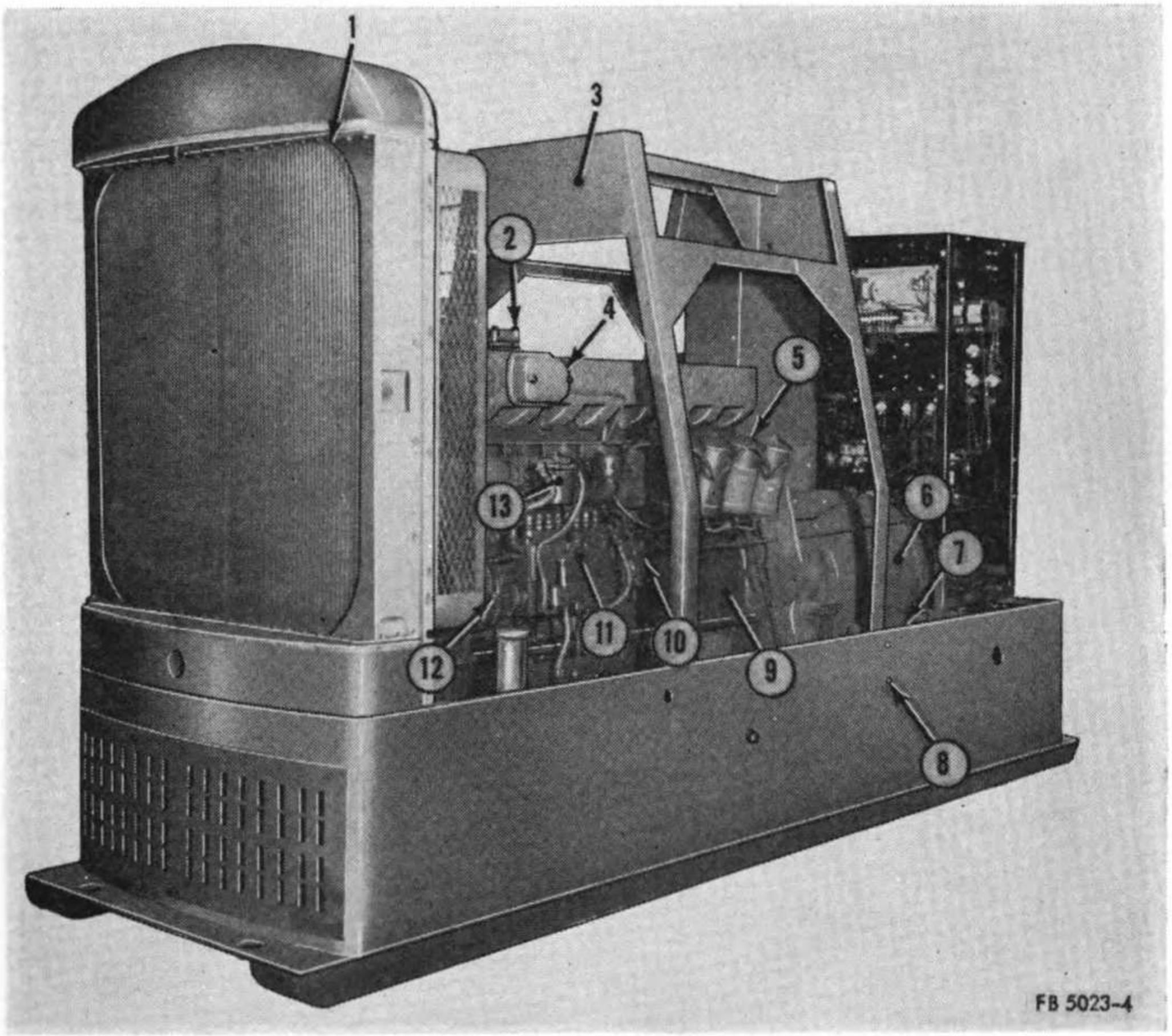


1 Radiator fill cap
2 Intake manifold
3 Lifting eyes
4 Tripper assembly
5 Access door
6 Wiring diagram
7 Operating instruction plate
8 Crankcase fill cap
9 Fuel diagram
10 Fuel transfer pump
11 Radiator overflow tube
12 Fuel tank cap
13 Fuel injection pump

Figure 3. Generator set with access doors opened, right front three-quarter view.

c. Generator.

(1) The generator (6, fig. 4) is a Y-connected, three-phase, rotating field generator with a dc (direct current) stationary field exciter. It is manufactured by the Century Electric Company.



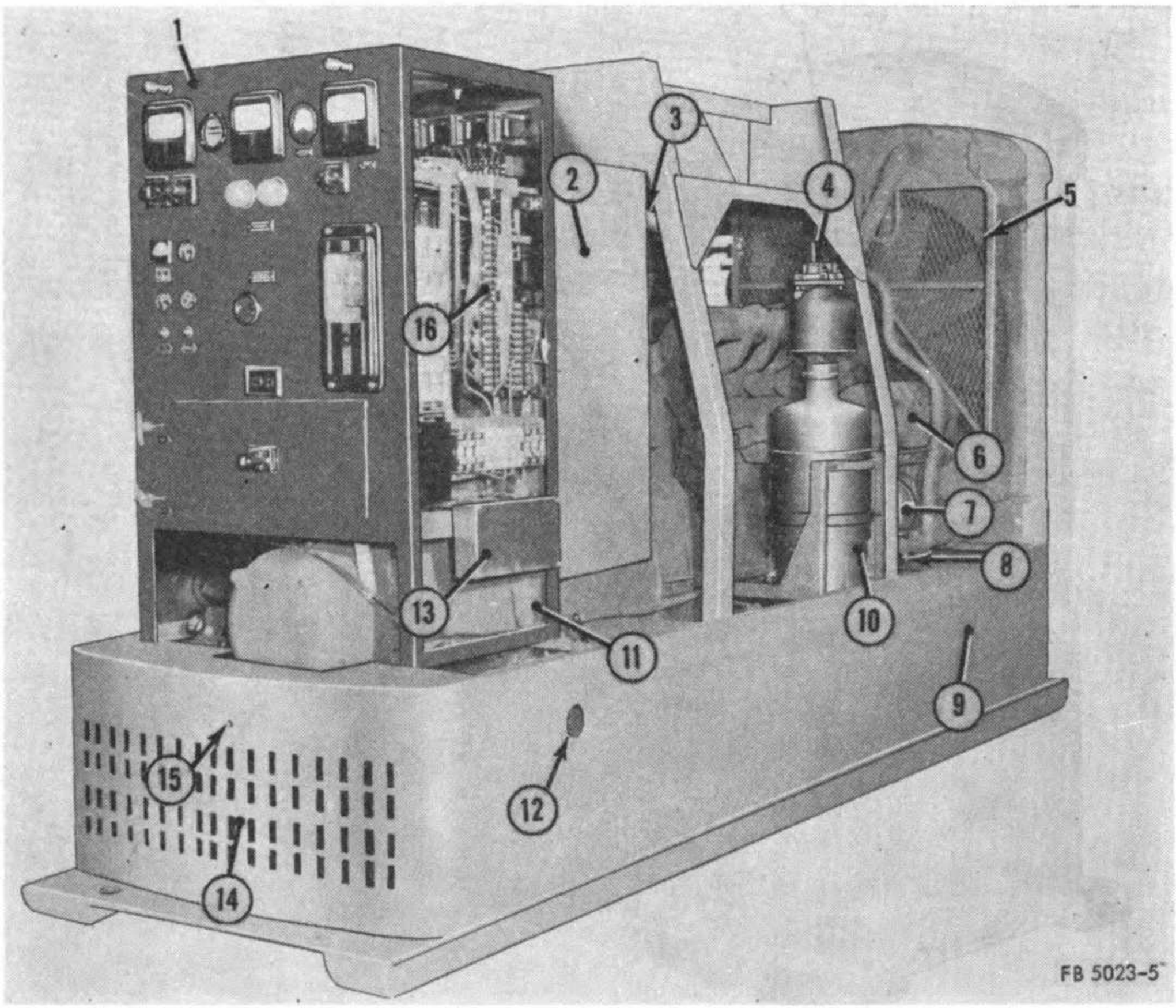
1	Radiator	8	Cap screw, ¾ x 3¼ NC (8 rqr)
2	Exhaust outlet flange	9	Engine
3	Lifting fork	10	Engine speed governor
4	Air intake heater	11	Fuel injection pump
5	Oil filters	12	Accessory drive
6	Generator	13	Secondary fuel filter
7	Compartment		

Figure 4. Generator set with housing removed, right front three-quarter view.

(2) The revolving field is supplied with a dc excitation current to produce the required magnetic field. This excitation current is supplied through sliprings by the conventional, self-excited, dc generator.

(3) Alternating current is generated in stator windings which are directly connected to the generator terminal box (2, fig. 5). Connections for the desired voltage are made at the generator terminal box and tapped at the load terminal block (16).

(4) The generated voltage is controlled by regulating the amount of direct current flowing in the generator field. This can be controlled either automatically or manually. Meters are provided to show the current and voltage in each phase of the generator.



1	Control panel	9	Subbase
2	Generator terminal box	10	Air cleaner
3	Ground strap	11	Generator
4	Exhaust outlet	12	Load line access hole
5	Fan guard	13	Load terminal box
6	Supercharger	14	Battery access cover
7	Water pump	15	Screw, rd-hd, ⅜ x 1 NC
8	Draincock	16	Terminal block

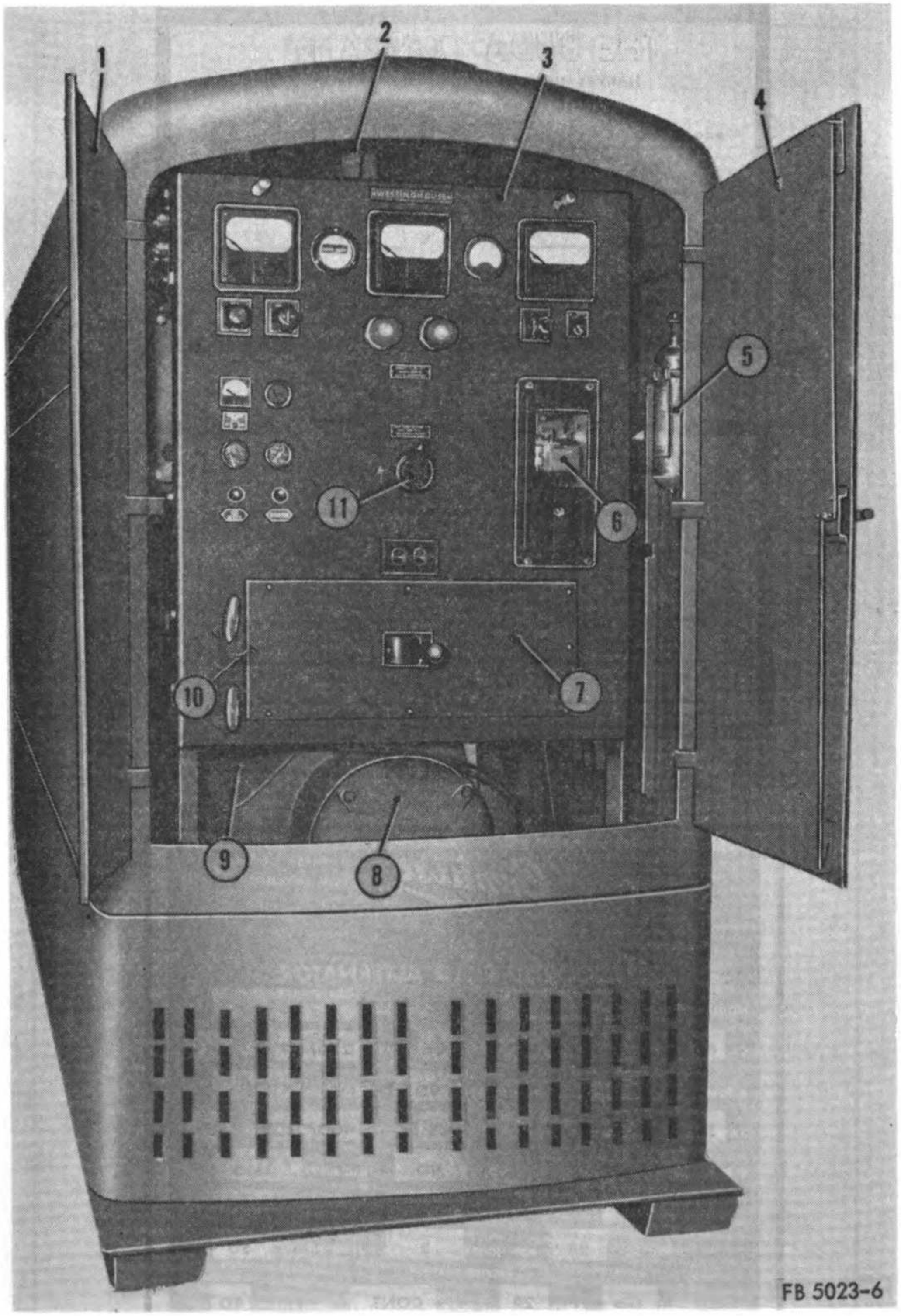
Figure 5. Generator set with housing removed, right rear three-quarter view.

(5) Voltage is controlled automatically by the voltage regulator (6, fig. 6), or can be controlled manually by the exciter field rheostat (11).

4. Identification

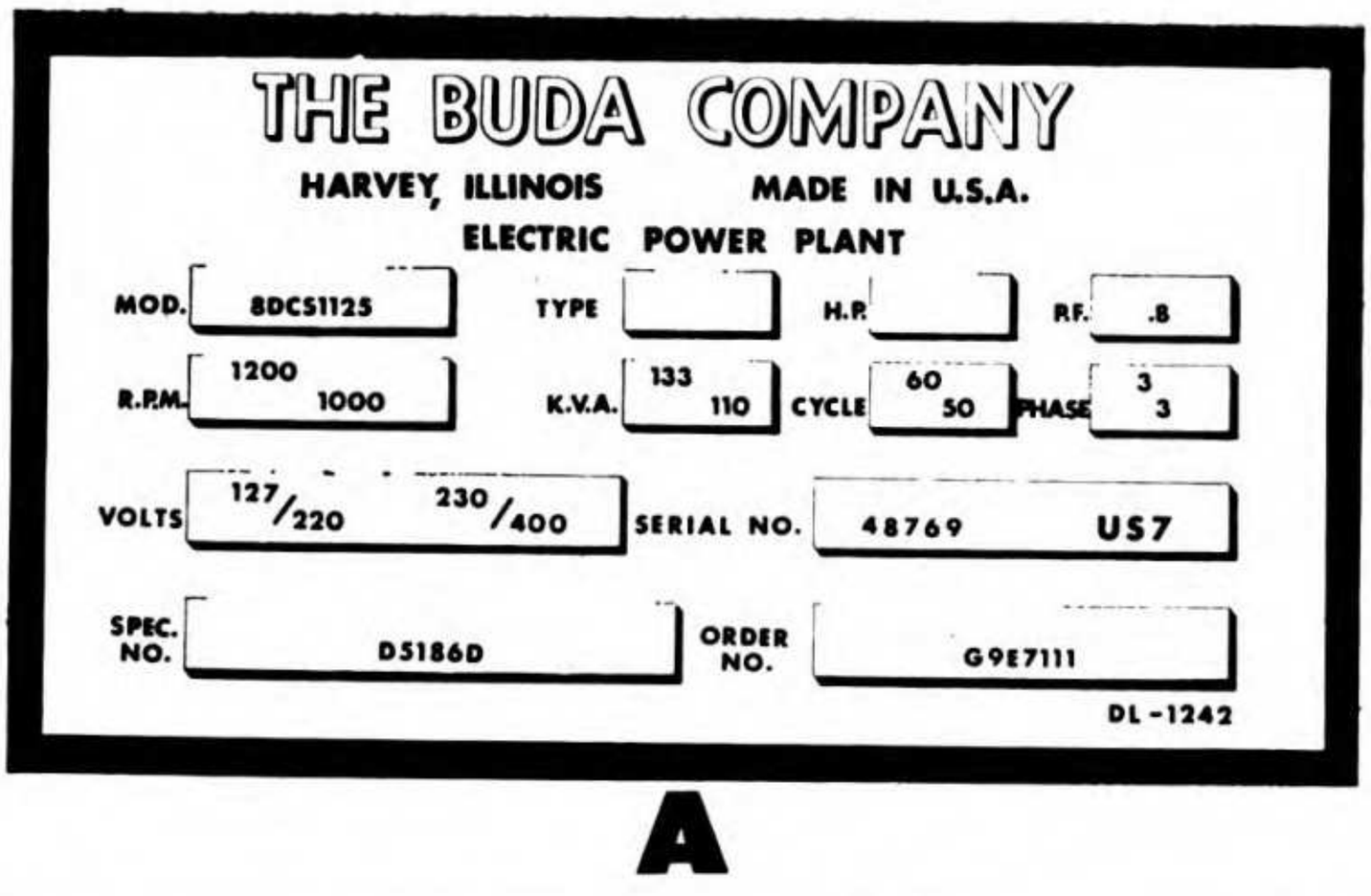
(fig. 7)

The generator set has three identification plates and one operating instruction plate. The generator set identfication plate (A) is located on the housing in the front of the generator set. It specifies the manufacturer, model number, serial number and other pertinent data. The engine identification plate (B) located on the left side of the engine block, specifies the manufacturer, model and serial numbers, and the bore and stroke. The generator identification plate (C), located below the generator terminal box on the right side of the

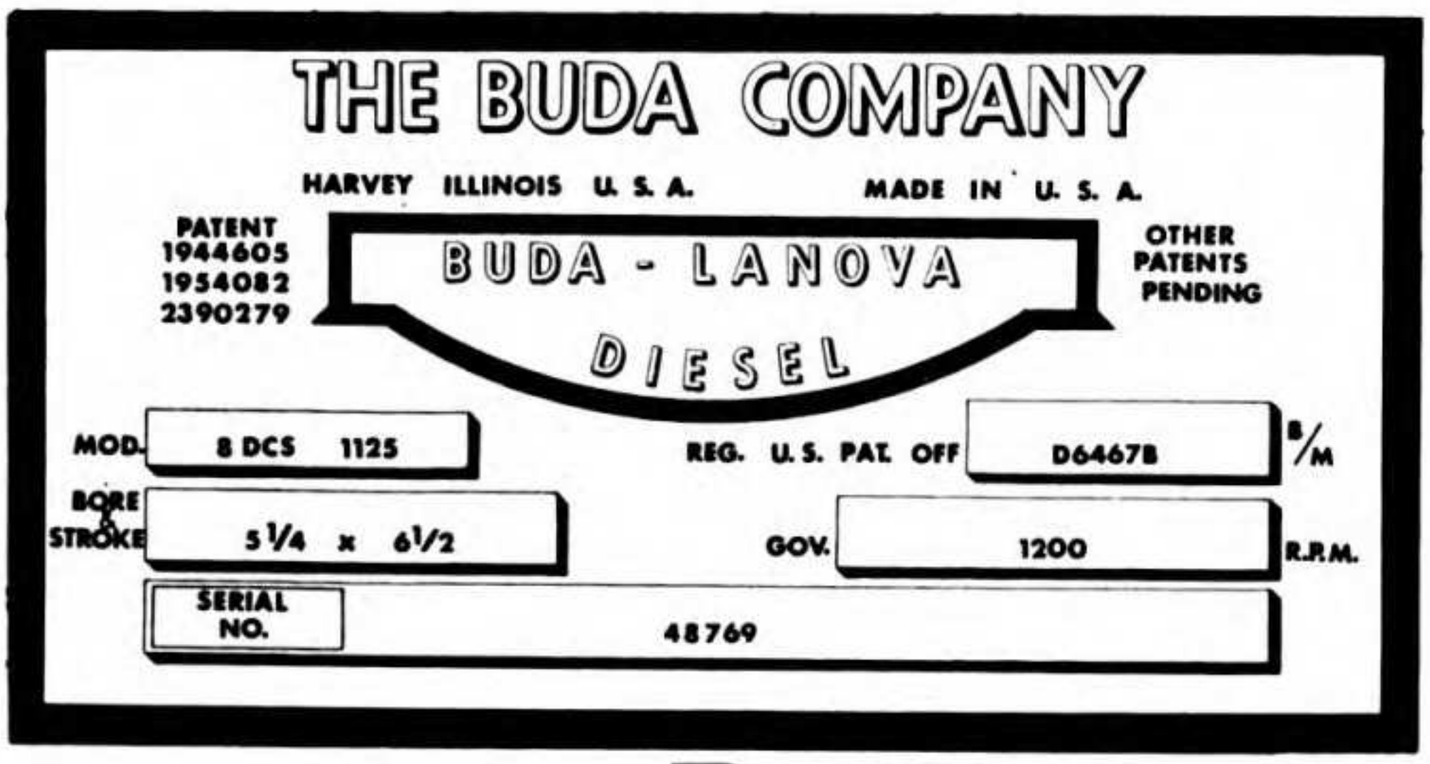


1 Left control panel door
2 Control panel brace
3 Control panel
4 Right control panel door
5 Fire extinguisher
6 Voltage regulator
7 Cover plate
8 Exciter
9 Generator
10 Screw, rd-hd, ¼ x ¾ NF (8 rqr)
11 Exciter field rheostat

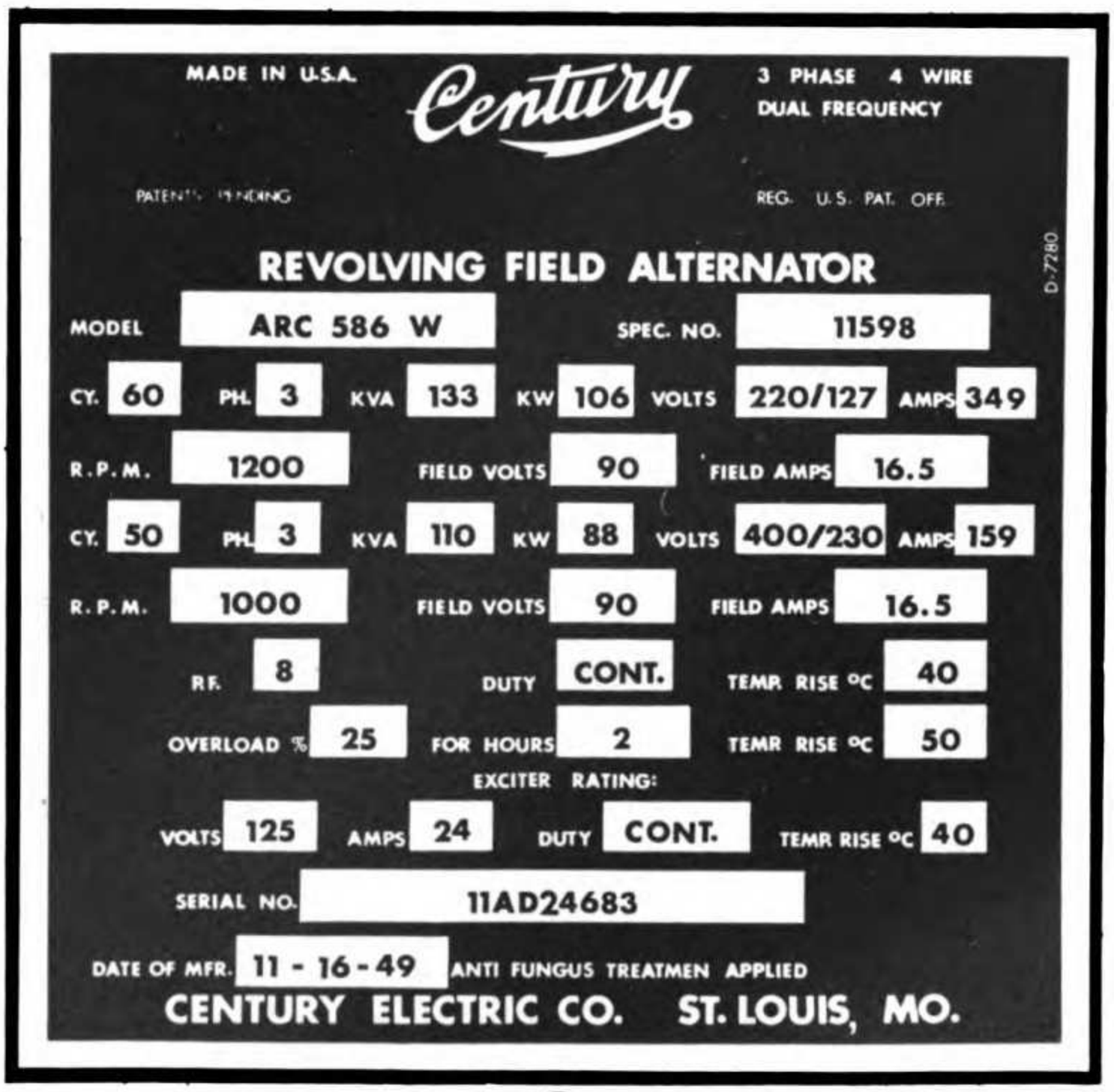
Figure 6. Control panel end of generator set.



A



B



C

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Figure 7. Identification plates.

THE BUDA COMPANY
HARVEY, ILLINOIS, U.S.A.
INSTRUCTIONS

TO PREPARE ENGINE FOR OPERATION:

Inspect all water, fuel, and wiring connections. Fill crankcase with the oils recommended below. Fill radiator with clean water or proper anti-freeze.

TO PREPARE GENERATOR FOR OPERATION (LOADING CONNECTIONS):

Check fuel system valves before starting engine. For external fuel tank, close two yellow painted valves and open two black valves. For internal fuel tank, close two black painted valves and open two yellow valves. Be sure circuit breaker is in "off" position. Prime fuel filter and inspection pump. For starting engine:

1. Push stop control clear in.
2. Release pump plunger by turning 1/4 to 1/2 counter-clockwise rotation. Operate pump with even strokes exerting approximately ten pounds pressure.
3. At the same time depress starter and heater switch buttons until engine starts.
4. Release starter and heater buttons.
5. After engine is started push plunger on pump all the way in and turn clockwise until spring catch engages.

Run engine without load until water temperature reaches 140 F.

OPERATION:

Push "stop" control full in - adjust throttle knob for 1200 RPM (60 cycle). Consult Instruction Manual for 50 cycle operation. Close circuit breaker to apply load. Oil pressure gauge should indicate 20 to 35 pounds. Water temperature should not exceed 200 F., oil temperature, 225 F. Under normal operating conditions side doors should be adjusted to maintain engine temperature between 160 F. to 180 F.

Maximum radiator temperature should not exceed below 5 F. below boiling point of coolant.

PARALLEL OPERATION:

1. Adjust voltage with regulator rheostat to about one volt higher than bus voltage.
2. Adjust speed until frequency is same as bus frequency.
3. Close paralleling switch and adjust governor until lights blink slowly.
4. When lights are dark close breaker.
5. Adjust governor until wattmeter reads proportional load with other units on the bus.
6. Adjust regulator rheostat until ammeters show minimum and proportional current with other units on the bus.

Make sure that voltage and current comparisons are made with phase switch pointers on the same phase as other units on the bus. Leave paralleling switch in "off" position.

LUBRICATION:

Every 8 hours of operation:
Change the oil in the air filter cup. Check crankcase oil level. If needed, add oil according to the following recommendations.
Temperatures below 20 F. - SAE-10, from 20 F. to 90 F.-SAE-30, over 90 F.-SAE-50.

Every 64 hours of operation:
Drain crankcase, injection pump sump and governor, and refill with oil according to above recommendations. Lubricate battery - charging generator with a few drops of SAE-10.

TO PREPARE UNIT FOR STORAGE:

Drain lubricating oil from crankcase, fuel injection pump, governor, and filters. Fill engine, pump and governor to normal level with rust preventative (Polar type) compound, Grade II. Disconnect fuel line to tank, drain fuel from filters and injection pump. Connect suction line to a supply of Grade II compound mixed half and half with fuel oil. Prime fuel system. Start engine and run for five minutes at low idle speed. Stop engine. Remove energy cell plugs - pour one ounce of rust preventative into each cylinder. Crank engine for 25 revolutions with throttle wide open. Reinstall energy cell plugs. Drain rust preventative. Brush a substantial quantity of rust preventative over the valve operating mechanism. Drain water from system. Leave drain plugs open. Coat starter mechanism and all unpainted parts with rust preventative compound (Polar type) Grade I. Cover and tape all openings.

CONSULT INSTRUCTION MANUAL FREQUENTLY.

D

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Figure 7—Continued.

generator set, specifies the model number, date manufactured, specification number and other pertinent data. The operating instruction plate (D) located on the center lower access door on the left side of the generator set, provides instructions for operating the equipment.

5. Differences in Models

This manual covers only the portable generator set model 8DCS–1125. No differences exist between any of the units bearing this model number.

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 (fig. 8).

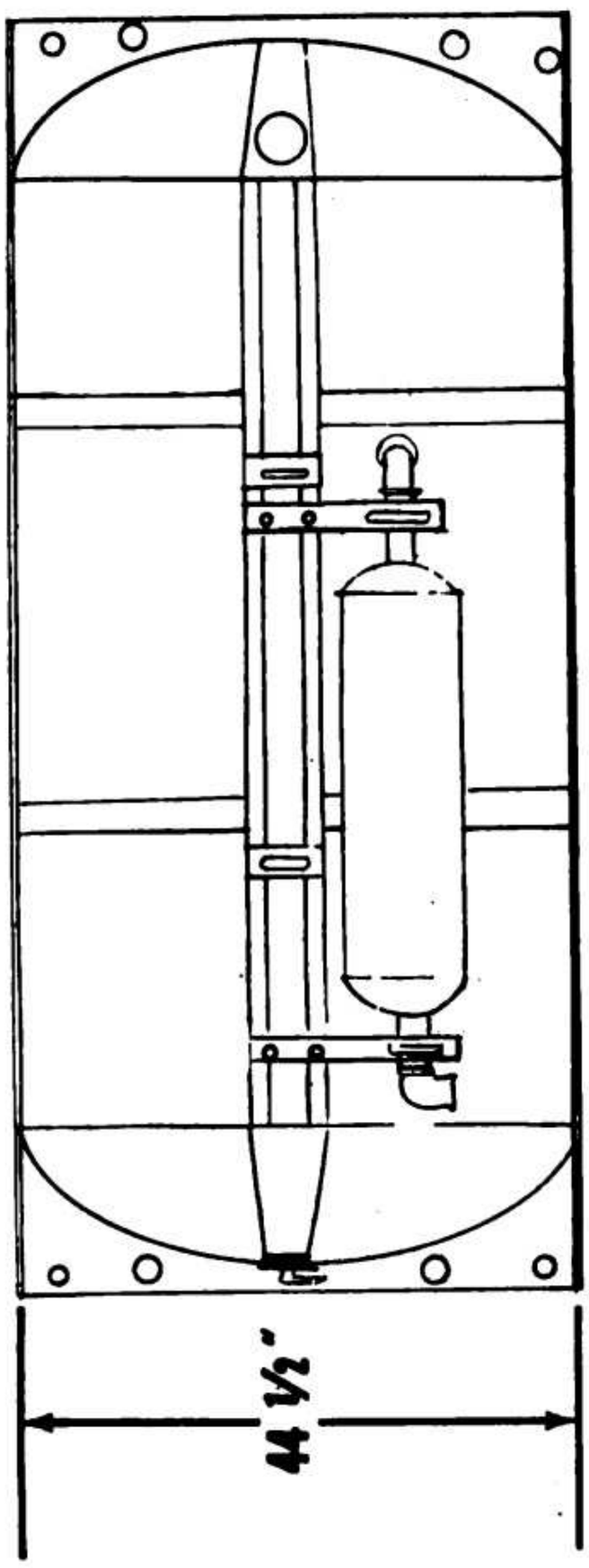
Manufacturer	Buda Company
Model	8DCS–1125
Length overall	154¼ in.
Width overall	44½ in.
Height overall	100 5/16 in.
Gross operating weight	12,576

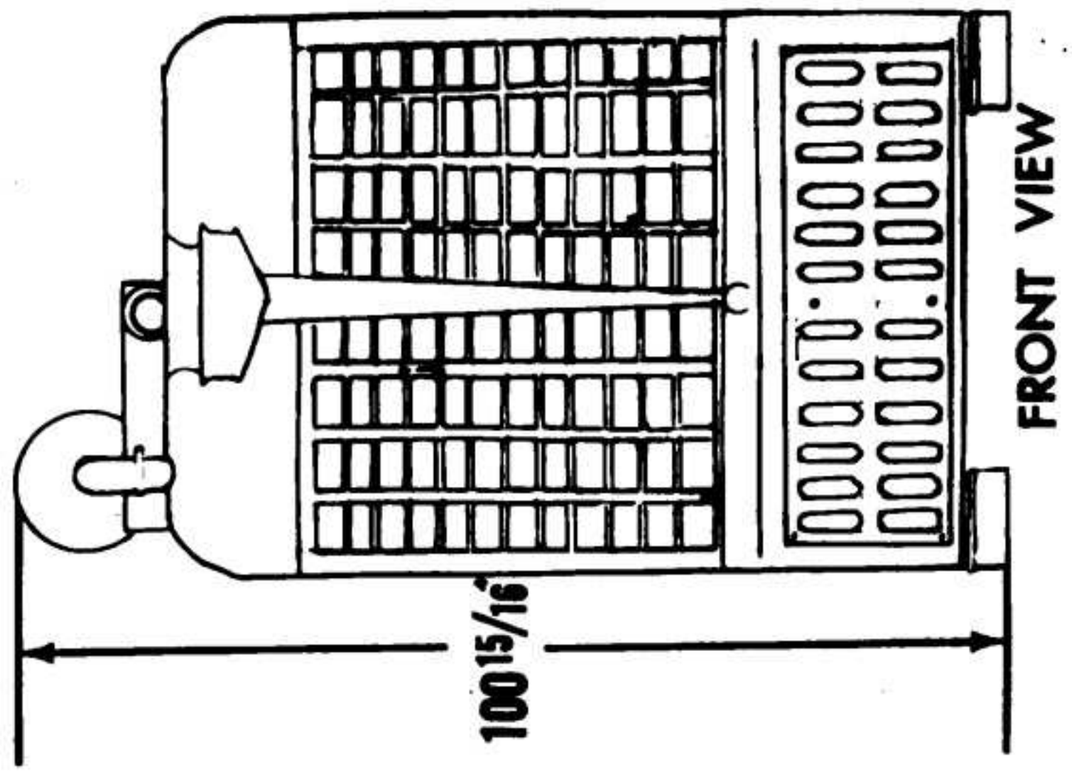
b. Engine.

Manufacturer	Buda Company
Model	8DCS–1125
Type	Four cycle, full diesel
Number of cylinders	8
Bore and stroke	5¼ in. x 6½ in.
Displacement	1,125 cu. in.
Brake horsepower at 1800 rpm	300
Rpm (governed speed)	1000/1200
Firing order	1–6–2–5–8–3–7–4
Number of main bearings	9
Cylinder sleeves	Wet
Lubrication	Full pressure
Cooling	Liquid
Cooling system capacity	15½ gal.
Crankcase oil capacity	7 gal.
Fuel tank capacity	90 gal.
Normal operating oil pressure	35 to 45 psi
Normal operating water temperature	165° to 190° F.
Intake and exhaust valve tappet clearance (hot)	.015 in.

c. Generator.

Manufacturer	Century Electric Company
Serial No.	11AD24683
Model	ARC–586–W
Rated speed, 60 cycle/50 cycle	1200/1000
Drive	Direct coupled





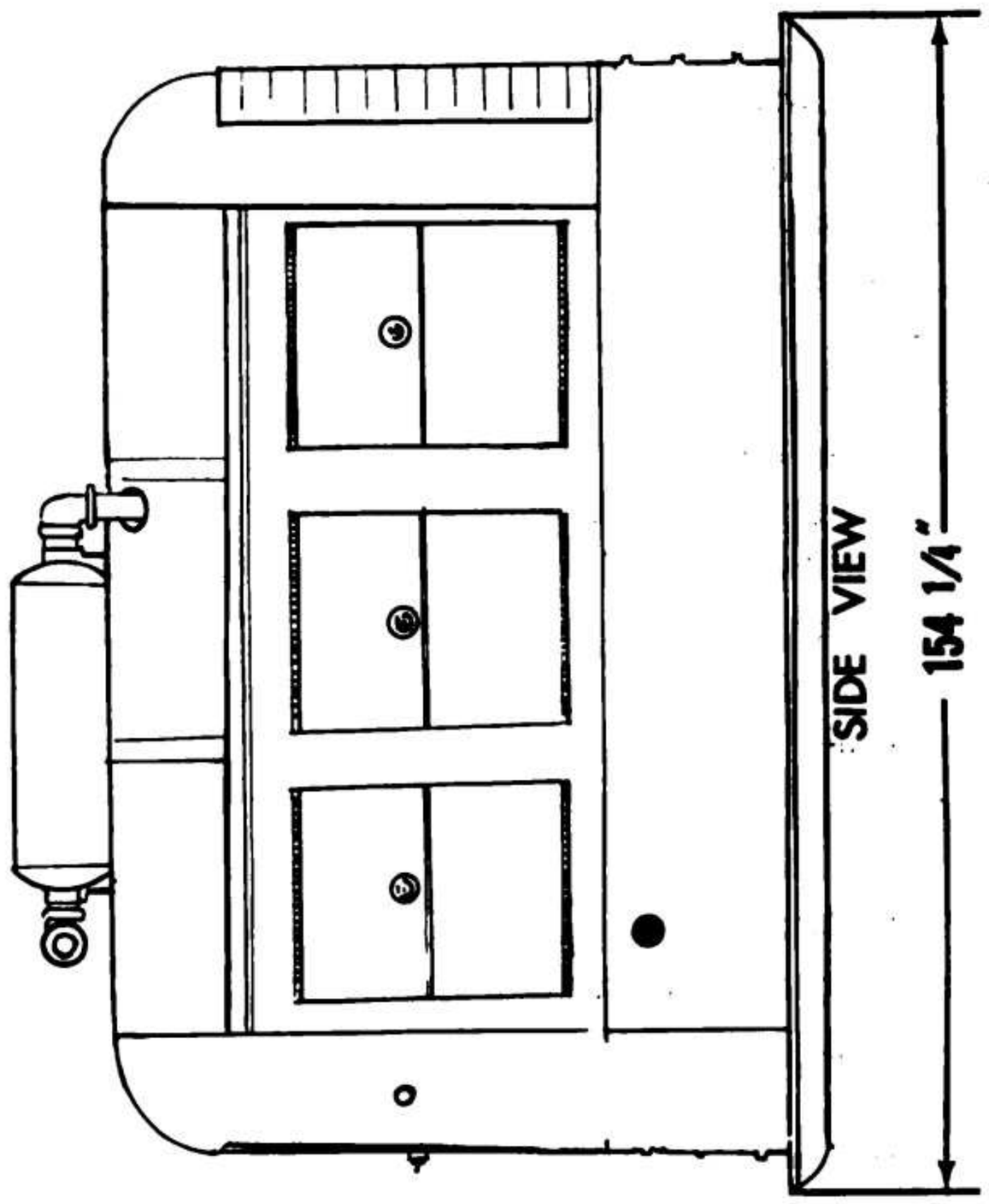


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Figure 8. Overall dimensions and foundation plan.

Number of phases	3
Rated KW 60 cycle/50 cycle	100–88
Power factor	0.8
Rated KVA, 60 cycle, 50 cycle	133/110
Volts, 60 cycle	127/220
Volts, 50 cycle	230/400
Amperes, full load, 60 cycle	349
Amperes, full load, 50 cycle	159
Temperature rise	40° c.
Number of bearings	1
Duty classification	Continuous
Method of cooling	Air cooled
Degree of inclosure	Dripproof-protected
Cycles	60/50

Exciter:

Type designation	DG–284–W
Rated KW	3
Voltage	125
Rated speed, 60 cycle/50 cycle	1200/1000
Amperes, full load	24
Temperature rise	40° c.
Duty classification	Continuous
Degree of inclosure	Dripproof-protected
Method of cooling	Air cooled

d. Accessories.

Starting motor:

Make	Delco Remy
Model	862
Serial No.	162
Volts	32
Number of brushes	12
Brush spring tension	36 to 40 oz.

Solenoid switch:

Make	Delco Remy
Model	1118178
Volts	32

Batteries:

Number	3
Make	Willard
Voltage per battery	12
Type	Lead storage

Blower:

Make	Supercharger Inc. (Div. of Bong Warner)
Model	F–4012
Serial No.	250

Air cleaner:

Make	Buda
Type	Oil bath

Overspeed governor:	
Make	**Pierce Governor Company**
Type	**MA–1431**
Engine speed governor:	
Make	**Pierce Governor Company**
Model	**MA–1623**
Fire extinguisher:	
Make	**Pyrene Mfg. Company**
Model	**B–2**
Capacity	**1 qt.**
Fuel injection pump:	
Make	**American Bosch**
Type	**APE8B–1100–2515A**
Rotation	**Clockwise**
Firing order	**1–6–2–5–8–3–7–4**
Fuel supply pump:	
Make	**American Bosch**
Fuel filters (primary and secondary):	
Make	**Commercial Filter Corp.**
Lubricating Oil filters:	
Make	**Military Standard**
Number	**4**
Capacity	**2 qts. each**
Replacement cartridge	**Fram c31–P2**
Cooling fan:	
Manufacturer	**Buda**
Diameter	**40 in.**
Number of blades	**8**
Thermostats (engine block):	
Manufacturer	**Detroit Lubricator Co.**
Type	**VD10102**
Opening temperature	**165° F.**
Number	**3**
Muffler:	
Manufacturer	**AP Muffler Corporation**
Model	**AP–6652**

e. Base Plan (fig. 8).

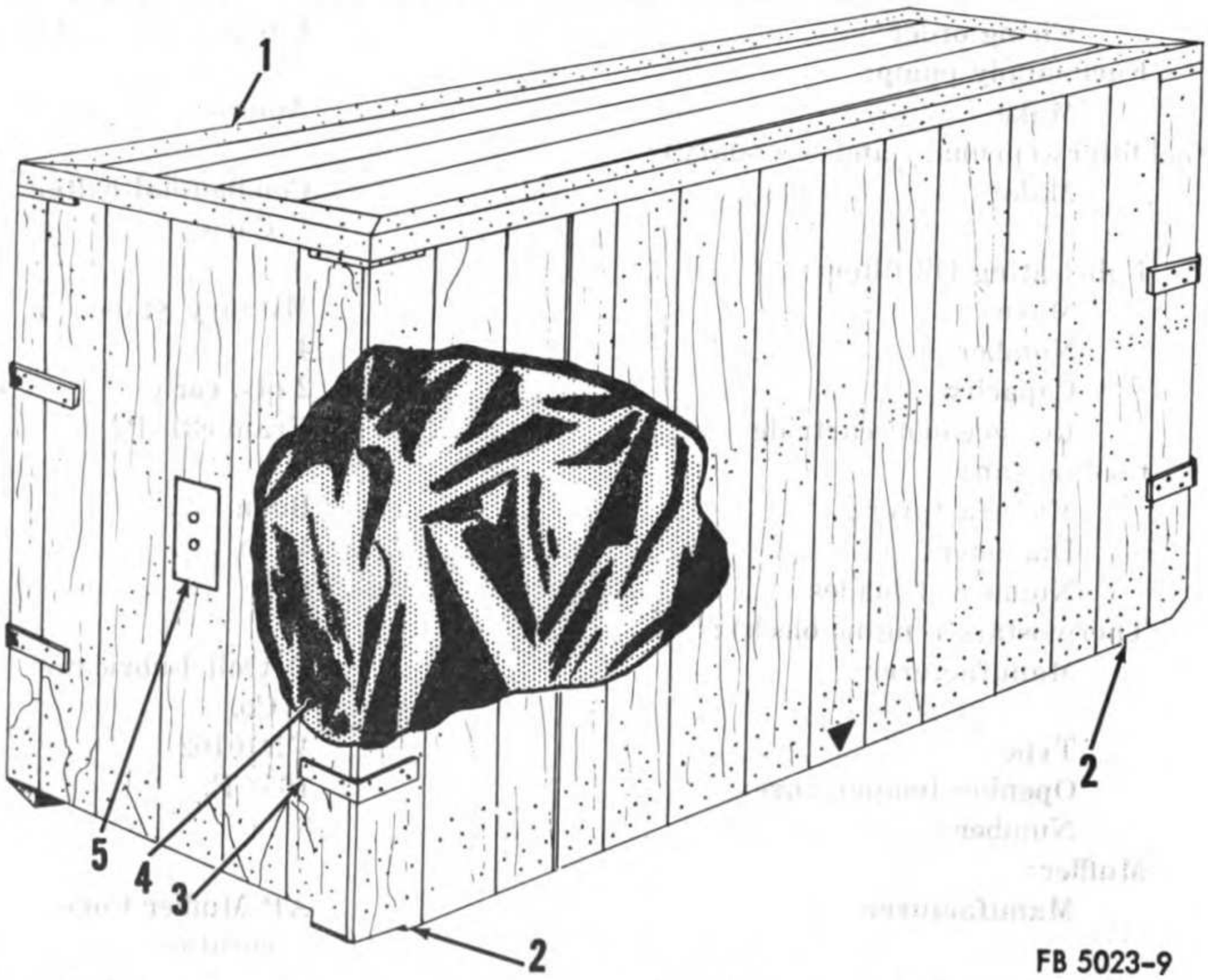
(1) *General.* This unit is designed for field use without the need of a foundation or shelter. The unit should be leveled as nearly as possible, but it will operate satisfactorily at an angle of 15° with the horizontal. The subbase is drilled with $^{15}/_{16}$-inch holes at each end of the four corners to facilitate bolting to a concrete or wooden platform.

CHAPTER 2
OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

7. New Equipment

a. General (fig. 9). New generator sets that are processed and boxed for either domestic or overseas shipment require certain services before the unit can be placed in operation.



1 Packing case top
2 Sling points
3 Brace
4 Moisture vaporproof bag
5 Hydrotector terminals

Figure 9. Generator set crated, cutaway view.

Caution: Before attempting to unload the generator set, be sure that the lifting equipment has a lifting capacity of not less than 15,280 pounds.

b. Unloading. Place a sling around each end of the crate at the sling points (2). Attach the lifting device through the slings and directly in the center of the crate.

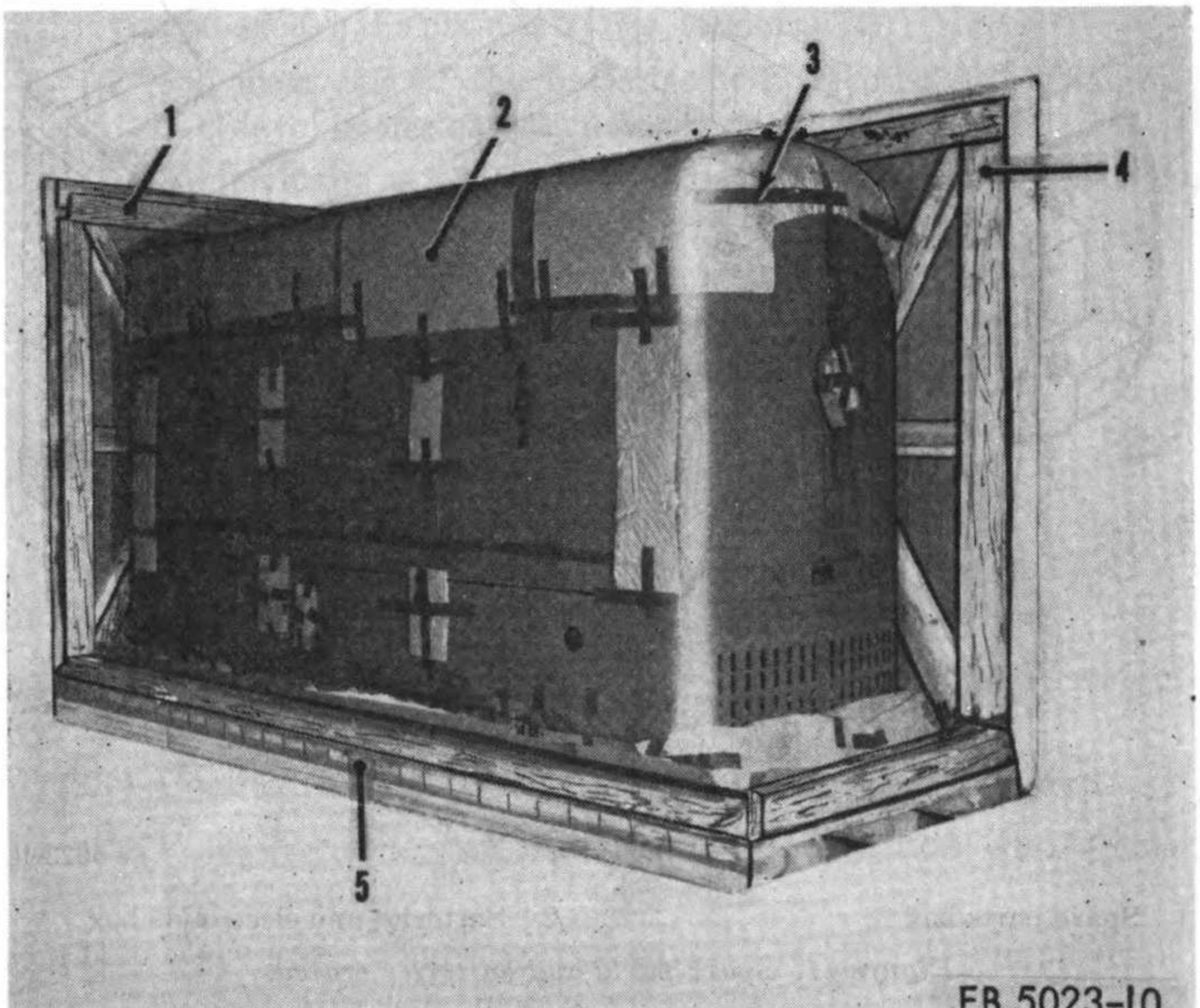
c. Uncrating.

(1) Disassemble the crate as near as possible to its operating location.

(2) Remove the braces.

(3) Use a nail puller and pry-bar to remove the top (1, fig. 9). Be careful not to pry against the generator.

(4) Remove the ends (1, fig. 10) and sides (4) as a unit.



1 Packing case end
2 Kraft paper
3 Preservative tape
4 Packing case side
5 Packing case platform

Figure 10. Generator set, partially uncrated.

(5) Remove the tape (3) and paper (2) from the generator set.

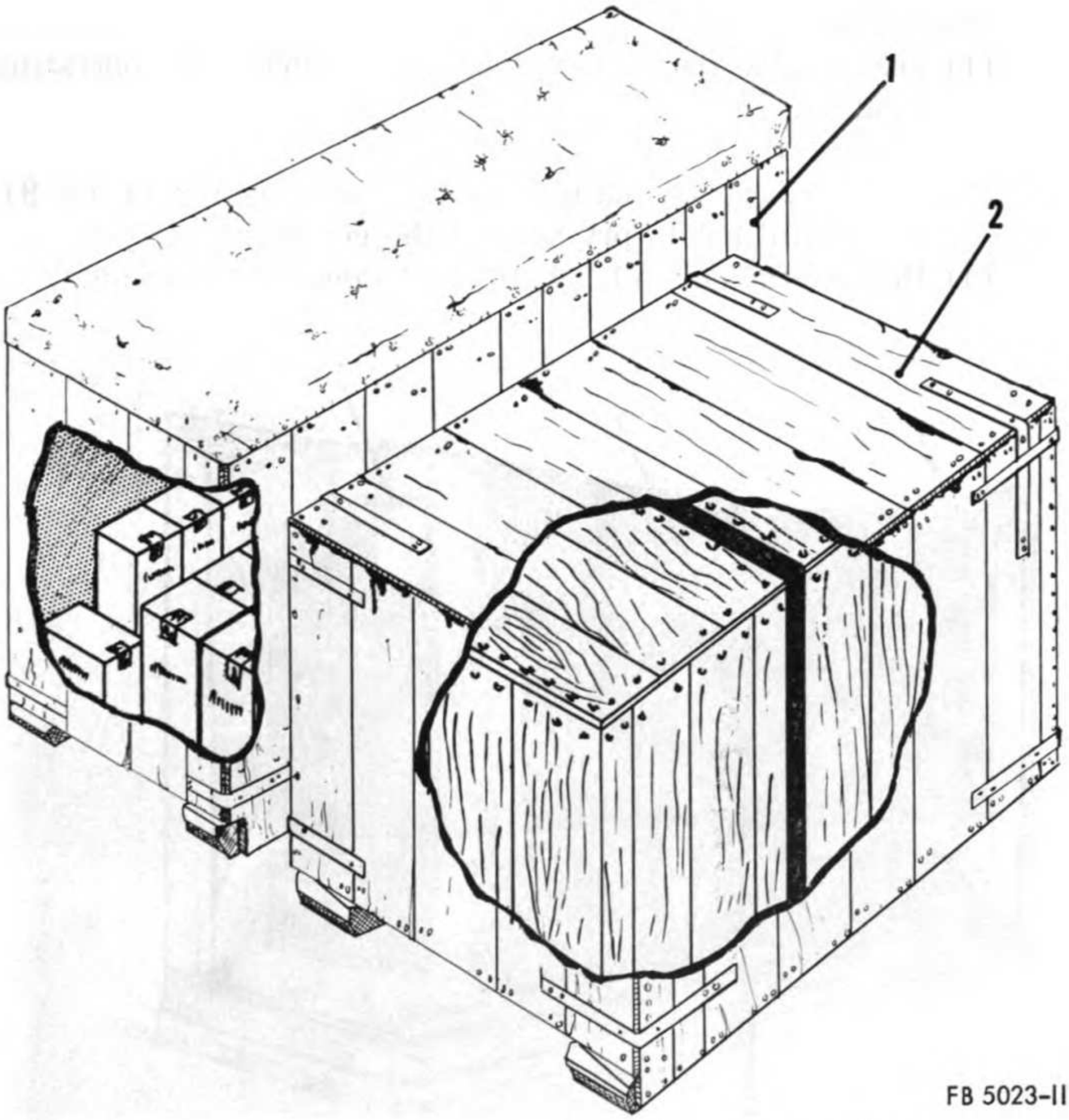
(6) Remove the two nuts on each side of the skid base.

(7) The lifting eyes (3, fig. 3) are stowed in the compartment (7, fig. 4).

(8) Install the lifting eyes (3, fig. 3) and secure with lockwashers and nuts.

(9) Attach a sling through the two lifting eyes (3) and remove the generator set from the platform (5, fig. 10).

(10) Unpack the spare parts box (1, fig. 11) and batteries and electrolyte box (2) in a similar manner.



1 Spare parts box

2 Batteries and electrolyte box

Figure 11. Spare parts and batteries crated.

d. Removal of Preservatives and Protective Devices.

(1) Open the access doors (5, fig. 3) on both sides of the generator set, and remove the bags of silica-gel desiccant (7, fig. 2).

(2) Remove the strap (1) from around the generator terminal box.

(3) Remove the preservative tape (3) from the air cleaner.

(4) Remove the preservative tape from the crankcase fill cap (8, fig. 3), radiator overflow tube (11), and the fuel tank cap (12).

e. Assembling.

(1) Loosen the four nuts and bolts on the exhaust outlet flange (2, fig. 4). Install the exhaust pipe and tighten the four nuts and bolts.

(2) Install an elbow (3, fig. 1) on the exhaust pipe.

(3) Secure the muffler (5) to the elbow by turning the muffler in a clockwise direction.

(4) Place a support (2) under the outlet pipe and inlet pipe at each end of the muffler. Secure the supports (2) to the top panel (1) with the two capscrews and nuts.

(5) Install a muffler clamp (4) at each end of the muffler (5), and secure the clamps to the supports (2).

(6) Fill each cell of the batteries with electrolyte. The correct level is one-half inch above the plates.

(7) Remove the six screws (15, fig. 5) and lift off the battery access cover (14).

(8) Remove the capscrew (5, fig. 12) from each end of the battery holddown (1), and lift off the battery holddown.

(9) Install the batteries (6) with the positive (+) posts toward the left side of the generator set.

(10) Place the ground cable (2) on the positive (+) post of the first battery. Place the jumper cables (3) in series, negative (—) to positive (+). Place the battery to solenoid cable (4) on the negative (—) post of the third battery, and tighten all terminal bolts.

(11) Coat the terminals with a light coat of chassis grease.

(12) Place the battery holddown (1) in position, and secure with a capscrew (5) at each end.

(13) Place the battery access cover (14, fig. 5) in position, and secure with the six screws (15).

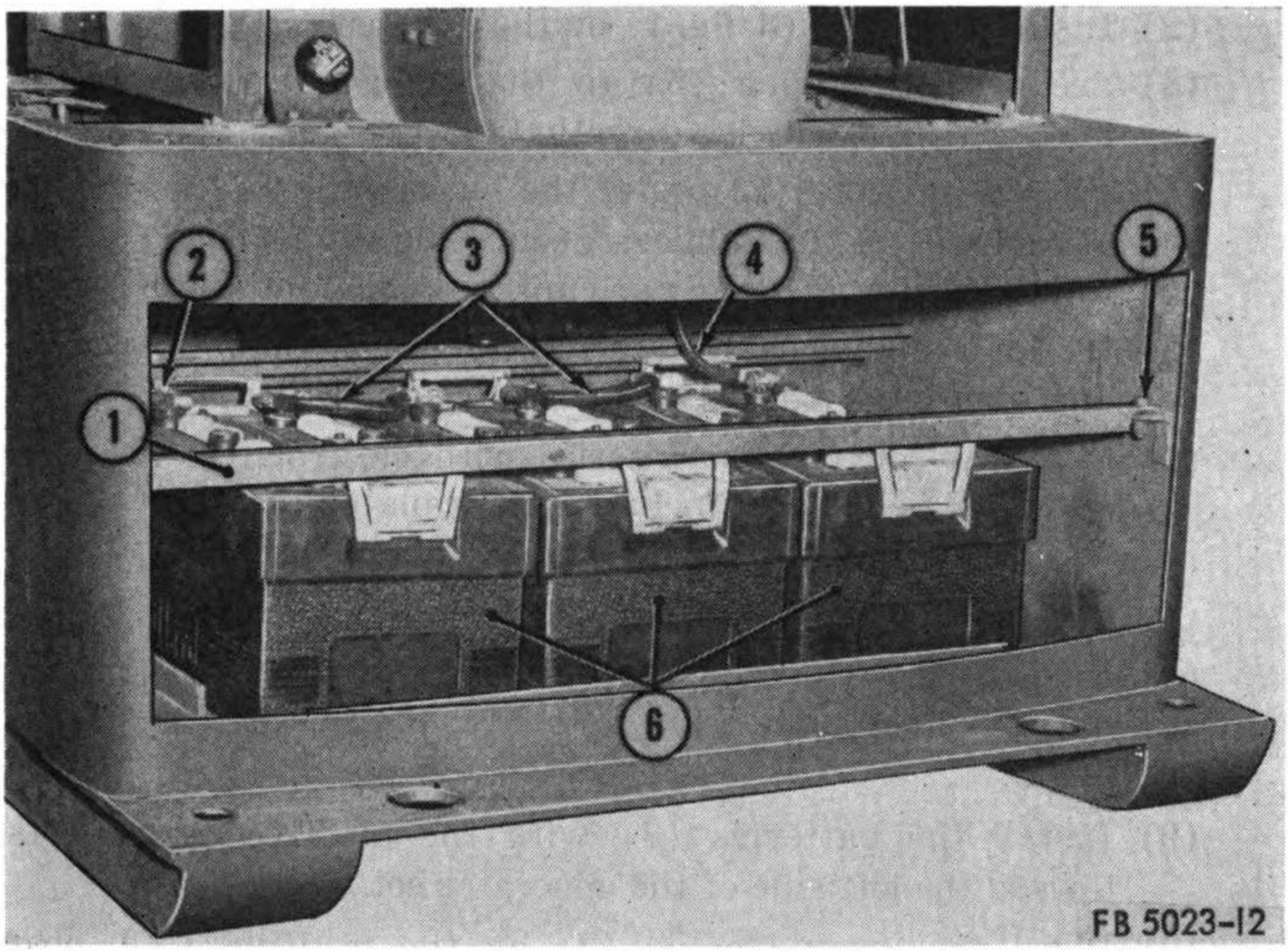
f. Inspection. Make a complete visual inspection of the generator set to determine any loss or damage which might have occurred during shipment.

(1) *Engine.*

(*a*) *Fuel system* (fig. 3). Utilize the fuel diagram (9) to check all connections for tightness and damage.

(*b*) *Cooling system* (fig. 5). Inspect the fan guard (5) to see that the fan clears. Check the fan and supercharger belts for proper tension. See that the belts can be deflected, without undue pressure, 1 to 1¼-inch midway between the pulleys. Inspect all hose connections for tightness. Close the draincock (8).

(*c*) *Lubrication system.* Inspect all external lines, fittings, and connections for tightness.



1	Battery holddown	4	Battery to solenoid cable
2	Ground cable	5	Capscrew, ⅜ x 1¼ NC (2 rqr)
3	Jumper cables	6	Batteries

Figure 12. Batteries, installed.

(*d*) *Electrical system.* Check all wiring and connections for damage and tightness.

(*e*) *Controls and instruments* (fig. 6). Check all engine controls and instruments on the control panel (3). See that the instruments are not damaged and all controls are connected.

(2) *Generator.*

(*a*) *Electrical connections.* Inspect all wiring and connections for tightness. See that the fuses are secure in their holders.

(*b*) *Controls and instruments* (fig. 6). Inspect all generator controls and instruments on the control panel (3). Check for instrument damage and tight connections.

g. Service.

(1) Lubricate the generator set in accordance with instructions in paragraphs 30 and 31.

(2) Perform the before-operation services (par. 34).

(3) Remove the rocker arm covers (par. 97*b*(1)) and lubricate the valve stems with a mixture of 50 percent diesel and 50 percent lubricating oil. Do not over lubricate.

(4) Check the valve clearance. When the engine is cold, the intake valves should be set at 0.018 and exhaust valves 0.020. Install rocker arm covers (par. 97*g*(a)).

(5) Remove the fuel tank cap (12, fig. 3) and fill the tank with diesel fuel.

(6) Fill the radiator at the radiator fill cap (1) with the proper coolant.

(7) Make sure that the fire extinguisher (5, fig. 6) is full.

h. Installation.

(1) *General.* Whenever possible, avoid sandy, muddy, or generally dirty locations; dirt and moisture will shorten the life of all moving parts.

(2) *Indoor installation.* When the unit is to be operated within a building or vehicle, pipe the exhaust to the outside using as few bends as possible in the exhaust line. Make certain that there is adequate ventilation to provide an ample supply of oxygen. All exhaust connections must be gas tight. Provide at least two feet of space on all sides of the generator set.

(3) *Leveling.* Level the unit every time a new installation is made. The set is designed to operate satisfactorily at an angle of up to 15° from level.

(4) *Ground connections.* Connect the frame or base of the generator set to a low resistance ground, such as a pipe or rod driven into the ground. The ground cable should be large enough so that it will not fuse under a sustained short circuit between line and ground. The ground connection should be as short as conditions permit to minimize radiation of RF (radio frequency) waves. The ground rod or pipe must be driven into the ground to a depth of not less than eight feet and must be at least five-eighths inch in diameter.

i. Generator Connections (fig. 13).

Caution: Do not make any connections or changes until the circuit breaker has been placed in the OFF position and the engine stopped.

(1) The generator set is shipped from the factory connected for 127/220-volt, 60-cycle operation. The connections inside the generator terminal box (2, fig. 5) are as shown in A, figure 13. The terminal block (16, fig. 5) is connected at lettered terminals as shown in C, figure 13*c*.

(2) To connect the unit for 50-cycle, 230/400-volt operation, change the links on the terminal board located inside

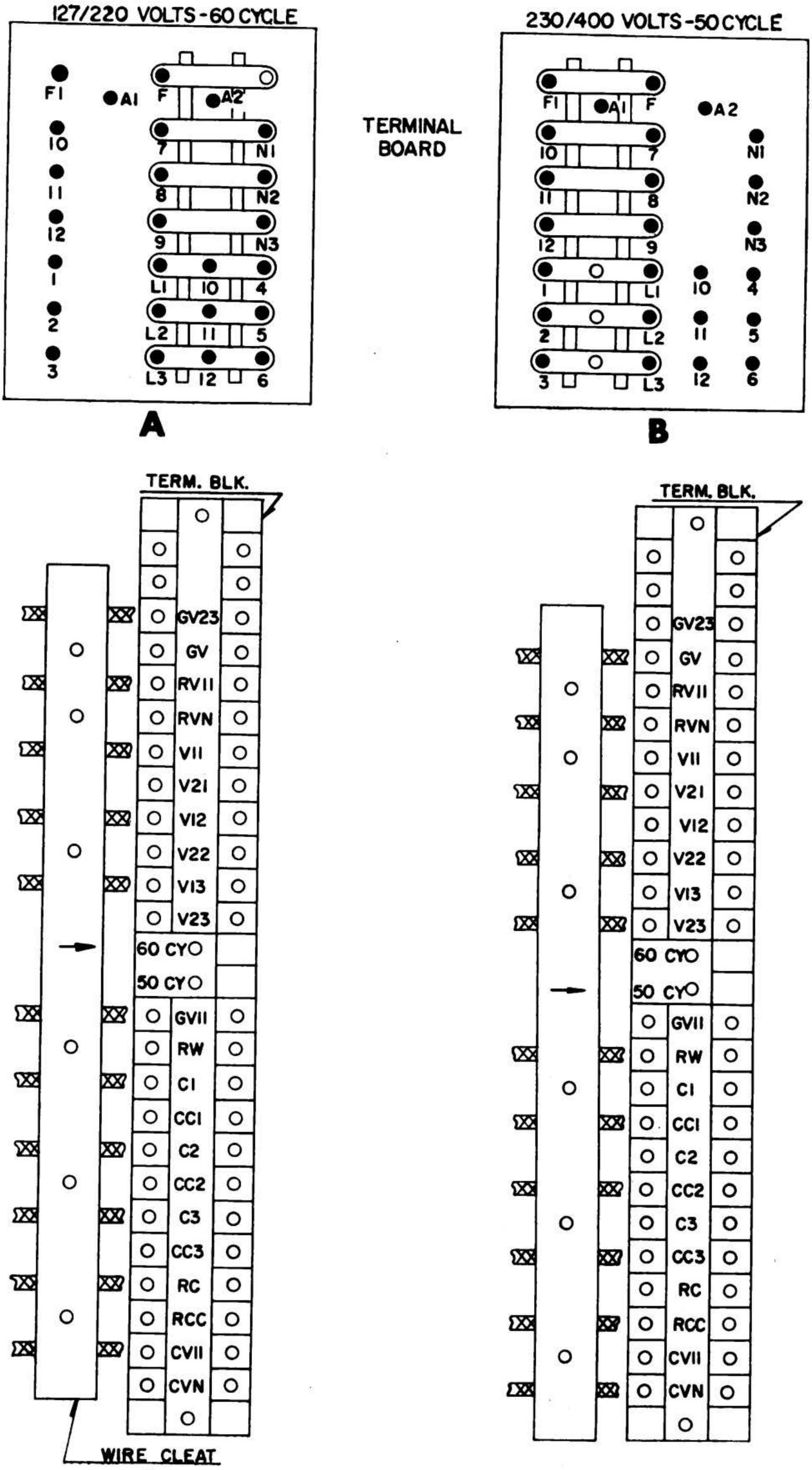


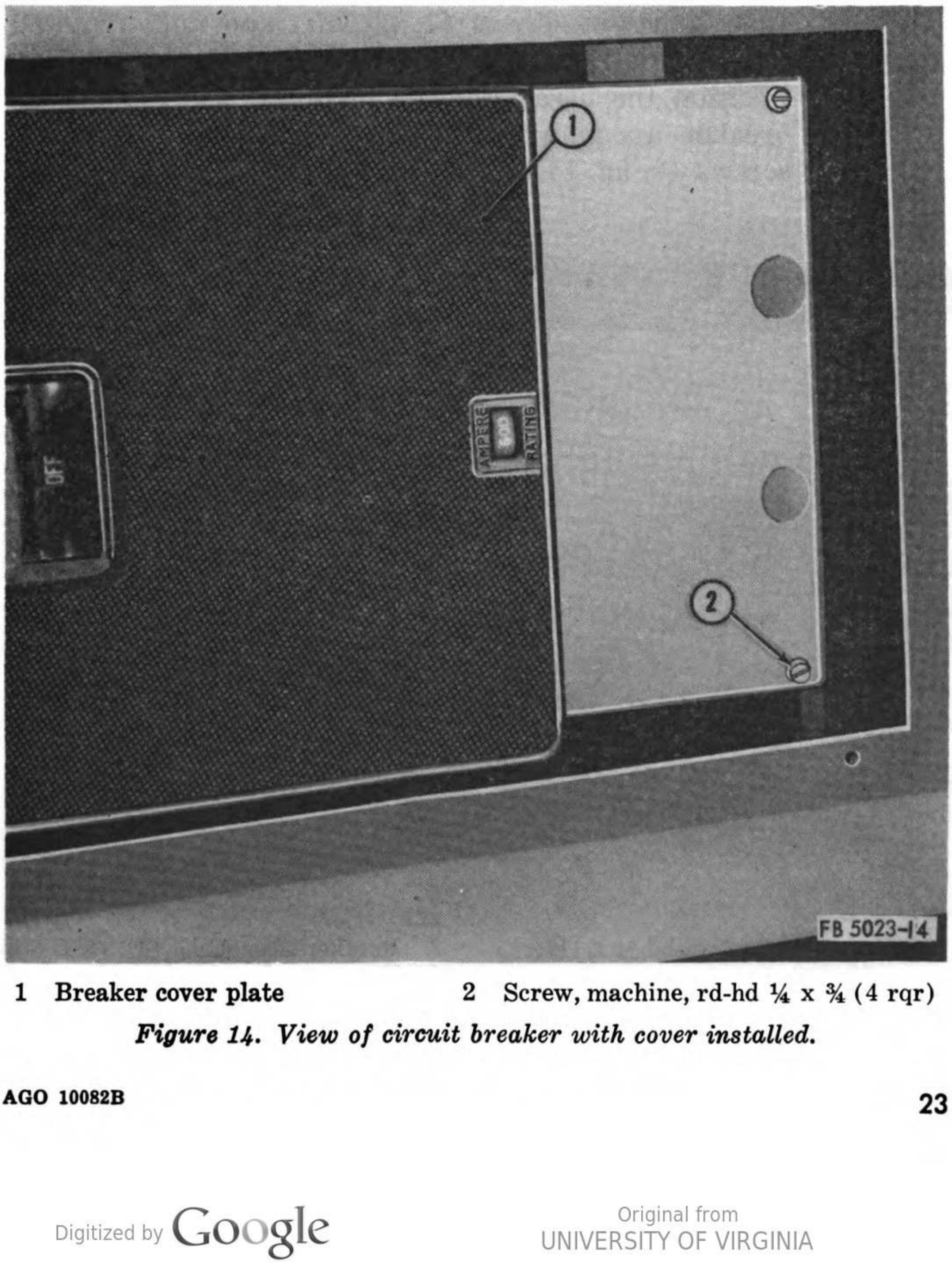
Figure 13. Generator connections.

A—Terminal board connections for 127/220-volt, 60-cycle operation.
B—Terminal board connections for 230/400-volt, 50-cycle operation.
C—Terminal block connections for 127/220-volt, 60-cycle operation.
D—Terminal block connections for 230/400-volt, operation.

Figure 13—Continued.

the generator terminal box (2, fig. 5) to conform to the changeover diagram plate (2, fig. 2), or see B, figure 13. Change the wires on the terminal block (16, fig. 5) to conform to D, figure 13. Make sure all connections are tight.

(3) To complete the changeover from 60-cycle to 50-cycle operation, it will be necessary to remove the 600A tripper assembly in the circuit breaker and install the spare 275A tripper which is mounted on the angle brace at the rear of the control panel.



1 Breaker cover plate
2 Screw, machine, rd-hd ¼ x ¾ (4 rqr)

Figure 14. View of circuit breaker with cover installed.

(*a*) Remove the eight screws (10, fig. 6) from the cover plate (7), and remove the plate.

(*b*) Remove the two screws (2, fig. 14) from each end of the breaker cover plate (1). Remove the plate.

(*c*) Remove the six screws (1, fig. 15) and six nuts (5). Raise the tripper assembly (2) slightly to disengage the tripper from the breaker assembly (3) and remove the tripper assembly.

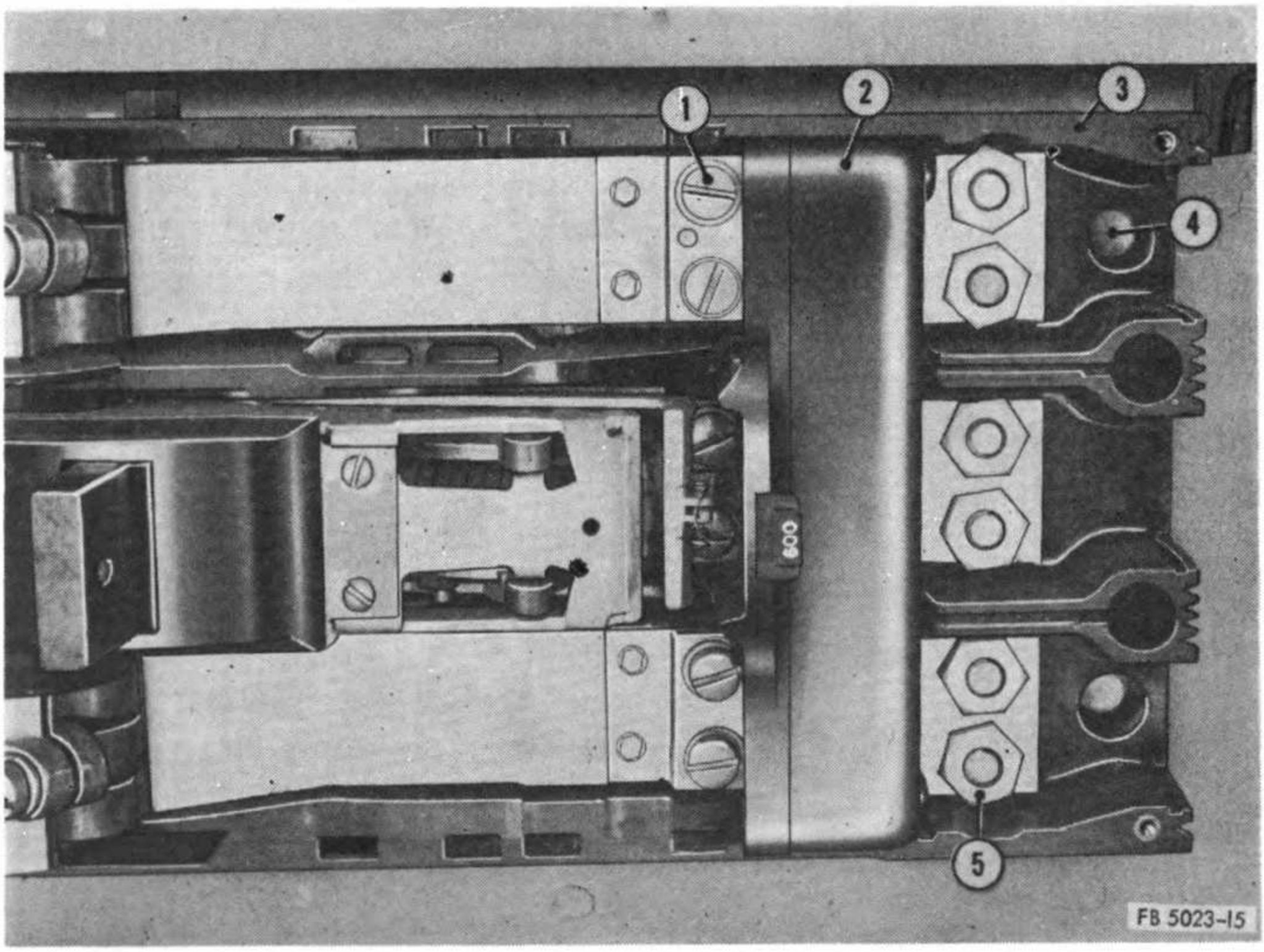
(*d*) Remove the two bolts and nuts securing the 275A tripper assembly (4, fig. 3) to the angle brace at the rear of the control panel, and remove the tripper assembly.

(*e*) Position the unused 600A tripper assembly to the angle brace and secure with the two bolts and nuts.

(*f*) Place the 275A tripper assembly in position in the breaker assembly (3, fig. 15).

(*g*) Install the six screws (1, fig. 15) and nuts (5) and tighten progressively.

(*h*) Position the breaker cover plate (1, fig. 14) on the breaker assembly (3, fig. 15) and secure with the screws (2, fig. 14).



1 Screw, machine, rd-hd ¼ x 1¼ (6 rqr)
2 Tripper assembly
3 Breaker assembly
4 Capscrew, ⅜ x 1¼ NF (4 rqr)
5 Nut, hex, ½ NC (6 rqr)

Figure 15. View of circuit breaker with cover removed.

(*i*) Place the cover plate (7, fig. 6) in position, and install the eight screws (10) and tighten.

8. Used Equipment

Used equipment is prepared, processed, and packaged in the same manner as new equipment. Therefore, the instructions in paragraph 7 apply to used equipment as well as new equipment.

Section II. CONTROLS AND INSTRUMENTS

9. General

(fig. 16)

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. All controls and instruments are located on the control panel. To turn on the panel lights (2) throw the panel light switch (10) to the ON position.

10. Engine Controls

a. Starter Switch (fig. 16).

(1) *Description.* The starter switch (18) is a push button switch. When pressed in, it closes the electrical circuit from the batteries to the starting motor to crank the engine.

(2) *Location.* The starter switch is mounted on the lower left side of the control panel below the oil temperature gage.

(3) *Purpose.* It is used to start the engine.

b. Throttle Control Knob (fig. 16).

(1) *Description.* The throttle control knob (16) is a cast T-shaped knob.

(2) *Location.* The throttle control knob is located at the lower left side of the control panel.

(3) *Purpose.* It controls the speed of the engine. Turning the knob clockwise increases the speed of the engine.

c. Engine Stop Knob (fig. 16).

(1) *Description.* The engine stop knob (17) is a cast T-shaped knob.

(2) *Location.* The engine stop knob is located at the lower left side of the control panel above the throttle control knob.

(3) *Purpose.* It is used to stop the engine. Pulling and holding the knob out will stop the engine.

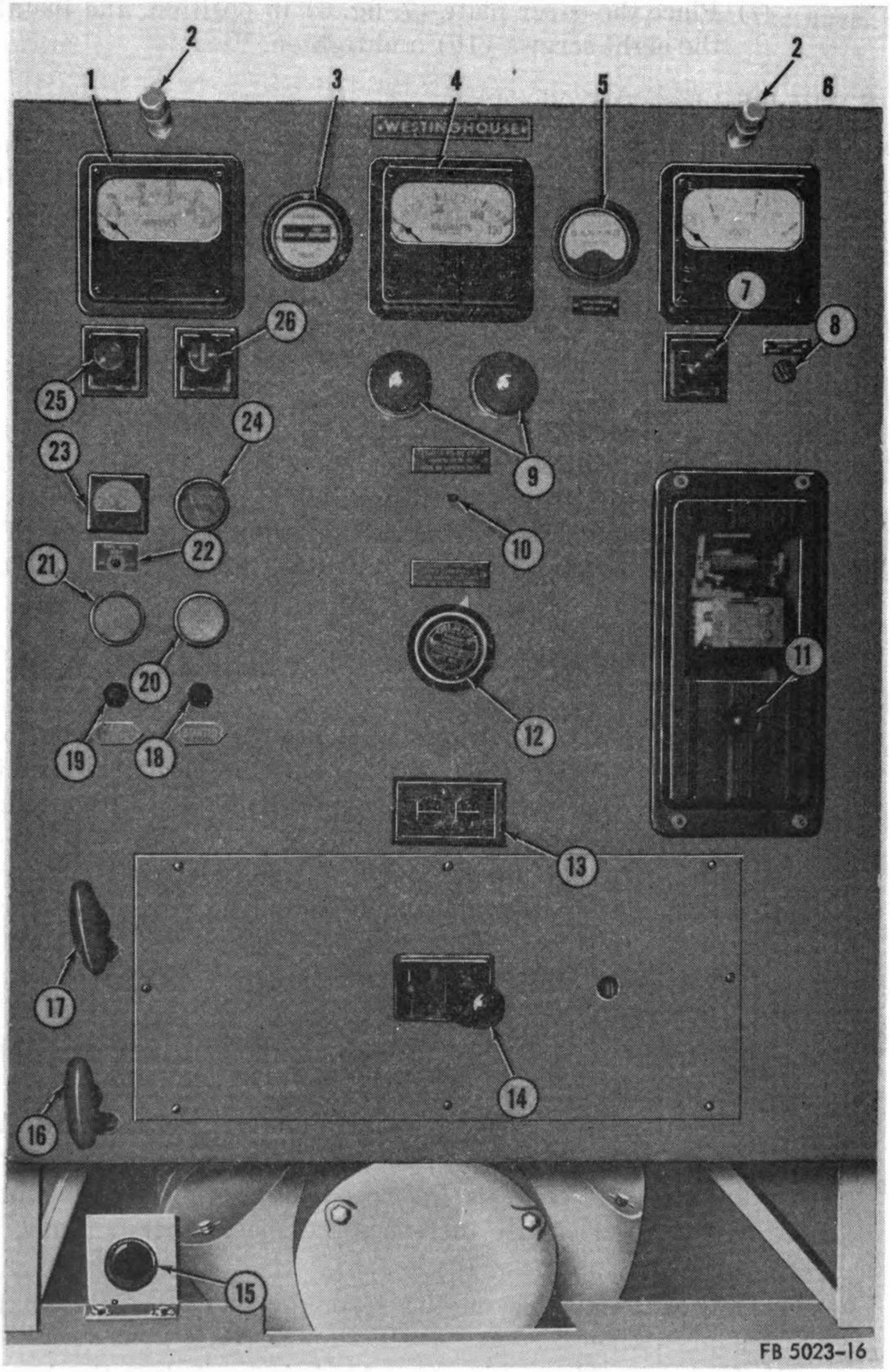


Figure 16. Control panel.

1	AC ammeter	14	Circuit breaker
2	Panel lights	15	Air heater pump
3	Frequency meter	16	Throttle control knob
4	Wattmeter	17	Engine stop knob
5	Hourmeter	18	Starter switch
6	Voltmeter	19	Air heater switch
7	Voltmeter switch	20	Oil temperature gage
8	Voltage regulator switch	21	Oil pressure gage
9	Synchronizing lights	22	Battery charge switch
10	Panel light switch	23	Battery charging ammeter
11	Voltage regulator rheostat	24	Water temperature gage
12	Exciter field rheostat	25	Ammeter switch
13	120-volt receptacle	26	Synchronizing switch

Figure 16—Continued.

d. Air Heater Switch (fig. 16).

(1) *Description.* The air heater switch (19) is a push button switch. When pressed in, it closes the electrical circuit from the batteries to the porcelain electrode in the air heater, mounted on the air intake manifold.

(2) *Location.* The air heater switch is mounted on the lower left side of the control panel below the oil pressure gage.

(3) *Purpose.* It works in conjunction with the air heater to preheat the ingoing charge of air to the cylinders to insure easy starting in cold weather.

e. Air Heater Pump (fig. 16).

(1) *Description.* The air heater pump (15) is a single-plunger hand-operated pressure pump. The suction side of the pump is connected directly to the main fuel tank.

(2) *Location.* The air heater pump is mounted on the subbase just below the control panel on the left side.

(3) *Purpose.* The pump supplies fuel under pressure to the air heater burner unit discharge nozzle. The pump plunger, when not in use, is held in the IN position by a lock mechanism which can be released by pulling hand knob out.

f. Battery Charge Switch (fig. 16).

(1) *Description.* The battery charge switch (22) is a three position toggle switch. Throw the switch to HI when a high rate of charge is needed. Throw the switch to LO when a low rate of charge is needed. The switch should be in the off position when the batteries are fully charged.

(2) *Location.* The battery charge switch is mounted on the left center portion of the control panel.

(3) *Purpose.* It works in conjunction with the solenium rectifier to keep the batteries fully charged.

11. Engine Instruments

a. Battery Charging Ammeter (fig. 16).

(1) *Description.* The battery charging ammeter (23) is a single scale meter. It is calibrated from 0 to 3 amperes.

(2) *Location.* The battery charging ammeter is mounted on the left center of the control panel, below the ac ammeter switch (25).

(3) *Purpose.* It indicates the amount of current being charged into the batteries.

(4) *Readings.* When the battery charge switch (22) is in HI position, a maximum charge of 2 to 3 amperes is being supplied to the batteries. On the LO position, a maximum charge of ½ to 1 ampere is being supplied to the batteries.

b. Water Temperature Gage (fig. 16).

(1) *Description.* The water temperature gage (24) is a single scale gage. It is calibrated from 100° to 220° F.

(2) *Location.* The water temperature gage is mounted on the left center of the control panel, just above the oil temperature gage.

(3) *Purpose.* It indicates the engine coolant temperature.

(4) *Readings.* Under normal operating conditions, the gage should read between 165° to 190° F.

c. Oil Temperature Gage (fig. 16).

(1) *Description.* The oil temperature gage (20) is a single scale gage. It is calibrated from 100° to 350° F.

(2) *Location.* The oil temperature gage is mounted on the lower left of the control panel just above the starter switch.

(3) *Purpose.* It indicates the temperature of the engine lubricating oil.

(4) *Readings.* Under normal operating conditions, the gage should read between 225° to 230° F.

d. Oil Pressure Gage (fig. 16).

(1) *Description.* The oil pressure gage (21) is a single scale gage. It is calibrated from 0 to 50 psi.

(2) *Location.* The oil pressure gage is mounted on the left center of the control panel just above the air heater switch.

(3) *Purpose.* The oil pressure gage indicates whether or not the proper amount of oil pressure is being delivered to the internal parts of the engine.

(4) *Readings.* Under normal operating conditions, the gage should read between 35 and 45 psi pressure, with oil of the recommended viscosity.

12. Generator Controls

a. Ammeter Switch (fig. 16).

(1) *Description.* The ammeter switch (25) is a four-position switch; OFF, 1, 2, and 3. The output terminal designations are marked on the switch plate.

(2) *Location.* The ammeter switch is mounted on the upper left of the control panel just below the ac ammeter.

(3) *Purpose.* The ammeter switch connects the ac ammeter to permit the reading of phase currents at the output terminals.

b. Voltmeter Switch (fig. 16).

(1) *Description.* The voltmeter switch (7) is a six-position switch; OFF, 1, 2, 3, 4, 5, and 6. The output terminal designations are marked on the switch plate.

(2) *Location.* The voltmeter switch is mounted on the upper left right of the control panel just below the voltmeter.

(3) *Purpose.* The voltmeter switch connects the voltmeter to permit the reading of phase voltage at the output terminals. Switch position 1 gives voltage across L1 to N. Switch position 2 gives voltage across L2 to N. Switch position 3 gives voltage across L3 to N. Switch position 4 gives voltage across L1 and L2. Switch position 5 gives voltage across L2 and L3. Switch position 6 gives voltage across L3 and L1.

c. Voltage Regulator Switch (fig. 16).

(1) *Description.* The voltage regulator switch (8) is a two-position switch; AUTOMATIC and MANUAL.

(2) *Location.* The voltage regulator switch is mounted on the upper right of the control panel just opposite the voltmeter switch.

(3) *Purpose.* The voltage regulator switch is used to select either AUTOMATIC or MANUAL operation of the voltage regulator.

d. Synchronizing Switch (fig. 16).

(1) *Description.* The synchronizing switch (26) is a two-position rotary-type switch.

(2) *Location.* The synchronizing switch and its associated lights (9) are used only when it is necessary to synchronize two units for parallel operation.

e. Synchronizing Lights (fig. 16).

(1) *Description.* The synchronizing lights (9) are inside-frosted, vibration-service, 25-watt, 120-volt bulbs.

(2) *Location.* The synchronizing lights are mounted at the upper center of the control panel just above the panel light switch.

(3) *Purpose.* The synchronizing lights and their associated switch are used only when it is necessary to synchronize two units or more for parallel operation.

f. Exciter Field Rheostat (fig. 16).

(1) *Description.* The exciter field rheostat (12) is a manually-controlled variable resistor that is placed in series with the exciter field.

(2) *Location.* The exciter field rheostat is mounted in the center of the control panel.

(3) *Purpose.* It controls the voltage output of the exciter. The value of the exciter voltage determines the amount of exciter current flowing in the alternator field coils. The amount of exciter current, in turn, controls the voltage output of the alternator. Turning the rheostat clockwise increases voltage, counterclockwise decreases voltage.

g. Voltage Regulator Rheostat (fig. 16).

(1) *Description.* The voltage regulator rheostat (11) is a small variable resistor mounted on the voltage regulator unit. It is in operation only when the voltage regulator switch (8) is in the AUTOMATIC position.

(2) *Location.* The voltage regulator rheostat is located on the voltage regulator unit on the lower right side of the control panel.

(3) *Purpose.* The voltage regulator rheostat when set at the required voltage, will automatically keep this set voltage constant. Turning the rheostat clockwise increases the voltage, counterclockwise decreases voltage.

h. Circuit Breaker (fig. 16).

(1) *Description.* The alternating-current circuit breaker (14) is a single-throw type electrical contactor. It has ON and OFF positions; to the left is ON, to the right is OFF.

(2) *Location.* The circuit breaker is mounted at the lower center of the control panel.

(3) *Purpose.* It acts as a main switch to disconnect and connect the load line from the generator set to the powered

equipment and as an overload protective device. In case of overload, short circuit, or ground on the load line or within the powered equipment, the circuit breaker will automatically disconnect the load from the generator set.

i. 120-volt Receptacle (fig. 16).

(1) *Description.* The 120-volt receptacle (13) is an alternating-current duplex receptacle.

(2) *Location.* The 120-volt receptacle is mounted at the lower center portion of the control panel just above the circuit breaker.

(3) *Purpose.* The receptacle is a convenience outlet to power equipment requiring 110/130-volts.

13. Generator Instruments

a. AC Ammeter (fig. 16).

(1) *Description.* The ac ammeter (1) is a dual scale meter. It is calibrated from 0 to 250 amperes and 0 to 500 amperes. The 0 to 250-ampere scale is to be used when generator is connected for 230–400-volt 50 cycle, and the 0 to 500-ampere scale when generator is connected for 127–220-volt 60 cycle.

(2) *Location.* The ac ammeter is located at the upper left corner of the control panel.

(3) *Purpose.* It indicates the line current.

(4) *Readings.* Maximum amperes at full load 60 cycles is 349. Maximum amperes at full load 50 cycles is 159.

b. Hour-Meter (fig. 16).

(1) *Description.* The hour-meter (5) is a time-totalizing instrument. It is a 100,000-hour maximum reading, non-reset, type meter.

(2) *Location.* The hour-meter is mounted on the upper right of the control panel between the wattmeter and voltmeter.

(3) *Purpose.* It indicates the number of hours the unit has been operated.

c. Frequency Meter (fig. 16).

(1) *Description.* The frequency meter (3) is a dual-scale, vibrating-reed meter. The scale to the left of the meter is calibrated from 48 to 52 cycles, this scale will be used when operating on 50 cycles. The scale to the right of the meter is calibrated from 58 to 62 cycles, and will be used when operating on 60 cycles.

(2) *Location.* The frequency meter is mounted on the upper left of the control panel, between the ac ammeter (1) and wattmeter (4).

(3) *Purpose.* The frequency meter indicates the frequency in cycles per second of the generator alternating-current output.

d. Wattmeter (fig. 16).

(1) *Description.* The wattmeter (4) is a single-scale meter. It is calibrated in kilowatts from 0 to 150.

(2) *Location.* The wattmeter is mounted at the top center of the control panel.

(3) *Purpose.* It indicates the output of the generator in kilowatts.

(4) *Readings.* If the wattmeter indicates more than 100 kilowatts, the load on the service lines must be reduced to bring the wattmeter reading to 100 kilowatts or lower.

e. Voltmeter (fig. 16).

(1) *Description.* The voltmeter (6) is a dual-scale meter. It is calibrated from 0 to 300 volts and 0 to 600 volts. The 0 to 300-volt scale is to be used when generator is connected for 127/220-volt 60-cycle, and the 0 to 600-scale when generator is connected for 230/400-volt 50-cycle.

(2) *Location.* The voltmeter is located in the upper right corner of the control panel.

(3) *Purpose.* It indicates the voltage at the output terminals.

Section III. OPERATION UNDER USUAL CONDITIONS

14. 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 applying the load, 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.

15. Starting

a. Preparation for Starting.

(1) Perform the before-operation services (par. 34).

(2) Make sure the circuit breaker (14, fig. 16) is in the OFF position.

(3) Connect the generator for the required voltage and frequency (par. 7*i*), and connect the load lines to the terminals at the load terminal box (13, fig. 5).

(4) Set the voltage regulator switch (8, fig. 16) to MANUAL.

(5) Turn the exciter field rheostat (12) counterclockwise as far as it will go.

(6) Set the synchronizing switch (26) to the OFF position.

(7) Turn the ammeter switch (25) and voltmeter switch (7) to the OFF position.

(8) Make sure the engine stop knob (17) is all the way in.

(9) Turn the throttle control knob (16) ten complete turns clockwise.

b. Venting Fuel System (fig. 17). When starting the unit for the first time after shipment, or if it has been allowed to run out of fuel, it will be necessary to vent the fuel system before attempting to start the engine.

(1) Loosen the vent screw (3) and operate the hand primer (16) to expel all air. The hand primer cannot be operated unless the knob is turned to the left a few turns to release plunger handle.

(2) Close the vent screw (3). Loosen the bleeder screw (17) and operate the hand primer (16).

(3) Tighten the bleeder screw (17) while continuing to operate the hand primer (16).

(4) Tighten the hand primer knob by turning it to the right.

(5) Loosen the nipple nuts (1) at each injector (2) about one turn.

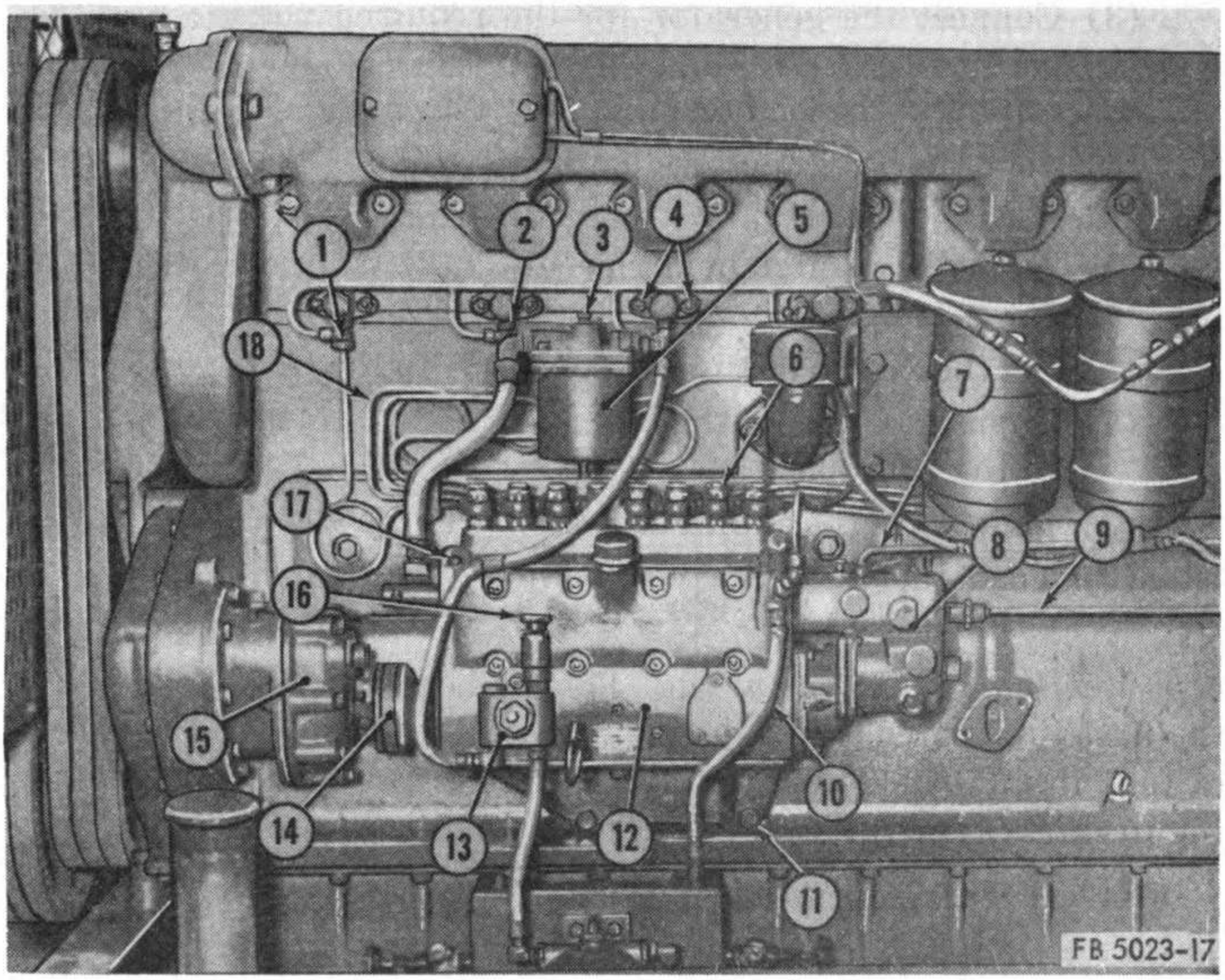
(6) Set the throttle control knob (16, fig. 16) in the full load position; press the starter switch (18); and crank the engine until fuel flows from all the loosened nipple nuts (1, fig. 17). Then tighten all the nipple nuts (1).

c. Starting Engine (fig. 16).

(1) In temperatures below 50° F. the air intake heater must be used to insure easy starting.

(2) Operate the heater pump (15) with long steady strokes; continue to operate the pump while holding in the air heater switch (19) and starter switch (18).

(3) If the engine does not start in 15 seconds, release the switches and pump. Do not try to start again for at least 2 minutes.



1	Nipple nut	10	Fuel return line
2	Fuel injector	11	Cap screw, ½ x 1¼ NC (4 rqr)
3	Vent screw	12	Fuel injection pump
4	Nut, (16 rqr)	13	Fuel transfer pump
5	Secondary fuel filter	14	Injection pump coupling
6	Delivery valve holder	15	Accessory pump drive
7	Stop control rod	16	Hand primer
8	Engine speed governor	17	Bleeder screw
9	Throttle control rod	18	Fuel injection lines

Figure 17. Fuel injection pump, installed.

(4) As soon as the engine starts, discontinue pumping and release both the air heater and starter switches immediately.

(5) Check the engine instruments. The oil pressure gage (21) should indicate between 35 and 45 psi. The water temperature gage (24) should read 165° to 190° F. when operating temperature is reached. The oil temperature gage (20) should read 220° to 230° F. when operating temperature is reached. The battery charging ammeter (23) should indicate a 2½-ampere charge when the battery charge switch (22) is in the HI position, and ½-ampere charge when the switch is in the LO position.

d. Applying Load (fig. 16).

(1) When the engine reaches operating temperature, 165° to 190° F. turn the throttle control knob (16) clockwise

until the frequency meter (3) reads 62 cycles for 60-cycle operation, or 52 cycles when operating on 50 cycles.

(2) Turn the exciter field rheostat (12) clockwise until the voltmeter (6) reads the required voltage.

(3) Throw the voltage regulator switch (8) to AUTO and adjust the voltage regulator rheostat (11) until the voltmeter reads the required voltage.

(4) Throw the circuit breaker (14) to the ON position.

(5) Readjust the engine speed to the desired operating frequency after the load is applied.

16. Operating Details

a. Generator Load Balance (fig. 16). The electrical load on the generator should be kept balanced between the three phases when single-phase loads are being carried. Check for balance by turning the ammeter switch (25) and voltmeter switch (7) to a terminal designation. Readings in the different switch positions or between the three phases must not vary more than 10 percent. If abnormal readings are obtained, the load on the service lines must be redistributed to bring the readings within acceptable limits.

b. Single-Unit Operation. To operate the generator set as a single unit or nonparallel operation, refer to paragraph 15.

c. Parallel Operation.

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

(1) *General.* When load requirements cannot be handled by one generator set, two or more units may be operated in parallel. Parallel operation will give the same output voltage, but will increase the available power.

(2) *Operation.*

(*a*) Connect the leads from L1, L2, and L3 at the load terminal box (13, fig. 5) to corresponding terminals on each unit to be operated in parallel.

(*b*) Connect the load to the terminals of one of the units.

(*c*) Place one unit in operation (par. 15). Make sure that the no-load voltage and frequency are carefully adjusted; then place part of the load on the line and throw the circuit breaker (14, fig. 16) to the ON position.

(*d*) Start the incoming unit and adjust the voltage to the required value.

(*e*) Recheck and readjust voltage of the loaded unit. Both voltmeters must read the same in order to avoid cross-currents (circulating currents) between units.

(*f*) Throw the synchronizing switch (26) of both units to the ON position. The synchronizing lights (9) will flash on and off. If the lights on both units do not reach maximum brilliance and fade out in unison, shut down both units and check for proper load line connections. It will be found that interchanging any two leads between the units will correct this condition.

(*g*) Using the throttle control knob (16), adjust the speed of the incoming unit until the synchronizing lights on both units go on and off very slowly.

(*h*) At the moment when synchronizing lights are completely dark, throw the circuit breaker (14) of the incoming unit to ON.

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

(*i*) Adjust the throttle of the incoming unit until the ampere readings as indicated on the ac ammeter are equal and at a minimum. Increasing the throttle setting of a unit will cause it to take a greater share of the load. If the frequency meter (3) indicates too high a frequency, adjust both generators for lower speed.

(*j*) When adjusted for parallel operation, the frequency, voltage, and current on each generator should be the same. If this adjustment is not done properly, circulating currents between generators will result, with loss in generating capacity and overheating of the generator.

(*k*) Turn the synchronizing switch (26) to the OFF position.

(*l*) To remove a unit from the line, throw the circuit breaker to OFF and proceed as in paragraph 17 to stop the generator set.

Caution: Do not have a load greater than the rating of the operating unit 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.

17. Stopping

a. Throw the circuit breaker (14, fig. 16) to the OFF position.

b. Turn the throttle control knob (16) counterclockwise to idle position and allow the engine to idle for a few minutes to insure even cooling of the cylinder block.

c. Pull the engine stop knob (17) out and hold it out until the engine stops.

d. See that the panel light switch (10) and all other switches are in the OFF position.

18. Movement to a New Location

a. Disconnect the load lines at the load terminal box (13, fig. 5) and remove the load lines.

b. Close all access doors.

c. For short moves over relatively smooth terrain, the generator set may be skidded by using the towing eyes (15, fig.1).

d. If conditions do not permit skidding the generator set, lift the unit to the bed of a suitable carrier by means of the lifting eyes (3, fig. 3). Block the sides and ends of the skid base to prevent movement.

e. After the generator set has been relocated, inspect and service it as directed in paragraph 7.

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

19. Fire Extinguisher

a. Description. The fire extinguisher (5, fig. 6) is bracket-mounted to the inside of the right control panel door. It is of the vaporizing-liquid type with a 1-quart capacity.

b. Operation. Remove the extinguisher from the bracket, turn the handle to the left, and operate the handle like a pump. Direct the stream at the base of the flame; or for liquids burning in a container, direct the stream on the inside against the side of the container.

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

c. Refilling and Maintenance. Refer to TM 5–687 and TM 9–1799 for complete maintenance and refilling instructions.

20. Air Heater

a. Description. The air heater (4, fig. 4) proper is mounted in the engine air intake manifold. The device consists of two as-

semblies. One unit comprises the hand-operated pressure pump (15, fig. 16) and an air heater switch (19) mounted convenient to the engine controls. The other unit contains the burner nozzle, filter, ignition coil, and ignition points. The air heater is essentially a small pressure oil burner with electric ignition that preheats the ingoing charge of air to the cylinder sufficiently to insure easy starting of the engine in cold weather.

b. Operation. Refer to paragraph 15*c*.

Section V. OPERATION UNDER UNUSUAL CONDITIONS

21. 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.

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

a. General. This generator set has no winterization unit and therefore, definite steps must be taken to insure satisfactory operation and easy starts.

b. Engine. When starting a cold engine, use the air intake heater as instructed in paragraph 15*c* (1 and 2), and continue to use the heater pump (15, fig. 16) after the engine starts and until such time as the engine runs satisfactorily from its own operating heat. At low temperatures, the engine may fire for a time with the combined help of the starter and primer before developing sufficient power to run unassisted. Under these conditions, it is advisable to pause briefly at the end of each pumping stroke to allow the engine time to absorb the heat generated. Refer to the current lubrication order for the proper grades of oil to be used. It is advisable at the end of operations to drain the oil from the crankcase and place it in a warm room until the unit is restarted. Allow the engine to warm up at slightly faster than idling speed until the water temperature gage (24) reads between 165° to 190° F. Do not race a cold engine.

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

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

(*b*) Keep the tanks full and use only clean containers to store or transfer fuel. Drain the primary and second-

ary filters daily while the equipment is warm. If available, add one-half pint of denatured alcohol to every 20 gallons of fuel.

(2) *Cooling system.*

(*a*) Drain and flush the cooling system, refer to paragraph 77*b*.

(*b*) Make sure that all hoses, connections, and fittings are tight. Add antifreeze according to table I. The cooling system capacity is 15½ gallons.

Table I. Freezing Points, Composition, and Specific Gravities of Military Antifreeze Materials

Lowest expected ambient temp ° F.	Pints of inhibited glycol per gal of coolant [1]	Compound, antifreeze, Arctic [2]	Ethylene glycol coolant solution specific gravity at 68° F. [3]
+20	1½	Issued full-strength and ready mixed for 0° to —65° F. temperatures for both initial installation and replenishment of loses.	1.022
+10	2		1.036
0	2¾		1.047
—10	3¼		1.055
—20	3½		1.062
—30	4		1.067
—40	4¼		1.073
—50	Arctic Antifreeze preferred	DO NOT DILUTE WITH WATER OR ANY OTHER SUBSTANCE.	
—60			
—75			

[1] Maximum protection is obtained at 60 percent by volume, that is 4.8 pints of ethylene glycol per gallon of solution.

[2] Military Specification MIL–C–11755 Arctic type, nonvolatile antifreeze compound is intended for use in the cooling system of liquid-cooled internal combustion engines for protection against freezing primarily in Arctic regions where the ambient temperature remains for extended periods of time close to —40° F. or drops below, to as low as —90° F.

[3] Use an accurate hydrometer. To test hydrometer, use 1 part ethylene glycol type antifreeze to 2 parts water. This should produce a hydrometer reading of 0° F.

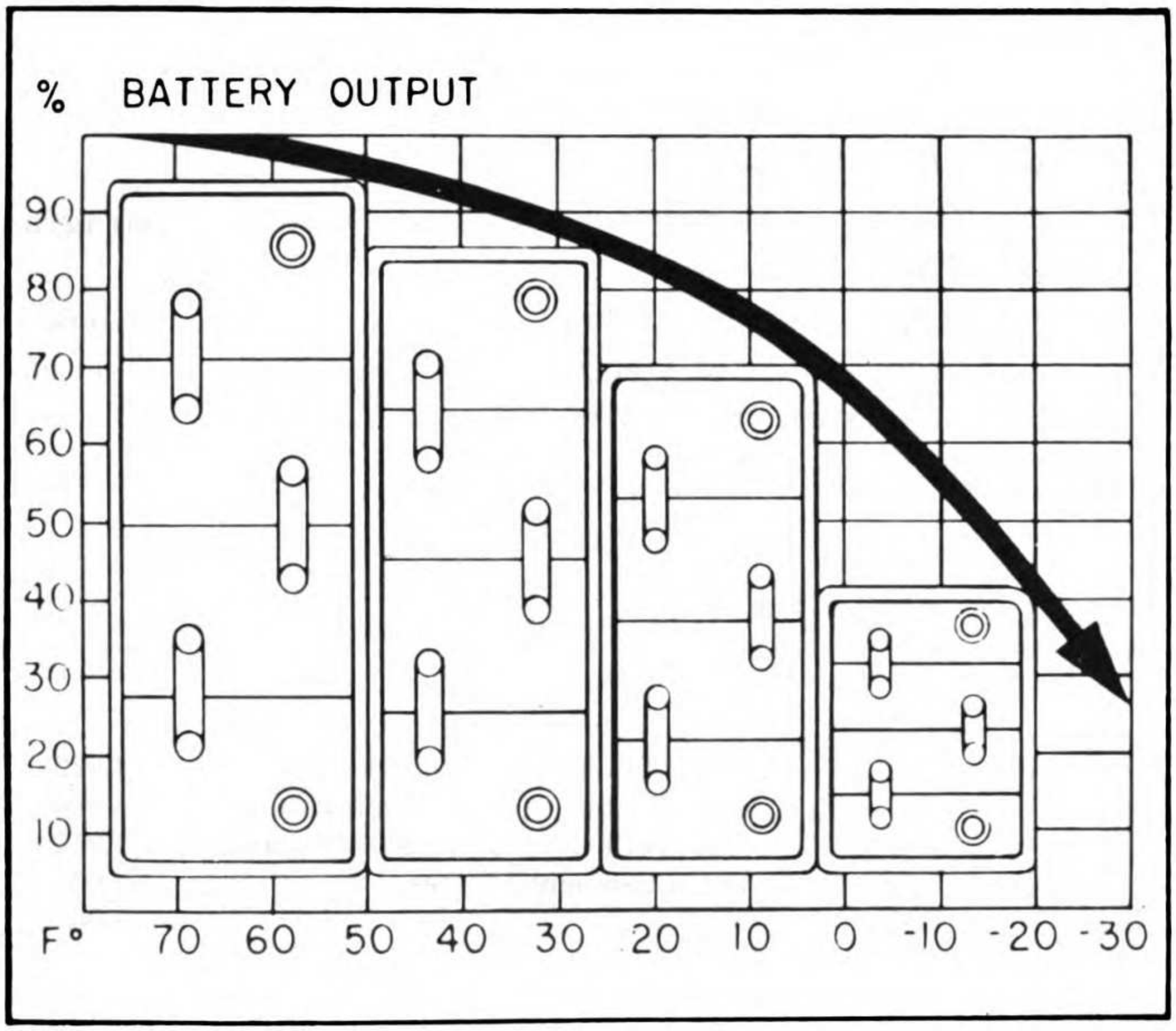
Note. Fasten a tag near the radiator filler cap indicating the type of antifreeze.

(3) *Electrical system.*

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

(*b*) Make sure the starter motor commutator is kept clean.

(*c*) Check the batteries with a hydrometer daily, and if the reading is below 1.270, recharge the batteries. Add water only when the set is to be operated for 1 hour or longer and the battery charge switch (22, fig. 16) is in the HI or LO position. Storage battery voltage drops with temperature. In extreme cold it may be



FB 5023-18

Figure 18. Battery output graph.

necessary to remove the batteries and store them in a warm place to raise the voltage enough to turn the engine over. Figure 18 graphically illustrates the loss of battery power at low temperatures.

c. Generator.

(1) *General.* The generator (5, fig. 2) has been designed to operate through a wide range of ambient temperatures from —65° to +125° F.

(2) *Stabilization period.* After engine has reached operating temperature, between 165° to 190° F. allow a 15-minute stabilization period, if possible, before making load connections.

(3) All temperature grease is used in the prepacked bearings and the generator bearings need no special attention.

(4) *Wiring.* Wiring and wiring harness will become brittle in extremely cold temperatures. Do not bend brittle insulation as it will crack and may cause grounds or short circuits. Warm the wiring before bending it or before

attempting rewiring operations. Keep the wiring dry at all times.

23. Operation in Extreme Heat

a. Engine.

(1) *Cooling system.*

(*a*) Make sure that all connections are tight and the fan belts are properly adjusted (par. 78*c*(3)).

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

(2) *Lubrication.* Refer to LO 5–5023 for the proper grades of lubricants to be used. Check the oil level in the crankcase, governor, and injection pump twice in every 8 hours of operation and keep the air cleaner and oil filler caps clean.

(3) *Batteries.* Check the battery electrolyte level daily, and refill with distilled or clean water. The correct level is one-half inch above the plates. A specific gravity reading as low as 1.220 can be safely permitted in torrid climates.

b. Generator. The generator has been designed to operate at temperatures up to 125° F. Keep the ventilating covers and fan guard clean at all times.

(1) *Ventilation.* When operating in dirt-free air, raise the side panels to provide maximum ventilation. If operating indoors, allow sufficient room around the unit for air circulation and ventilate the room with exhaust fans.

(2) *Lubrication.* Lubricate the generator as specified in LO 5–5023.

24. Operation in Dusty or Sandy Areas

a. General. Dust and sand will shorten the life of mechanical parts faster than any other natural agent. If possible, 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 a cloth dampened with diesel fuel or an approved cleaning solvent.

b. Engine.

(1) *Lubrication.* Inspect the air cleaner daily for an accumulation of dirt and dust. Clean and re-oil as required.

Keep the crankcase breather cap and injection pump fill cap clean and well oiled. Lubricate the generator set at more frequent intervals.

(2) *Cooling system.* Inspect the radiator fins daily and blow out any accumulation of dust and dirt with compressed air.

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

c. Generator. Keep the ventilating covers clean. Blow out any accumulation of dust and dirt from the ventilating fan. Keep the side panels and control panel doors closed as much as possible. After use, blow out the generator set with not over 25 pounds of compressed air, and wipe it down with a cloth dampened with diesel fuel or an approved cleaning solvent.

25. Operation in Wet or Humid Areas

If the unit is outside and not operating, put a canvas or suitable covering over it. Remove the cover and allow the unit to dry out before operating. Keep the unit well painted. Keep the fuel tank full to avoid condensation.

26. Operation in Salt Water Areas

Erect a shield of canvas, lumber, or whatever materials are on hand to protect the unit from salt spray and wipe down the exterior of the generator set with fresh water regularly. Keep the unit well painted. Lubricate the generator set more frequently if necessary. Clean the interior parts of the generator set with an approved cleaning solvent. Keep all access doors closed as much as possible during operation. After operation, protect the unit with a canvas or suitable covering.

27. Operation at High Altitudes

The generator set is designed to operate under continuous full load at altitudes up to 5,000 feet. Keep in mind, as altitude increases, the boiling point of the water in the radiator increases and engine horsepower decreases. Service the air cleaner daily as instructed in LO 5–5023.

CHAPTER 3
ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

28. Special Organizational Maintenance Tools and Equipment

The tools and equipment in table II bearing identification numbers are listed in Department of the Army ENG 3–41, ENG 5–41, and ENG 6 supply manuals or in ORD 6 SNL–G27, Section I. 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.

29. Tool and Publications Set

The tools normally supplied with this equipment for the use of the operator are listed in appendix II.

Table II. Special Organizational Maintenance Tools and Equipment

Item	Stock No.	References		Use
		Fig.	Par.	
Hydrometer, antifreeze	18–4212.300.500		36	Testing antifreeze solution.
Hydrometer, storage battery	18–4212.850.800		36, 90*b*	Testing specific gravity of battery electrolyte.
Scale	17–9060.490.210		103*d*, 104*c*	Checking generator brush spring tension.
Tester, battery	17–9064.500.600		36	Testing battery cell voltage.
Thermometer	18–8612.500.500		79*c*	Testing thermostats.

Section II. LUBRICATION AND PAINTING

30. General Lubrication Information

a. LO 5–5023 prescribes first and second echelon lubrication maintenance for the Buda generator set model 8DCS–1125.

b. A lubrication order is published for each item of equipment. The lubrication order shown in figure 19 is a reproduction of an

approved lubrication order for this generator set. For the current LO 5–5023, refer to DA Pam 310–4.

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

31. Detailed Lubrication Information

a. Care of Lubricants 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 oil cans and dispensing equipment are clean at all times.

b. Points of Application (fig. 19). Follow the detailed lubrication instructions given beneath each lubrication point illustration indicating the procedures to be followed at each point.

c. Cleaning. Before lubricating the equipment, clean all lubrication points and surrounding areas with an approved solvent and wipe dry.

d. Operation Immediately After Lubrication. Immediately after changing oil, start the engine and operate for 5 minutes to distribute tne lubricant to all internal parts of the engine. Stop the engine and recheck the oil level. Add oil if necessary.

e. Air Cleaner (fig. 20).

(1) *Servicing.*

(*a*) Loosen the wingnuts (23) holding the cup (1) and remove the cup from the body (19). Lift the baffle (2) from the cup (1).

(*b*) Empty the oil from the cup (1). Release the retaining ring (3) and remove the ring, upper baffle (4) and screen (21).

(*c*) Remove the wingnut (16) and lift off the cap (15). Loosen the clamp (13) and remove the precleaner (14).

(*d*) Clean all parts and the wire mesh at the bottom of the body (19) in an approved cleaning solvent. Blow dry with compressed air.

(*e*) Place the precleaner (14) on the body (19) and tighten the clamp (13). Position the cap (15) on the precleaner (14) and secure with the wingnut (16).

(*f*) Place the screen (21) and upper baffle (4) on the body (19) and secure with the retaining ring (3).

(*g*) Fill the cup (1) to the level mark with the grade oil specified in LO 5–5023 for the prevailing temperature.

(*h*) Place the lower baffle (2) in the cup (1) and position the assembly on the body (19) and secure with the two wingnuts (23) and washers (22).

LUBRICATION ORDER **LO 5-5023**

11 December 1955

GENERATOR SET, ELECTRIC, PORTABLE, DIESEL DRIVEN, SKID MOUNTED, 100KW, 127/220 VOLT, 3 PHASE, 60 CYCLE OR 230/400 VOLT, 3 PHASE, 50 CYCLE, BUDA MODEL 8DCS-1125

References: TM 5-5023, TB 5-5023-1

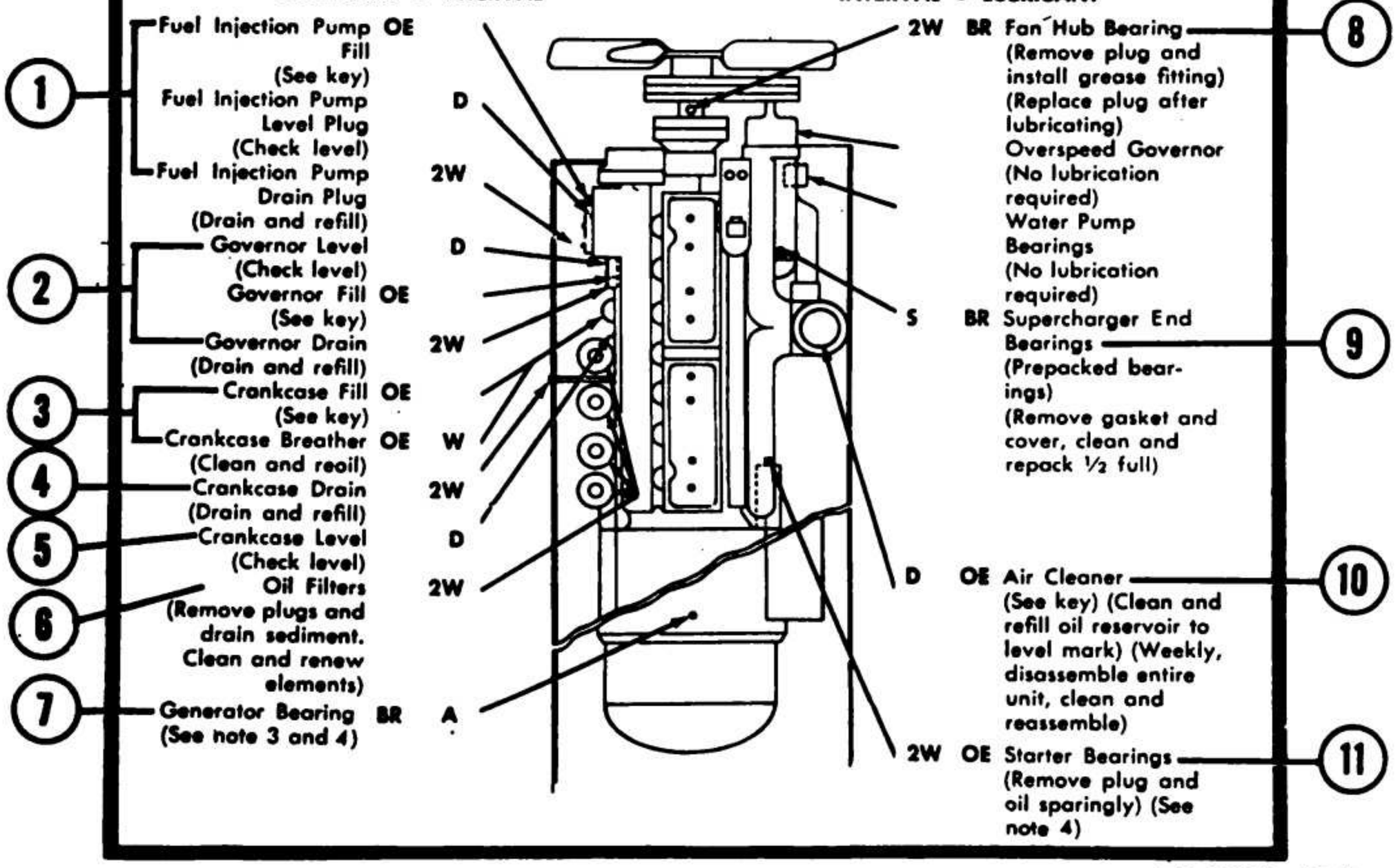
Intervals given are maximums for normal 8-hour day operation. For abnormal conditions or activities, intervals should be adjusted to compensate.
Clean fittings before lubricating.
Relubricate after washing.

Clean parts with SOLVENT, dry-cleaning, or with OIL, fuel, Diesel. Dry before lubricating.
Drain crankcase 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 W—Weekly 2W—2 Weeks S—Semi-annually A—Annually
Crankcase	28 qts				
Governor	⅜ qt	OE 30 or 9250	OE 10 or 9110	OE 10 or 9110	
Injection Pump	½ qt				
Air Cleaner	2 qts	OE 30 or 9250	OE 10 or 9110	OHA	
Other Points					

BR — Lubricant, Ball and Roller Bearing.
OHA — Oil, Hydraulic, Aircraft, Petroleum Base.



FB 5023-19/1

Figure 19. Lubrication order.

(2) *Removal* (fig. 20).

(*a*) Loosen the wingnuts (23) holding the cup (1), and remove the cup from the body (19). Lift the baffle (2) from the cup (1) and empty the oil from the cup.

(*b*) Loosen the clamps (17) and work the hose (18) toward the air cleaner and free of the supercharger inlet.

(*c*) Remove the nuts (11) and lockwashers (12) securing the bands (20) to the bracket (10). Remove the bands.

NOTES:

1. COLD WEATHER — (When winterization kit is not available.) Every 3 days, drain crankcase and refill to "Full" mark with OE 10. Add 9 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 9 qts of 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. GENERATOR BEARING — Disassemble, clean and inspect all parts, renew damaged or worn parts; repack housing ½ full and reassemble.
4. LUBRICATED BY TECHNICAL SERVICE PERSONNEL — Semi-annually or at disassembly, lubricate starter drive end bearing. Annually or at disassembly, lubricate the main generator bearing.
5. OIL CAN POINTS — Weekly, clean and coat governor linkages, pins, yokes, clevises, springs and exposed threaded surfaces with OE.

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 SECRETARY OF THE ARMY:
MAXWELL D. TAYLOR
General, United States Army,
Chief of Staff.

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

FB 5023-19/2

Figure 19—Continued.

(*d*) Lift the air cleaner straight up to clear the bracket and remove the air cleaner through the access door.

(3) *Disassembly* (fig. 20).

(*a*) Remove the wingnut (16) and lift off the cap (15). Loosen the clamp (13) and remove the precleaner (14).

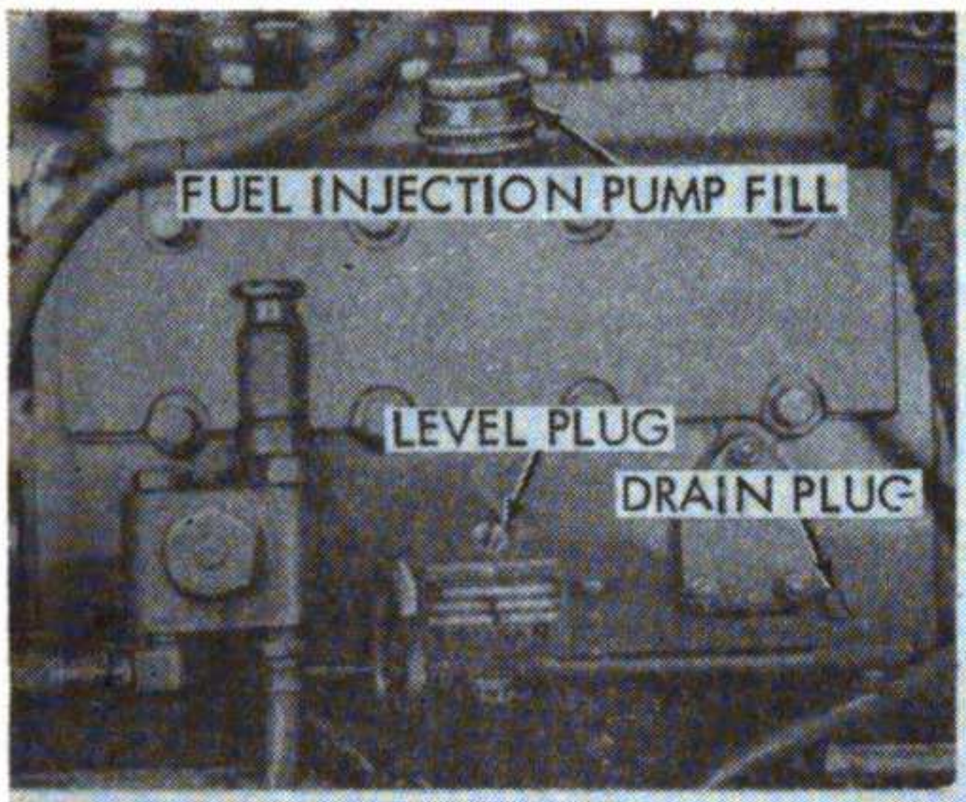
(*b*) Remove the hose (18) from the body (19). Remove the clamps (17) from the hose.

(*c*) Release the retaining ring (3) and remove the ring, upper baffle (4), and screen (21).

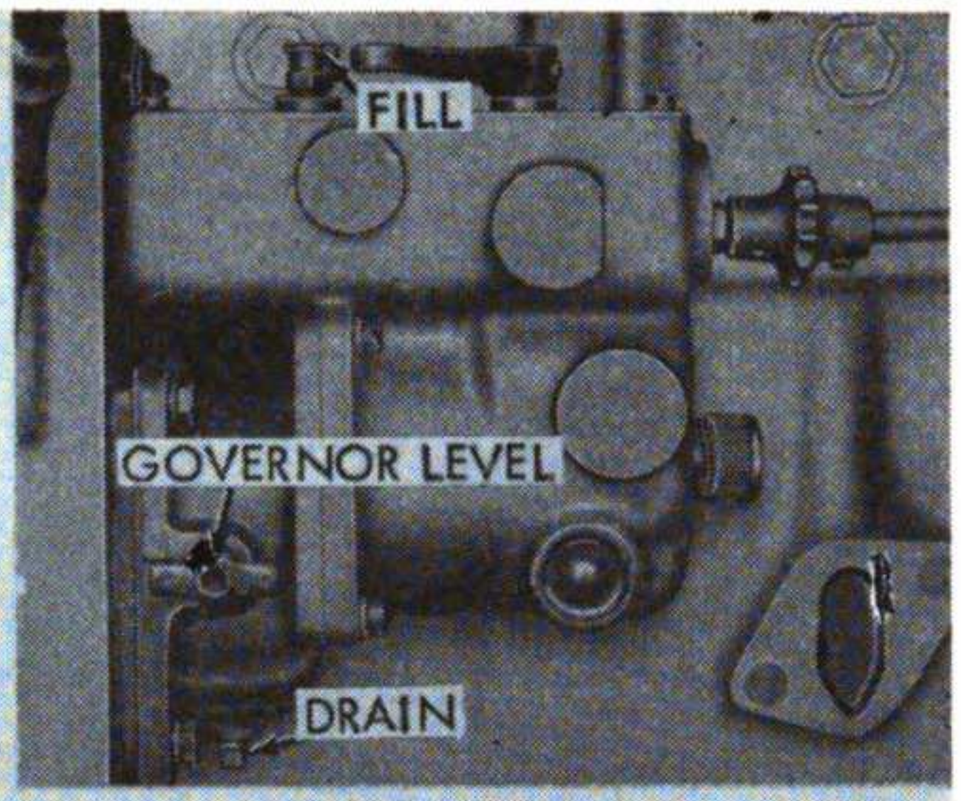
(4) *Cleaning and inspection* (fig. 20).

(*a*) Clean all parts and the wire mesh at the bottom of the body (19) with an approved cleaning solvent. Blow dry with compressed air.

(*b*) Inspect the nuts (11, 16, and 23) and the threaded surfaces on the precleaner (14) and bands (20) for damaged threads. Repair or replace parts as necessary. Check the hose (18) for cracks or breaks; replace if necessary.

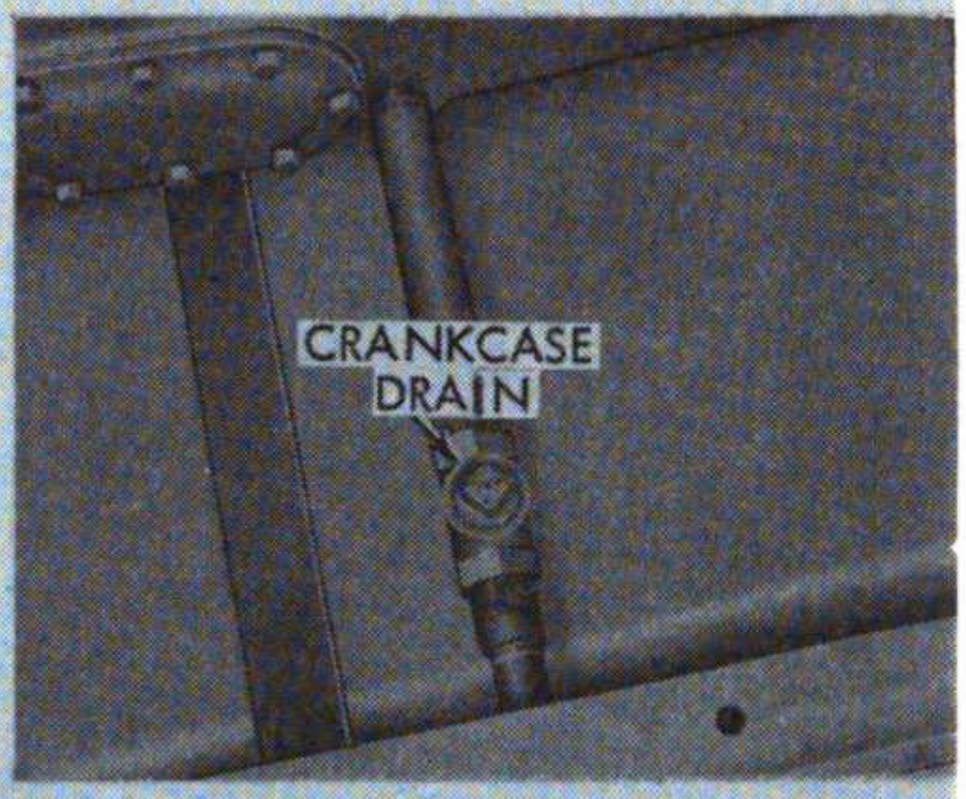


REFERENCE 1: Check level, drain and refill.



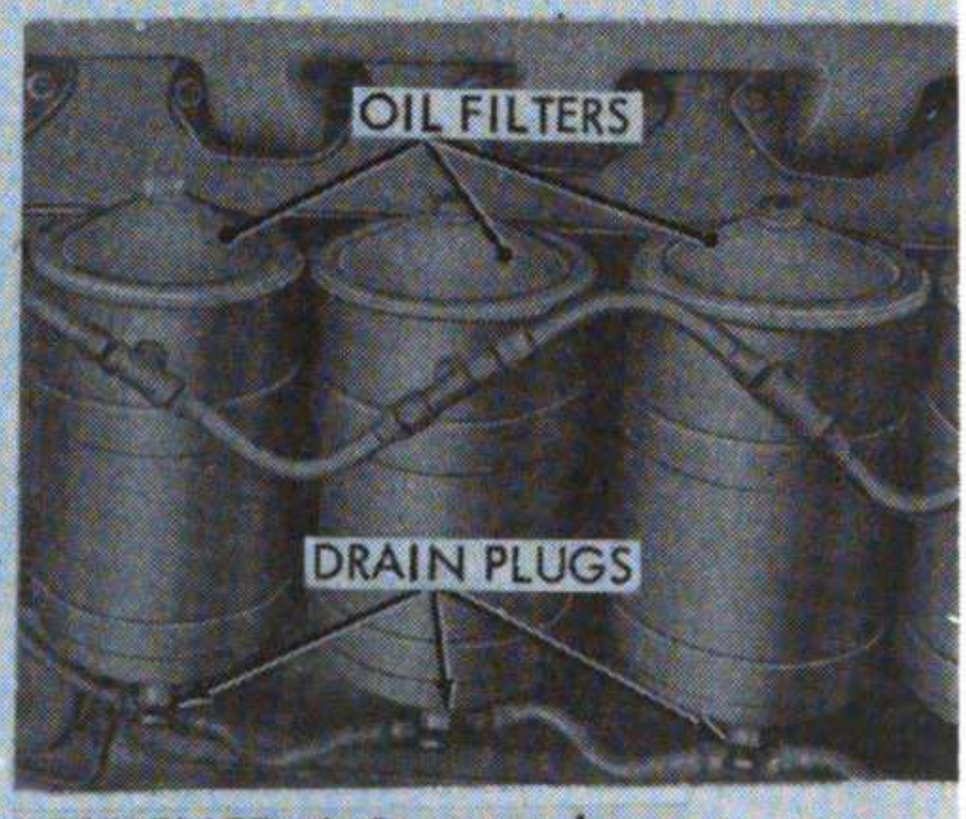
REFERENCE 2: Check level, drain and refill.

REFERENCE 3: Remove breather cap, clean and reoil.



REFERENCE 4: Drain and refill.

REFERENCE 5: Check level.



REFERENCE 6: Remove plugs, drain sediment, clean and renew elements.

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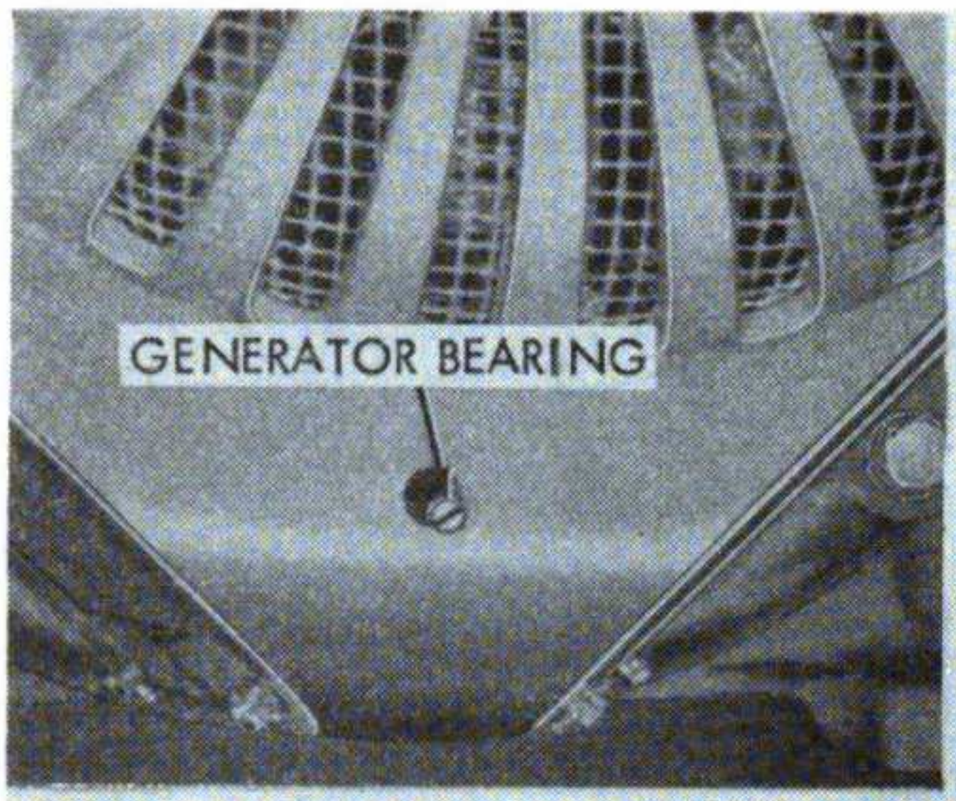
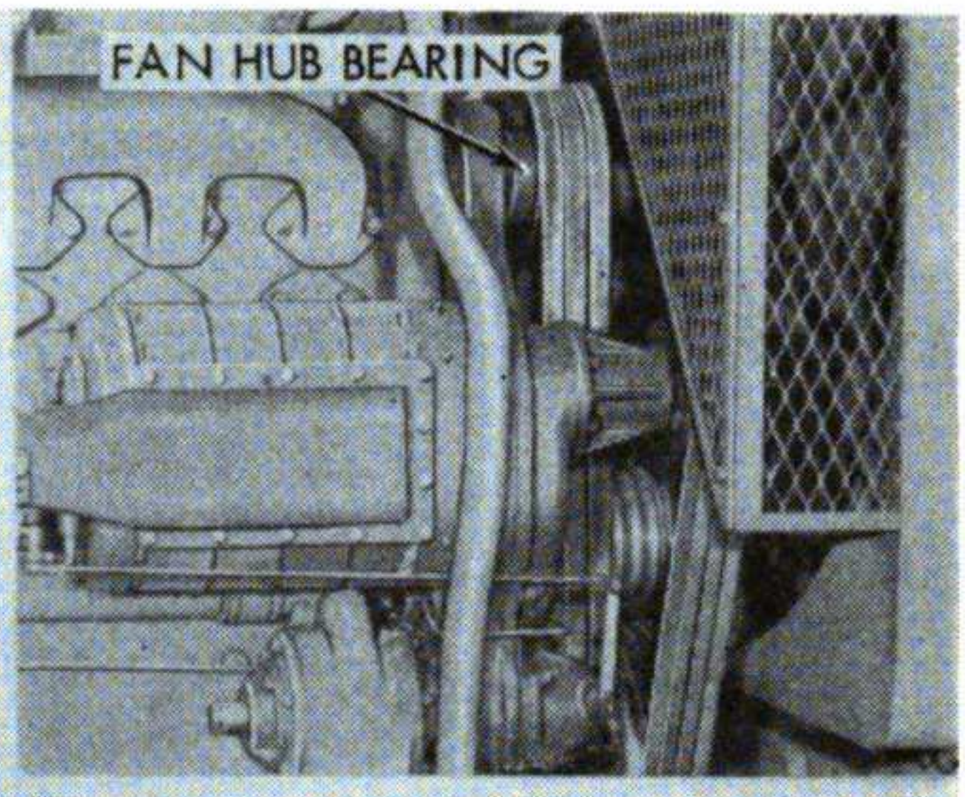
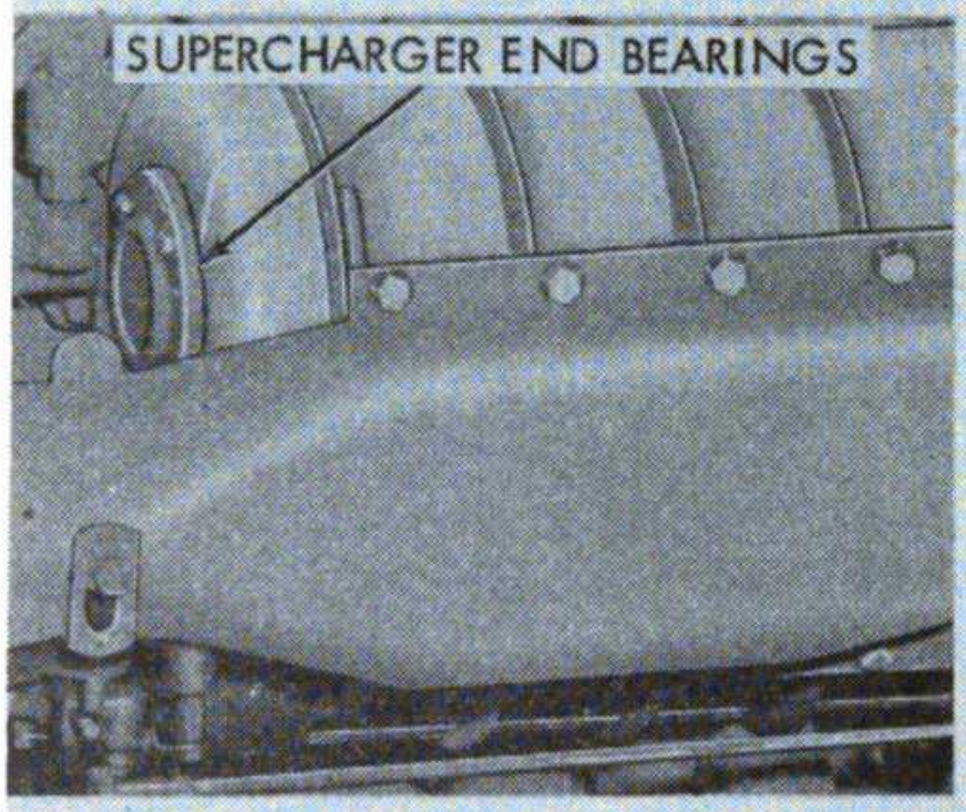
Figure 19—Continued.



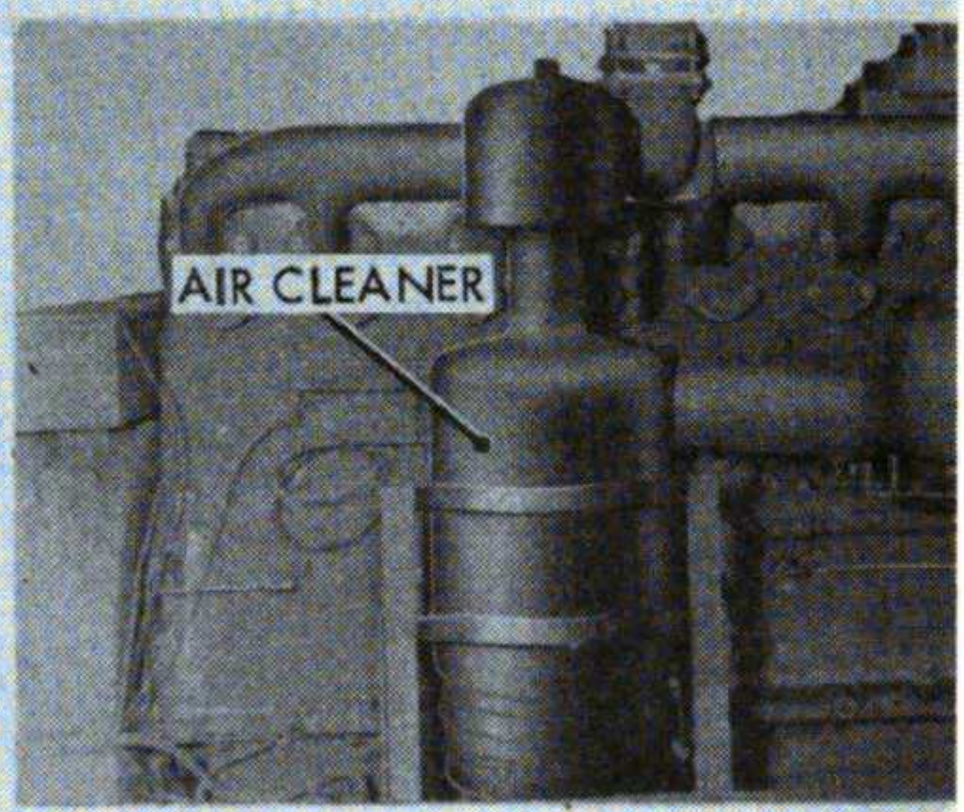
REFERENCE 7: Repack 1/2 full with ball and roller bearing lubricant.



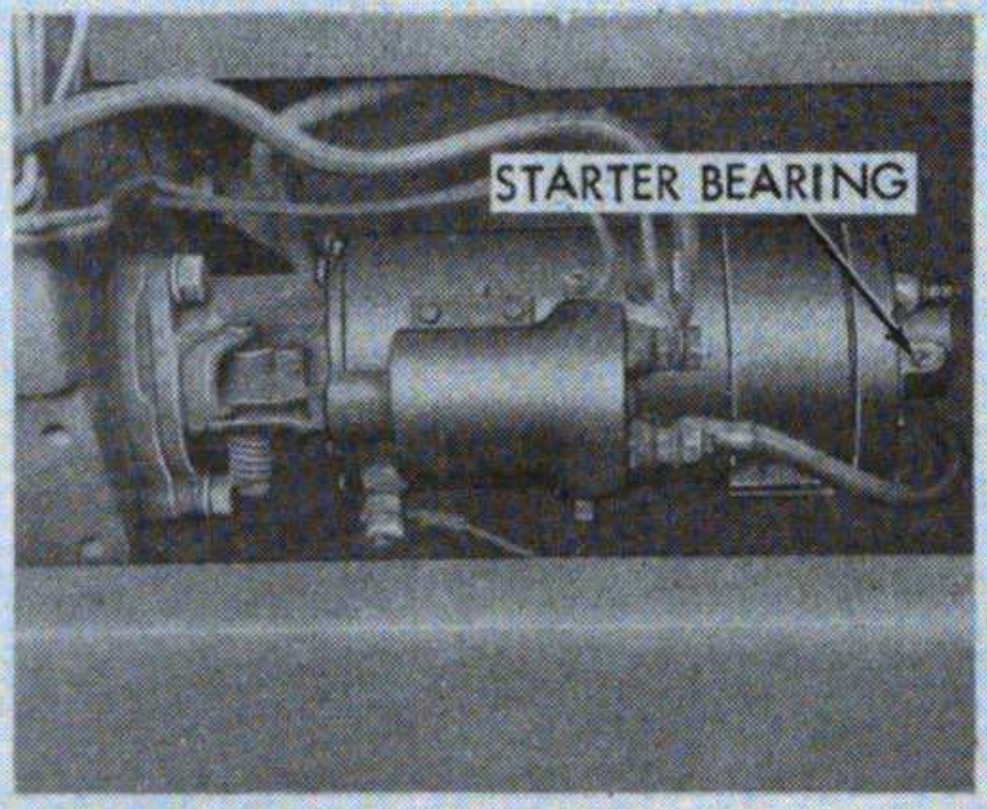
REFERENCE 8: Remove plug, and install grease fitting. Replace plug after lubricating.



REFERENCE 9: Remove cover and gasket, clean and pack 1/2 full.



REFERENCE 10: Clean and refill oil reservoir to oil level mark.



REFERENCE 11: Remove plug and oil sparingly.

FB 5023-19/4

***Figure 19*—Continued.**

(5) *Reassembly* (fig. 20).

(*a*) Place the screen (21) and upper baffle (4) on the body (19) and secure with the retaining ring (3).

(*b*) Place the precleaner (14) on the body (19) and tighten the clamp (13). Position the cap (15) on the precleaner (14) and secure with the wingnut (16).

(*c*) Place the clamps (17) on the hose and push the hose on the body (19).

(6) *Installation* (fig. 20).

(*a*) Place the air cleaner in position alining the hose (18) with the supercharger inlet. Install the hose on the supercharger inlet and tighten both clamps (17). This will hold the air cleaner in its approximate position while the bands are being installed.

(*b*) Position the bands (20) around the air cleaner and through the holes in the bracket (10). Install the washers (12) and nuts (11).

(*c*) Aline the air cleaner and while holding in position, tighten the nuts (11).

(*d*) Loosen the clamps (17) and reposition the hose (18) equally over the supercharger inlet and air cleaner outlet. Tighten the clamps.

(*e*) Fill the cup (1) to the level mark with the grade of oil specified in LO 5–5023 for the prevailing temperatures.

(*f*) Place the lower baffle (2) in the cup (1) and position the assembly on the body (19). Secure with the two wingnuts (23) and washers (22).

f. *Oil Filter Servicing* (fig. 21).

(1) Remove the retaining nut (1) and remove with the cover (2), spring, and gasket.

(2) Remove the drain plug (4).

(3) Remove and discard the filter element (6).

Note. Discard the cover gasket after removing cover assembly.

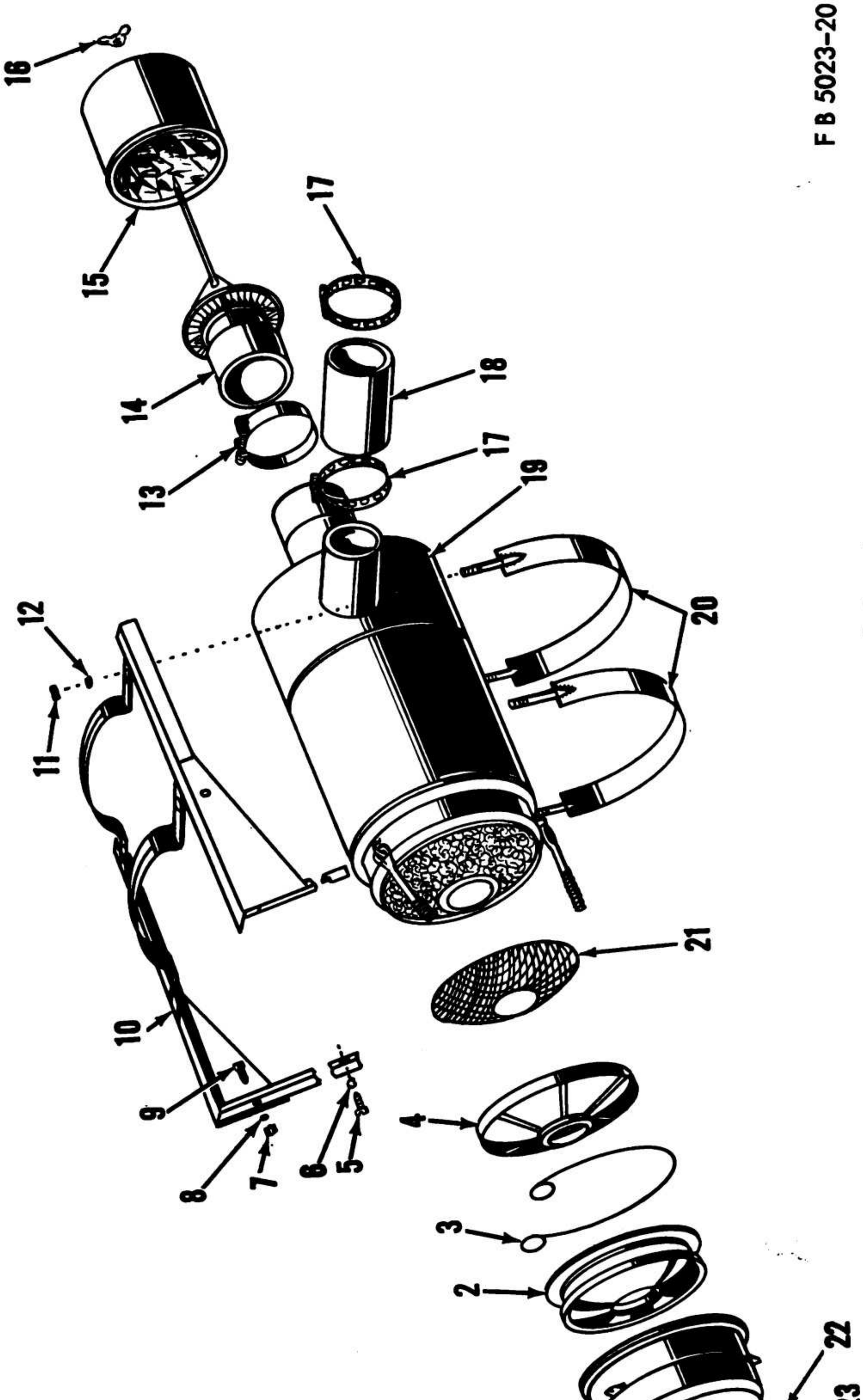
(4) Wipe the interior of the filter body (5) with a clean cloth to remove any sludge that may have settled in the bottom of the body.

(5) Place a new element (6) in the filter body (5).

(6) Install the drain plug (4).

(7) Using a new gasket, install the cover (2) and attached spring, placing the cover evenly on the filter body (5) and tighten the retaining nut (1).

(8) Add one quart of OE to the crankcase for each filter serviced.



FB 5023-20

Figure 20. Air cleaner, exploded view.

1	Cup	13	Clamp
2	Baffle, lower	14	Precleaner
3	Retaining ring	15	Cap
4	Baffle, upper	16	Wingnut
5	Cap screw, ½ x 1½ NC (2 rqr)	17	Clamp, hose
6	Lockwasher, ½ (2 rqr)	18	Hose
7	Nut, hex, ⅜ NC (2 rqr)	19	Body
8	Lockwasher, ⅜ (2 rqr)	20	Band
9	Cap screw, ⅜ x 1 NC (2 rqr)	21	Screen
10	Bracket	22	Washer, flat $\frac{5}{16}$ (2 rqr)
11	Nut, hex, ⅜ NC (4 rqr)	23	Wingnut
12	Lockwasher, ⅜ (4 rqr)		

Figure 20—Continued.

(9) Run the engine and observe the oil pressure (par. 11*d*). Check level to make sure oil level is correct.

g. Supercharger End Bearings (fig. 22).

(1) *General.* The closed end bearings (2) are designed for grease lubrication and should be inspected at regular intervals (LO 5–5023). Keep the grease chamber (1), one-half full at all times.

(2) *Servicing.*

(*a*) Remove the four capscrews (4) and lockwashers from bearing caps (3).

(*b*) Pack the grease chamber one-half full (LO 5–5023).

(*c*) Install the bearing caps (3) and new gaskets (5) and secure with the four capscrews (4) and lockwashers.

32. Painting

a. General. Painting to be done by organizational maintenance personnel consists of doing touchup work on previously painted surfaces. Any area on which the paint has cracked, peeled, or blistered must be repainted.

b. Cleaning.

(1) Remove grease and dirt from the affected area by washing with an approved cleaning solvent. Wipe dry.

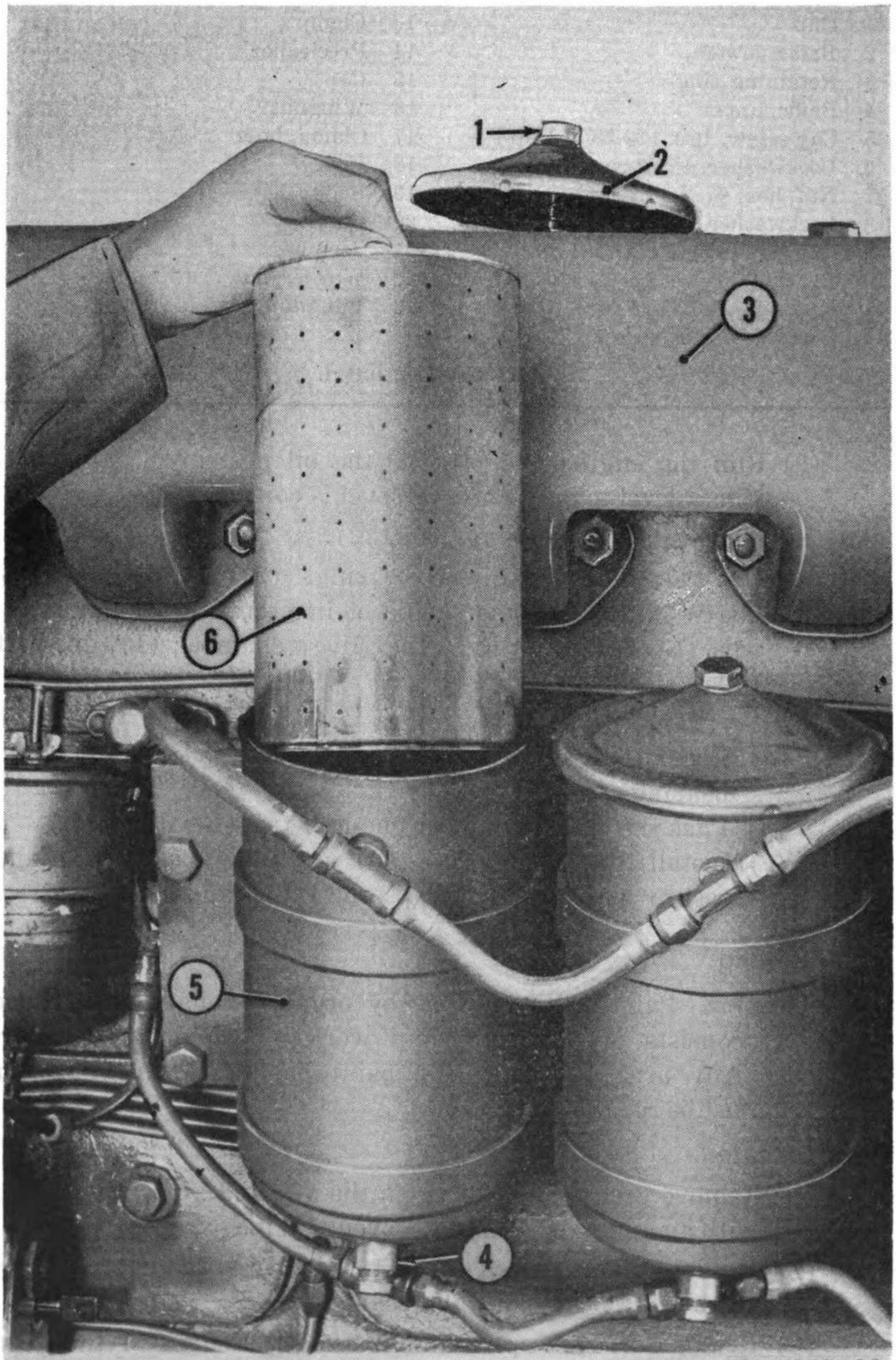
(2) If the paint is peeled or blistered, wire brush the area to remove all loose paint and scale.

(3) Remove all rust spots and feather the edges of the good paint with steel wool or sandpaper.

(4) Wipe all dust and dirt from the prepared area with a cloth dampened in cleaning solvent. Dry thoroughly.

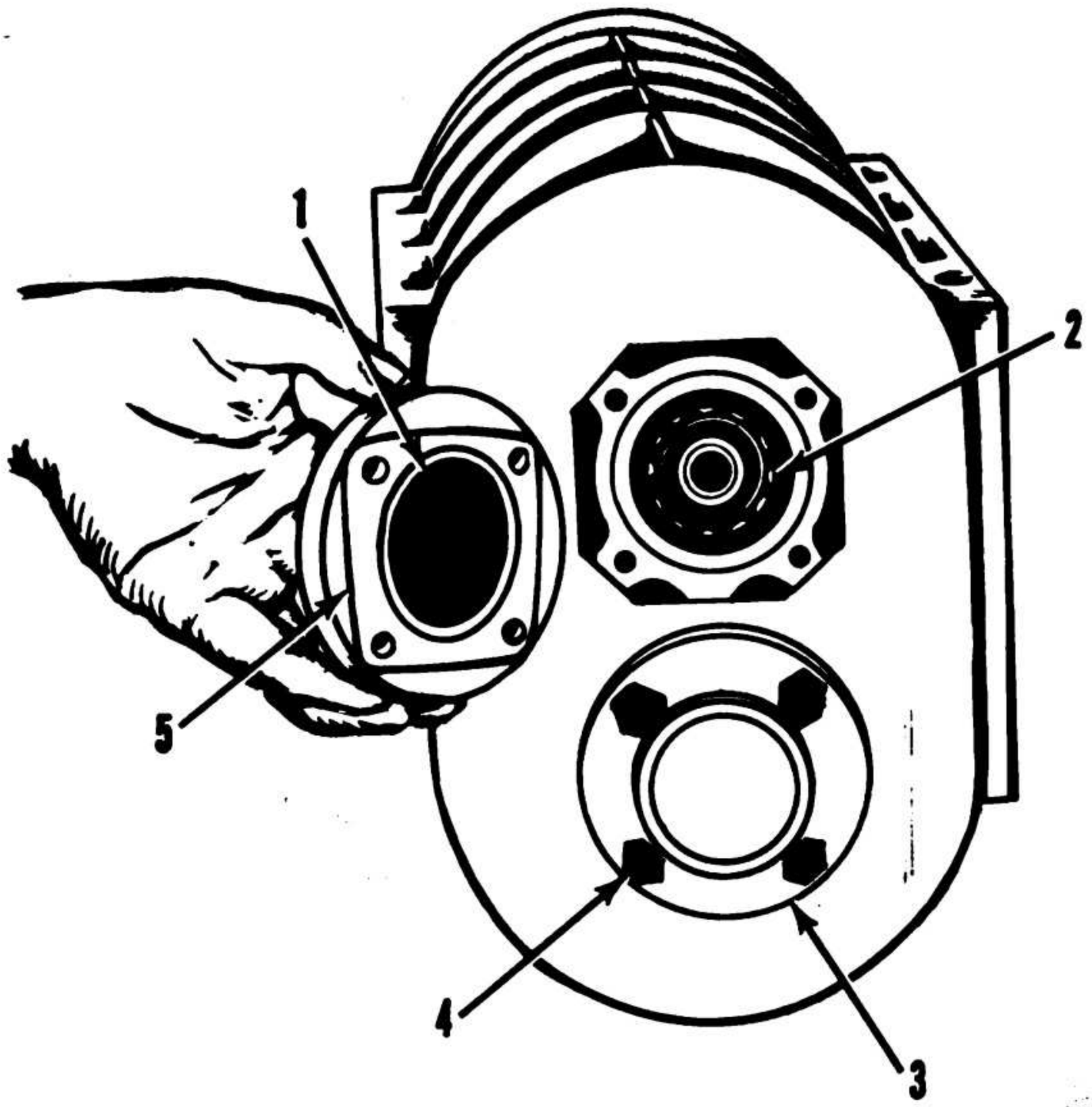
c. Painting.

(1) Use paint of the same color as the original.



1	Retaining nut	4	Drain plug
2	Cover	5	Filter body
3	Air intake manifold	6	Filter element

Figure 21. Oil filter servicing.



FB 5023-22

1 Grease chamber 2 Roller bearing 3 Bearing caps
4 Capscrew 5 Gasket

Figure 22. Supercharger closed end bearings.

(2) Use a brush of the proper size for the area to be painted.
(3) Apply the paint evenly over the prepared area into the feathered edge of the good paint.
(4) Refer to TM 9–2851 for additional information on painting.

Section III. PREVENTIVE MAINTENANCE SERVICES

33. General

To insure that the generator set is ready for operation at all times, it must be inspected systematically before operation, during operation, at halt, and after operation, so that defects may be discovered and corrected before they result in serious damage or failure. Preventive maintenance services will be performed at these designated intervals. Defects discovered during operation of the unit will be noted for future correction, to be made as soon as operation has ceased. The

operator must stop operation immediately if a deficiency is noticed which would damage the equipment if operation where continued. After operation services will be performed by the operator immediately after any operating period of ten hours or less. Defects or unsatisfactory operating characteristics beyond the scope of the operator to correct must be reported at the earliest opportunity to the proper authority.

34. Operator's Daily Services

Intervals				PROCEDURES
Before-operation	During-operation	At-halt	After-operation	
X	------	------	------	*Foundation.* Check the generator set to see that it is approximately level. If the generator set is mounted on a permanent foundation, check the mounting bolts for tightness.
X	------	X	X	*Fuel.* Check the fuel tank. See that the tank is full. Check the reserve supply of fuel and replenish if necessary. Keep the fuel level up to the bottom of filler pipe to allow room for expansion and to prevent condensation. If the generator set has not been operated for an extended period of time, or if the unit has been allowed to run out of fuel, it will be necessary to vent the fuel system before attempting to start the engine. Refer to paragraph 15*b*.
X	------	X	------	*Coolant.* See that the coolant is up to proper level in radiator. When filling a cold radiator containing antifreeze, allow room for expansion. ***Caution:*** If engine overheats due to lack of coolant, allow it to cool off before filling radiator; otherwise, there is danger of cracking the cylinder head. If it is necessary to fill the radiator before the engine has cooled, be sure to fill it slowly with engine running slightly above idling speed.
			X	Check coolant level in radiator; proper level is two inches below the filler neck with engine at operating temperature. Change coolant if it is contaminated with rust or dirt. If coolant is oily, report this condition to the proper authority. If antifreeze is used, check its freezing point. When adding antifreeze, operate the engine to mix the solution properly.
X	------	X	X	*Oil.* Check the oil level in the crankcase, injection pump, and engine speed governor. See if the oil is at the proper level, and add oil if necessary. Check the reserve supply of lubricants and replenish if necessary.

Intervals				PROCEDURES
Before-operation	During-operation	At-halt	After-operation	
X	X	X	X	*Leaks, general.* Check for leaks, paying particular attention to the cooling system, oil, and fuel lines, and connections, and for signs of leaks under the engine. Correct all deficiencies noticed, or report them to the proper authority.
X	------	X	X	*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. If operating under extreme dusty conditions, inspect the air cleaner and service as indicated in LO 5–5023.
X	------	------	X	Check the tension of the fan and supercharger belts. See that the belts can be deflected, without undue pressure, 1 to 1¼-inch midway between pulleys.
X	------	------	------	*Starting precautions.* Check to see that the fuel suction and fuel return valves are at their correct setting (par. 67*a*). Turn the exciter field rheostat knob fully counter clockwise. Check the circuit breaker to see that it is in the off position. Do not hold the starter push button in for more than 15 seconds at a time. When the engine starts, allow it to warm up at slightly faster than idling speed. *Do not race* the engine.
X	------	------	X	*Instruments, engine.* Check all instruments and gages for broken glass and secure mounting.
	X	------	------	Check all gage readings. When the engine is in full operation at governed speed, the engine instruments should read as follows: Oil pressure 35 to 45 psi. Water temperature 165° to 190° F. Oil temperature 220° to 230° F. Battery ammeter 2 to 3 amperes maximum. During the warmup period the oil pressure will rise above normal, and may drop below normal at idling speed after engine has warmed up. If the oil pressure drops below 10 psi or no pressure at all, stop the engine immediately and report the condition to the proper authority. During engine warmup the coolant temperature gage should show a gradual rise until it reaches a normal operating temperature of 165° to 190° F. When the engine is operating and the battery charge switch is in the LO position, the ammeter should indicate a ½ to 1 ampere

Intervals				PROCEDURES
Before-operation	During-operation	At-halt	After-operation	
				charge. If this rate of charge is inadequate, the charging rate can be increased to 3 amperes by placing the battery charge switch, located beneath the battery charging ammeter, to the HI position. If the battery charging ammeter indicates a zero reading with the switch in either the HI or LO position, when the engine is operating, report this condition to the proper authority.
X	------	------	X	*Instruments, generator.* Check all instruments for broken glass and secure mounting.
	X	------	------	Check all readings. When the generator is operating under load, the frequency meter should indicate 60 cycles at 1200 rpm and 50 cycles at 1000 rpm. Varying load conditions will affect the frequency meter, check the frequency meter frequently and make adjustments accordingly. Engine surging will cause the frequency reading to vary constantly. Report engine surging to the proper authority. The ammeter and voltmeter phase selector switches are used to determine the amperage and voltage readings at the output terminals. The output terminal designations are marked on the switch plates. Amperage and voltage readings are determined by turning the switches from the off position to a terminal designation. The readings must not vary more than 10 percent between the different switch positions. If abnormal readings are obtained, the load on the service lines must be redistributed to bring the readings within acceptable limits. The normal position of the switch is off. The wattmeter indicates the output of the generator in kilowatts. If the wattmeter indicates more than 100 kilowatts, the load on the service lines must be reduced to bring the wattmeter reading to 100 kilowatts or lower.
	X	------	------	*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 the unit down and report to the proper authority.
X	------	------	X	*Electrical wiring.* Check all wiring for worn, cracked, or frayed insulation, broken wires, and loose connections.

Intervals				PROCEDURES
Before-operation	During-operation	At-halt	After-operation	
			X	*Clean equipment.* Clean all dirt, oil, and grease from the exterior of the generator set. Make sure all terminal points and cables are clean and dry. See that the radiator core and guard are clean. Remove any foreign material which may have become lodged in the generator cooling louvres.
X				*Tools and equipment.* See that all tools and equipment assigned to the generator set are clean and properly stowed or mounted, and that the toolbox lid will close and fasten. Report any unserviceable tools to the proper authority.
X				*Lubrication.* Lubricate the generator set as required by LO 5–5023.
X				*Fire extinguisher.* Check the condition of the fire extinguisher and inspect for a full charge and proper mounting.
X				*Protection.* See that the generator set control panel doors and hood side panels are closed and fastened. If the generator set is not under a shelter, cover it with a suitable covering. If there is any danger of water 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.

35. Maintenance and Safety Precautions

a. Make all electrical connections before starting operation.

b. Use sandpaper only for cleaning exciter commutator and slip rings, and for seating brushes. Never use emery cloth.

c. Keep the generator clean and dry.

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

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

36. 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 as which the service is to be performed. The technical inspection column is provided for the information and guidance of personnel performing technical inspections, and constitutes the minimum inspection requirements for the equipment.

Technical inspection	Services	
	Monthly	Weekly
1	1	1
2	2	2
	2	2
3	3	3
	3	3
4	4	4

GENERAL

Before operation services. Check and perform services listed in paragraph 34.

Lubrication. Inspect the entire unit for missing or damaged lubrication fittings, oil lines, oil cups, and for indications of insufficient lubrication.

Lubricate as necessary. Refer to the current lubrication order. Replace missing or damaged fittings. Record the lubrication order number and its date of publication in the spaces provided on DA Form 464.

Tools and equipment. Inspect condition of all tools and equipment assigned to the unit. Check the condition and mounting of the toolbox and compartments.

See that all tools and equipment assigned to the generator are clean, serviceable, and properly stowed or mounted. See that toolbox is in good condition.

Fire extinguishers. Check carbon-tetrachloride type for full charge and secure mounting. Check for signs of corrosion. Inspect carbon-dioxide (CO_2) type for insecure mounting, kinked or damaged hose, and missing or broken seal. If the seal is missing or broken, the extinguisher should be weighed to determine the amount of charge; the empty and full weights are stamped on the valve body. Check date of

Technical inspection	Services		
	Monthly	Weekly	
			last hydrostatic test stamped on the cylinder just below the neck. It should not exceed 5 years.
	4	4	See that any extinguisher deficiencies are corrected or reported to the proper authority.
5	5	5	*Publications.* See that a copy of this technical manual, TB 5–5023–1, LO 5–5023, and DA Form 285 are on the equipment and in serviceable condition.
6	6	6	*Appearance.* Inspect the general appearance of the generator set, paying special attention to cleanliness, 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	-------	*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 heads, manifolds, and gaskets.* Inspect cylinder heads, manifolds, and exhaust pipe for leaks, loose bolts, and defective gaskets.
	11	11	Tighten manifolds and exhaust pipe mounting bolts and nuts if there is definite indications of looseness or leaks. Replace defective gaskets (par. 88*b* and *d*).
			On new or reconditioned engines, check all cylinder-head bolts for tightness at the first weekly service. Correct torque wrench pull is 150 to 160 foot-pounds for ⅝-inch nuts and 95 to 100 foot-pounds for ½-inch nuts. The valves must be adjusted after tightening the head bolts.
12	12	12	*Valve mechanism.* Check condition of valve mechanism and valve adjustment if excessive tappet noise or loss of power is noticed. Inspect the rocker arm cover gasket for good condition, and see that the cover fits securely.
	12	12	Adjust the valve clearance if necessary. Adjust the valves while engine is hot. The correct adjustment for both intake and exhaust valves is 0.015 inch.
14	14	14	*Crankcase, breather.* Inspect the crankcase for leaks. Check the condition and cleanness of the crankcase and breather.
	14	14	Correct or report any oil leaks noticed. If the breather is dirty, remove and service as instructed in LO 5–5023.

Technical inspection	Services	
	Monthly	Weekly
15	15	15
	15	15
16	16	16
	16	16
17	17	17
	17	17
18	18	18

Oil filters, oil cooler. With engine running, inspect the oil filters, oil cooler, and connections for oil leaks. Remove radiator filler cap and observe condition of coolant. The presence of oil in the cooling system indicates a leaking oil cooler. Check external metal oil lines for sharp bends or dents that would restrict the oil flow.

Tighten loose oil connections and repair any leaks or damaged lines. Service oil filters as recommended by LO 5–5023. Replace oil filter elements if necessary. If any indication of oil is noticed in the cooling system, report the condition to the proper authority.

Radiator. Inspect the radiator for leaks, insecure mounting, and obstructions in the core air passages. Inspect all lines and connections for leaks. Check hoses for deterioration and loose connections. Check engine operating temperature and condition of coolant. If coolant temperature remains below 170° F. or rises above 190° F. during operation, thermostats may be defective. If antifreeze is used, check the freezing point of the coolant.

Drain, flush, and refill cooling system if coolant is contaminated with rust or dirt. See that core air passages 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 the coolant from freezing, and record its freezing point on DA Form 464.

Water pump, fan and guard. Inspect the pump for leaks and for loose mounting bolts. Check the condition and mounting of the fan and guard.

Tighten or replace loose or missing bolts and capscrews, and correct misalinement. If the pump leaks, replace it (par. 82) with a new or reconditioned one.

Belts and pulleys. Inspect for worn, cracked, or frayed belts. Check the fan and supercharger belts for proper tension, and check the alinement of the pulleys. The belts are properly adjusted when they can be deflected 1 to 1¼-inch from normal position, without undue pressure at a point midway between the drive and driven pulleys.

Technical inspection	Services	
	Monthly	Weekly
	18	18
		Adjust tension of belts if necessary and correct any misalinement. Replace belts if they are frayed or badly worn. Always replace belts in sets.
20	20	20
		Governors and linkage. Inspect the limiting speed governor for loose mounting bolts. Check the overspeed governor for proper operation and adjustment.
	20	20
		Tighten or replace loose or missing bolts. Adjust the overspeed governor if necessary. Repair or replace any linkage found worn or damaged.
		FUEL SYSTEM
38	38	38
		Fuel pump and housing. Inspect the fuel transfer pump and lines for leaks. Check the pump mounting gasket for lubricating oil leaks.
	38	38
		Tighten all connections and mounting bolts. Replace pump mounting gasket if oil leak is found. Replace a defective pump.
40	40	40
		Filters. Check fuel filters for cleanliness and tightness of connections.
	40	40
		Remove the drain plugs and drain out the water sediment from the bottom of both the primary and secondary filters. Replace the plugs and vent the fuel system. Replace the elements if necessary.
41	41	41
		Air cleaner. Inspect all joints between air cleaner and supercharger and intake manifold to see if they are tight.
	41	41
		See that air cleaner is securely mounted and that all connections are tight. Service air cleaner as specified in LO 5–5023.
42	42	42
		Injection pump, and nozzles. Check fuel injection pump, breather, nozzles, and drive coupling for proper mounting. Check the condition and cleanness of breather. Check all lines and connections for leaks. If engine operates erratically, check injection nozzles for proper operation.
	42	42
		Tighten any loose or replace any missing mounting bolts and nuts. Tighten loose connections. Replace a defective nozzle. Service dirty injection pump breather.
43	43	43
		Tank, cap, and gasket. Inspect the engine fuel tank for loose mounting bolts. Check for leaks in the tank and for dirty fillercap and strainer.
	43	----------
		See that tank is securely mounted. Report any leaks in tank to proper authority. Open the draincock in bottom of fuel tank and drain

Technical inspection	Services	
	Monthly	Weekly
			out any water that may have accumulated. See that the fillercap and strainer are in place and clean.
44	44	44	*Fuel lines.* Check all fuel lines for leaks and damage.
	44	44	Repair or replace leaky or damaged fuel lines.
			ELECTRIC SYSTEM
47	47	47	*Batteries.* Inspect the batteries for cracks, leaks, loose holddown bolts or clamps, and for dirt and corrosion on top of the case. Check for loose cable connections and corroded and damaged terminals and cables. Check the level of the electrolyte; it should be about one-half inch above the plates.
			Check the electrolyte level and voltage of each cell and record the specific gravity and voltage readings on DA Form 464.
	47	47	Clean all dirt and corrosion off the top of the batteries, posts, cables, and cable terminals. Replace damaged cables. Apply a thin film of chassis grease over terminals after they are clamped tight. Add distilled water if needed but do not overfill. If freezing temperatures prevail, batteries must be charged after adding water long enough to mix solution thoroughly. See that the batteries are securely mounted and that caps are tight and vent holes are open.
48	48	48	*Starter motor.* Inspect the starter for loose mounting bolts. Inspect all external wiring connections for cleanness and secure mounting. See that the starter linkage and retracting spring are in good condition and secure.
48	48	-------	Remove the inspection cover and see if the brushes are in good condition and not excessively worn; check to see whether brushes are free in the holders and have sufficient spring tension to hold them in contact with the commutator; and that the brush-connecting wires are secure and not chafing.
	48	-------	Clean and tighten all external wiring connections and mounting bolts. Clean the commutator end of the starter if necessary.
50	50	50	*Wiring, switches.* Inspect wiring for oil-soaked, cracked, or frayed insulation; broken wires, and loose and corroded connections. Check operation of switches.
	50	50	Replace defective switches and wires. See that all wiring is clean, and that connections are clean and tight.

Technical inspection	Services	
	Monthly	Weekly
57	57	57
	57	57
58	58	58
	58	58
59	59	59
	59	59
		CONTROL SYSTEM
80	80	80
	80	80
		FRAMES AND MOUNTINGS
172	172	172

Gages. Check all gages for cracked or broken glass, loose mounting screws, and defective operation.

Tighten or replace loose or missing mounting screws. Replace damaged or defective gages.

Meters. See that the ac voltmeter, ac ammeter, wattmeter, hourmeter, frequency meter, and battery charging ammeter are mounted securely and that the glass is not cracked or broken. Check for loose connections.

Tighten loose mounting screws and connections. Replace damaged or defective meters.

Regulators and rheostats. See that the main generator regulator and rheostat controls are securely mounted. The regulator should hold a given voltage without hunting.

Replace a defective regulator. Clean rheostats if necessary to insure good contact.

Frame (hood, covers). Inspect for cracks, breaks, and damaged sheet metal, defective door or side-panel latches, and loose or missing mounting bolts and screws.

Tighten or replace all loose or missing bolts, nuts, and screws. Repair or replace defective door and side-panel latches. See that all cracks, breaks, or other damages are repaired.

GENERATOR

Armature, commutator, sliprings. Inspect all visible parts in the exciter and alternator brush compartments for an accumulation of dust, dirt, oil, and grease. Inspect the brushes for wear and loose connections. Brushes should be renewed when they are worn to one-half original length. The length of a new slipring brush is 1¼ inches, and the exciter brush is 1⅜ inches. See if the brushes move freely in the holders and make firm contact with the collector rings and commutator and if the brush springs have about equal pressure. Inspect the collector rings 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.

Technical inspection	Services	
	Monthly	Weekly
	172	172
173	173	173
174	174	--------
	174	--------

Blow dust and dirt from the inside of the generator if necessary, using compressed air, if available, of not more than 25 psi pressure. Air must be free of oil and water. See that brushes, commutator, and collector rings are clean.

Replace excessively worn or damaged brushes. See that brushes are free in the holders, that brush wires are in good condition, and that connections are tight. Adjust or replace brush springs if necessary. If sliprings or commutator are pitted or rough, or if mica is high between commutator segments, report the condition to the proper authority.

Controls, instruments, wiring. Inspect all controls and instruments on the front of the control panel to see if they 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 control, instruments, and other units that are visible from the back of control panel. *Do not remove cover from any of the instruments or controls.*

Caution: Be sure that the main circuit breaker is in the OFF psition. 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.

Clean 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.

Drive coupling. Inspect the driving disc for any signs of insecure mounting and damage.

See that driving disc is securely mounted. Check the fan for an accumulation of dust and dirt. Clean dust and dirt from the fan. If any damage to the disc is noticed, report the deficiency to the proper authority.

Section IV. TROUBLESHOOTING

37. 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. 106 to 205) pertain to operations that are the responsibility of the field and depot maintenance personnel. Organizational maintenance personnel should not proceed without proper authorization.

38. Engine Hard to Start or Fails to Start

Probable cause	*Possible remedy*
Air in fuel lines	Vent the fuel system (par. 15*b*)
Incorrect timing	Correct the timing (par. 75*c*(3))
Sheared or broken supercharger gears	Replace the gears (pars. 157–162). See note in paragraph 37.
Fuel transfer pump pressure insufficient.	Replace the fuel transfer pump (par. 72).
Dirty or clogged fuel filters	Clean the primary and secondary filters (pars. 70*b* and 71*b*).
Piston rings worn	Replace the rings (par. 174). See note in paragraph 37.
Injection pump drive coupling key sheared.	Replace key and time pump to engine (par. 75).
Fuel valves not set at proper position	Refer to the fuel diagram (9, fig. 3)
Valves pitted or warped	Reseat or replace valves (par. 98)

39. Engine Stops Suddenly

Probable cause	*Possible remedy*
Insufficient fuel or fuel lines clogged	Fill the fuel tank and vent the fuel system (par. 15*b*). Remove and blow the fuel lines clear (par. 68*a*). Remove and clean the primary and secondary fuel filter bodies and replace the cartridge (pars. 70*b* and 71*b*).
Fuel transfer pump defective	Replace the fuel transfer pump (par. 72).
Fuel injection pump coupling loose	Time pump to engine and tighten coupling (par. 75).

40. Engine Misses or Runs Erratically

Probable cause	*Possible remedy*
Air in fuel lines	Vent the fuel system (par. 15*b*).
Water in fuel	Drain fuel system and refill. Service filters (pars. 70*b* and 71*b*).

Probable cause	*Possible remedy*
Fuel filters dirty	Remove and clean the primary and secondary fuel filter bodies and replace the cartridge (pars. 70*b* and 71*b*).
Fuel delivery valve not seating properly.	Remove and clean (pars. 111–113). See note in paragraph 37.
Valve clearance incorrect	Adjust valves (par. 97*g*).
Injectors leaking or dirty	Replace or clean injectors (par. 73).
Fuel injection pump plunger sticking	Replace pump (par. 75).

41. Engine Overheats

Probable cause	*Possible remedy*
Lack of coolant	Allow engine to cool and add coolant
Fan belt slipping	Adjust fan belt (par. 78*c*(3))
Thermostats not opening	Test and replace thermostats (par. 79).
Incorrect timing	Correct the timing (par. 75*c*(3)).
Cooling system dirty or clogged	Clean and flush the cooling system (par. 77*b*).
Muffler clogged causing back pressure.	Replace muffler (par. 88*d*(6)).

42. Engine Noisy

Probable cause	*Possible remedy*
Incorrect timing	Correct the timing (par. 75*c*(3))
Excessive valve clearance	Adjust the valves (par. 97*g*)
Engine overheated	See paragraph 41
Broken piston rings	Replace the rings (par. 174). See note in paragraph 37.
Piston pins or connecting rod bearings worn.	Replace the piston pins (par. 174) or connecting rod bearings (par. 174). See note in paragraph 37.
Main bearings worn	Replace main bearings (par. 177). See note in paragraph 37.
Defective injector	Replace injector (par. 73)
Accessory mountings loose	Tighten all loose mountings

43. Engine Lacks Power

Probable cause	*Possible remedy*
Air in fuel lines	Vent the fuel system (par. 15*b*)
Clogged air cleaner	Service the air cleaner (par. 31*e*(1))
Valve clearance too close	Adjust the valves (par. 97*g*).
Worn cylinder sleeves, rings, or pistons.	Replace (pars. 174 and 175). See note in paragraph 37.
Fuel too heavy	Drain fuel system. Replace the primary and secondary filter elements (pars 70*b* and 71*b*). Refill tank with proper grade of fuel. Vent the fuel system (par. 15*b*).

44. Oil Consumption High

Probable cause	*Possible remedy*
Leaks in lubrication system	Check for leaks around the rear main seal and timing cover seal. Check all oil lines for breakage or loose connections.
Oil too light for climate	Drain the crankcase and refill with the proper grade of oil. Refer to LO 5–5023.
Main or connecting rod bearings worn	Replace bearings (pars. 174 and 177). See note in paragraph 37.
Piston rings worn or broken, or cylinder sleeves and pistons scored.	Replace (pars. 174 and 175). See note in paragraph 37.

45. Exhaust Smoky

Probable cause	*Possible remedy*
Worn piston rings	Replace the rings (par. 174). See note in paragraph 37.
Worn intake valve guides or valves not seating properly.	Replace worn valve guides and reseat the valves (par. 132). See note in paragraph 37.
Air cleaner dirty	Service the air cleaner (par. 31*e*(1)).
Leaky or dirty injectors	Replace the injectors (par. 73)
Incorrect timing	Correct the timing (par. 75*c*(3))
Fuel delivery valve stuck	Replace the injection pump (par. 75)

46. Low or No Oil Pressure

Probable cause	*Possible remedy*
Oil level low	Add oil and check for leaks
Broken oil pressure regulating valve spring or setting incorrect.	Replace the spring or adjust the valve setting (par. 151). See note in paragraph 37.
Dirty or clogged oil pump screen	Clean screen assembly (par. 150). See note in paragraph 37.
Main connecting rod, or camshaft bearings worn.	Replace main bearings (par. 177). Connecting rod bearings (par. 174) or camshaft bearings (par 181). See note in paragraph 37.
Defective oil pump	Replace or repair oil pump (pars. 150). See note in paragraph 37.

47. Starter Motor Fails to Operate

Probable cause	*Possible remedy*
Poor electrical connections	Clean and tighten the battery cables and all electrical connections to and from the starter.
Batteries discharged	Replace or recharge batteries (par. 90).
Starter commutator dirty or starter brushes worn.	Clean commutator (par. 91*b*) or replace brushes (par. 186–188). See note in paragraph 37.
Defective solenoid	Replace solenoid (par. 91)

48. Generator Fails to Build Up Rated AC Voltage

Probable cause	*Possible remedy*
Voltage regulator defective	Replace voltage regulator (par. 99)
Open circuit in exciter external wiring.	Utilize the wiring diagram (6, fig. 3) and check wiring from exciter to alternator and switchboard.
Exciter field rheostat circuit open	Check connections. Replace rheostat (par. 99).
Exciter or alternator windings open or short circuited.	Inspect, test and repair exciter (pars. 197*b*, *c*, and 198*b* and *c*). See note in paragraph 37.
Loss of residual magnetism in exciter	Raise brushes off commutator and contact a 6- or 12-volt battery to the positive and negative brushes for an instant to polarize the field.
Commutator or sliprings dirty	Clean commutator and sliprings (pars. 102 and 104).
Generator terminal box connections incorrect.	Check connections (par. 7*i*).
Brushes worn or broken	Replace exciter brushes (par 103) or alternator brushes (par. 104).

49. Generator Voltage too High

Probable cause	*Possible remedy*
Engine speed too high	Adjust the throttle
Voltage regulator not operating	Check connections. Replace regulator (par. 99).
Field resistance not correctly adjusted	Adjust exciter field rheostat (par. 12*f*) or voltage regulator rheostat (par 12*g*).

50. Erratic Voltage

Probable cause	*Possible remedy*
Generator terminal box connections loose.	Shut down the generator set and tighten loose connections (par. 7*i*).
Defective voltage regulator	Replace regulator. (par. 99)
Poor brush contact	Clean and reseat brushes (pars. 103 and 104).
High mica on exciter commutator	Undercut mica (par. 198*a*). See note in paragraph 37.
Slipring surfaces rough	Clean (par. 104)
Loose brush holder	Tighten brush holder. Check exciter brushes for neutral setting (par. 200). See note in paragraph 37.

51. Generator Overheats

Probable cause	*Possible remedy*
Generator overloaded	Reduce load
Alternator stator windings shorted	Inspect, test and repair (pars. 197*b* and 198*b*). See note in paragraph 37.
Air passages obstructed	Clean air passages
Unbalanced load	Balance the load (par. 16*a*)

Probable cause	*Possible remedy*
Voltage too high	See paragraph 49
Exciter or alternator windings shorted or open.	Repair or replace windings (par. 197*b*, *c*, 198*b* and *c*). See note in paragraph 37.

52. Flickering Lights in Service Line

Probable cause	*Possible remedy*
Loose load line connections	Tighten connections
Field winding shorted on exciter or generator.	Repair or replace winding (pars. 197*c* and 198*c*). See note in paragraph 37.
Defective alternator bearing causing uneven air gap.	Replace bearing (pars. 196–199). See note in paragraph 37.
Speed too low	Increase speed to proper frequency
Generator overloaded	Reduce load
Erratic voltage	See paragraph 50

53. Generator Noisy

Probable cause	*Possible remedy*
Defective bearing	Replace (pars. 196–199). See note in paragraph 37.
Loose field winding	Inspect and repair as required
Rotor rubbing on stator	Check coupling for loose mounting bolts and alinement.

54. Circuit Breaker Continues to Trip

Probable cause	*Possible remedy*
Short in service line	Inspect line and correct short circuit
Defective tripper assembly	Replace tripper assembly (par. 7*i*)
Defective circuit breaker	Replace circuit breaker (par. 99)
Generator overloaded	Reduce load

55. Voltmeter Fails to Register

Probable cause	*Possible remedy*
Loose or broken leads	Check wiring; tighten or replace the leads.
Blown fuse	Check wiring diagram (6, fig. 3) and replace fuse.
Defective voltmeter	Replace voltmeter (par 99)

56. Ammeter Fails to Register with Load Connected

Probable cause	*Possible remedy*
Loose or broken leads	Check the wiring and tighten or replace the leads.
Defective ammeter	Replace ammeter (par. 99)

57. Frequency Meter Does not Register

Probable cause	*Possible remedy*
Loose or broken leads	Check wiring and tighten or replace leads.
Fuse blown	Check wiring diagram (6, fig. 3) and replace fuse.
Defective frequency meter	Replace frequency meter (par. 99)

Section V. RADIO INTERFERENCE SUPPRESSION

58. Definitions

a. Radio Intereference. Radio interference is any electrical disturbance which causes an undesirable response or malfunctioning of any electronic receiver.

b. Receiver. Receiver, as used herein, includes any type of electronic equipment in which electrical disturbances may cause undesirable effects.

c. Suppression. Suppression is to minimize electrical disturbances which prevent or make difficult the reception of wanted signals and disclose the location of equipment to sensitive electrical detectors.

59. Sources of Interference

Rf (radio frequency) waves which create interference are caused by brush sparking and poor electrical contacts between stationary metal parts of the generator set.

60. Methods Used to Suppress Interference

a. Engine and Accessories. The suppression methods are as follows:

(1) Air cleaner support grounded to engine by one 8-inch binding strap.

(2) Engine grounded to subbase at mounting points and through main generator frame.

b. Terminal Box.

(1) Six 0.01 mfd, 500-volt capacitors.

(2) Two 0.1 mfd, 500-volt capacitors.

(3) Two 4-inch bonding straps.

(4) One 8-inch bonding strap.

c. Control Box.

(1) One 0.01 mfd, 500-volt capacitor.

(2) One 0.1 mfd, 100-volt, dc capacitor.

(3) Two 10-inch bonding straps.

d. Main Generator.

(1) Two 0.01 mfd, 500-volt capacitors.

(2) Two 4-inch bonding straps.

61. Effects of Suppression

A generator set that is satisfactorily suppressed will not radiate or conduct radio interference over the frequency range of 0.35 megacycles through 100 megacycles at a distance of 5 feet from the unit.

62. Suppression System Testing

a. Install a battery-powered radio receiver in good condition not more than 5 feet from the generator set. A wide band receiver is preferred which will cover the frequency range from 0.35 to 100 megacycles.

b. Start the generator set (par. 15*c*) and tune the receiver. Turn the receiver volume control to 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. A clicking sound, which varies with engine speed and ceases when the engine is shut off, is caused by poor electrical contact between adjacent metal parts of the generator set.

d. A whining sound, which varies with engine speed and continues a few seconds after the ignition is shut off, is caused by the exciter.

e. Systematically replace suppression components in the circuit causing trouble, testing after the replacement of each component to see if the trouble has been eliminated.

63. Suppression Component Replacement

a. General. When replacing suppression components, make sure the new components are of the same value and rating as the original. Tooth-type lockwashers must be used at all points where originally used by the manufacturer.

b. Replacement. Refer to paragraph 60 for the location of suppression components. All nuts, bolts, and screws must be installed in their original position with tooth-type lockwashers to insure good electrical connections.

Section VI. HOUSING

64. Description

The generator set housing consists of side panels (6, fig. 1), top panel (1), front panel (13), rear panel (8, fig. 2), access doors (5, fig. 3), and control panel doors (1, fig. 6) and (4). The control panel doors (1) and (4) allow access to the control panel (3), and the access doors (5, fig. 3) allow access to the engine and generator. The lifting fork (3, fig. 4) serves as the frame for the generator set.

65. Top, Side, Front, and Rear Panels

a. Removal.

(1) Remove the muffler (par. 88*b*).

(2) Remove the two nuts from each lifting eye (3, fig. 3) located on the inside of the top panel (1, fig. 1) and remove the lifting eyes.

(3) Remove the two bolts from the instrument panel support bracket located on the inside rear of the top panel (1).

(4) Remove the 28 screws (7) from the top panel (1) and lift off the top panel.

(5) Remove the eight screws (7) from each side panel (6) and remove side panels.

(6) Remove the six screws (7) from each side of the front panel (13) and the two screws (7) from the front of the front panel (13). Lift off the front panel.

(7) Remove the four nuts, bolts, and lockwashers located on the inside bottom of the rear panel (8, fig. 2) and remove the rear panel.

b. Cleaning, Inspection, and Repair.

(1) Wash all parts of the housing in cleaning solvent and wipe dry.

(2) Inspect all components for signs of rust, chipped paint, and dents.

(3) Hammer out dents with a soft mallet.

(4) Clean and paint rusted and chipped areas (par. 32).

(5) Oil the hinges and latch pivot points of all access doors with OE 10.

c. Installation.

(1) Place the rear panel (8, fig. 2) on the base and install the four bolts on the inside bottom of the panel and secure with the nuts and lockwashers.

(2) Place the front panel (13, fig. 1) on the base and secure with six screws (7) in each side of the front panel and two screws (7) in the front of the front panel.

(3) Place the side panels (6) in position on the base and secure with eight screws (7) in each side panel.

(4) Place the top panel (1) in position and secure with 28 screws (7).

(5) Install the two bolts in the instrument panel support bracket located on the inside rear of the top panel (1) and secure with the nuts and lockwashers.

(6) Place the lifting eyes (3, fig. 3) through the holes provided in the top panel (1, fig. 1) and secure with two $\frac{7}{8}$-inch nuts on each lifting eye.

(7) Install the muffler (par. 88*d*).

66. Lifting Fork

a. Removal.

(1) Remove the panels (par. 65*a*).

(2) Remove the four nuts and lockwashers from the cap screws (8, fig. 4) on each side of the lifting fork (3).

(3) Attach a sling through the top of the lifting fork (3) and hoist the lifting fork straight up and clear of the generator set.

b. Installation.

(1) Hoist the lifting fork (3) and lower it into position on the subbase (9, fig. 5).

(2) Position the four cap screws (8, fig. 4) on each side through the subbase and lifting fork and secure with nuts and lockwashers.

(3) Install the panels (par. 65*c*).

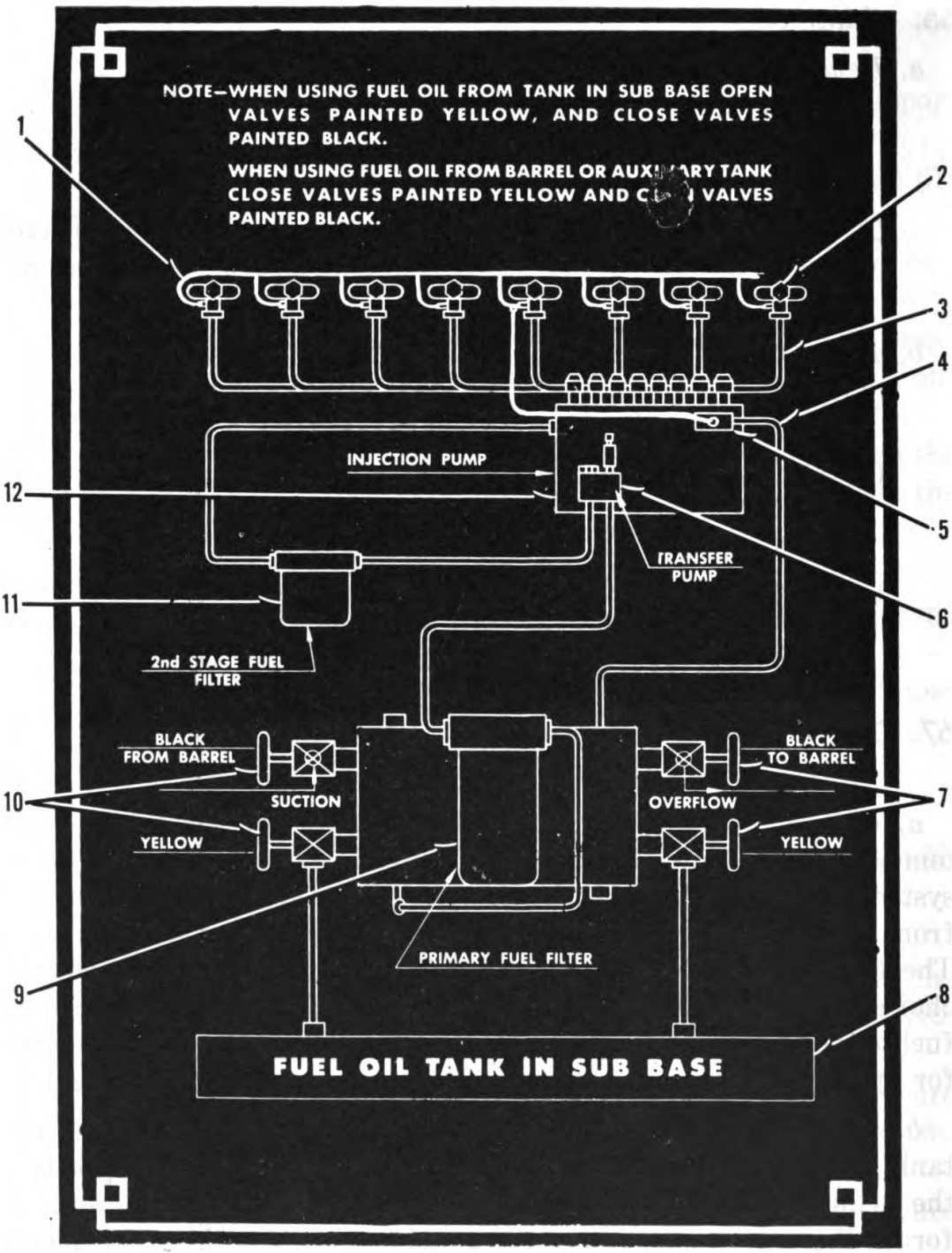
Section VI. FUEL SYSTEM

67. Description (fig. 23)

a. General. The fuel system consists of a low-pressure supply system with a fuel transfer pump (6) and a high-pressure injection system activated by the fuel injection pump (12). Fuel is drawn from a tank (8) mounted within the unit or from an external source. The fuel suction valves (10) and fuel return valves (7) permit a choice of fuel supply. The system cleans and controls the flow of fuel to the engine. All parts of the fuel system are readily accessible for operation, servicing, and preventive maintenance in the field.

b. Low-Pressure Supply System. Fuel is drawn from the fuel tank (8) or external source through the suction valves (10) through the primary filter (9) to the transfer pump (6). From there, it is forced through the secondary filter (11) to the fuel injection pump (12). An overflow valve (5) bypasses surplus fuel in the injection pump back to the return valves which return it to the source of supply.

c. High-Pressure Injection System. The high-pressure system consists of an injection pump (12), injection lines (3), fuel injectors (2), and the nozzle drip tube (1). Fuel, under pressure from the injection pump, is delivered to the combustion chambers through the injection lines and injectors. Surplus fuel from the injectors is bypassed back to the fuel return line (4) through the nozzle drip tube (1).



FB 5023-23

1	Nozzle drip tube	5	Overflow valve	9	Primary filter
2	Fuel injector	6	Fuel transfer pump	10	Fuel suction valves
3	Fuel injection lines	7	Fuel return valves	11	Secondary filter
4	Fuel return line	8	Fuel tank	12	Fuel injection pump

Figure 23. Fuel system diagram.

68. Fuel Lines and Valves

a. Fuel Lines (fig. 23). The main fuel lines are braided flexible hose with a male fitting at one end and a swivel nut at the other. Fittings between the hoses and components of the fuel system are brass. The injection lines (3) are thick-walled tubes with a union

nut at each end. The nozzle drip tube (1) is one-quarter inch copper tubing.

(1) *Removal.* Use open-end wrenches to make and break connections. Never use pliers, as the fittings, lines, or tubes will be damaged. Avoid bending metal tubes that are to be reinstalled. When removing lines with swivel nuts, hold the adjacent fitting with one wrench and unscrew the swivel nut with a second wrench.

(2) *Cleaning and inspection.*

(*a*) Clean fuel lines with an approved solvent and blow clear with compressed air.

(*b*) Inspect fuel lines for cracks or breaks and bends.

(*c*) Inspect flared ends of tubing for splitting.

(*d*) Replace broken, cracked, or split fuel lines.

(3) *Installation.* When installing the fuel lines, line up the fittings properly to avoid cross-threading. When a line on the high pressure system has been removed it will be necessary to vent the system, paragraph 15*b* (5 and 6). Start the engine and check for leaks.

b. Fuel Valves (fig. 24). The fuel suction valves (7 and 8) and return valves (3 and 4) are gate-type valves. Turn the valves counterclockwise to close. When fuel is supplied from the unit fuel tank (5), open the return valve (4) and suction valve (7). Close valves (3 and 8). When using fuel from an auxiliary source, connect the auxiliary fuel suction line to the suction valve (8) and connect the auxiliary return line to the return valve (3). Close valves (4 and 7).

(1) *Removal.* Disconnect the fuel lines at the valve. Turn the valve counterclockwise to remove.

(2) *Cleaning, inspection, and repair.*

(*a*) Remove the packing and clean the valve with an approved cleaning solvent. Dry thoroughly.

(*b*) Inspect the packing for breaks. Replace the packing if it is broken, hard, or brittle.

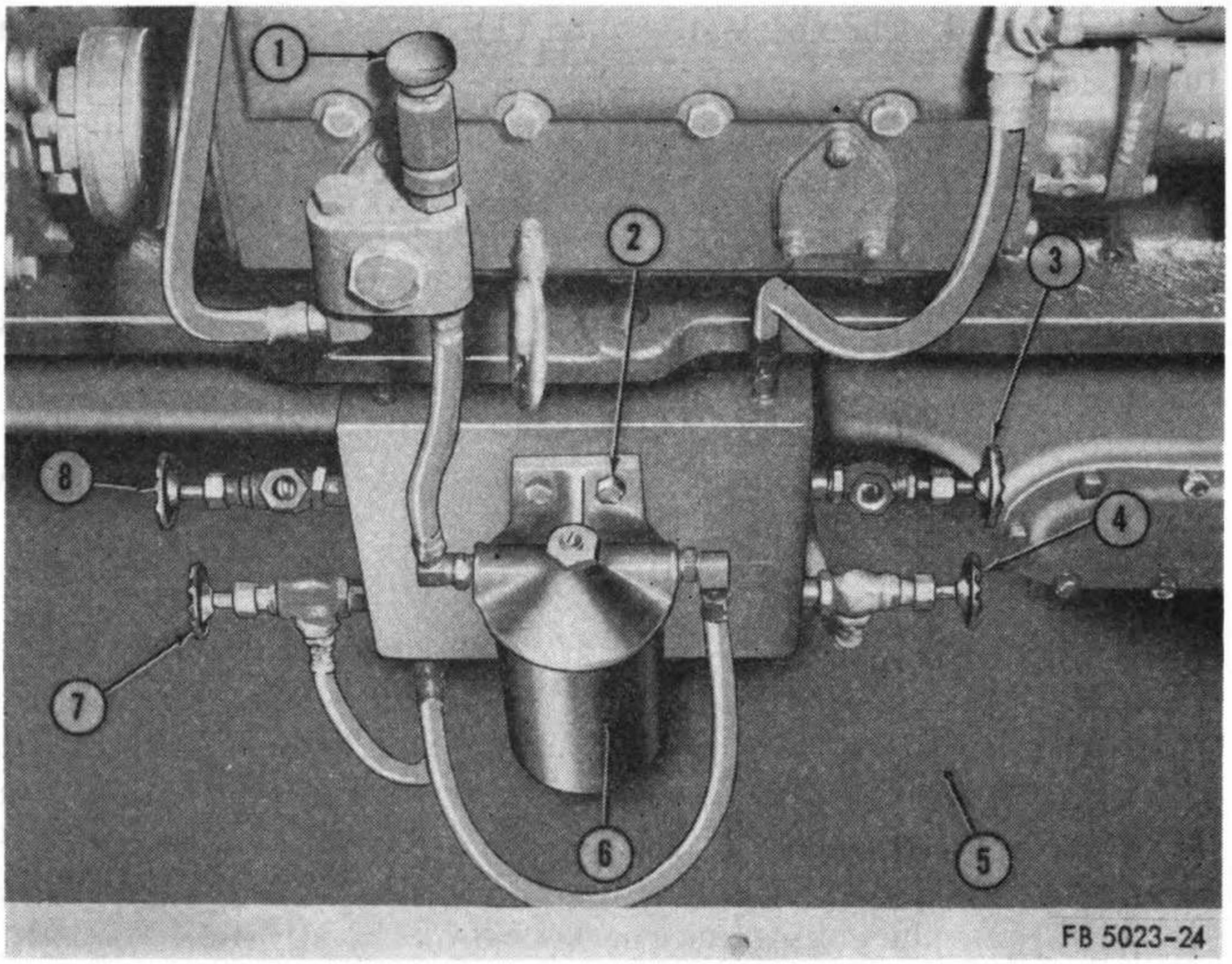
(*c*) Check the valve for damaged threads. Replace if necessary.

(3) *Installation.*

(*a*) Line up the valve properly to avoid cross threading. Turn the valve clockwise to install.

(*b*) Connect the fuel lines to the valve.

(*c*) Open the valve by turning the valve handle counterclockwise. Operate the hand primer (1, fig. 24) and check for leaks.



1 Hand primer
2 Cap screw, ⅜ x 2 NC
3 Auxiliary fuel return valve
4 Unit tank return valve
5 Fuel tank
6 Primary filter
7 Unit tank fuel suction valve
8 Auxiliary fuel suction valve

Figure 24. Fuel valves.

c. Overflow Valve (fig. 23). The overflow valve (5) is mounted on the fuel injection pump (12). It maintains a set pressure in the pump manifold and bypasses surplus fuel to the pump return line.

(1) *Removal.* Disconnect the fuel return line (4) and unscrew the valve (5) from the injection pump (12).

(2) *Cleaning and inspection.* Remove the valve screw, spring, and valve from the body. Wash all parts in cleaning solvent. If the valve is worn or the spring is defective, replace the entire assembly. Reassemble the valve, spring, and screw, in the valve body.

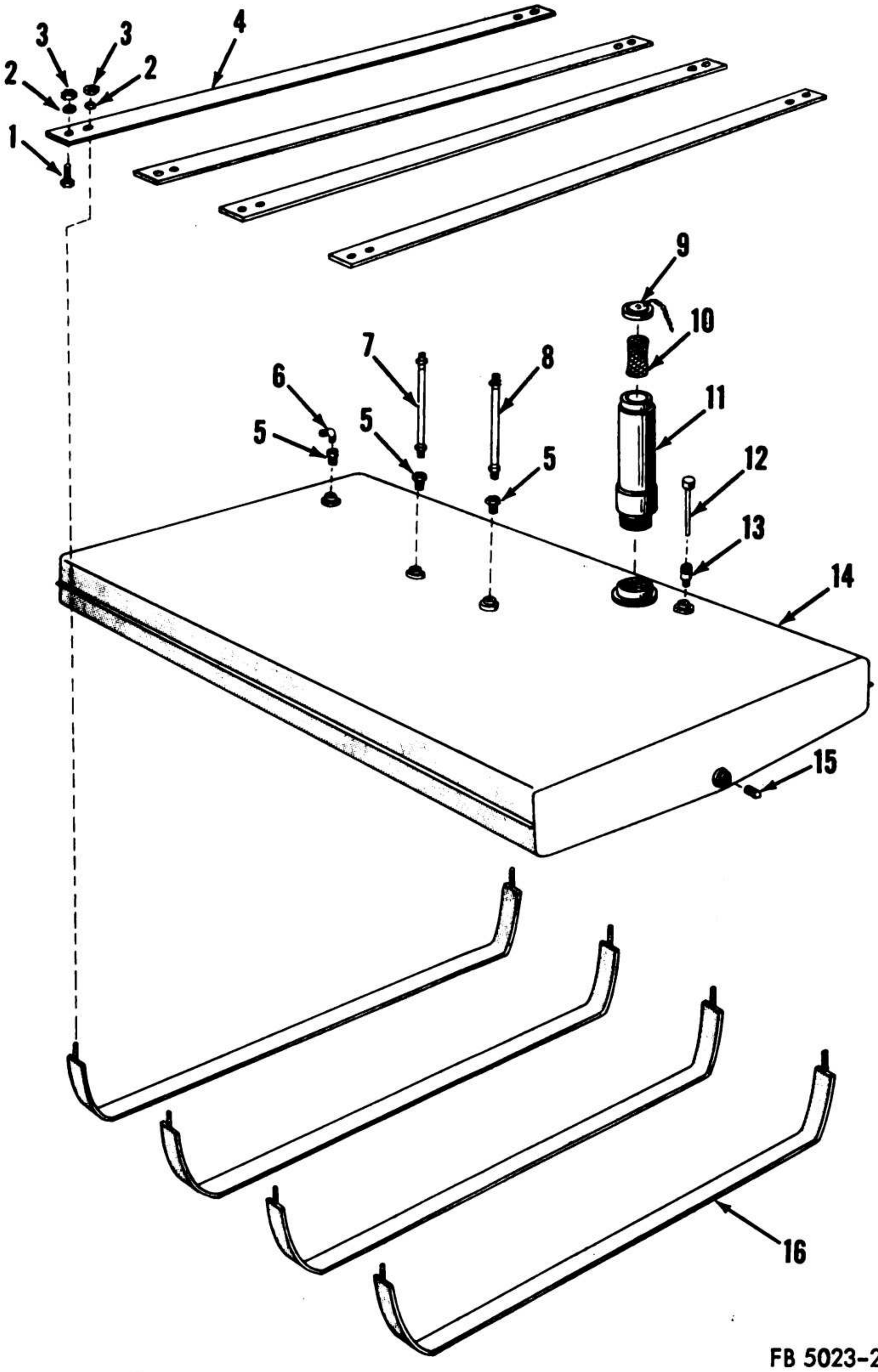
(3) *Installation.* Screw the overflow valve (5) in the injection pump and connect the fuel return line (4).

69. Fuel Tank

a. Description. The fuel tank (5, fig. 24) is located in the subbase. It is equipped with a strainer (10, fig. 25) in the filler pipe, a level gage (12) and drain plug (15).

b. Removal.

(1) Remove the drain plug (15, fig. 25) and drain the fuel tank.



FB 5023-25

1	Cap screw, ⅜ x 1¾ NC (8 rqr)	9	Cap, with chain
2	Lockwasher, ⅜ (16 rqr)	10	Strainer
3	Nut, hex, ⅜ NC (16 rqr)	11	Filler pipe
4	Support bar	12	Level gage
5	Reducer, ¼ x ⅛ (3 rqr)	13	Nipple
6	Elbow	14	Fuel tank
7	Fuel tank return line	15	Drain plug
8	Fuel suction line	16	Strap assembly

Fuel 25. Fuel tank, exploded view.

(2) Disconnect the fuel lines (7) and (8) at the return valve (4, fig. 24) and suction valve (7). Remove the lines (7 and 8, fig. 25) from the fuel tank (14). Remove the filler pipe (11).
(3) Disconnect the fuel line from the air heater pump at the elbow (6).
(4) Remove one nut (3), lockwasher (2), and cap screw (1) from each end of the support bar (4). Remove one nut (3) and lockwasher (2) from each end of the strap assembly (16).
(5) Remove the six screws (7, fig. 1) from the gas tank access cover (14) and remove the cover.
(6) Slide the support bars (4, fig. 25) and fuel tank (14) out through the front of the generator set.
(7) Remove the straps (16) from the subbase.

c. Disassembly (fig. 25).

(1) Remove the elbow (6) and the 3 reducers (5).
(2) Remove the level gage (12) and nipple (13).
(3) Remove the cap (9) and strainer (10) from the filler pipe (11).

d. Cleaning, Inspection, and Repair (fig. 25).

(1) Clean all parts and fittings in an approved cleaning solvent. Dry thoroughly.
(2) 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.
(3) Use a wire brush to clean scale and rust from the outside, particularly along the seams.
(4) Inspect the reducers (5), elbow (6), filler pipe (11), nipple (13), and drain plug (15) for damaged threads. Inspect the threads on the strap assembly (16) for damage. Repair or replace parts as necessary.
(5) To test for leaks, plug all openings and submerge the tank in water. Apply air pressure, not over 25 psi, to the tank through the filler pipe opening. Leaks will be indicated by air bubbling up through the water.
(6) Clean the area around the leak and remove all plugs or adapters before welding or soldering.
(7) Retest for leaks before installing.
(8) Dents in the tank can often be popped out by the application of air pressure. Do not use more than 25 psi.

e. Reassembly (fig. 25).

(1) Install the strainer (10) and cap (9) on the filler pipe (11).

(2) Install the nipple (13) and level gage (12) in the fuel tank (14).
(3) Install the drain plug (15), and the 3 reducers (5) in the fuel tank (14).
(4) Install the elbow (6) in the reducer (5) at the rear of the fuel tank.

f. Installation (fig. 25).

(1) Place the straps (16) and fuel tank (14) in the subbase.
(2) Place the support bars (4) in position, alining the hole in the support bar with the hole in the bracket on the subbase. Install the cap screw (1), lockwasher (2) and secure with the nut (3) at each end.
(3) Position the strap assembly (16), alining the strap with the hole in the support bar (4).
(4) Install the lockwasher (2) and secure with the nut (3).
(5) Position the gas tank access cover (15, fig. 1) in place, and secure with the six screws (7).
(6) Connect the fuel line from the air heater pump to elbow (6, fig. 25).
(7) Install the fuel lines (7) and (8) in the tank (14). Connect the lines (7) and (8) to the return valve (4, fig. 24) and suction valve (7).
(8) Fill the tank, and check for leaks.

70. Primary Filter

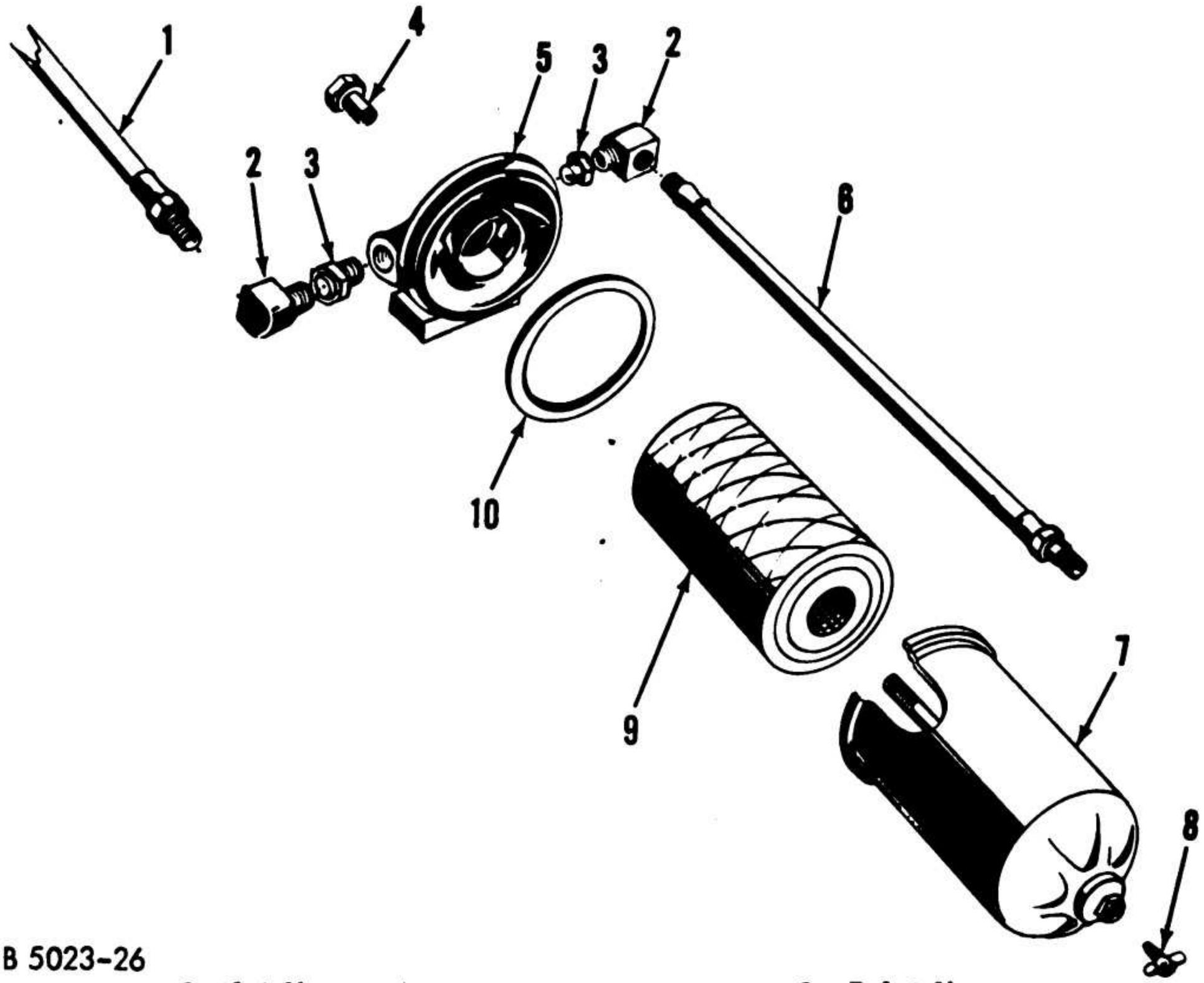
a. Description. The primary filter (6, fig. 24), is bracket mounted below the injection pump. The cartridge is replaceable and is the absorbent type.

b. Servicing (fig. 26).

(1) Open the draincock (8) and drain the filter.
(2) Unscrew the cover nut (4) and remove the shell (7), element (9), and gasket (10). Discard the gasket (10).
(3) Clean the shell (7) in an approved cleaning solvent. Blow dry with compressed air. Replace the element.
(4) Using a new gasket (10), install the gasket, element (9), and shell (7) in the head (5) and secure with the cover nut (4).
(5) Close the draincock (8) and vent the fuel system (par. 15*b*).

c. Removal.

(1) Open the draincock (8) and drain the filter.
(2) Disconnect the outlet line (1) and inlet line (6) at the elbows (2).



FB 5023-26

1	Outlet line	6	Inlet line
2	Elbow, pipe to tube	7	Shell assembly
3	Reducer, ½ x ⅜ (2 rqr)	8	Draincock
4	Cover nut	9	Element
5	Head, fuel filter	10	Gasket

Figure 26. Primary fuel filter, exploded view.

(3) Remove the two cap screws (2, fig. 24) and remove the filter (6).

d. Disassembly (fig. 26).

(1) Unscrew the cover nut (4) and remove the shell (7), element (9), and gasket (10). Discard the gasket (10) and element. Remove the draincock (8).

Note. Before removing or installing the elbows (2), install a tube nut in the female end to prevent damage to the threads.

(2) Secure the head (5) in a vise. Remove the elbows (2), and reducers (3). Remove the head (5) from the vise.

e. Cleaning and Inspection.

(1) Clean all parts in an approved cleaning solvent and blow dry with compressed air.

(2) Inspect all threaded surfaces for damaged threads. Replace parts as necessary.

f. Reassembly (fig. 26).

(1) Secure the head (5) in a vise. Install the reducers (3) and elbows (2). Remove the head (5) from the vise.

(2) Using a new gasket (10), install the gasket, element (9),

and shell (7) in the head (5). Secure with the cover nut (4). Install the draincock (8).

g. Installation (fig. 24).

(1) Position the filter (6) on the bracket and secure with the two cap screws (2).

(2) Connect the fuel lines and vent the fuel system (par. 15*b*).

71. Secondary Filter

a. Description. The secondary filter (5, fig. 17) is mounted on the cylinder block just above the injection pump. The cartridge is replaceable and is the absorbent type.

b. Servicing (fig. 27).

(1) Remove the drainscrew (12) and drain the filter.

(2) Remove the 4 cap screws (4) and lockwashers (3). Separate the shell (11), element (13) and gasket (15) from the head (2). Discard the gasket (15).

(3) Refer to paragraph 70*b*(3) for cleaning instructions.

(4) Using a new gasket (15), install the gasket, element (13), and shell (11) in the head (2) and secure with the 4 cap screws (4) and lockwashers (3).

(5) Install and tighten the drainscrew (12) and vent the fuel system (par. 15*b*).

c. Removal (fig. 27).

(1) Remove the drainscrew (12) and drain the filter.

(2) Disconnect the inlet line (10) at the elbow (7). Disconnect the outlet line (14) at the injection pump and unscrew the outlet line from the elbow (1).

(3) Remove the two nuts (8) and lockwashers (9). Remove the filter.

d. Disassembly (fig. 27).

(1) Remove the 4 cap screws (4) and lockwashers (3). Separate the shell (11), element (13), and gasket (15) from the head (2). Discard the gasket (15).

(2) See note following paragraph 70*d*(1) before removing the elbow (7).

(3) Secure the head (2) in a vise. Remove the elbows (7) and (1), reducer (6), and vent screw (5). Remove the head from the vise.

e. Cleaning and Inspection. Refer to paragraph 70*e* for the cleaning and inspection.

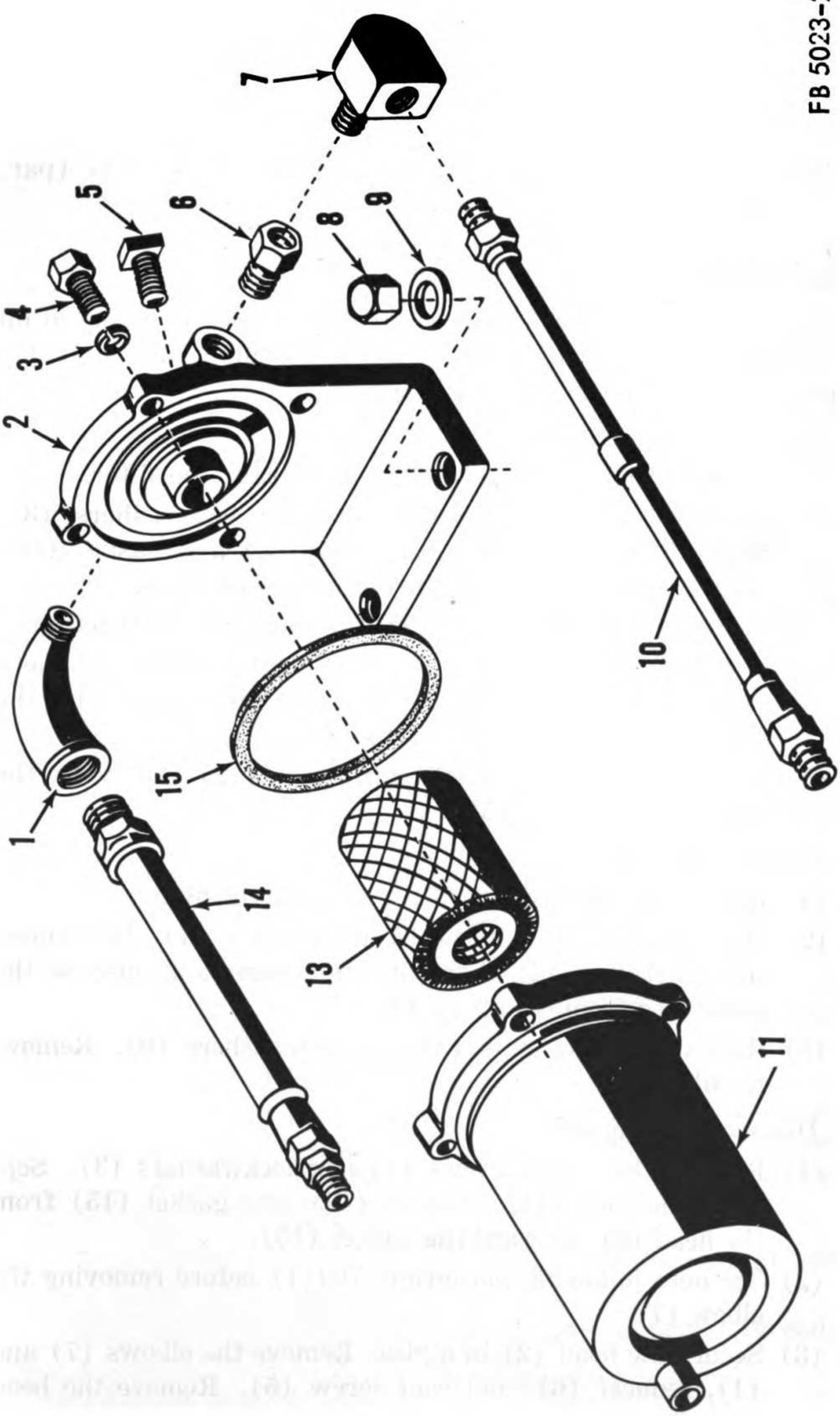


Figure 27. Secondary fuel filter, exploded view.

1 Elbow
2 Head
3 Lockwasher, ¼ (4 rqr)
4 Cap screw, ¼ x 1¼ NC (4 rqr)
5 Vent screw
6 Reducer
7 Elbow
8 Nut, hex, ½ NC (2 rqr)
9 Lockwasher, ½ (2 rqr)
10 Inlet line
11 Shell
12 Drainscrew
13 Element
14 Outlet line
15 Gasket

Figure 27—Continued.

f. Reassembly (fig. 27).

(1) Secure the head (2) in a vise. Install the reducer (6), elbows (7 and 1), and vent screw (5). Remove the head from the vise.

(2) Using a new gasket (15), install the gasket, element (13), and shell (11) on the head (2). Secure with the four cap screws (4) and lockwashers (3).

(3) Install and tighten the drainscrew (12).

g. Installation (fig. 27).

(1) Position the filter on the cylinder block and secure with the nuts (8) and lockwashers (9).

(2) Connect the inlet line (10) to the elbow (7). Screw the pipe-thread end of the outlet line (14) into the elbow (1), and connect the swivel end to the elbow at the injection pump.

(3) Vent the fuel system (par. 15*b*) and check for leaks.

72. Fuel Transfer Pump (fig. 17)

a. Description. The transfer pump (13) is mounted on the injection pump housing and is operated by the injection pump camshaft. The transfer pump consists of a plunger type pump and a hand-operated, plunger type primer (16).

b. Testing. Many troubles with the fuel supply system attributed to the transfer pump (13) may be traced to such causes as clogged fuel filter or lines, leaks at the fuel line connections, air in the system or a defective overflow valve.

(1) Connect a pressure gage with a range of 0 to 30 psi at the outlet side of the transfer pump (13).

(2) Start the engine (par. 15).

(3) If the pressure is less than 10 psi and the other probable sources of trouble mentioned above have been checked, replace the pump.

c. Removal.

(1) Disconnect the fuel lines at the transfer pump (13).

(2) Remove three nuts and lockwashers attaching the transfer pump to the injection pump (12).

(3) Remove the transfer pump and gasket.

d. Installation.

(1) Place a new gasket and the transfer pump (13) on the studs of the injection pump (12) and secure with the three lockwashers and nuts.

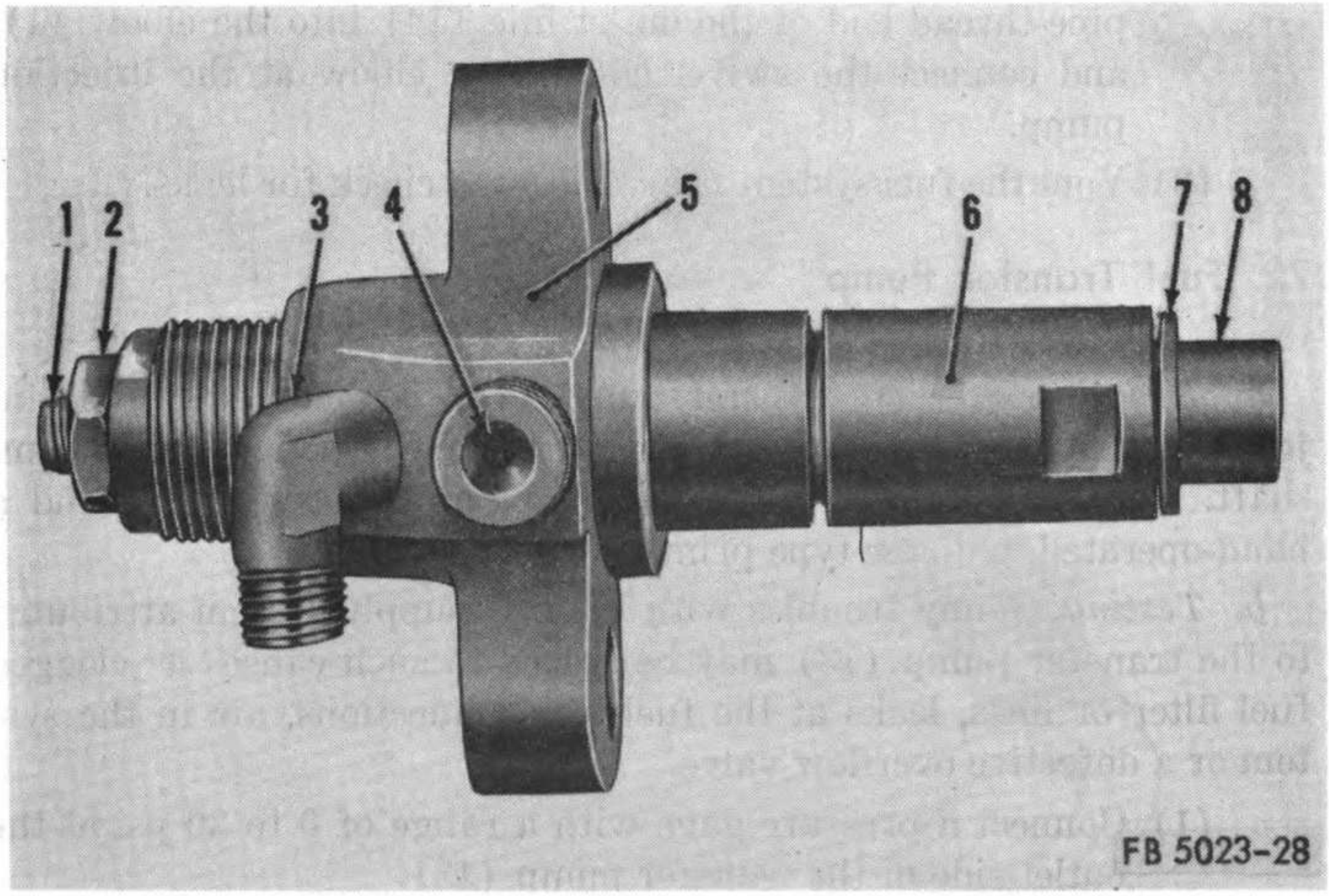
(2) Connect the fuel lines and vent the fuel system (par. 15*b*).

73. Fuel Injectors

a. Description. The injectors direct a definite spray pattern of fuel into the engine combustion chambers. They are of the self-cleaning pintle type, and are operated hydraulically by the pressure of the delivered fuel. Excess fuel within the injectors is returned through the nozzle drip tube elbow (3, fig. 28).

b. Testing.

(1) A rough test to isolate an injector that is not working properly can be performed while the engine is running at idling speed.



1 Adjusting screw
2 Locknut
3 Nozzle drip tube elbow
4 Fuel inlet
5 Holder
6 Cap nut
7 Gasket
8 Nozzle

Figure 28. Fuel injector with protection cap removed.

(2) Loosen one injection line at the injector, allowing fuel to escape and preventing it from entering the injector.
(3) Notice the engine performance and tighten the line.
(4) Repeat for each injector in turn. The one least affecting engine performance is the defective injector.

c. Removal.

(1) Wash the outside of the injector (2, fig. 17) with solvent or fuel oil.
(2) Disconnect the nozzle drip tube at the elbow (3, fig. 28) and injection line at the fuel inlet (4).
(3) Remove two nuts (4, fig. 17) and lockwashers, and pull the injector and gasket (7, fig. 28) out of the cylinder head, being careful not to strike the end of the nozzle (8) against any hard surface.

d. Cleaning (fig. 28).

(1) Clean the carbon from the exposed surfaces of the injector 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 between the gasket (7) and cylinder head seat will cause the assembly to be cocked and permit blowby of combustion gases.

e. Installation.

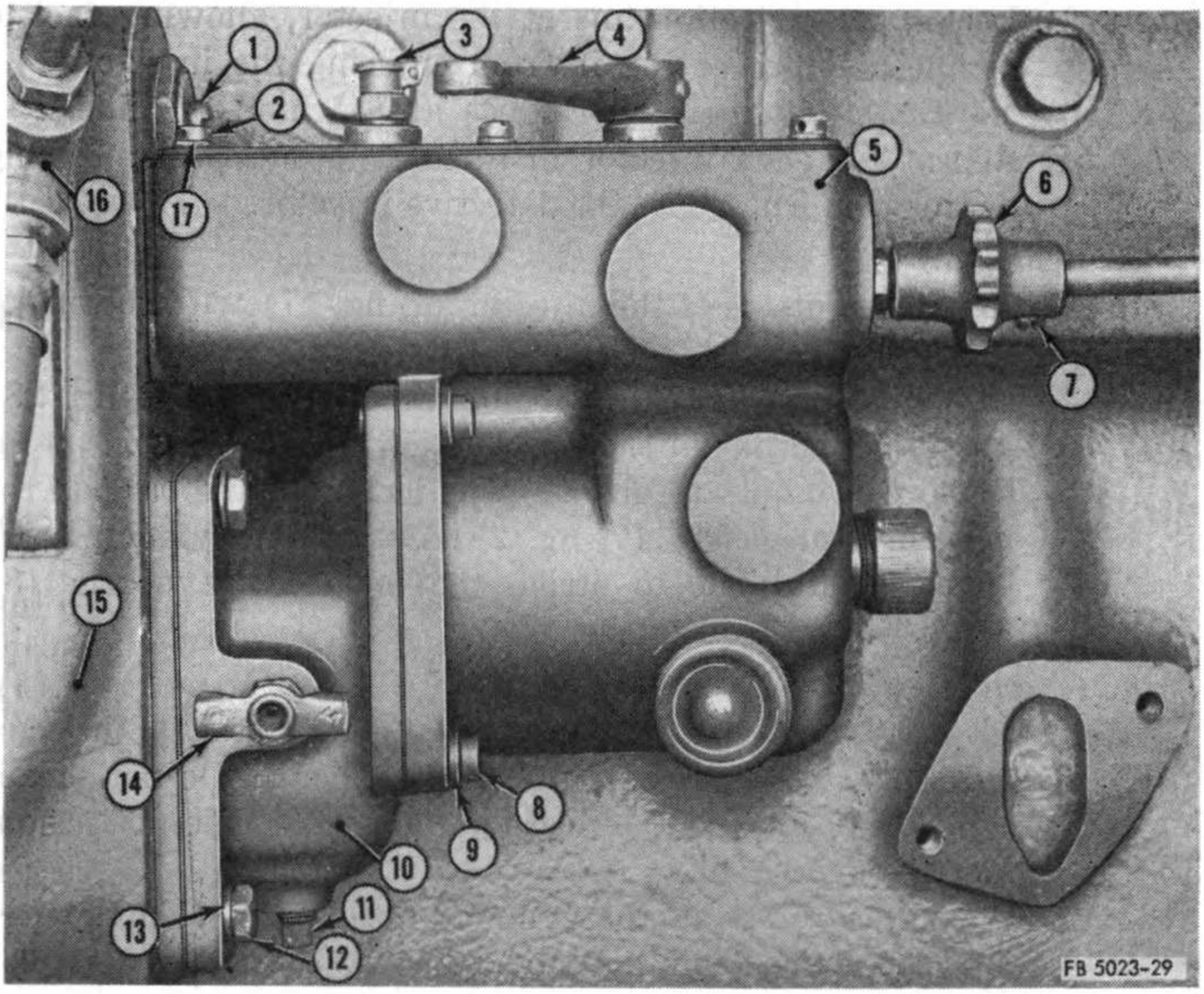
(1) Place the gasket (7) on the nozzle (8) and insert the injector carefully so that the nozzle does not strike the seating surface and raise a bur.
(2) Secure the injector with the nuts (4, fig. 17) and lockwashers.
(3) Connect the injection line to the fuel inlet (4, fig. 28) and the nozzle drip tube to the elbow (3).

74. Engine Speed Governor

a. Description. The engine speed governor (fig. 29) is of the mechanical, constant-speed type, located at the rear of the fuel injection pump. The governor controls and maintains the engine speed of 1,200 rpm regardless of engine load. The governor is driven from a gear attached to the fuel injection pump camshaft.

b. Removal.

(1) Remove the drain plug (11) and drain the governor.
(2) Disconnect the throttle control rod (9, fig. 17) at the speed adjusting knob (6, fig. 29) by removing the setscrew (7)



1	Screw, fil hd, #10–24 x ⅜ (1 rqr)	9	Lockwasher, ¼ (4 rqr)
2	Screw, drilled hd, #10–24 x ⅜ (6 rqr)	10	Governor adapter
3	Oil cup	11	Governor drain plug
4	Stop control lever	12	Cap screw, ⅜–16 x ⅞ (4 rqr)
5	Governor body	13	Lockwasher, ⅜ (4 rqr)
6	Speed adjusting knob	14	Oil level draincock
7	Setscrew	15	Injection pump housing
8	Screw, rd-hd, ¼–28 x ¾ (4 rqr)	16	Overflow valve
		17	Lockwasher, #10 (7 rqr)

Figure 29. Engine speed governor, installed view.

and sliding control rod (9, fig. 17) out of the speed adjusting knob (6, fig. 29).

(3) Disconnect the stop control rod (7, fig. 17) at the stop control lever (4, fig. 29).

(4) Remove the six machine screws (2) and lockwashers (17). Remove the machine screw (1) and remove the governor cover.

(5) Disconnect the fuel control rack located inside the governor body (5) by removing the spring clip and clevis pin.

Note. Control rack must be disconnected before governor can be detached from the fuel injection pump.

(6) Remove the four machine screws (8) and lockwashers (9) attaching the governor body (5) to the governor adapter (10). Remove the governor and its gasket. Discard the gasket.

(7) Remove the four cap screws (12) and lockwashers (13) securing the assembled adapter (10) to the injection pump housing (15). Remove and discard gasket.

c. Installation.

(1) Install a new gasket and secure the adapter (10) to the fuel injection pump housing (15) with the four cap screws (12) and lockwashers (13).

(2) Install the drain plug (11).

(3) Using a new gasket, install the governor body (5) to the adapter (10) and secure with the four machine screws (8) and lockwashers (9).

(4) Connect the fuel control rack located inside the governor body (5) with the clevis pin and spring clip.

(5) Install the governor cover to the governor body (5) with the six machine screws (2) and lockwashers (17). Install machine screw (1) and lockwasher securing the cover to the injection pump housing (15).

(6) Connect the stop control rod (7, fig. 17) at the stop control lever (4, fig. 29).

(7) Connect the throttle control rod (9, fig. 17) at the speed adjusting knob (6, fig. 29) by sliding the control rod (9, fig. 17) in the speed adjusting knob and securing with the setscrew (7, fig. 29).

(8) Fill the governor with the prescribed lubricant (LO 5–5023) and check the lubricant level by observing the flow at the oil level draincock (14).

75. Fuel Injection Pump

a. Description. The fuel injection pump (12, fig. 17) is mounted on the left side of the engine and is driven through a coupling (14) and the accessory drive (15) from the timing gear housing. It is a positive-displacement, multiple-plunger type pump. Fuel enters the pump through the fuel inlet, and the pump plunger injects measured quantities of fuel through injection lines (18) to the injector (2). Clean all external parts to the pump thoroughly before removal.

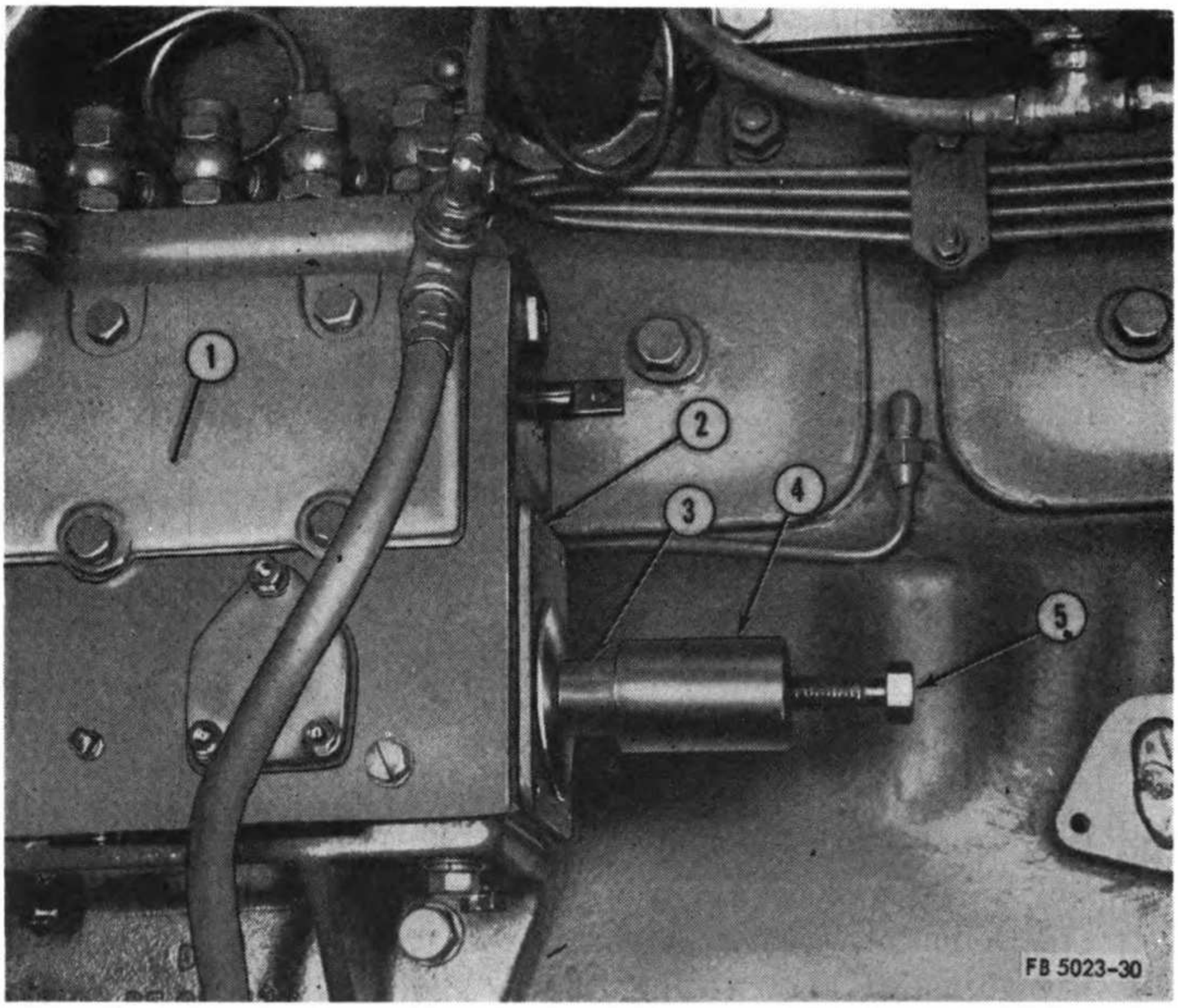
b. Removal.

(1) Remove the fuel transfer pump (par. 72*c*).

(2) Remove the overflow valve (par. 68*c*(1)).

(3) Remove the engine speed governor (par. 74*b*).

(4) Remove the nut and flat washer from the pump camshaft. Pull the governor gear and rubber bushing from the camshaft.



1 Fuel injection pump
2 End plate
3 Gear spacer
4 Puller
5 Puller screw

Figure 30. Removing camshaft gear spacer.

(5) Remove the spacer (3, fig. 30) from the camshaft by threading the puller (4) over the threads of the spacer. Turn the puller screw (5) clockwise and draw the spacer (3) from the pump camshaft.

(6) Disconnect the injection lines (18, fig. 17) at the delivery valve holders (6) and immediately tape or cover pump openings to prevent the entrance of dirt.

(7) Place marks on both hubs and the intermediate disk of the coupling (14) so they can be properly alined when the pump is installed.

(8) Remove the four cap screws (11) and lockwashers attaching the pump bracket to the cylinder block and remove the assembled pump and intermediate disk of the coupling (14).

(9) Remove the nut and lockwasher attaching the rear hub of the coupling (14) to the pump camshaft and use a puller to remove the hub. Remove the key from the camshaft.

(10) To separate the pump (12) and bracket, remove the six cap screws, lockwashers, and plain washers from the pump and bracket assembly.

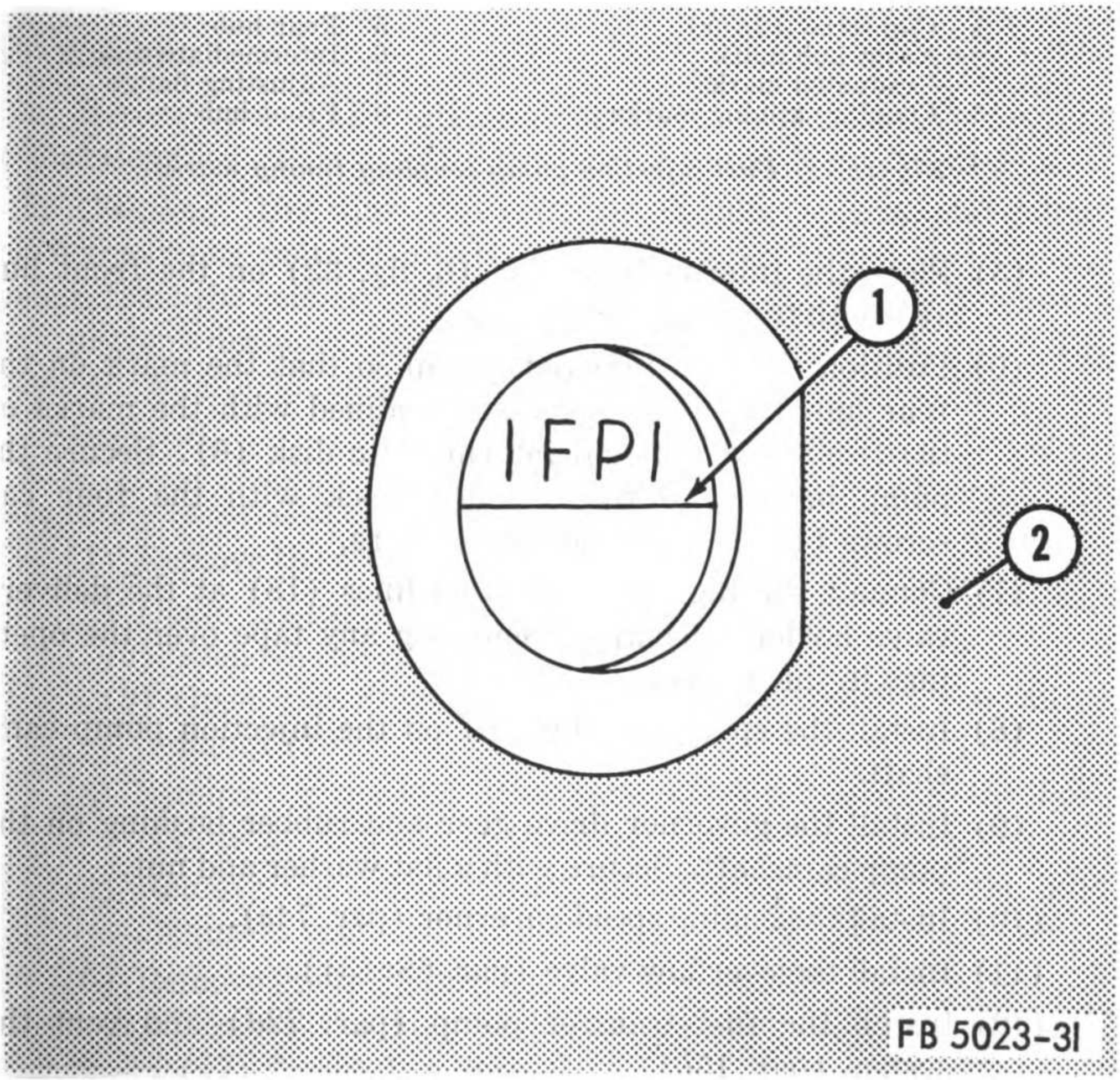
c. Installation.

(1) Attach the bracket to the pump (12) and secure with the six cap screws, lockwashers, and plain washers.

(2) Place the woodruff key in the injection pump camshaft recess, and press on the rear hub of the coupling (14). Secure with the nut and lockwasher.

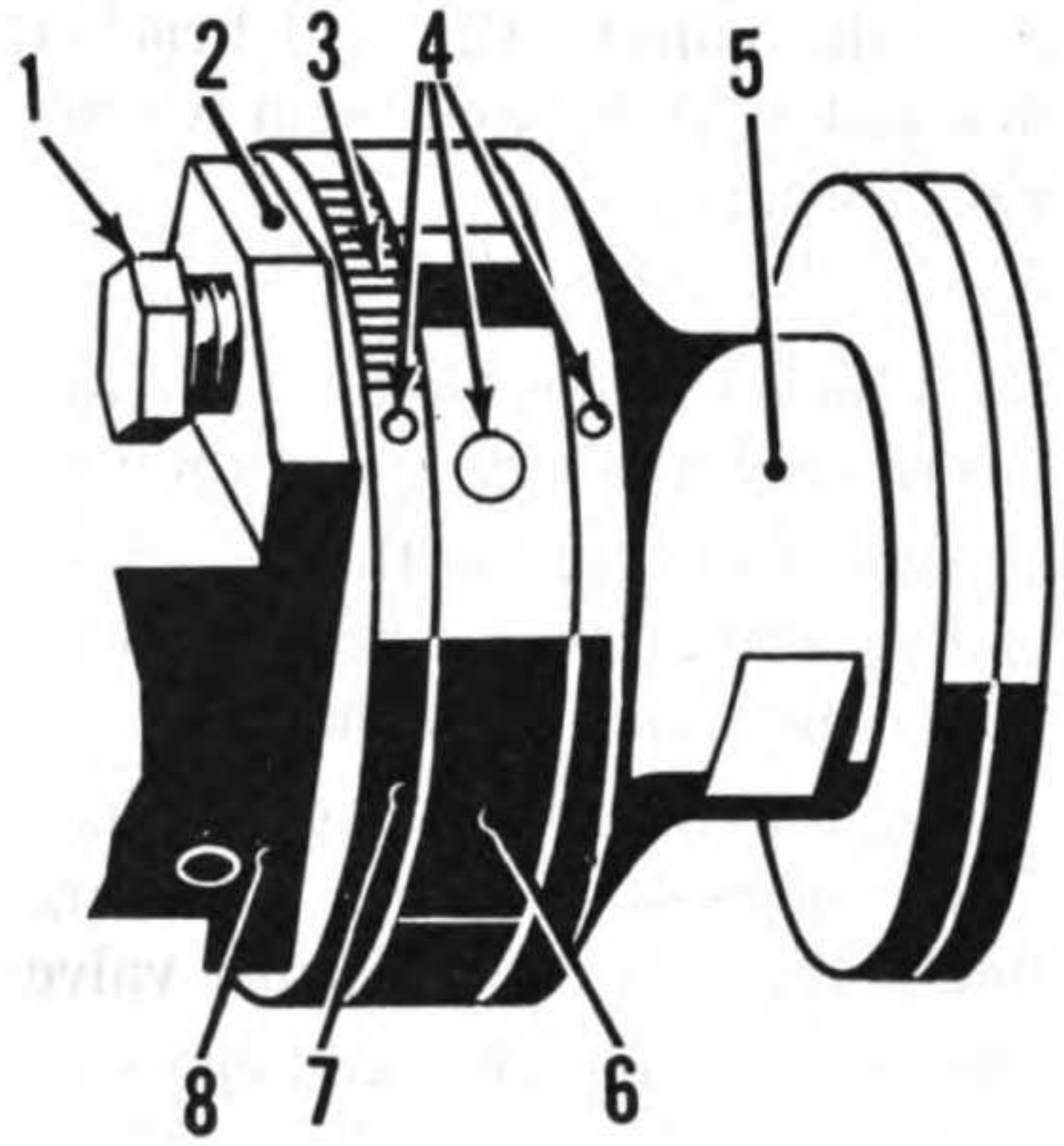
(3) Rotate the engine by hand using a cranking bar until number 1 piston nears the end of the compression stroke at which time both intake and exhaust valve will be closed.

(4) Remove the timing hole plug and check to see that the fuel injection pump timing mark (fig. 31) is centered in the hole.



1 Fuel pump timing mark
2 Flywheel housing

Figure 31. Fuel injection pump timing mark on flywheel.



FB 5023-32

1 Cap screw (2 rqr)
2 Front hub mark
3 Graduated marks
4 Coupling alining marks
5 Rear hub
6 Intermediate disk
7 Adjusting flange
8 Front hub

Figure 32. Fuel injection pump coupling timing marks.

(5) Place the intermediate disk (6, fig. 32) on the front hub (8) with the marks (4) in line.

(6) Position the fuel injection pump so that the mark on the rear hub (5) of the coupling is alined with the marks on the front hub (8) and intermediate disk (6). Secure the pump bracket to the cylinder block with the four cap screws (11, fig. 17) and lockwashers.

(7) Connect the high pressure fuel lines (18) at the delivery valve holders (6) after removing any tape over the openings in the holders.

(8) Install the spacer (3, fig. 30) on the injection pump camshaft.

(9) Install the governor drive gear and rubber bushing on the pump camshaft. Secure with a flat washer and nut.

(10) Install the engine speed governor (par. 74*c*).

(11) Install the overflow valve (par. 68*c*(3)).

(12) Install the fuel transfer pump (par. 72*d*) and vent the system (par. 15*b*).

Section VIII. COOLING SYSTEM

76. Description

The engine is cooled by means of a liquid cooling system having a capacity of 62 quarts. The system consists of the following components: radiator (3, fig. 33) mounted on the subbase assembly at the front of the engine; centrifugal water pump (10) for circulating the coolant through the engine and radiator; three thermostats housed in the water outlet manifold (13) protected by the thermostat housing cover (14) located at the front of the water outlet manifold; and the necessary coolant hose and tubing to conduct the flow of coolant throughout the system. The system also consists of a fan guard (17), fan shroud (4), fan and fan belts. When the coolant temperature reaches 165° F., the thermostats open allowing the heated coolant to flow through the radiator (3). Only a portion of the coolant flows through the bypass tube (12) after the thermostats have opened.

77. Radiator

a. Description. The radiator is of unit construction and cannot be disassembled. It is used to dissipate the heat from the coolant.

b. Cleaning. Use approved radiator cleaning solvent and follow the instructions marked on the container label. Drain the cooling system from the coolant outlet tube (7, fig. 33) since foreign deposits may prevent drainage from coolant drain valve (8). Refer to TM 9–850 for additional cleaning instructions.

c. Removal.

Note. **If any leaks are noticed during operation, mark the location of the leaks before removing the radiator.**

(1) Remove the front housing and panels (par. 65*a*).

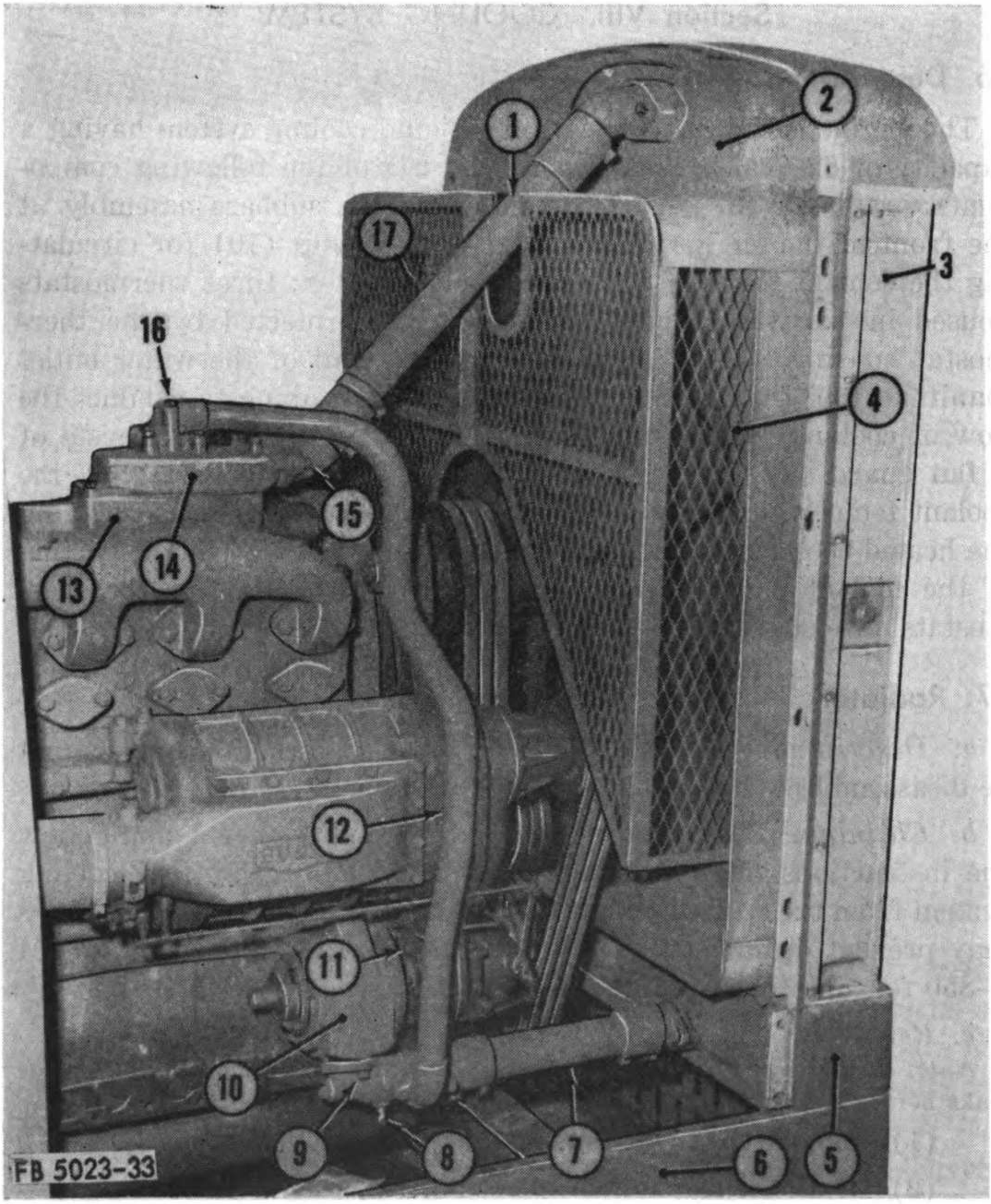
(2) Drain the radiator in the following manner:
  (*a*) Remove the radiator fill cap.
  (*b*) Open the drain valve (8) located beneath the water pump (10).

(3) Remove the coolant inlet tube (1) by loosening the hose clamps at each end of the tube.

(4) Remove the coolant outlet tube (7) by loosening the hose clamps at each end of the tube.

(5) Remove the fan guard (17) as follows:
  (*a*) Remove the nuts and washers securing the fan guard (17) to the fan shroud (4).
  (*b*) Remove the guard by lifting up and away from the radiator assembly.

Note. **Be careful not to damage the fan blades.**



1	Coolant inlet tube	10	Water pump
2	Upper tank	11	Nut, hex, ⅜ NF (6 rqr)
3	Radiator	12	Coolant bypass tube
4	Fan shroud	13	Water outlet manifold
5	Lower tank	14	Thermostat housing cover
6	Subbase	15	Nut, hex, ⅜ NC (2 rqr)
7	Coolant outlet tube	16	Capscrew, ⅜ x 2¾ NC (2 rqr)
8	Coolant drain	17	Fan guard
9	Capscrew, ⅜ x 1¼ NC (2 rqr)		

Figure 33. Cooling system components, removal points.

(6) Remove the fan blade assembly in the following manner:

(*a*) Remove the six cap screws and lockwashers securing the fan blade assembly to the fan pulley.

(*b*) Slide the fan blade assembly slightly ahead and lift off the dowel pins.

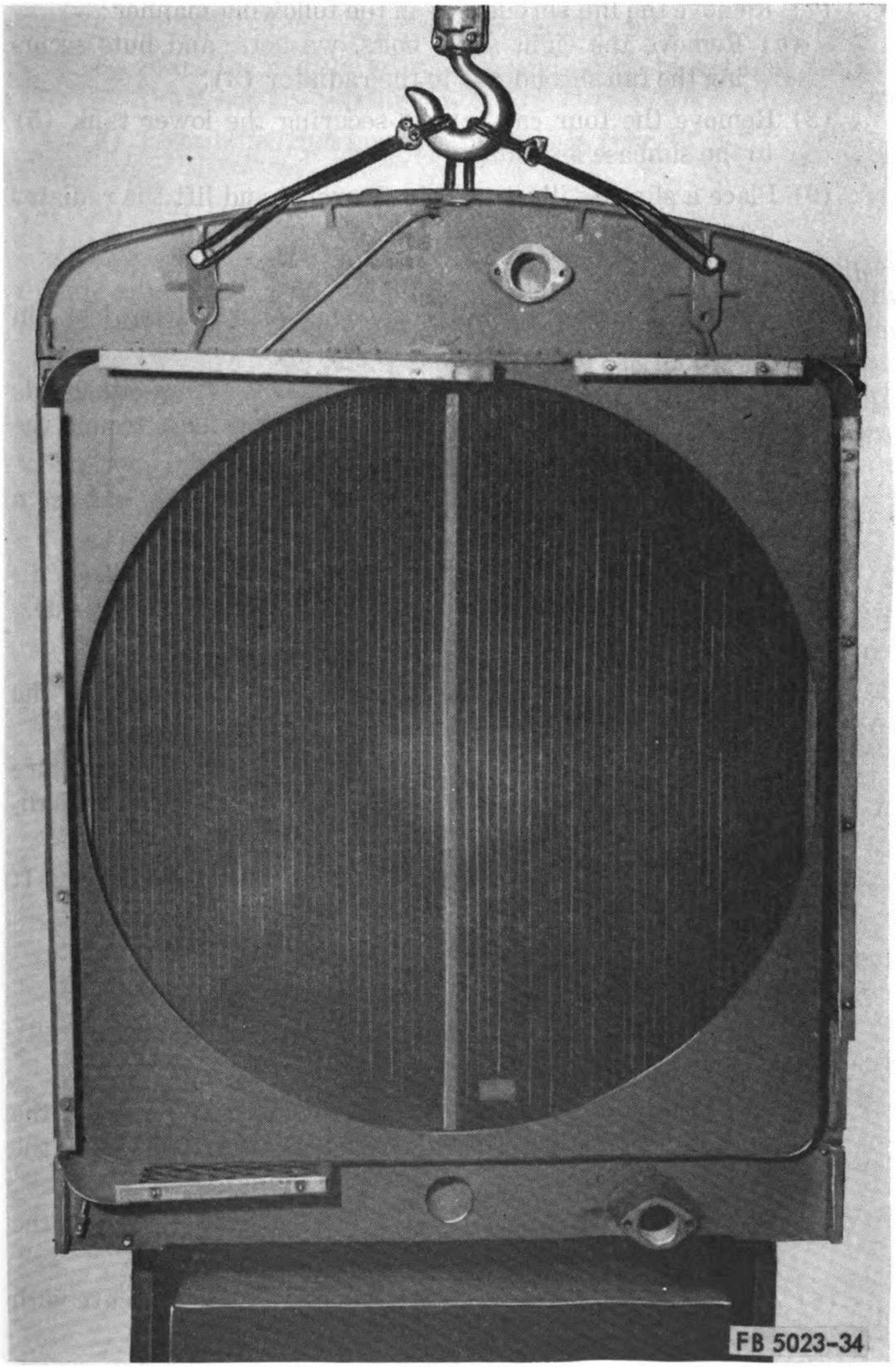


Figure 34. Removing radiator.

(7) Remove the fan shroud (4) in the following manner:
  (*a*) Remove the eight stove bolts, washers, and nuts securing the fan shroud (4) to the radiator (3).

(8) Remove the four cap screws securing the lower tank (5) to the subbase assembly (6).

(9) Place a sling as illustrated in figure 34 and lift the radiator assembly from the subbase.

d. Radiator Repair.

(1) Locate the marks made before removal indicating leaks in the radiator.

(2) Solder all minor leaks which are accessible from either side of the radiator using acid flux to clean the area around the leak before soldering.

(3) Clean the radiator with a soft bristle brush. *Do not use a wire brush.*

(4) Use compressed air to clean radiator core air passages directing the blast through the radiator from the front side.

e. Testing.

(1) Plug the inlet, outlet, and the overflow tube and place the radiator in a tank of water.

(2) Wrap a cloth around an air hose and apply low pressure air (10 to 15 psi) at the filler pipe. Leaks will be indicated by air bubbling up through the water.

(3) Solder or braze leaks in the core or tank (*d* above). If radiator is beyond repair, replace the radiator.

(4) See that the overflow tube is not mashed or broken.

f. Installation.

(1) Attach slings (fig. 34) and position the radiator (3, fig. 33) on the subbase (6).

(2) Aline the holes in the lower tank (5) with the holes in the subbase assembly (6) and secure the radiator with the four $\frac{5}{8}$-inch cap screws. Remove the sling.

(3) Secure the fan shroud (4) to the radiator (3) with the eight stove bolts, washers, and nuts.

(4) Install the fan using the dowel pins as a guide. Secure with the six cap screws and lockwashers.

(5) Position the fan guard (17) against the fan shroud (4) alining the holes in the guard over the studs on the shroud. Secure with the twelve nuts and lockwashers.

(6) Install the coolant inlet tube (1) and coolant .outlet tube (7) and secure with the hose clamps.

(7) Close the drain valve (8) beneath the water pump (10) and fill the cooling system. Install the fillercap.

(8) Start the engine (par. 15*c*) and check to see that none of the hoses are leaking.

(9) Install the front housing and panels (par. 65*c*).

78. Fan and Fan Hub Assembly

a. General. The fan is driven off the crankshaft pulley by belts, forcing air through the radiator and thus cooling the circulating water. It has eight blades that are connected to a ball bearing pulley hub revolving around a pulley shaft, the rear end of the shaft having a holding spacer and keyed locknut. An adjusting screw runs through the fan bracket and a threaded hole in the spindle shaft, the operation of which tightens or loosens the fan belt tension.

b. Fan Removal. Refer to paragraph 77*c* (1) through (6).

c. Supercharger and Fan Belt Adjustment.

(1) *General.* There are seven belts on the equipment. Four of the belts drive the superchargers and three belts drive the fan assembly.

(2) *Supercharger belt adjustment.*

Note. Proper adjustment is when the belts (8) can be deflected 1 to 1¼ inches at a point midway between the supercharger drive pulley (10) and crankshaft pulley.

(*a*) Loosen the swivel locking bolt (5, fig. 35).

(*b*) To increase belt tension, raise the idler pulley (7) assembly and lock in position by tightening the swivel locking bolt (5).

(*c*) To decrease belt tension, lower idler pulley (7) assembly and lock in position ((*b*) above).

(3) *Fan belt adjustment.*

(*a*) The fan belt is properly adjusted when it can be deflected 1 to 1¼ inches at a point midway between the crankshaft pulley and fan pulley.

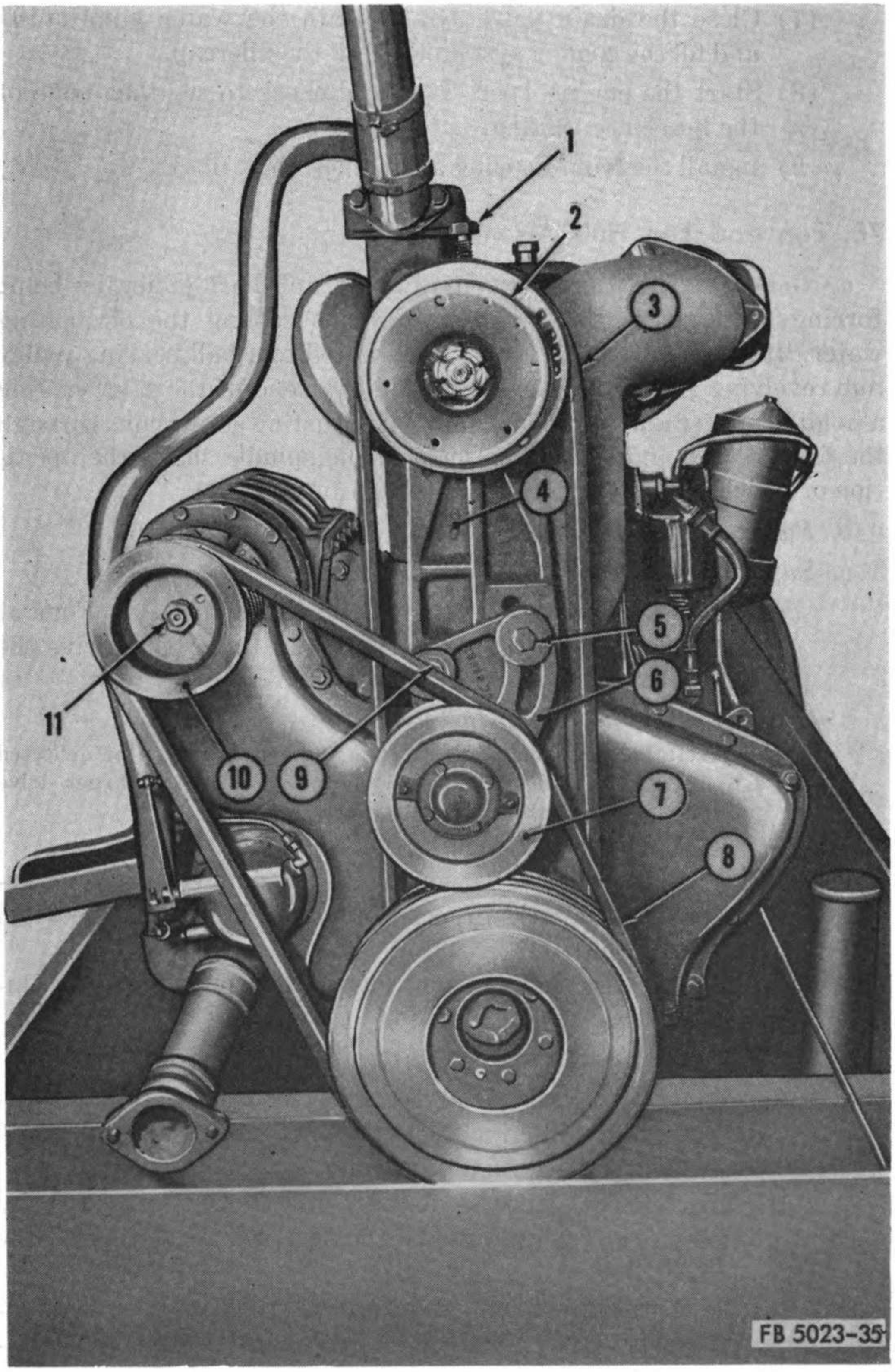
(*b*) Increase or decrease tension on the fan belts (3) by loosening the locknut on the fan belt adjusting screw (1).

(*c*) To increase tension, turn adjusting screw counterclockwise. To decrease tension, turn adjusting screw clockwise.

(*d*) Tighten the locknut.

d. Supercharger Belt Replacement.

(1) Decrease tension on the supercharger belts (8). Refer to *c* (2) above.



1	Fan belt adjusting screw	7	Idler pulley
2	Fan hub	8	Supercharger belts
3	Fan belts	9	Swivel bracket retaining nut
4	Fan bracket	10	Supercharger drive pulley
5	Swivel locking bolt	11	Retaining nut
6	Swivel bracket		

Figure 35. Fan and supercharger belt adjustment points.

(2) Lift belts from around supercharger drive pulley (10) and crankshaft pulley. If any belt is defective, replace all four belts.

(3) Adjust supercharger belts (*c*(2) above).

e. Fan Belt Replacement.

(1) Remove supercharger belts (*d* above).

(2) Loosen locknut on fan belt adjusting screw (1).

(3) Decrease belt tension and lift fan belts from around fan pulley and crankshaft pulley. If any belt is defective, replace all three belts.

(4) Adjust belt tension (*c*(3) above).

f. Fan Hub.

(1) *Removal.*

(*a*) Remove the fan (par. 77*c*(1)–(6)).

(*b*) Loosen the nut (31, fig. 36) and unscrew the adjusting screw (32) lockwasher (30) out of the spindle (24).

(*c*) Remove the rear clamp nut (29) and washer (28) to separate the bracket (27) and the hub (9).

(2) *Disassembly.*

(*a*) Remove the cap screws (22) and lockwashers (29) securing the spacer (15) and spacer gasket (14) to the hub (9).

(*b*) Pull the cotter pin (12), unscrew the bearing clamp nut (13), and remove the washer (11).

(*c*) Press the spindle (24) and bearing cone (6) out of the hub (9). Press the spindle out of the bearing cone.

(*d*) Remove the front bearing cup (7) out of the hub (9).

(*e*) Remove the snap ring (1), seal retainer (2), seal (3), washer (4), and gasket (5) from the hub (9).

(*f*) Pull the rear bearing cone (6) and cup (7) out of the hub.

(3) *Inspection.*

(*a*) Check the fan blade assembly (19) for bent blades or cracks. If the blades cannot be brought back to their original position, or if cracks have developed, replace the assembly.

(*b*) Examine the bearing cones (6) and bearing cups (7) for signs of scoring or wear. Replace bearing cup and cone as an assembly if replacement is necessary.

(*c*) Check the spindle (24) and adjusting screw (32) for stripped or damaged threads. Replace if threads are damaged or stripped.

1 Snap ring
2 Seal retainer
3 Cork seal
4 Washer
5 Gasket
6 Bearing cone
7 Bearing cup
8 Belt
9 Hub
10 Plug, pipe, ⅛
11 Front clamp washer
12 Pin, cotter, ⅛ x 1¾
13 Bearing clamp nut
14 Spacer gasket
15 Blade spacer
16 Blade dowel
17 Snap ring
18 Blade gasket
19 Fan blade assembly
20 Cap screw, $\frac{5}{16}$ x 1½ NC (6 rqr)
21 Lockwasher, $\frac{5}{16}$ (6 rqr)
22 Cap screw, ⅜ x ½ NC (6 rqr)
23 Lockwasher, ⅜ (6 rqr)
24 Spindle
25 Cap screw, ½ x 1½ NC (4 rqr)
26 Lockwasher, ½ (4 rqr)
27 Fan bracket
28 Rear clamp washer
29 Rear clamp nut
30 Lockwasher, ⅝ (1 rqr)
31 Nut, hex, ⅝ NC (1 rqr)
32 Adjusting screw
33 Bracket brace
34 Washer, flat, $\frac{7}{16}$ (2 rqr)
35 Lockwasher, $\frac{7}{16}$ (2 rqr)
36 Cap screw, $\frac{7}{16}$ x 1 NC (2 rqr)

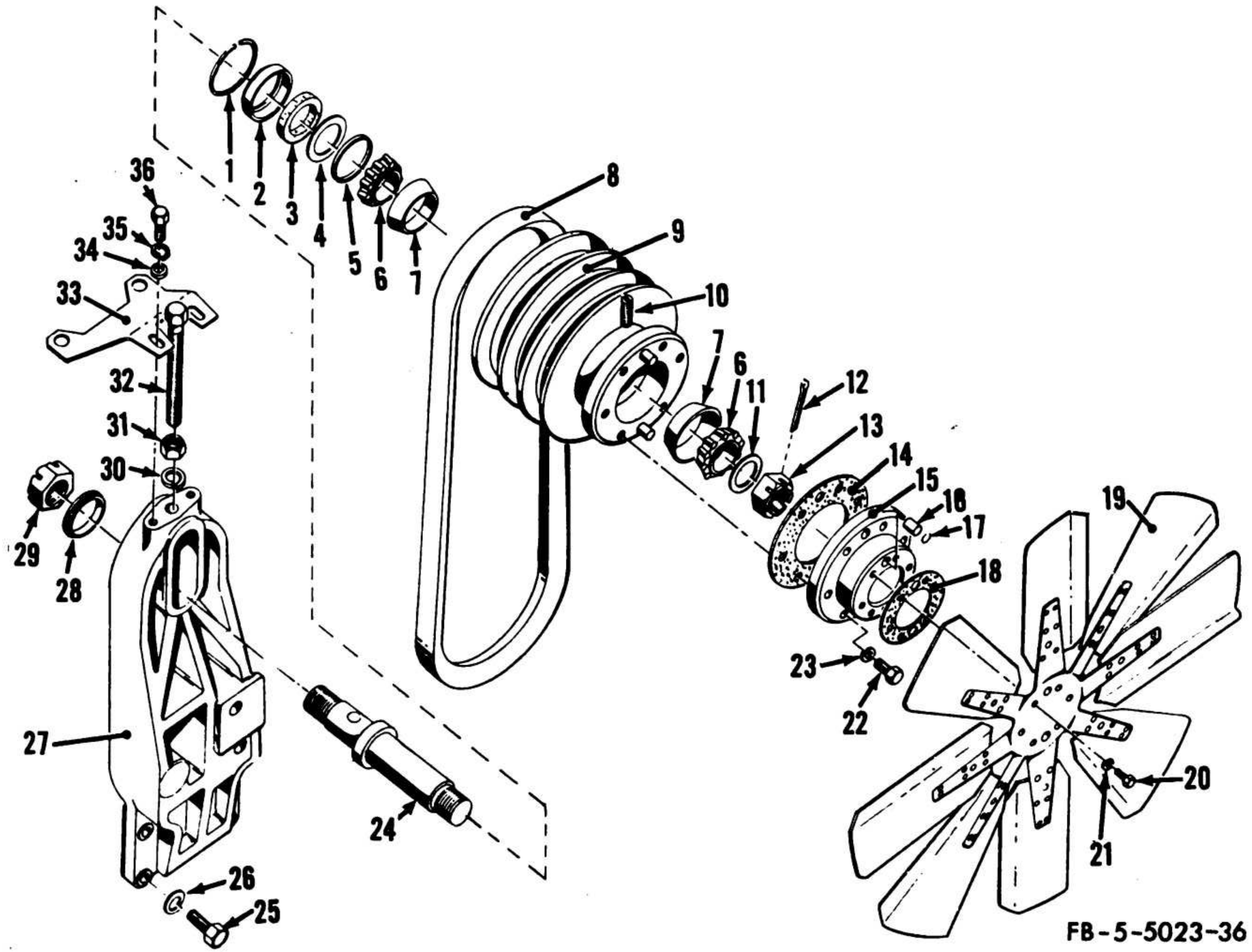


Figure 36. Fan assembly, exploded view.

(*d*) Check the oil seal assembly (2–5) for signs of leakage or wear. Replace the entire assembly if any component is defective.

(4) *Reassembly.*

(*a*) Install the bearing cups (7) in the hub (9).

(*b*) Repack the bearing cones (6) and cups (7). Refer to LO 5–5023 for approved lubricant.

(*c*) Press back bearing cone against shoulder on spindle (24). Install spindle and bearing in the hub (9).

(*d*) Install front bearing cone (6). Make sure the bearing cone seats in the cups properly.

(*e*) Secure the front bearing with washer (11), clamp nut (13), and cotter pin (12). Rotate the hub to make sure it does not bind on spindle.

(*f*) Install gasket (5), washer (4), seal (3), seal retainer (2) and snap ring (1) in the rear of the hub.

(*g*) Attach the gasket (14) and spacer (15) to the hub with the cap screws (22) and lockwashers (23).

(5) *Installation.*

(*a*) Install the hub assembly in the bracket (27) and secure with washer (28) and clamp nut (29).

(*b*) Install the adjusting screw (32) with lockwasher (30) and locknut (31) on the screw and to the spindle (24). Tighten the locknut (31).

(*c*) Install the fan belts (*e* above) and adjust (*c*(3) above).

(*d*) Install the fan (par. 77*f*(4)–(9)).

79. Thermostats

a. Description. The thermostats (5, fig. 37) are located in a housing which is integral with the front water outlet manifold (4). When the engine is cold, the coolant is forced to flow in the bypass line (12, fig. 33) and return to the water pump (10) bypassing the radiator (3).

b. Removal.

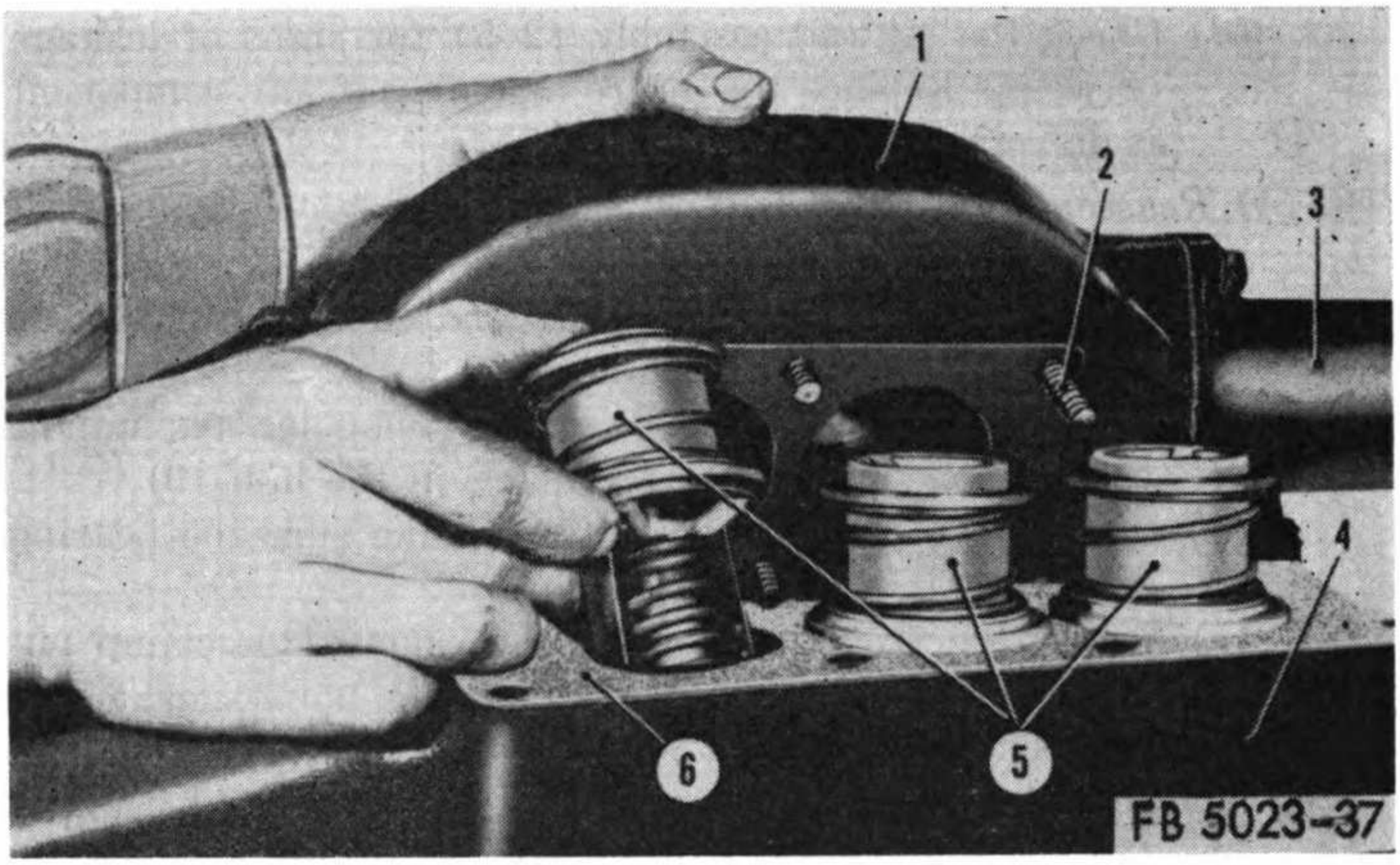
(1) Drain the cooling system (par. 77*c*(2)).

(2) Connect the bypass tube (12, fig. 33) by removing cap screws (16) and the cap screws at the lower end of the bypass where it is secured to the water pump inlet.

(3) Disconnect the inlet tube (1) by loosening the hose clamps nearest the thermostat housing cover (14).

(4) Remove the cap screw (2, fig. 37) and remove the thermostat housing cover (1) and gasket (6).

(5) Remove the thermostats (5).



1 Thermostat housing cover
2 Cap screw (8 rqr)
3 Flanged elbow
4 Water outlet manifold
5 Thermostats
6 Gasket

Figure 37. Removing thermostats.

c. Testing. Each time a thermostat is removed because of improper engine operating temperature, test the thermostat in the following manner before it is replaced.

(1) Suspend the thermostat by a piece of wire in a large container of water so that it is completely submerged and 1 or 2 inches from the bottom.

(2) Suspend a thermometer in the water so that the bulb is at the same level as the thermostat element.

(3) Heat the water slowly and stir it frequently to normalize the temperature.

(4) If the valve *does not* open at 165° F., replace the thermostat.

(5) If the valve does not open ½-inch to $^{9}/_{16}$-inch from its seat in boiling water, replace the thermostat.

d. Installation.

(1) Place the thermostats (5, fig. 37) in the thermostat housing at the front of water outlet manifold (4).

(2) Use a new gasket (6) and install the thermostat housing cover (1). Secure with cap screws (2).

Note. Place the cap screws (2) in their correct location as observed on removal.

(3) Connect the inlet tube (1, fig. 33) and tighten the hose clamp nearest the thermostat housing.

(4) Install the bypass tube (12) and secure with cap screws (16). Connect the lower end of the bypass tube with cap screws where the tube is connected to the water pump inlet.
(5) Fill the coolant system and start the engine (par. 15*c*). Check for leaks.

80. Idler Pully Assembly

a. Description. The idler pulley (7, fig. 35) is mounted on the fan bracket and is used to maintain tension on the supercharger drive belts.

b. Removal.

(1) Remove the fan guard (par. 77*c*).
(2) Remove the swivel locking bolt (5, fig. 35).
(3) Unscrew the swivel bracket retaining nut (9) and washer. Slide the swivel bracket (6) and pulley assembly (7) off the shaft.

c. Disassembly.

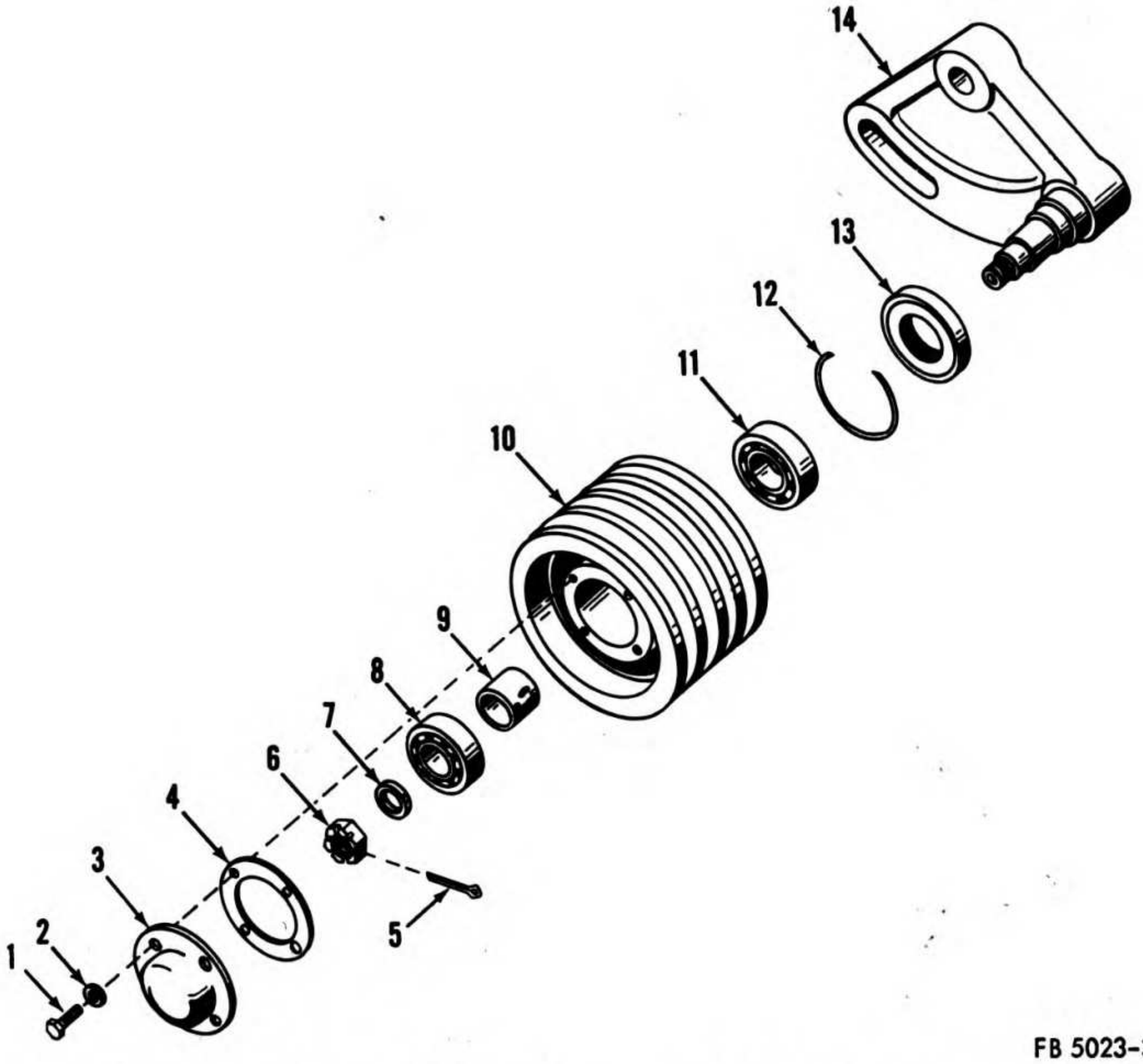
(1) Remove the four cap screws (1, fig. 38) and lockwashers (2). Remove the cover (3) and discard gasket (4).
(2) Remove cotter pin (5), slotted nut (6), and flat washer (7) from the shaft on the arm and bracket assembly (14).
(3) Remove idler pulley (10) from the arm and bracket assembly (14).

Note. Be careful not to drop the bearing (8) when removing idler pulley (10).

(4) Remove bearing (8) and spacer (9) from idler pulley (10) by hand.
(5) Remove oil seal (13) from the rear of the idler pulley (10).
(6) Remove bearing retaining ring (12) and remove bearing (11) from idler pulley (10).

d. Cleaning and Inspection.

(1) Clean bearings (8) and (11) in a container filled with an approved solvent.
(2) Use clean, dry compressed air to thoroughly dry the bearings. Do not spin the bearings.
(3) Clean the inside hub of the idler pulley making sure there is no dirty lubricant or foreign material in the hub.
(4) Inspect bearings for roughness or other signs of wear by spinning the bearing. *Do not spin bearing with compressed air.* Replace defective bearings.
(5) Inspect oil seal (13) for wear or signs of damage to the leather retainer. Replace a damaged seal.



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1	Cap screw, ¼ x ¾ NC (4 rqr)	8	Bearing, ball, annular
2	Lockwasher, ¼ (4 rqr)	9	Bearing spacer
3	Cover, idler pulley	10	Idler pulley
4	Cover gasket	11	Bearing, ball, idler pulley
5	Cotter pin	12	Bearing retaining ring
6	Nut, hex, slotted	13	Oil seal
7	Flat washer	14	Arm and bracket assembly

Figure 38. Idler pulley assembly exploded view.

(6) Inspect the swivel bracket shaft on the arm and bracket assembly (14) for damaged threads or scored bearing surfaces. If damaged, replace the arm and bracket assembly (14).

e. Reassembly.

(1) Pack the idler pulley bearing (11) with approved bearing grease.

(2) Install the bearing (11) in the rear of the idler pulley (10) and secure with the bearing retaining ring (12) in the recess of the hub.

(3) Install the oil seal (13) with the open side of the leather seal towards the inside of hub.

(4) Turn the idler pulley (10) over and pack the hub with approved lubricant.

(5) Install the bearing spacer (9).

(6) Pack the annular bearing (8) with approved lubricant and install in the hub of the idler pulley (10). Make sure the bearing fits firmly against the shoulder in the hub.

(7) Install the assembled idler pulley (10) over the shaft on the arm and bracket assembly (14).

(8) Spin the pulley making sure the bearings do not bind and that the pulley turns freely on the shaft.

(9) Install flat washer (7) and install the slotted hex nut (6).

Note. Make sure the washer fits squarely against the inner race of the bearing (8). Do not overtighten the slotted hex nut (6).

(10) Check the assembled idler pulley (10) by hand feel, to make sure there is no end play. Turn the pulley again to make sure bearings are rotating freely in the hub.

(11) If there are signs of binding, back off on the slotted hex nut until hub rotates freely.

(12) Aline the slots in the hex nut (6) with the hole in the threaded portion of the shaft and install cotter pin (5). Make sure the end of the cotter pin is bent back enough to clear the idler pulley cover (3).

(13) Install the gasket (4) and cover (3) and secure with the four cap screws (1) and lockwashers (2). Check to see that there is no clicking noise due to the cotter pin.

f. Installation.

(1) Position the idler pulley assembly over the shaft on the fan bracket (4, fig. 35) assembly.

(2) Secure with the flat washer and swivel bracket retaining nut (9).

(3) Position the supercharger belts (8) over the idler pulley (7).

(4) Install the flat washer and swivel locking bolt (5). Adjust supercharger belt tension (par. 78*c*(2)).

(5) Install the fan guard (par. 77*f*).

81. Fan Bracket Assembly

a. Description. The fan bracket assembly (4, fig. 35) is a rigid casting that supports the fan pulley and supercharger drive belt idler assemblies. The bracket assembly consists of the bracket and idler pulley support bracket shaft attached to the bracket by a hex nut and lockwasher from the back of the bracket. The assembly is attached to the front and center of the timing gear cover by four cap screws, lockwashers, and tapped holes in the timing gear cover.

b. Removal.

(1) Remove the fan (par. 77*c*).
(2) Remove the idler pulley assembly (par. 80*b*).
(3) Remove the fan hub (par. 78*f*(1)).
(4) Remove the two cap screws (36, fig. 36), lockwashers (35), and plain washers (34) securing the bracket brace (33) to the fan bracket (27).
(5) Remove the four cap screws (25) and lockwashers (26) securing the fan bracket (27) to the timing gear cover.
(6) Remove the fan bracket (27).

c. Inspection.

(1) Inspect the fan bracket (27) for cracks or other evidence of damage.
(2) Replace a damaged fan bracket (27).

d. Installation.

(1) Position the fan bracket (27) on the timing gear cover and secure with the four cap screws (25) and lockwashers (26).
(2) Secure the bracket brace (33) to the fan bracket (27) with the two cap screws (36), lockwashers (35), and plain washers (34).
(3) Install the fan hub (par. 78*f*(5)).
(4) Install the idler assembly (par. 80*f*).
(5) Install the fan (par. 78*f*(5)).

82. Water Pump

a. Description. The gear-driven centrifugal type water pump (10, fig. 33) located in the right side of the engine block in back of the timing gear housing, circulates coolant through the engine and radiator. It is equipped with sealed bearings and does not require lubrication.

b. Removal.

(1) Drain the cooling system (par. 77*c*(2)).
(2) Disconnect the hoses at the pump inlet and outlet elbows.
(3) Remove the bypass tube (12).
(4) Remove the two cap screws (9) securing the water pump inlet elbow to the water pump (10).
(5) Remove the inlet elbow and bypass adapter assembly and gasket.
(6) Remove the six hex nuts (11) and lockwashers securing water pump to the timing gear housing and remove the pump by pulling back off the studs.

c. Installation.

(1) Position the water pump (10) against the timing gear housing so that the pump fits squarely over the mounting studs.
(2) Secure with the six nuts (11) and lockwashers.
(3) Connect the bypass adapter assembly with the two cap screws (9) and lockwashers using a new gasket between the adapter and pump housing.
(4) Install bypass tube assembly (par. 79*d*(4)).
(5) Connect the hoses at the pump inlet and outlet connections.
(6) Fill the cooling system.

83. Water Outlet Manifolds

a. Description (fig. 39). The water outlet manifolds (2 and 5) are mounted on the top left side of the cylinder heads. They are connected together by a hose (4) and clamps (3). A heat deflector (7) is connected and attached to the rear manifold to protect the hose from the heat of the exhaust manifold assembly. The water temperature sending unit adapter (13) is mounted on the end of the rear manifold (2) and is connected by a capillary tube to the coolant temperature indicator. Coolant is collected by the manifolds from the cylinder heads and conducted to the thermostat housing cover to the elbow assembly, and into the radiator inlet.

b. Removal.

(1) Remove the thermostats (par. 79*b*).
(2) Remove the coolant temperature sending unit from the sending unit adapter (13, fig. 39) in the rear manifold.
(3) To remove the manifolds (2 and 5) and gaskets (10), remove the cap screws (12) and lockwashers (11).
(4) Remove the cap screws (9) and lockwashers (8) attaching the heat deflector (7) to the rear manifold (2).
(5) To separate the manifolds, loosen the hose clamps (3) and remove the hose (4).

c. Cleaning and Inspection.

(1) Check the manifolds (2 and 5) for cracks and breaks. Replace a defective manifold.
(2) Check hose (4) for cracks or sponginess. Replace a defective hose.
(3) Clean scale or deposits from inside of manifolds with an approved solvent and wire brush. Blow dry with compressed air.
(4) Clean the gasket mating surfaces between the manifolds and the cylinder heads.
(5) Replace all gaskets.

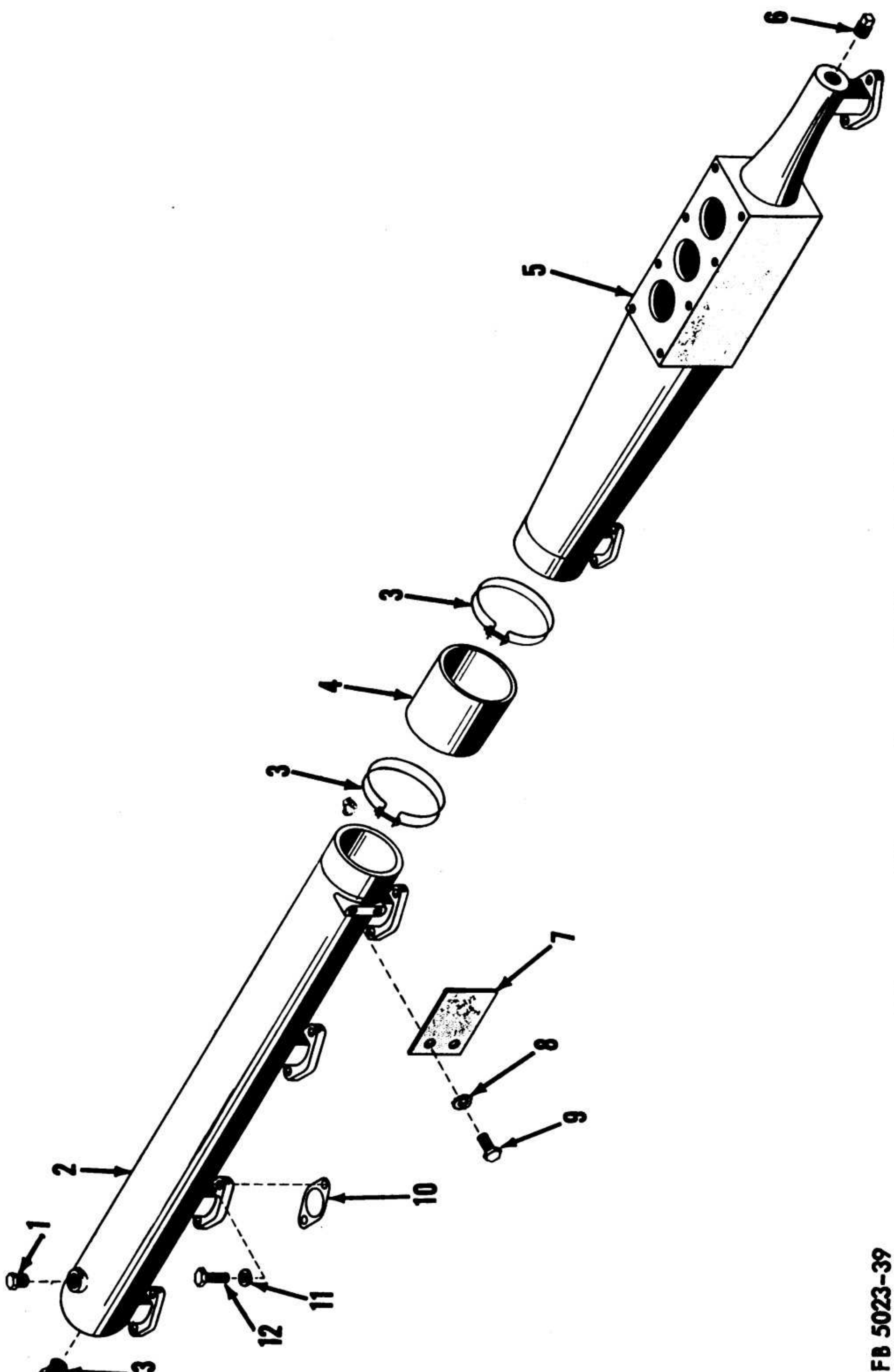


Figure 39. Water outlet manifolds, exploded view.

FB 5023-39

1 Pipe plug, ½ (1 rqr)
2 Rear water outlet manifold
3 Hose clamp
4 Hose
5 Front outlet manifold
6 Pipe plug, ¾ (1 rqr)
7 Heat deflector
8 Lockwasher, ⅜ (2 rqr)
9 Cap screw, ⅜ x ½ NC (2 rqr)
10 Outlet manifold gasket
11 Lockwasher, 7/16 (16 rqr)
12 Cap screw, 7/16 x 1¼ NC (16 rqr)
13 Temperature sending unit adapter

Figure 39—Continued.

d. Installation.

(1) Assemble the hose (4) and clamps (3) on the manifolds (2 and 5). Do not tighten clamps.
(2) Using new gaskets, place the manifolds on the cylinder heads, and secure with cap screws (12) and lockwashers (11).
(3) Tighten the hose clamps (3).
(4) Attach the heat deflector (7) to the rear manifold with the cap screws (9) and lockwashers (8).
(5) Install the water temperature sending unit adapter (13) and install sending unit.
(6) Install the thermostats (par. 79*d*).

Section IX. AIR INTAKE SYSTEM

84. Description

The air intake system consists of the following: an air cleaner (par. 31*e*); an air intake manifold (2, fig. 40); air heater assembly (6); and the necessary pipes and connections to conduct the air to cylinder heads.

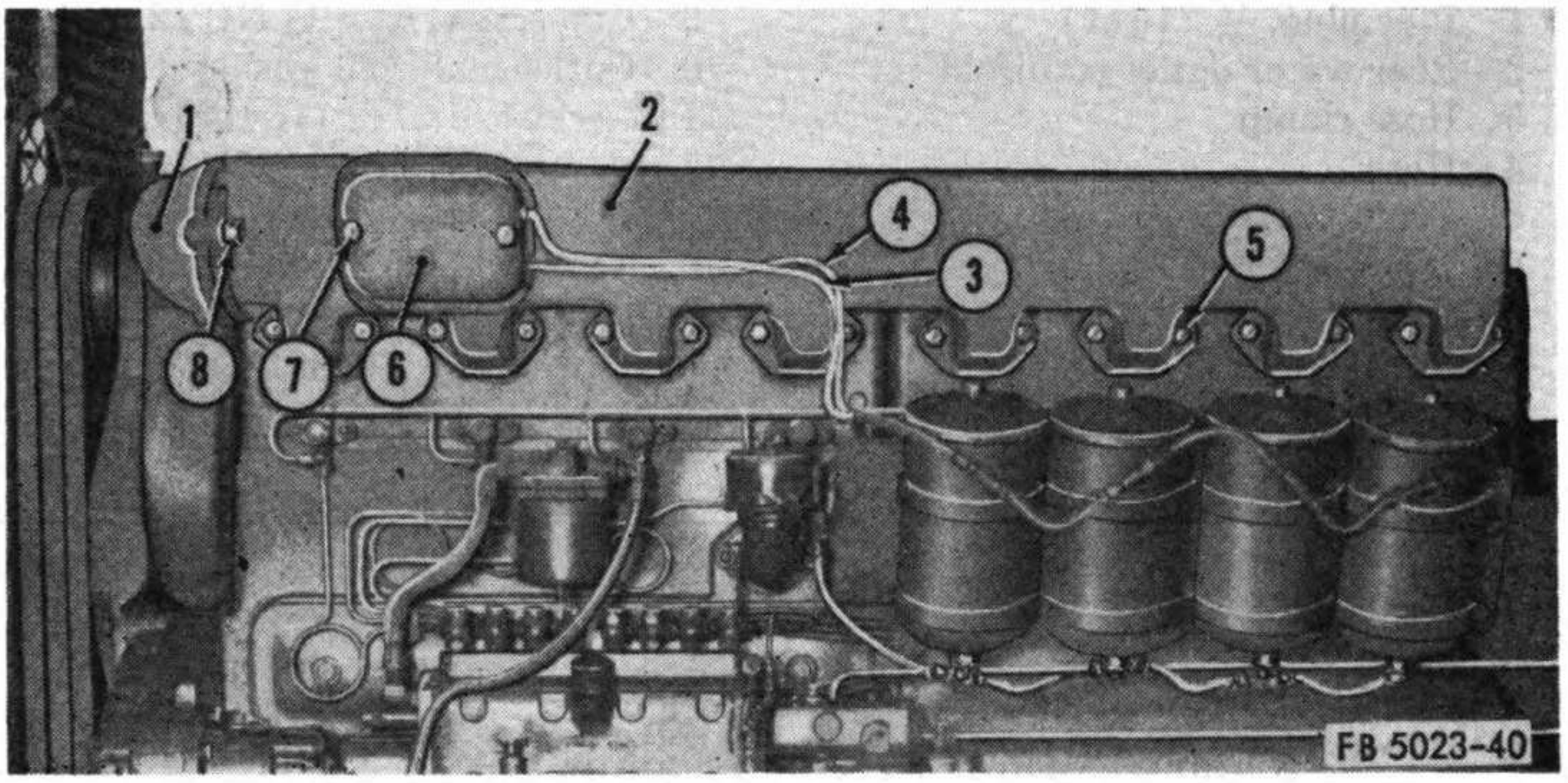
Note. Removal and installation of the supercharger assembly as well as disassembly and repair is the responsibility of field and depot maintenance personnel.

85. Air Heater

a. Description. Refer to paragraph 20*a*.

b. Removal.

(1) Remove two cap screws (7, fig. 40) and lockwashers securing coil cover to heater body (7, fig. 41) and remove the cover.
(2) Disconnect fuel line (8) by unscrewing inverted nut (11).
(3) Disconnect ignition wire (4) from the coil (15) by removing the terminal nut (5) and lockwasher.
(4) Remove cover gasket (6).



1 Pipe, supercharger-to-intake manifold
2 Air intake manifold
3 Air heater ignition wire
4 Air heater fuel line
5 Nut, hex, ¾ NF (16 rqr)
6 Air heater assembly
7 Cap screw, $\frac{5}{16}$ x 2⅞ NC (2 rqr)
8 Cap screw, $\frac{7}{16}$ x 1 NC (3 rqr)

Figure 40. Air intake manifold, removal points.

(5) Remove cap screw (12) and lockwasher (10) attaching air heater body (7) to air intake manifold (14). Remove the assembled body.

(6) Remove and discard cork gasket.

c. Testing, Servicing, and Cleaning.

(1) With the assembled air heater removed from the intake manifold, temporarily connect the fuel line (8) and ignition wire (4).

(2) Operate the controls at the control panel and check for sufficient fuel and proper firing by noticing the amount of flame at the electrode points at the rear of the assembly.

(3) If firing is not sufficient, service as follows:

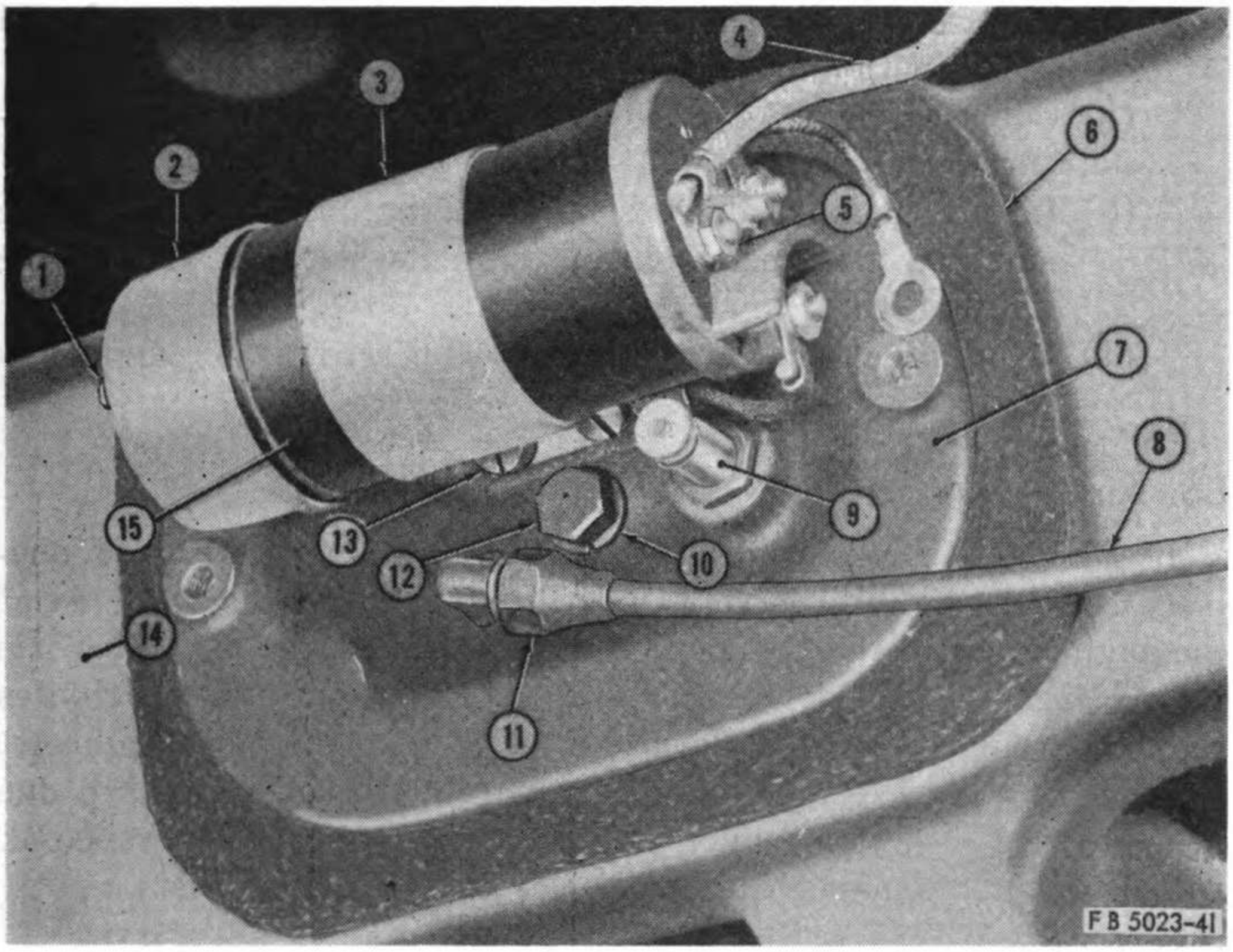
(*a*) Clean the electrode points by removing carbon deposits with tungsten file or coarse linen.

(*b*) Check the point gap and, if necessary, reset side electrode by bending wire until the gap is approximately ⅛-inch.

Note. Do not bend center electrode.

(*c*) If gap is correct, then remove porcelain center electrode by removing threaded gland and withdrawing electrode (9). Clean porcelain by washing off in an approved solvent and scraping or sanding off any carbon accumulation.

(*d*) If fuel does not appear at the spray nozzle, remove both ignition electrodes and unscrew nozzle assembly.



1	Machine screw	9	Center electrode assembly
2	Cover, interrupter point	10	Lockwasher, ⅜ (1 rqr)
3	Coil bracket	11	Inverted coupling nut
4	Air heater ignition wire	12	Cap screw, ⅜ x ¾ NC (1 rqr)
5	Terminal nut	13	Machine screw
6	Cover gasket	14	Air intake manifold
7	Air heater body	15	Coil
8	Fuel line		

Figure 41. Air heater assembly, removal points.

(*e*) Remove the nozzle, filter, spring, and vortex plug in the center of the nozzle.

(*f*) Wash all parts in cleaning solvent, and dry with compressed air. Reassemble vortex plug in the nozzle.

(*g*) Install the spring, filter, and nozzle in the flame thrower body using core to keep out all dirt during installation of these parts.

(*h*) Install and adjust the ignition electrodes ((*b*) above).

(*i*) Disconnect temporary conditions made for testing ((1) above).

d. Installation.

(1) Install a new cork gasket on the air intake manifold (14).

(2) Install the assembled air heater on the manifold (14) and secure with the cap screw (12) and lockwasher (10).

(3) Install the cover gasket (6).

(4) Connect the ignition wire (4) at the coil terminal and secure with the terminal nut (5) and lockwasher.
(5) Connect the fuel line (8) and secure by tightening the inverted coupling nut (11).
(6) Install the air heater assembly (6, fig. 40) cover and make sure the grommet is installed in its slot and around the ignition wire.
(7) Secure the cover with the two cap screws (7) and lockwashers.

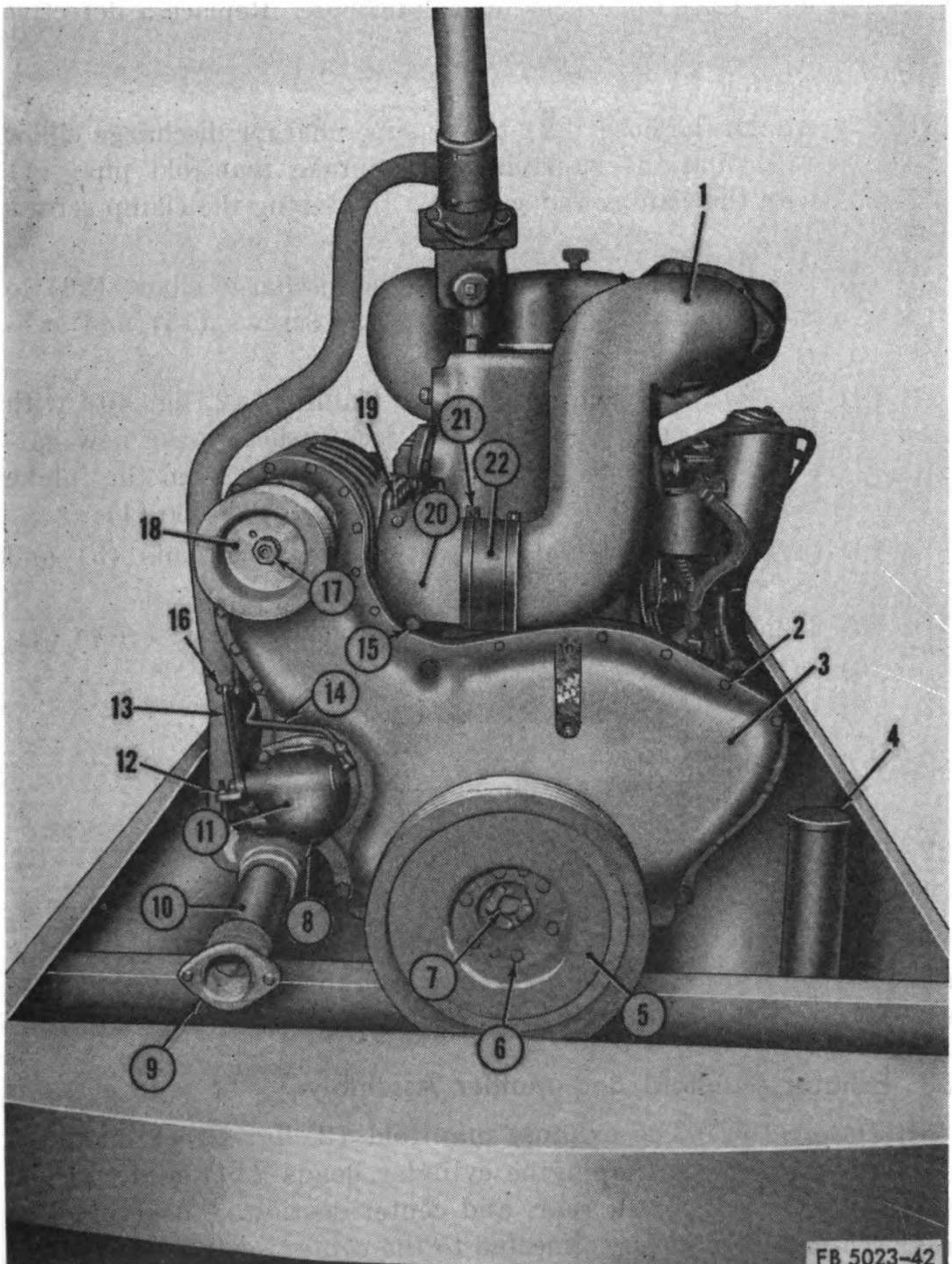
86. Air Intake Manifold

a. Description. The air intake manifold (2, fig. 40) is of one-piece construction and is conveniently mounted on the left side of the engine against the cylinder heads. It receives the air which has passed through the air cleaner and supercharger and distributes the air through the air intake parts into the combustion chambers. No servicing is necessary, unless the manifold becomes cracked due to a physical injury, in which case the manifold must be replaced. During any maintenance, always replace the manifold gaskets.

b. Removal.
(1) Remove the air heater (par. 85*b*).
(2) Remove the fan bracket assembly (par. 81*b*).
(3) Remove the two cap screws (15, fig. 42) and lockwashers securing the supercharger discharge elbow (20) to the supercharger.
(4) Remove the three cap screws (8, fig. 40) and lockwashers.
(5) Remove the supercharger-to-intake manifold pipe (1, fig. 42).
(6) Remove the sixteen nuts (5, fig. 40) and lockwashers securing the intake manifold (2) to the cylinder heads.
(7) Remove the intake manifold (2) and discard all gaskets.

Note. To avoid damage to other accessories below the manifold, two men must use caution in lifting manifold from the cylinder head studs.

c. Cleaning and Inspection.
(1) Inspect the air intake manifold (2) and flanges for breaks or slight cracks.
(2) Replace a defective manifold.
(3) Scrape all mating surfaces of the manifold and cylinder head parts of any gasket remains.
(4) Separate the supercharger discharge elbow (20, fig. 42) from the supercharger-to-intake manifold pipe (1) by loosening hose clamp screws (21). Remove and inspect



1	Pipe, supercharger-to-intake manifold	12	Overspeed governor adjusting nut
2	Timing gear cover cap screw	13	Overspeed governor arm
3	Timing gear cover	14	External oil line
4	Fuel tank fill	15	Cap screw
5	Vibration damper and pulley assembly	16	Linkage retaining nut
6	Cap screw	17	Drive pulley retaining nut
7	Starting jaw nut	18	Supercharger drive pulley
8	Governor cover cap screw	19	Cap screw
9	Radiator outlet flange	20	Discharge elbow
10	Radiator outlet tube	21	Clamp screw
11	Overspeed governor	22	Hose

Figure 42. Air intake system components, removal points.

hose (22) for cracks or leaking hose. Replace a defective hose.

d. Installation.

(1) Attach the hose (22) to the supercharger discharge elbow (20) and the supercharger-to-intake manifold pipe (1) with the clamps and secure by tightening the clamp screws (21).

(2) Use a new gasket and secure the discharge elbow (20) to the supercharger with the two cap screws (15) and lockwashers.

(3) Temporarily secure the intake manifold (2, fig. 40) with the three cap screws (8) and lockwashers using new gasket beneath each manifold flange and between the intake manifold (2) and supercharger-to-manifold pipe (1).

(4) Secure the manifold (2) with the sixteen nuts (5) and lockwashers.

(5) Tighten the manifold-to-supercharger pipe cap screws (8).

(6) Install the air heater (par. 85*d*).

(7) Install the fan bracket assembly (par. 81*d*).

Section X. EXHAUST SYSTEM

87. Description

The exhaust system consists of an exhaust manifold, a muffler, and an exhaust pipe used to conduct the exhaust gases to the muffler. The muffler is mounted above the top panel and is used to expel the exhaust gases and deaden their sound.

88. Exhaust Manifold and Muffler Assembly

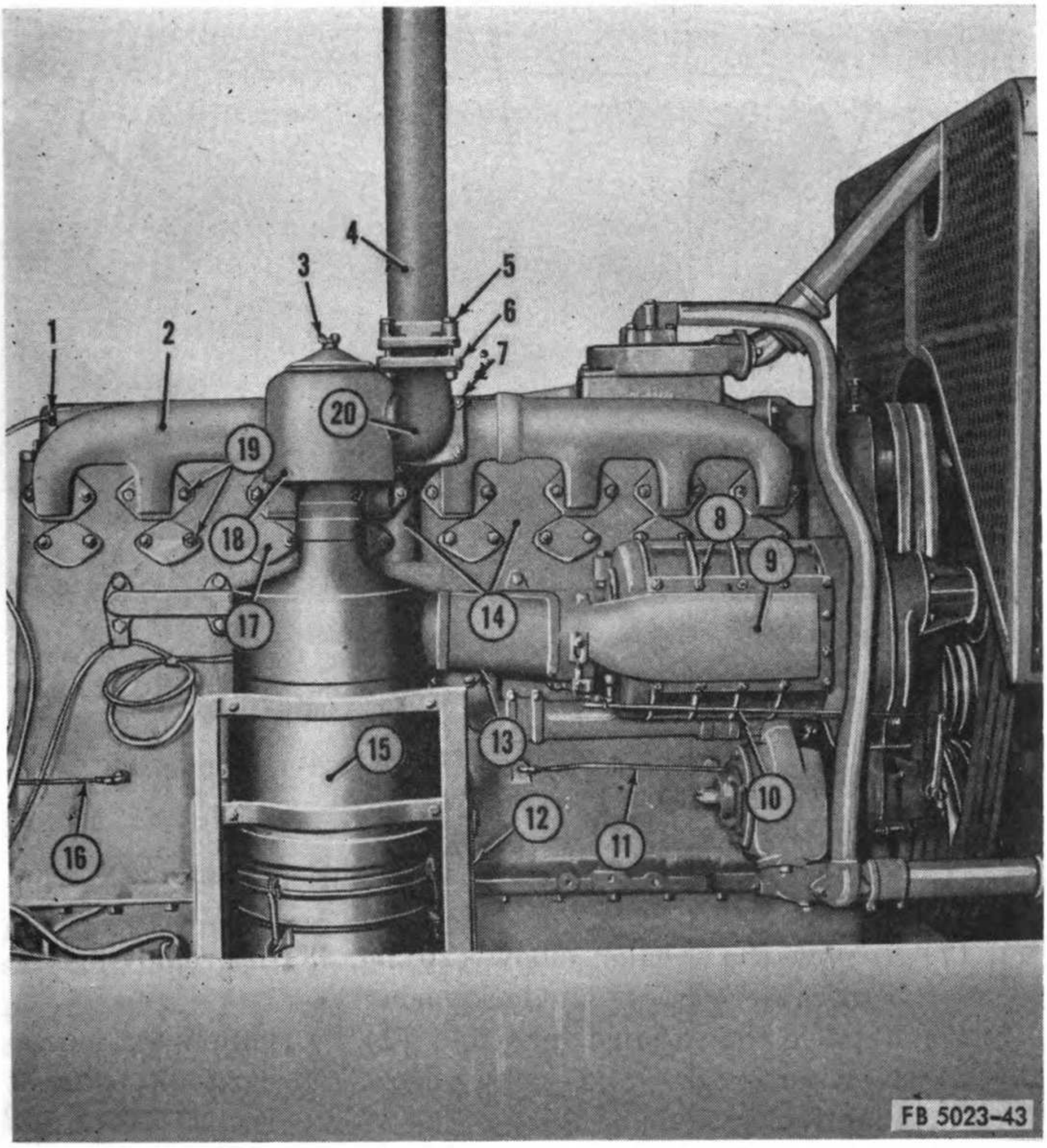
a. Description. The exhaust manifold (2, fig. 43) is mounted on the right side of the engine cylinder heads (14) and consists of three sections: front, rear, and center section. The front and rear sections are flange connected to the center section using steel rings between the sections to prevent exhaust gases from escaping. The exhaust manifold serves as a collector for the outgoing gases.

b. Removal and Disassembly.

(1) Remove the air precleaner (par. 31*e*(1)).

(2) Remove the flange cap screws (5), lockwashers, and nuts securing the exhaust pipe (4) to the exhaust elbow (20). Remove and discard the gasket between the flange and elbow.

Note. **If unit is being operated indoors, disconnect all external exhaust connections from the muffler.**

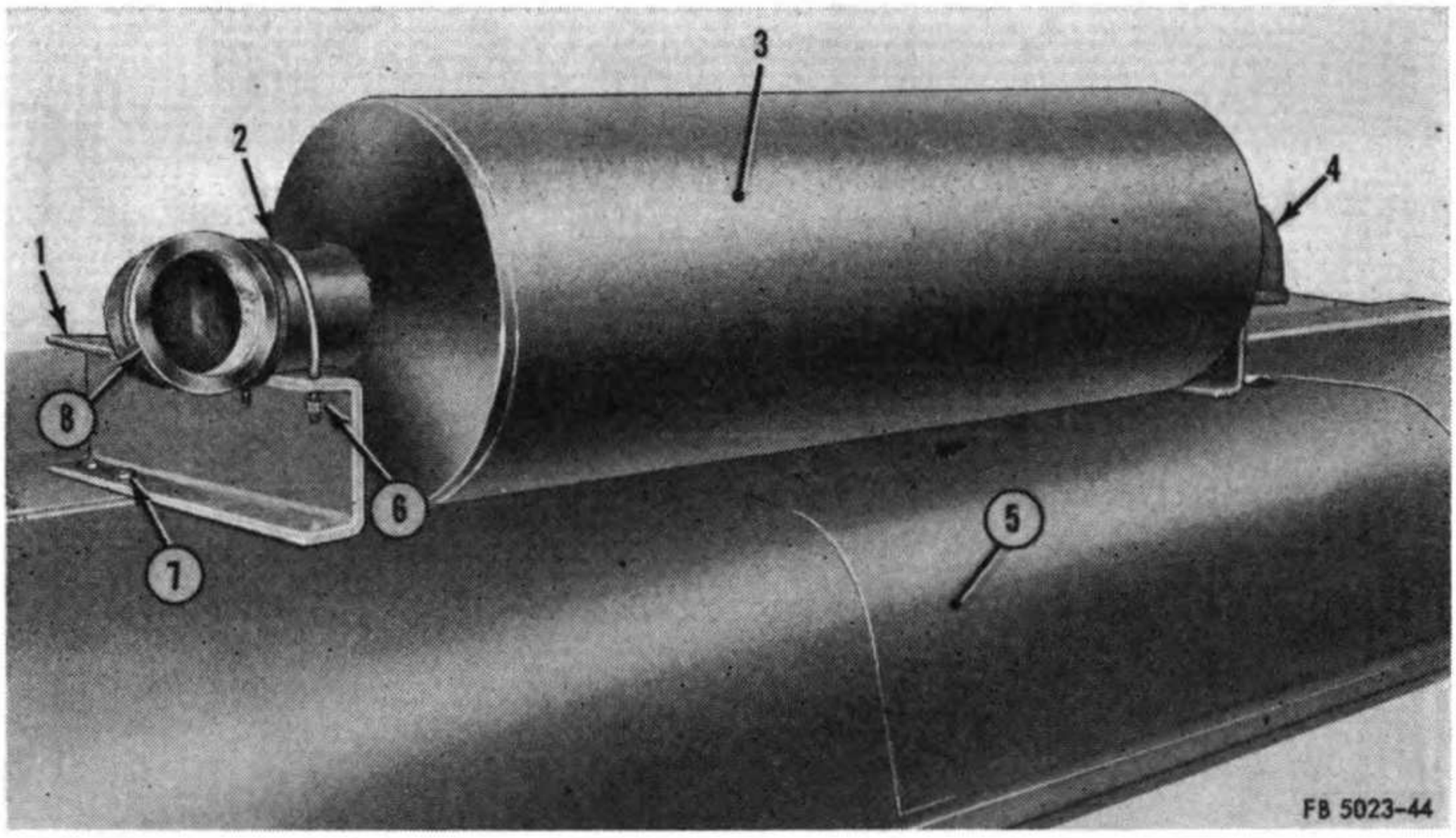


1 Water temperature sending unit
2 Exhaust manifold
3 Wing nut
4 Exhaust pipe
5 Cap screw, ½ x ¾ NC (4 rqr)
6 Exhaust pipe flange
7 Cap screw, ½ x 2 NC (4 rqr)
8 Cap screw, ⅜ x 1 NC (12 rqr)
9 Supercharger air horn
10 Overspeed governor linkage
11 External oil line
12 Air cleaner bracket
13 Air cleaner hose
14 Cylinder head
15 Air cleaner
16 External oil line
17 Air chamber clamp
18 Air precleaner
19 Nut, hex, ½ NC (32 rqr)
20 Exhaust elbow

Figure 43. Exhaust manifold, removal points.

(3) Remove the holddown U-bolts (2, fig. 44) by removing the nuts (6) and lockwashers on both ends of the muffler.

(4) Raise and block the muffler (3) so that the exhaust pipe (4, fig. 43) sufficiently clears the exhaust elbow (20). Unscrew the exhaust pipe (4) from the inlet elbow (4, fig. 44) on the muffler (3).



1 Mounting bracket
2 U-bolt
3 Muffler
4 Muffler inlet elbow
5 Top panel
6 Nut, hex, ½ NC (8 rqr)
7 Cap screw, ½ x 1¼ NC (4 rqr)
8 Muffler outlet elbow

Figure 44. Muffler, installed view.

(5) Remove the muffler (3).
(6) Remove the inlet elbow (4) and outlet elbow (8) from the muffler (3).
(7) Remove the exhaust elbow (20, fig. 43) by removing the four capscrews (7) and lockwashers.
(8) Remove the exhaust manifold (2) by removing the sixteen nuts (19) and lockwashers. Discard all exhaust manifold gaskets.
(9) Separate front and rear sections of the manifold from the center section. Remove and discard the seal rings.

c. Cleaning and Inspection.

(1) Inspect the exhaust manifold sections for cracks or broken flanges. Replace a defective section.

Note. Do not try to weld or braze a cracked or broken manifold section.

(2) Using a wire brush, remove all carbon from the seal ring recesses in the sections of the manifold.
(3) Inspect the muffler for leaks. Replace a defective muffler.

d. Reassembly and Installation.

(1) Connect the front and rear sections of the exhaust manifold to the center section using new seal rings.
(2) Install the assembled exhaust manifold (2) and secure the manifold to the cylinder heads with the sixteen nuts (19) and lockwashers. Use new manifold gaskets.

(3) Secure the exhaust elbow (20) and a new flange gasket to the exhaust manifold (2) with the four cap screws (7) and lockwashers.

(4) Install the inlet elbow (4, fig. 44) and outlet elbow (8) on the muffler (3).

Note. **Make certain the inlet elbow (4) faces downward to allow proper connection of the exhaust pipe.**

(5) Install the exhaust pipe (4, fig. 43) in the inlet elbow (4, fig. 44) and lower the assembled muffler so that the exhaust flange (6, fig. 43) fits squarely over the exhaust elbow (20). Use a new elbow gasket.

(6) Secure the assembled muffler and exhaust pipe to the exhaust elbow (20) with four bolts (5), nuts, and lockwashers.

(7) Secure the muffler (3, fig. 44) to the mounting brackets (1) with the U-bolts (2), nuts (6), and lockwashers.

(8) Make necessary external exhaust connections if unit is to be operated indoors.

Section XI. ENGINE ELECTRICAL SYSTEM

89. Description

The engine electrical system is comprised of the following components: three 12-volt batteries (6, fig. 12); a 32-volt heavy-duty starting motor and solenoid; the air heater, and the engine control panel lights. The battery charge is maintained by charging equipment and a circuit from the main generator (fig. 45).

90. Batteries

a. Description. Three 12-volt batteries (6, fig. 12) mounted in the subbase below the engine control panel supply the current necessary to operate the starting motor and panel lights. They are connected in series to provide 36 volts.

b. Battery Maintenance. Test all cells with a hydrometer at least once a month (240 hours). If any of the cells test below 1.225 specific gravity, they must be recharged. *Do not overcharge.* Refer to table III for correct temperature and specific gravity readings. Keep the terminals tight and coat the terminals with grease.

c. Cleaning, Inspection, and Replacement.

(1) Inspect the battery cables to see that they are clean and not frayed or broken. Replace defective cables.

(2) Inspect the battery terminals to see that they are not corroded and that the cable fits firmly on the battery terminal.

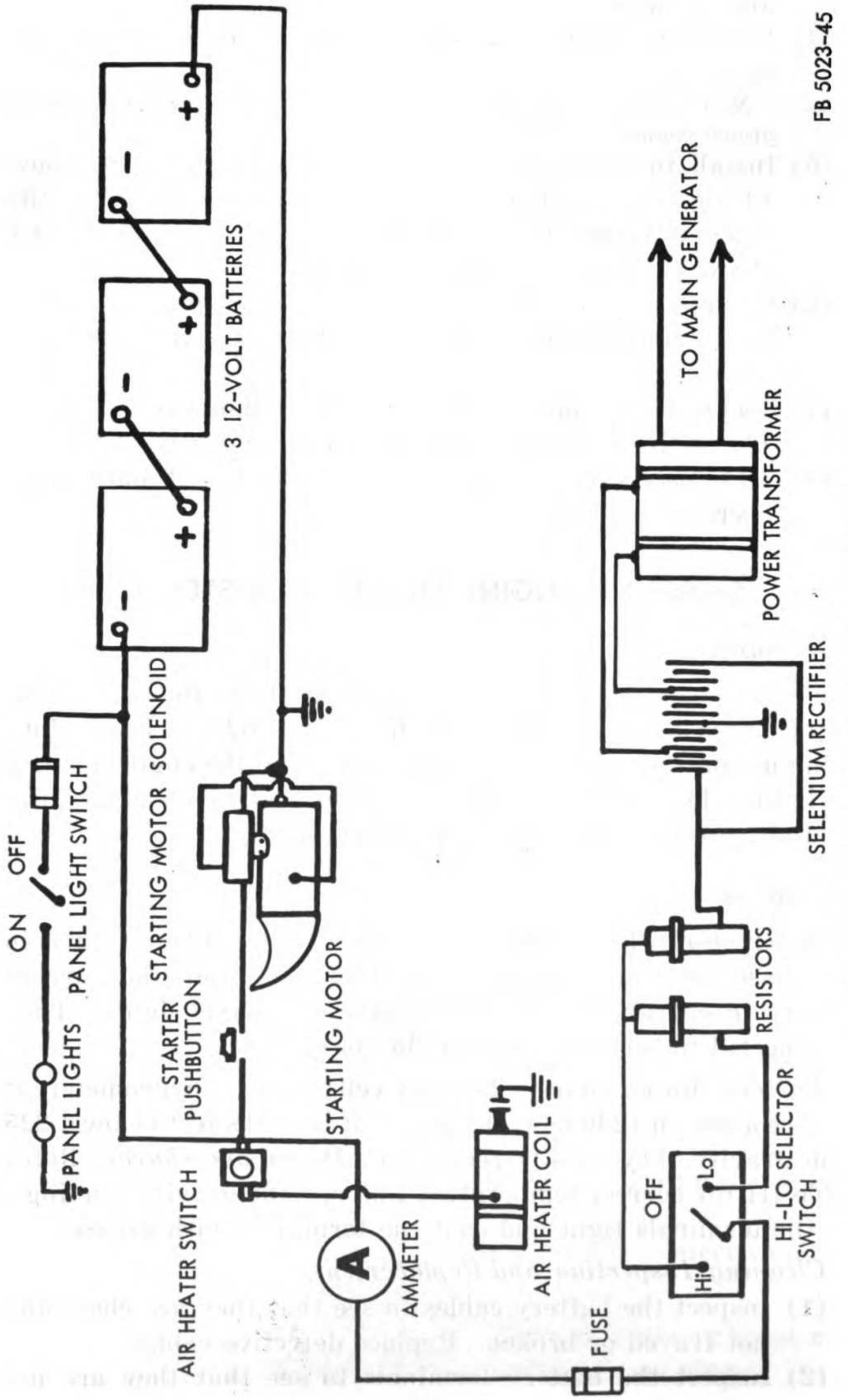


Figure 45. Engine electrical system wiring diagram.

(3) If there are any signs of corrosion on the battery terminals or cable lugs, clean as follows:

(*a*) Use a knife or other sharp instrument and scrape the corrosion from the terminal and from inside the cable lugs.

Table III. Specific Gravity Readings for Fully Charged Batteries.

Ambient temperature	Hydrometer reading
—65° F.	1.338
—40° F.	1.328
—20° F.	1.320
—10° F.	1.316
— 0° F.	1.312
+20° F.	1.304
+40° F.	1.296
+60° F.	1.289
+80° F.	1.280
+100° F.	1.272
+110° F.	1.268
+120° F.	1.265

(*b*) Use emery cloth to smooth the contact surfaces.

Caution: Be careful not to get acid on the skin, since acid is extremely dangerous if it contacts the skin or eyes. If possible, use gloves when cleaning corrosion from battery terminals or cable lugs.

d. Removal.

(1) Remove the battery access cover and battery holddown (par. 7*e* (7 and 8)).

(2) Disconnect and remove the ground cable (2, fig. 12) at the battery.

(3) Disconnect and remove battery-to-solenoid cable (4) at the battery.

(4) Disconnect and remove the two jumper cables (3) from the batteries.

(5) Lift and slide out each battery (6) separately.

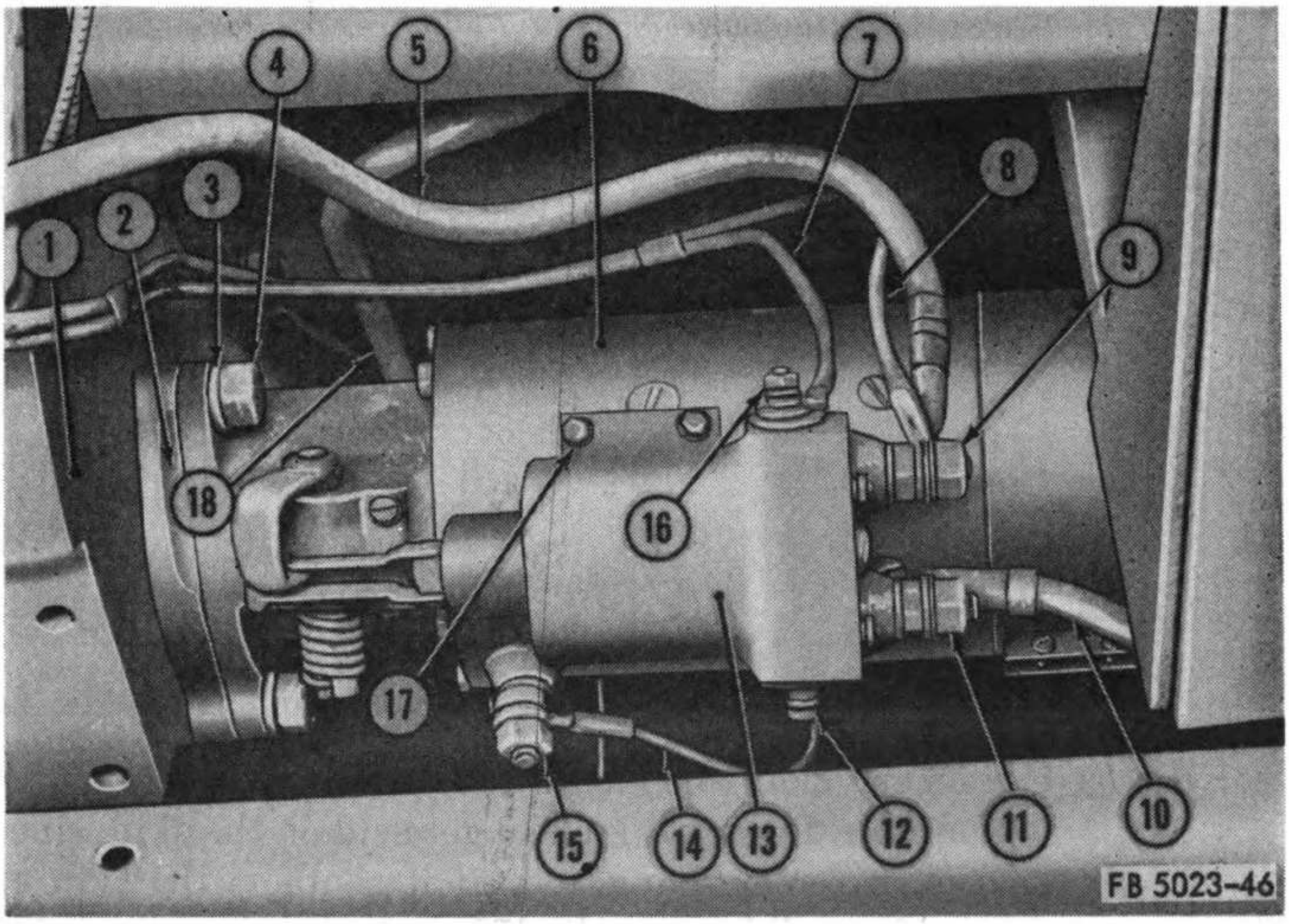
Caution: Do not try to lift the battery from the subbase without help due to the extreme weight of each battery. When lifting, be careful not to damage the battery case against the subbase assembly.

e. Installation. Refer to paragraph 7*e* (9) thru (13).

91. Starting Motor and Solenoid Switch

a. Description. The starting motor (6, fig. 46) cranks the engine when the starting motor solenoid switch (13) completes the circuit

between the batteries and the starting motor. The motor is a conventional heavy-duty type starting motor. The unit has a heavy-duty starting motor solenoid switch (13) mounted on it and employs a Dyer drive to mesh the drive pinion with the flywheel for cranking the engine.



1 Flywheel housing
2 Adapter flange
3 Lockwasher, ⅝ (3 rqr)
4 Cap screw, ⅝ x 2¼ NC (3 rqr)
5 Battery-to-solenoid switch cable
6 Starting motor
7 Pushbutton-to-solenoid lead
8 Pushbutton-to-solenoid energizing lead
9 Terminal nut
10 Solenoid-to-starter cable
11 Terminal nut
12 Terminal nut
13 Solenoid switch
14 Ground lead
15 Terminal nut
16 Terminal nut
17 Solenoid mounting cap screw
18 Ground cable

Figure 46. Starting motor and starting motor solenoid switch, installed view.

b. Brush and Commutator Inspection and Cleaning.

(1) Remove the cover band by removing the two cover band screws directly below starter-to-solenoid cable (10).

(2) See that the commutator is smooth and has a polished surface. If the commutator is dirty, remove the starting motor (*c* below) and cover band and clean or polish the commutator by hand. Use a strip of 00 sandpaper. *Do not use emery cloth.* If the commutator is pitted, rough, or burned, replace the starting motor with a new or reconditioned one.

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

(4) Inspect the brushes for wear. If the brushes are worn to less than one-fourth inch, replace the starting motor with a new or reconditioned one.

(5) Secure the cover band to the starting motor with the cover band screws.

c. Removal.

(1) Remove cables (5, 10, and 18), and lead (14).

(2) Remove leads (7 and 8).

(3) Remove the three cap screws (4) and lockwashers (3) securing the starting motor (6) and solenoid switch (13) to the flywheel housing (1).

(4) Remove the starting motor and switch.

(5) If the starting motor must be replaced, remove the solenoid switch (13) in the following manner:

(*a*) Remove the cotter pin from the solenoid clevis and remove the clevis pin.

(*b*) Remove the four cap screws (17) and lockwashers attaching the solenoid switch (13) to the starter frame. Remove the switch.

d. Installation.

(1) Install the solenoid switch (13) on the starting motor (6) frame and secure with four cap screws (17) and lockwashers.

(2) Install the starting motor and secure to flywheel housing with three cap screws (4) and lockwashers (3).

(3) Install the ground lead (14) and cable (18) and secure with terminal nuts (12 and 15).

(4) Install cable (5) and lead (8) and secure to terminals with terminal nut (9).

(5) Install cable (10) and secure to terminal with terminal nut (11).

(6) Install lead (7) at terminal and secure with terminal nut (16).

(7) Position the solenoid plunger clevis and secure to the shift lever with the clevis pin. Secure the clevis pin with a cotter pin.

Section XII. LUBRICATION SYSTEM

92. Description

The engine lubrication system consists of the following components: lubricating oil filters (5, fig. 4); oil pressure regulating valve; oil cooler and bypass assembly; and external oil lines as

required to lubricate engine accessories. Lubricating oil pressure is maintained by a gear-type oil pump located in the engine crankcase.

Note. All maintenance for the oil pressure regulating valve and the gear-type oil pump is the responsibility of field and depot maintenance personnel. Refer to the appropriate sections in chapter 4 for complete maintenance procedures.

93. Lubricating Oil Filters

a. Description. The four cartridge-type filters (5, fig. 4) are part of the external lubrication system. Each filter body (5, fig. 21) contains a replaceable-type filter element (6). The oil from the oil manifold enters the inlet at the top of the body (5) and flows through the element (6) and filter outlet in the mounting base and then back to the sump in the engine oil pan. Foreign particles in the oil are collected by the filter element.

b. Servicing. Refer to paragraph 31*f*.

c. Removal and Disassembly.

(1) Remove the four drain plugs (11, fig. 47) and drain filters.

(2) Remove the assembled oil filter mounting plate (20) and adapter (17) by removing the four stud nuts (15) and lockwashers (16). Lift the entire oil filter assembly from the engine and discard the gasket (18).

(3) Disconnect the oil inlet line (7) and oil outlet line (12) from the elbow (6) at the adapter (17).

(4) Remove the four cap screws (21), nuts (15), and lockwashers (16) and separate the plate (20) from the adapter (17).

(5) Disconnect filter connector lines (9) from the top and bottom of the filter at the tees (8).

(6) Remove four cap screws (29), lockwashers (13), and nuts (14) and lift the assembled filter from the plate (20).

(7) Remove the two strap retaining screws (23), nuts (28), and lockwashers (27) and remove the straps from the filter body (22).

(8) Remove the filter inlet adapter (25) and female tee (8) from the filter body.

(9) Disassemble the filter body (par. 31*f* (1–4)).

(10) Remove and disassemble remaining filters as outlined in (5 through 9) above.

d. Reassembly and Installation.

(1) Reassemble the filter body (par. 31*f* (5–7)).

1 Cover screw
2 Gasket
3 Filter cover
4 Cover gasket
5 Spring
6 Elbow, 90°
7 Oil inlet line
8 Oil inlet tee, female (4 rqr)
9 Filter connector line
10 Oil inlet tee, male (2 rqr)
11 Drain plug (4 rqr)
12 Oil outlet line
13 Lockwasher, ⅜ (16 rqr)
14 Nut, hex, ⅜ NC (16 rqr)
15 Nut, hex, ½ NC (4 rqr)
16 Lockwasher, ½ (4 rqr)
17 Filter plate-to-block adapter
18 Adapter gasket
19 Adapter mounting stud (4 rqr)
20 Filter mounting plate
21 Cap screw, $\frac{7}{16}$ x ½ NC (4 rqr)
22 Filter body
23 Screw, rd-hd, $\frac{5}{16}$ x 2½ NC (8 rqr)
24 Filter element
25 Adapter, filter inlet
26 Filter body retaining strap
27 Lockwasher, $\frac{5}{16}$ (8 rqr)
28 Nut, sq, $\frac{5}{16}$ (8 rqr)
29 Cap screw, ⅜ x ¾ NC (16 rqr)

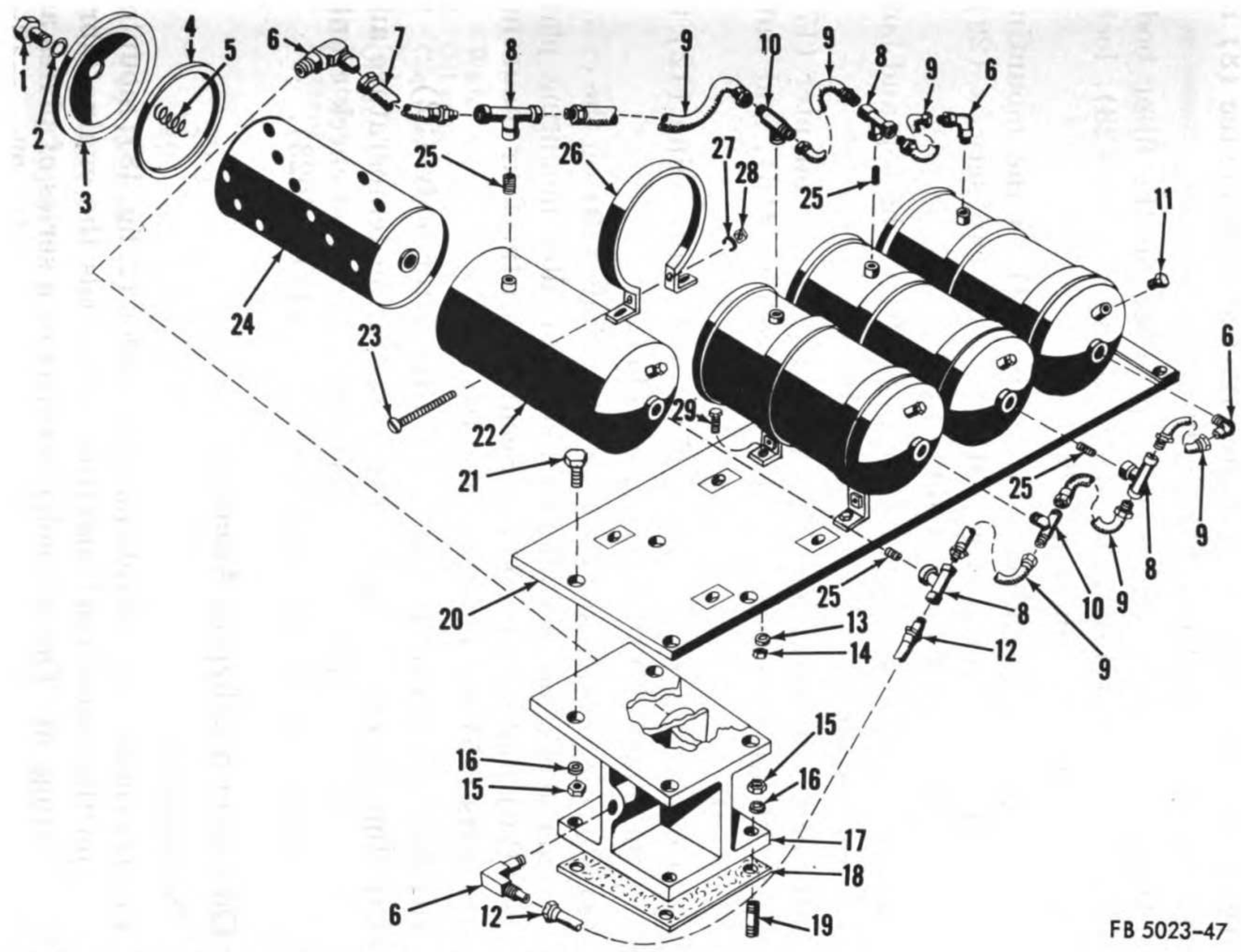


Figure 47. Lubricating oil filters, exploded view.

(2) Install the filter inlet adapter (25) and female tee (8) in the top and bottom of the body (22).

(3) Place the two retaining straps (26) on the filter body (22) and secure with the retaining screws (23), lockwashers (27), and nuts (28).

(4) Install the assembled filter body (22) to the mounting plate (20) and secure with the four cap screws (29), lockwashers (13), and nuts (14).

(5) Connect the filter connector lines (9) to the top and bottom of the filter body (22) at the tees (8).

(6) Secure the assembled filter plate (20) to the adapter (17) with the cap screws (21), lockwashers (16), and nuts (15).

(7) Connect the oil inlet line (7) and oil outlet line (12) to the elbow (6) at the adapter (17).

(8) Place a new gasket (18) over the studs (19) on the cylinder block and install the assembled filter mounting plate (20) and adapter (17). Secure with the four mounting nuts (15) and lockwashers (16).

(9) Install the drain plug (11) in the filter body (22).

(10) Run the engine up to normal operating temperature and check for leaks. Shut down the engine and check crankcase oil level. Add oil as necessary (LO 5–5023).

94. Oil Cooler and Bypass Assembly

a. Description.

(1) *Oil cooler.* A multiple-plate oil cooler (2, fig. 48), mounted on the water inlet manifold (1), cools the engine lubricating oil. The oil cooler consists of a series of plates assembled and attached together as a unit. The cooling liquid leaves the water pump (6), enters the water inlet manifold (1), and flows around the oil cooler and between the core plates.

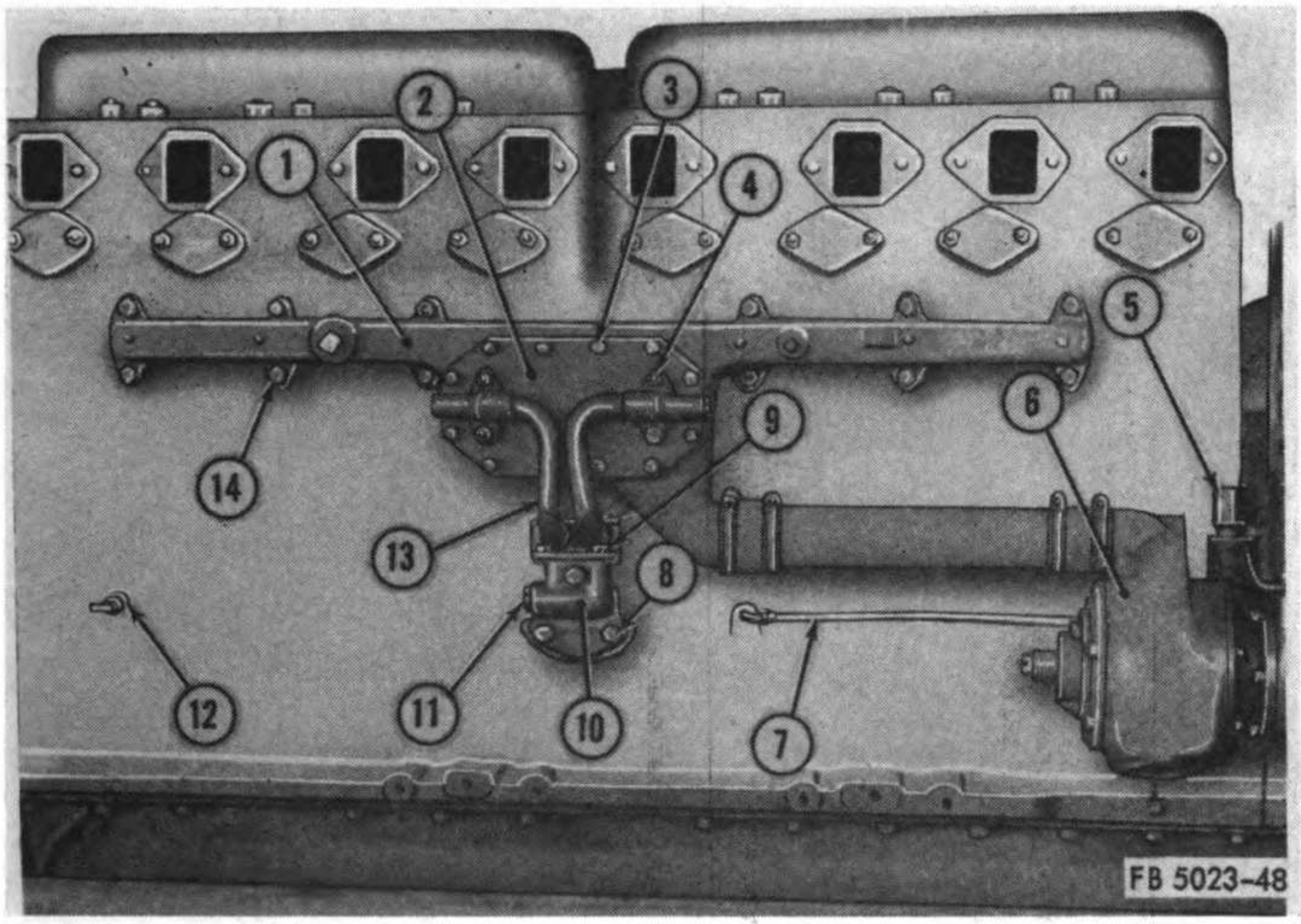
(2) *Bypass valve.* A bypass valve (10) is mounted beneath the oil cooler (2). If the oil cooler passage becomes blocked, the oil will circulate through the bypass valve thus allowing sufficient lubrication of the engine.

b. Removal and Disassembly.

(1) Drain the cooling system (par. 77*c*(2)).

(2) Remove the air cleaner (par. 31*e*(2)).

(3) Remove the oil tube assembly (4, fig. 49) by removing the nuts (4, fig. 48), cap screws (9), and lockwashers.



1	Water inlet manifold	8	Cap screw, ½ x ¼ NC (3 rqr)
2	Oil cooler	9	Cap screw, $\frac{5}{16}$ x 1¾ NC (3 rqr)
3	Cap screw, ⅜ x 1 NC (12 rqr)	10	Bypass valve
4	Nut, hex, ⅜ NF (4 rqr)	11	Spring retaining cap nut
5	Oil pressure regulating valve	12	External oil connection
6	Water pump	13	Oil tube assembly
7	External oil line	14	Cap screw, ½ x 1½ (12 rqr)

Figure 48. Oil cooler, installed view.

Remove the oil tube assembly and bypass valve (5, fig. 49). Remove and discard the gaskets (6) and (7).

(4) Remove the oil cooler mounting cap screws (3) and remove the oil cooler (4, fig. 50) from the water inlet manifold (1). Remove and discard the gasket (3).

(5) Remove the three cap screws (8, fig. 48) and remove the assembled bypass valve (10). Discard the mounting gasket.

(6) Disassemble the bypass valve (10) as follows:

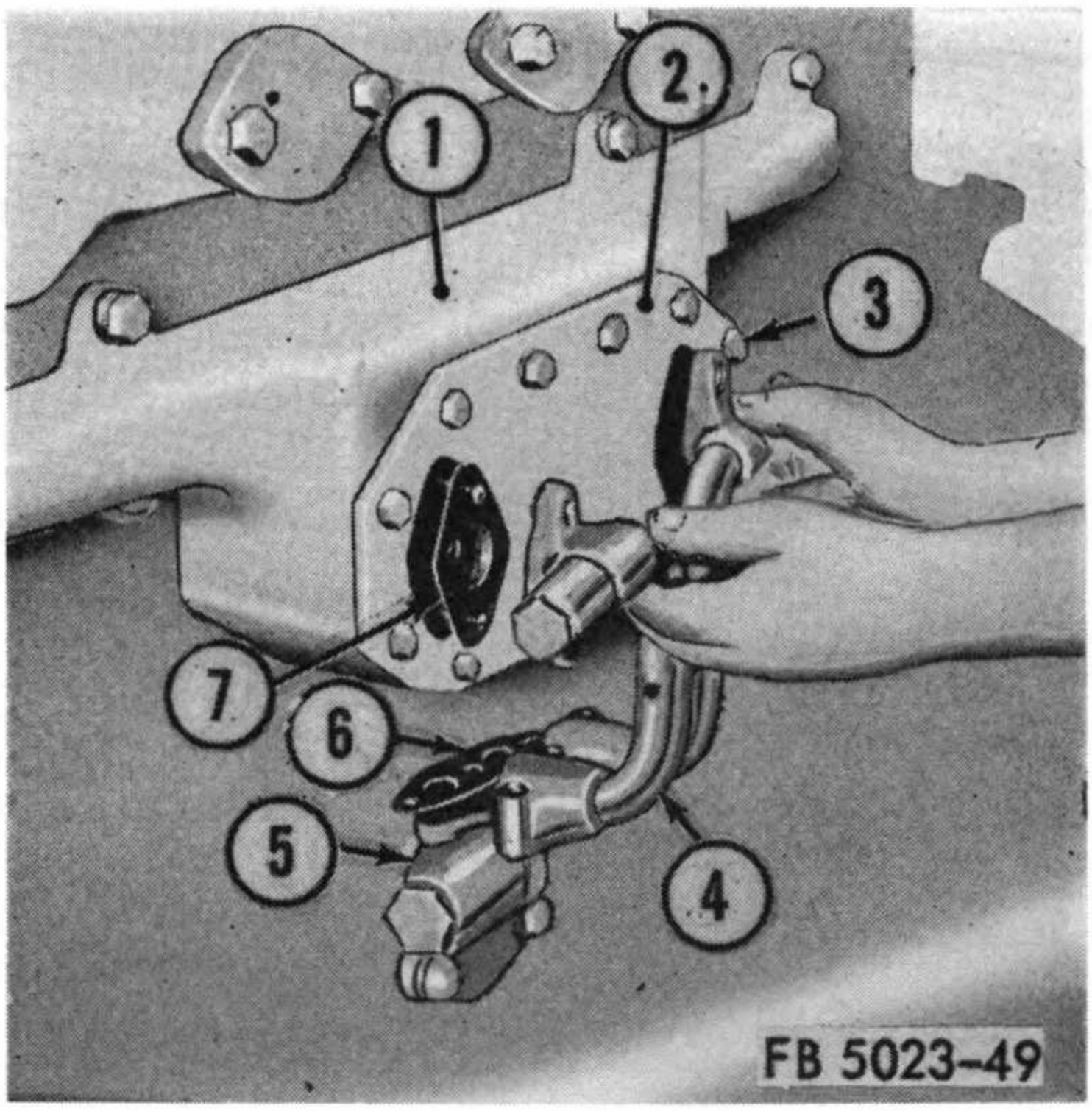
(*a*) Remove the spring retaining nut (7, fig. 51).

(*b*) Remove the ball check valve spring (6) and ball check valve (5).

c. Inspection and Cleaning.

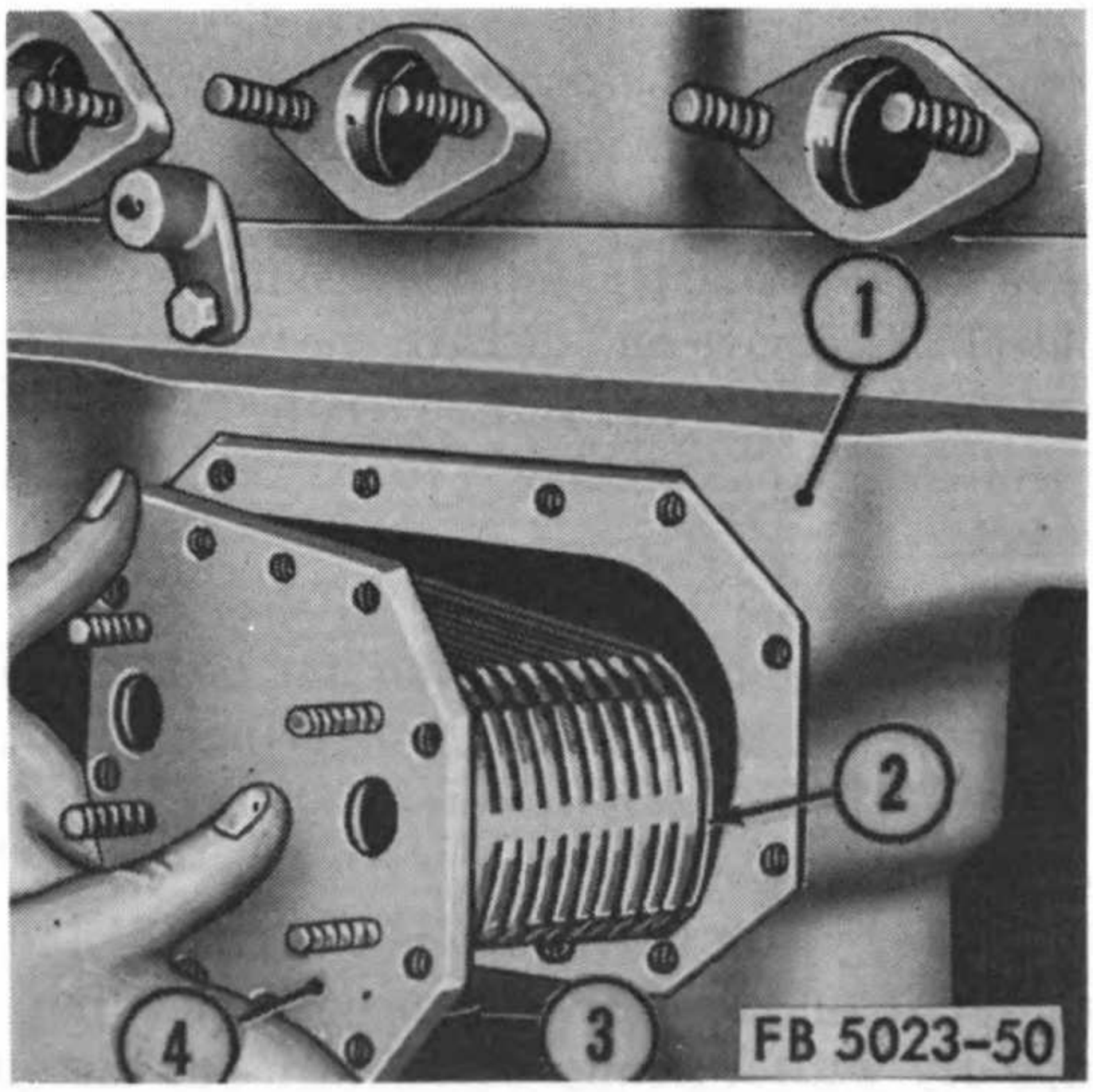
(1) Clean the bypass valve assembly housing and the outside of the oil tubes with an approved cleaning solvent and wipe dry with a clean cloth. Clean out the oil tubes then dry thoroughly with heat or compressed air.

(2) Replace the oil tubes if split. Replace a damaged oil cooler cover or element.



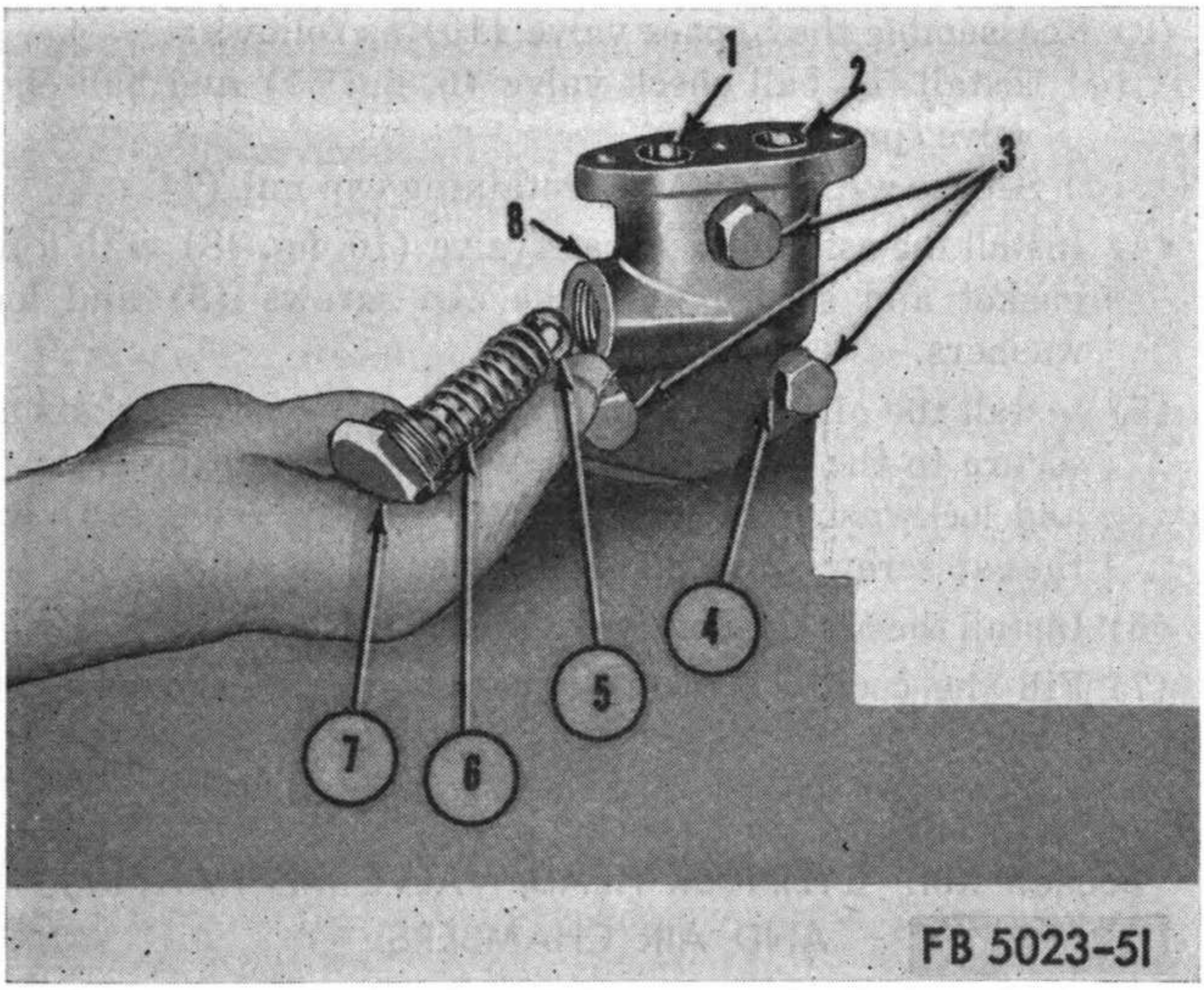
1 Water inlet manifold
2 Oil cooler
3 Cap screw, ⅜ x 1 NC (12 rqr)
4 Oil tube assembly
5 Bypass valve
6 Bypass valve gasket
7 Oil tube gasket

Figure 49. Removing oil tube assembly and bypass.



1 Water inlet manifold
2 Oil cooler core
3 Oil cooler gasket
4 Oil cooler

Figure 50. Removing oil cooler.



1	Cooler to main gallery oil passage	5	Ball check valve
2	Pump oil passage	6	Ball check valve spring
3	Cap screw, ½ x 1¼ NC (3 rqr)	7	Spring retaining cap nut
4	Lockwasher, ½ (3 rqr)	8	Bypass valve housing

Figure 51. Oil cooler bypass valve.

(3) Inspect the bypass valve assembly housing for cracks or breaks; replace the housing as a unit if it is defective.

(4) Replace all gaskets and damaged lockwashers, cap screws, or nuts.

(5) Fill a container with a cleaning solvent and submerge the oil cooler in a container with enough solvent to completely cover the cooler. Let the oil cooler stand in the solvent to remove sludge, iron rust, or other foreign matter.

(6) After removing the oil cooler from the solvent, thoroughly flush with clean hot water.

(7) Remove all gasket material from the mating surfaces of the oil cooler and water inlet manifold and clean the surfaces thoroughly.

d. Reassembly and Installation.

(1) Install a new oil cooler gasket on the mounting flange of the water inlet manifold.

(2) Mount the oil cooler with element against the water inlet manifold (1, fig. 48) and secure with the cap screws (3) and lockwashers.

(3) Reassemble the bypass valve (10) as follows:
  (*a*) Install the ball check valve (5, fig. 51) and ball check valve spring (6).
  (*b*) Secure with the spring retaining cap nut (7).

(4) Install the assembled bypass valve (10, fig. 48) with a new gasket and secure with the cap screws (8) and lockwashers.

(5) Install the oil tube assembly (13) using new gaskets and secure to the oil cooler (2) with the mounting nuts (4) and lockwashers. Secure to the bypass valve (10) with the cap screws (9) and lockwashers.

(6) Install the air cleaner (par. 31*e*(6)).

(7) Fill the cooling system, run the engine, and check for leaks.

Section XIII. CYLINDER HEAD, VALVE MECHANISM, AND AIR CHAMBERS

95. Description

The cylinder heads (14, fig. 43) seal the end of the cylinders to form the top of the combustion chamber. They contain the necessary passages for the intake of air and the expulsion of exhaust gases, as well as passages through which coolant flows to prevent overheating. The heads also contain the valves, injectors, the air chambers, and support the rocker arm assemblies.

96. Air Chambers

a. Removal.

(1) Remove the nuts (19, fig. 43) and lockwashers attaching the air chamber clamps (17) to the cylinder heads (14).

(2) Remove the air chamber plug.

(3) Remove the air chamber.

b. Cleaning and Inspection.

(1) Remove carbon deposits from the air chambers, plugs, and cylinder head recesses with a carbon solvent.

(2) If excessive carbon is present, the fuel injectors may be defective. Refer to the troubleshooting section for remedy of a defective injector.

(3) Inspect the air chambers for burned spots at the edges nearest the pistons and for internal burns. Replace defective air chambers.

c. Installation.

Note. **The plugs and air chambers are sliding fits in the cylinder heads.**

(1) Insert the air chambers and air chamber plugs into the cylinder heads.

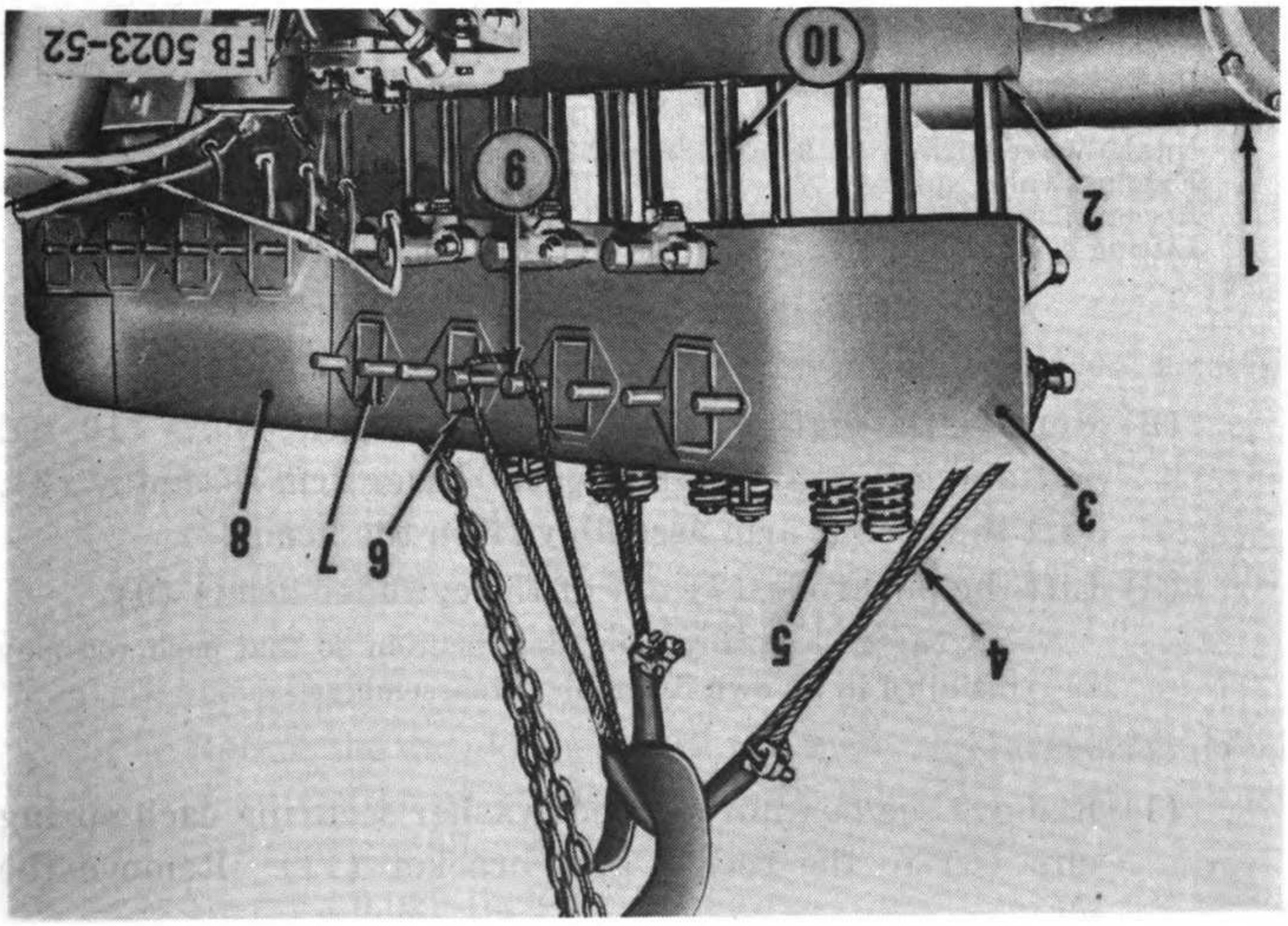
(2) Install the air chamber clamps (17) and secure with the nuts (19) and lockwashers.

97. Rocker Arm Assemblies

a. Description. The rocker arm transmits downward the upward thrust of the pushrods. One end of the rocker arm contacts the pushrod, the other end which has a removable valve stem contact button, actuates the valve. It is this rocking motion which opens the valve. Lubrication of the assemblies is through drilled holes in the crankcase and cylinder head assembly through which oil is forced by the oil pump to the hollow rocker arm shaft. Holes in the shaft line up with holes in the rocker arm.

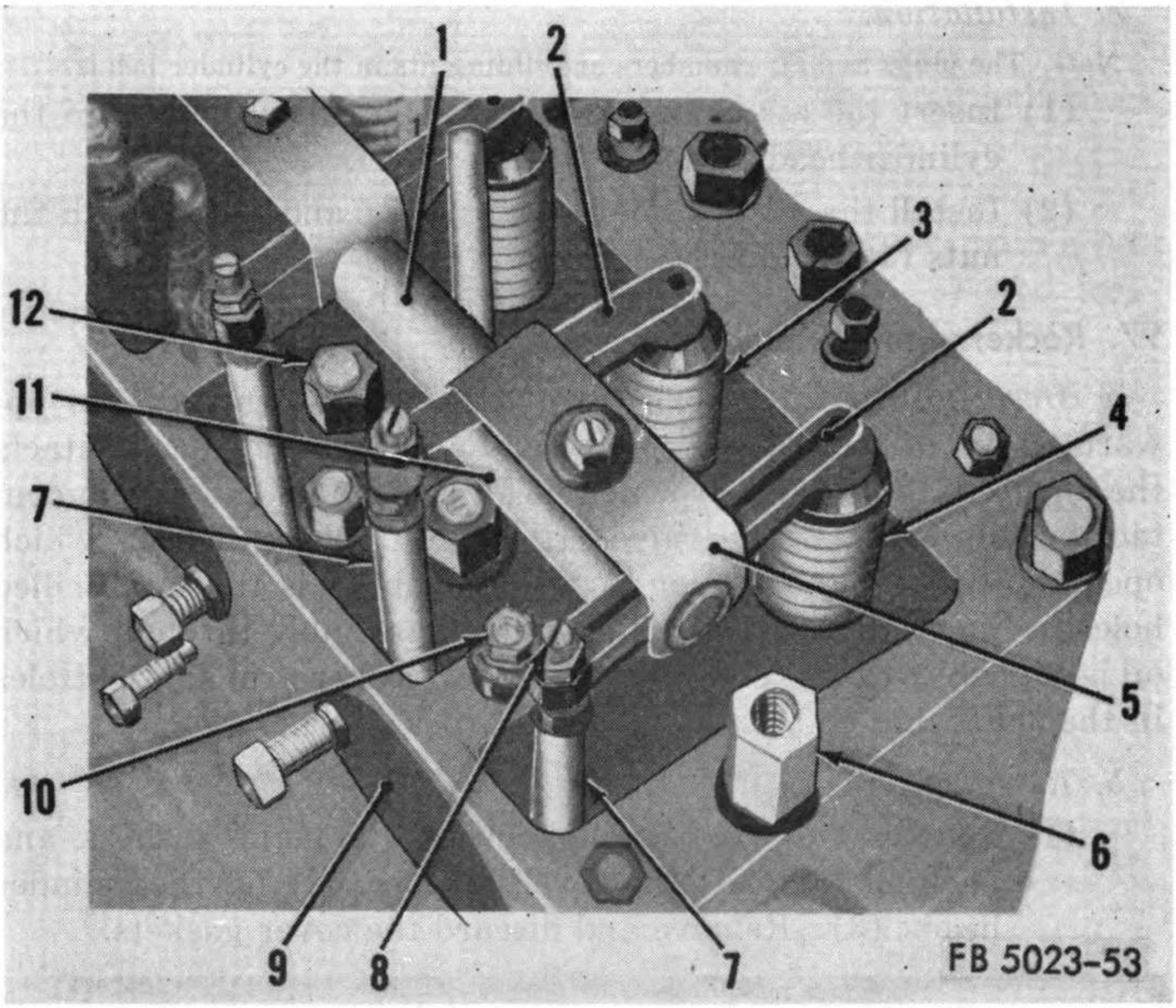
b. Removal.

(1) Remove the cylinder head cover nuts, plain washers, and packings and lift the covers (8, fig. 52) off the cylinder heads (3). Remove and discard the cover gaskets.



1	Supercharger housing	6	Air intake port
2	Cylinder head gasket	7	Air inlet manifold stud
3	Front cylinder head	8	Rear cylinder head cover
4	Lifting sling	9	Air intake manifold stud nut
5	Exhaust valve	10	Cylinder head studs

Figure 52. Removing cylinder head.



1	Rocker arm shaft	7	Pushrods
2	Rocker arm assemblies	8	Adjusting screw
3	Intake valve spring	9	Cylinder head
4	Exhaust valve spring	10	Rocker arm shaft bracket nut
5	Rocker arm shaft spring clip	11	Rocker arm shaft bracket
6	Lifting eye hex nut	12	Cylinder head stud nut

Figure 53. Rocker arm assembly, removal points.

(2) Remove the eight rocker arm shaft bracket nuts (10, fig. 53) and lockwashers from each rocker arm assembly (2). Lift the rocker arm assembly from the heads.

(3) Lift the pushrods (7) out of the cylinder heads (9).

Note. **Tag each pushrod for identification so that each rod may be reinstalled in its own lifter upon reassembly.**

c. Disassembly.

(1) Remove the hex nut and lockwasher securing each spring clip (5) to the rocker arm bracket (11). Remove the clips.

(2) Remove bracket stud from the rocker arm brackets (11).

(3) Slide the rocker arms (2), and brackets (11) from the shaft (1) and note the order of removal to facilitate installation.

d. Cleaning and Inspection.

(1) Clean all parts with an approved cleaning solvent.

(2) Inspect the rocker arm bushings for excessive wear. If worn, replace the complete rocker arm.

(3) Check the rocker arm bracket shaft (1) for ridges on the rocker arm bearing surfaces. Replace a defective shaft.

(4) Check the rocker arm brackets for cracks or breaks. Replace damaged brackets.

(5) Inspect the valve contact buttons for looseness. If loose or damaged, replace the complete rocker arm.

(6) Inspect pushrods for bends. Replace all bent pushrods.

e. Reassembly.

(1) Install the rocker arms (2), spacers and bracket (11) in order noted during removal.

(2) Temporarily secure the brackets (11) to the rocker arm shaft with the bracket stud.

(3) Install spring clip (5) over the two rocker arms (1 clip for each intake and exhaust rocker arm) and secure with the flat washer and hex nut. *Do not tighten nut.*

f. Installation.

(1) Install the pushrods (7) in the cylinder heads in same hole indicated by the tags made during removal.

(2) Install the rocker arm, bracket, and bracket shaft on the mounting studs of the cylinder heads.

(3) Secure with lockwashers and nuts (10).

(4) Aline and center rocker arm and adjusting screw sockets over their respective valve and pushrod.

(5) Center the rocker arm bracket shaft in the assembly and tighten the bracket stud.

(6) Tighten hex nut and flat washer securing the spring clip (5) to the rocker arm bracket (11).

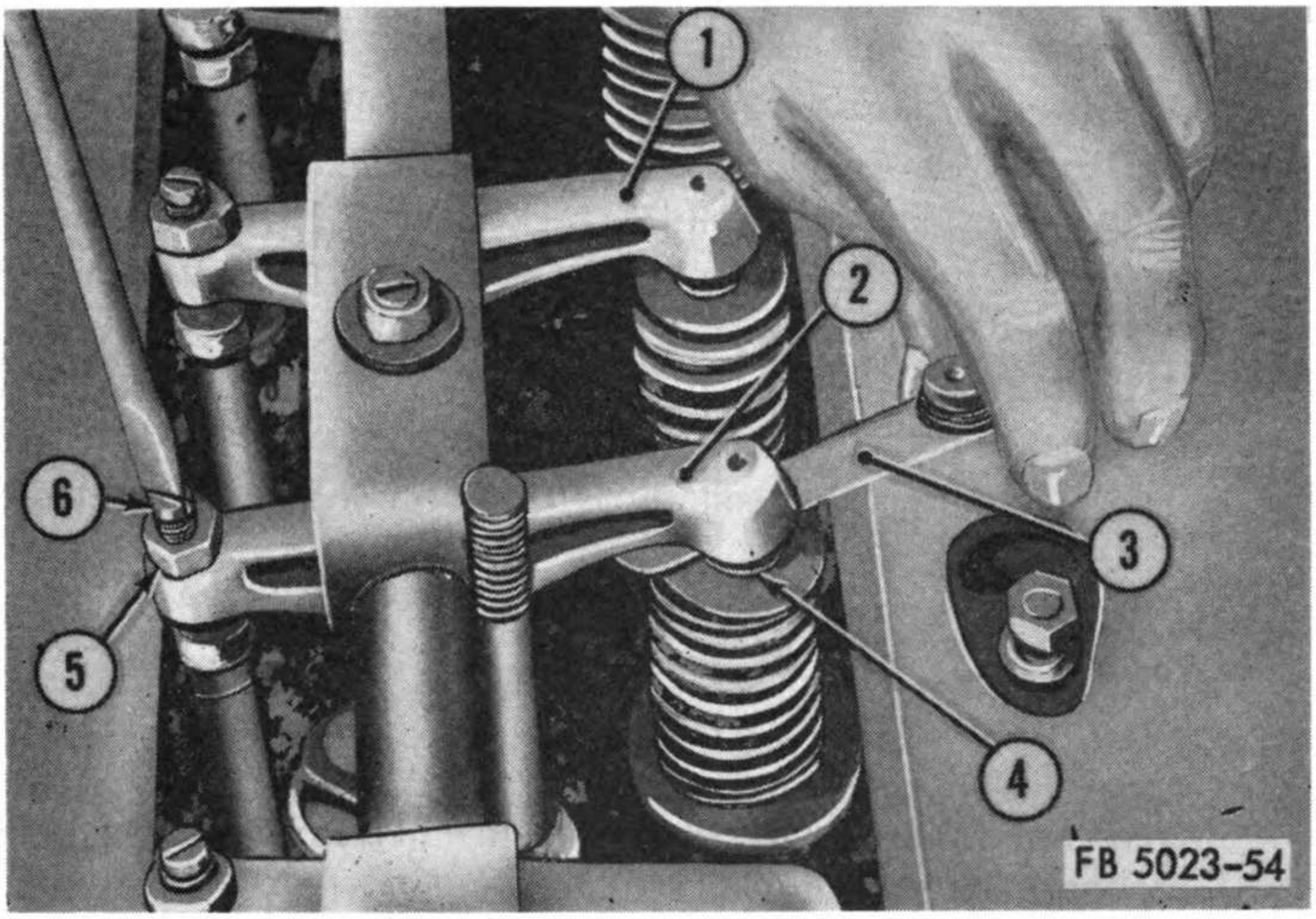
g. Adjustment.

(1) Rotate the crankshaft until the number 1 piston is at top dead center at which time both the intake and exhaust for that cylinder will be valves fully closed.

(2) Insert a 0.020-inch feeler gage between the exhaust valve stem (4, fig. 54) and rocker arm (2).

Note. The location of the exhaust valve can be determined by the exhaust port, the exhaust valve being directly in line.

(3) If the gage slides with a slight drag, the clearance is correct. Use a 0.018-inch gage for the intake valve adjustment.



1 Intake valve rocker arm
2 Exhaust valve rocker arm
3 Feeler gage
4 Exhaust valve stem
5 Adjusting screw locknut
6 Adjusting screw

Figure 54. Adjusting valve clearance.

(4) Rotate the crankshaft one quarter revolution for each cylinder and check the clearance of the valves for the remaining cylinders in firing-order sequence; 6–2–5–8–3–7–4.

(5) If adjustment is necessary, proceed as follows:

(*a*) Loosen the locknut (5), and turn the adjusting screw (6) until the proper clearance is obtained, then tighten the locknut.

(*b*) Repeat above procedures for the remaining cylinders rotating the crankshaft to properly position valves for each cylinder.

(*c*) Start the engine (par. 15*c*), and run the engine until operating temperature is reached, then shut down the engine.

(*d*) Repeat procedures as outlined above and adjust both intake and exhaust valves to 0.015-inch clearance (hot).

(6) Place a new cylinder head cover gasket on each cylinder head (3, fig. 52) and install the covers (8). Install a plain washer, packing, and nut on each cover stud. Tighten the nuts securely.

98. Cylinder Heads and Valves

a. Remove Cylinder Heads.

(1) Remove the air cleaner and air cleaner bracket (par. 31*e*(2)).

(2) Remove the exhaust manifold (par. 88*b*).

(3) Remove the water outlet manifold (par. 83*b*).

(4) Remove the air intake manifold (86*b*).

(5) Remove the rocker arm assemblies (par. 97*b*).

(6) Remove the 32 cylinder head stud nuts (12, fig. 53) and flat washers from the cylinder head studs (10, fig. 52) using a lifting sling (4), remove the cylinder head (3) from the cylinder block.

(7) Remove and discard the cylinder head gasket (2).

(8) Repeat the same procedure for removing the remaining cylinder head.

Caution: Do not crank the engine with the cylinder heads removed, as the cylinder liners may be pushed out. If the heads are to remain off the block, cover the cylinders to prevent the entrance of dirt and possible damage to the liners and pistons.

b. Remove Valves.

(1) Lay the cylinder head (4, fig. 55) on its side with the injectors (2) facing upward.

(2) Compress the valve springs (5) with a valve spring compressor (3) and remove the retainer locks (6).

(3) Release the compressor (3) and remove the retainers (7), springs (5), snap rings, and the valves.

(4) Mark the valves with the number of the cylinder from which they were removed, or place in a rack numbered to correspond with each cylinder. Each valve must be replaced in the same valve guide from which it was removed.

c. Cleaning and Inspection.

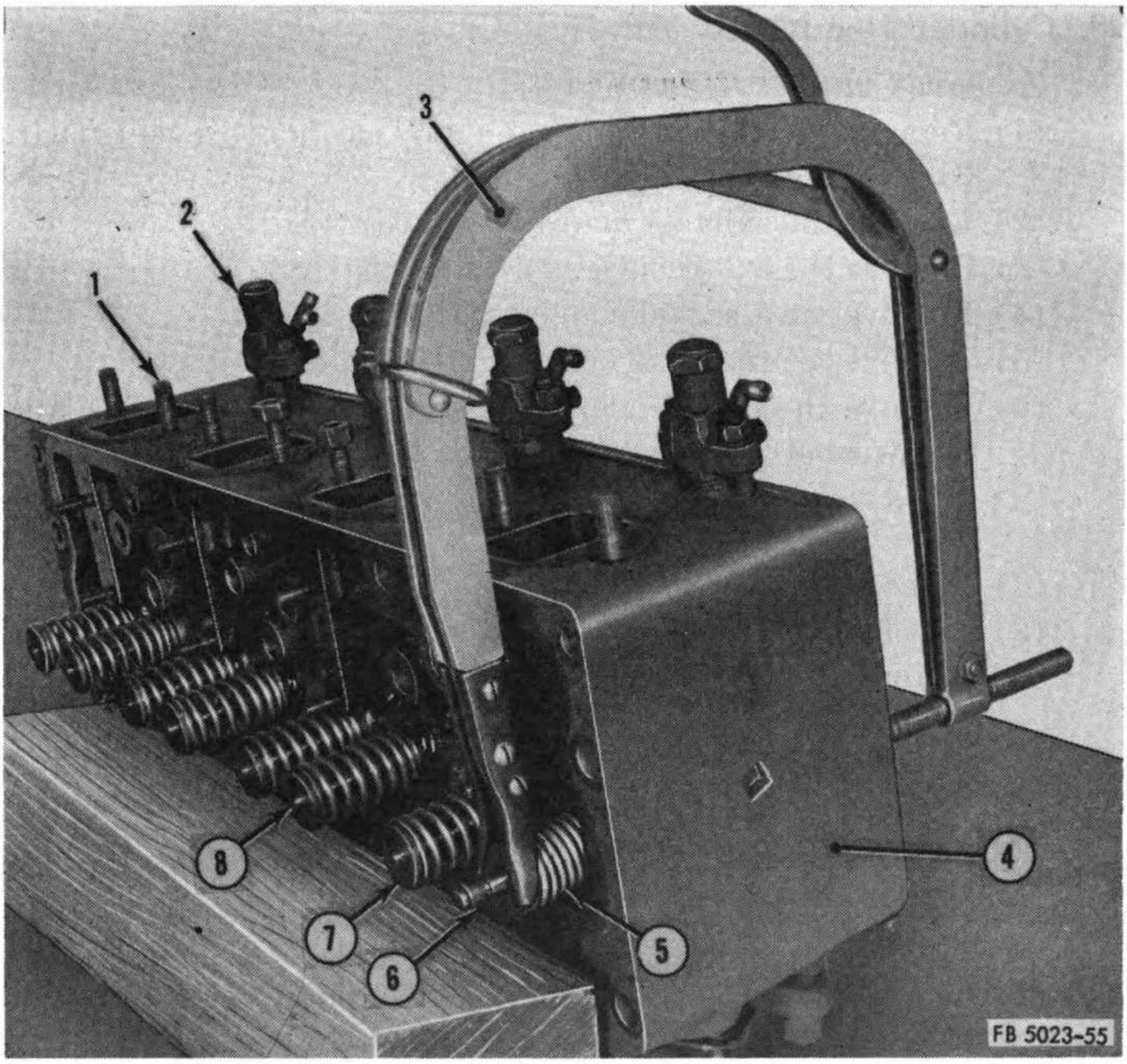
(1) Thoroughly clean the heads (4) with cleaning solvent to remove all carbon deposits.

(2) Check the heads for cracks. Replace cracked heads.

(3) Inspect the valve seats in the head for deep pits or burns. If the seats are badly pitted or grooved, replace the cylinder head.

(4) Check the valve guide clearance as follows:

(*a*) Remove all carbon from the valve stem and the inside of the valve guide with wire brushes.



1 Air intake manifold stud
2 Injector
3 Valve spring compressor
4 Cylinder head
5 Valve spring
6 Retainer locks
7 Valve spring retainer
8 Valve stem

Figure 55. Valve spring compressor in use.

(*b*) Thoroughly coat the valve stem and inside valve guide with oil.

(*c*) Place a thumb over the opposite opening in the valve guide and insert the valve slowly into the guide.

(*d*) If the valve falls freely and touches the thumb, this is evidence of excessive wear and the valve guide must be replaced.

(*e*) If resistance is felt due to the air being trapped between the thumb and the end of the valve stem, the clearance is adequate.

(*f*) Check the valves for warped stems, cracks, or deep pits. Replace a warped or bent valve. If pits or burns cannot be removed by refacing the valves, replace valves.

(*g*) Check for cracked, broken or weak springs. The free length of each spring is 3.250 inches. At 62 to 68 pounds pressure, the spring must compress to 2.750 inches.

d. Refacing Valves.

(1) Mount the valves in a refacing machine, with the valve face at a 45° angle to the abrasive wheel.

(2) Remove only enough metal to give a smooth 45° surface around the valve face.

e. Refacing Valve Seat.

(1) Using a 45° stone (3, fig. 56) in a valve seat grinding tool (2), grind the intake and exhaust valve seats until a new cut shows evenly all around.

(2) If the seating surfaces have been broadened to a width of more than one-eighth inch, narrow them down with a 70° stone until a width of between $\frac{3}{32}$- to $\frac{1}{8}$-inch is obtained.

(3) Before removing the valve seat refacing stone pilot from the valve guide, install a dial indicator, properly positioned, against the valve seat.

(4) Rotate the indicator around the valve seat. The maximum eccentricity must not exceed 0.002 inch.

f. Install Valves (fig. 55).

(1) Make 10 or 12 equally spaced marks with a soft lead pencil across the face of each valve.

(2) Insert each valve into its proper opening in the heads as noted during removal.

(3) Rotate each valve two or three turns against its seat. Remove the valve and check the pencil marks.

(4) If the marks are wiped off, the valve is properly seated. Repeat the refacing procedures if any pencil marks are left intact.

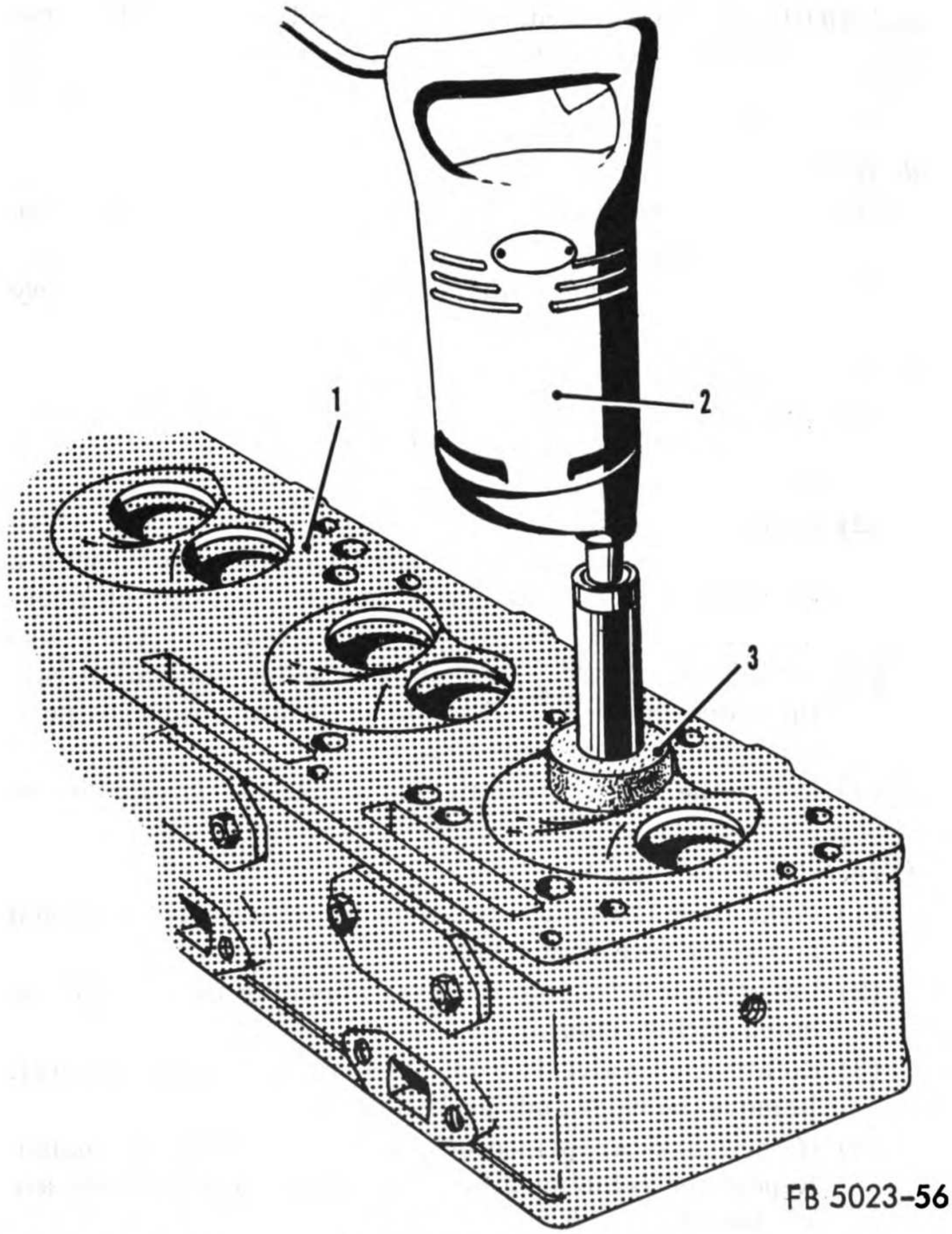
(5) Install the valves in their original positions in the heads and install a snap ring on each valve stem (8).

(6) Place the springs (5) and retainers (7) on the valve stem (8).

(7) Compress the spring with the valve spring compressor (3); install the retainer locks (6) and remove the compressor.

g. Install Cylinder Heads.

(1) Place a new cylinder head gasket (2, fig. 52) over the studs (10) on the cylinder block.



1 Cylinder head 2 Valve seat grinding tool 3 45° stone

Figure 56. Refacing valve seats.

(2) Using a sling (4), lower the assembled cylinder head (3) over the studs (10) and secure with the cylinder head stud nuts (12, fig. 53).

Note. **Tighten the nuts on large studs 190 to 200 ft-lb, and tighten the small stud nuts to 95 to 105 ft-lb. Proper tightening sequence is obtained by tightening the center head nuts first, then working outwardly.**

(3) Install the rocker arm assemblies (par. 97*f*).

(4) Install the air intake manifold (par. 86*d*).

(5) Install the water outlet manifold (par. 83*d*).

(6) Install the exhaust manifold (par. 88*d*).

(7) Install the air cleaner and air cleaner bracket (par. 31*e*(6)).

(8) Adjust the valves (par. 97*g*).

Section XIV. CONTROL PANEL

99. Control Panel

Complete electrical connections for the control panel, alternator, exciter, engine electrical system, and the air heater are shown in figure 57. All wire and terminal markings agree with those on the equipment. The numbers shown in the wiring diagram can be found at both terminal ends of the respective wires. For removal and replacement of all wiring, instruments and meters, refer to the wiring diagram in figure 57 to insure proper connections. For complete description and location of all controls and instruments, refer to paragraphs 10 through 13.

100. Care of Wiring

Electrical wiring must be kept clean, dry, and tightly connected at all times. Keep wires free of grease, oil, or other lubricants which could destroy the insulation.

Note. **Special care must be taken when handling wire in extreme cold, since insulation could crack or break resulting in short circuits.**

Warning: Never attempt to make any replacements or do any electrical work on the control panel or associated electrical equipment while the generator set is in operation.

Section XV. GENERATOR ASSEMBLY

101. Description

a. Alternator. The single-bearing, rotating-field alternator is directly connected to the engine flywheel through a disk type flexible coupling. The alternator inspection covers, located on the bearing bracket, are removed to inspect or service the alternator brushes, brush rigging, or sliprings.

b. Exciter. The 125-volt dc exciter and alternator are both mounted on a common shaft. Inspection covers must be removed

to inspect or service the exciter brushes, brush rigging, or slip-rings.

Note. **The inspection covers located in the bearing bracket will expose both alternator and exciter brush assemblies when removed.**

102. Exciter Commutator

a. Inspection. Remove the inspection covers from the bearing bracket (1, fig. 58) and inspect the commutator (2) for dirt, roughness, pits, and high mica between the commutator segments. A good commutator has a polished look and a light color but should have a thin film of graphite around it to provide a good conducting surface for the brushes.

Note. **Even though the commutator appears to be in good condition when inspected, it may spark badly when running.**

Check the brush length and spring tension (par. 103). If sparking still occurs when the brushes are the proper length and have the correct spring tension, report this deficiency to the proper authority to prevent possible damage.

b. Cleaning. Lift the brushes (3) clear of the commutator (2) and clean the commutator with a strip of 00 sandpaper.

Caution: Do not use lubricants or emery cloth to clean the commutator.

An alternator method of cleaning 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, the commutator must be undercut or machined. If machining or undercutting is necessary, report the condition to the proper authority.

103. Exciter Brushes

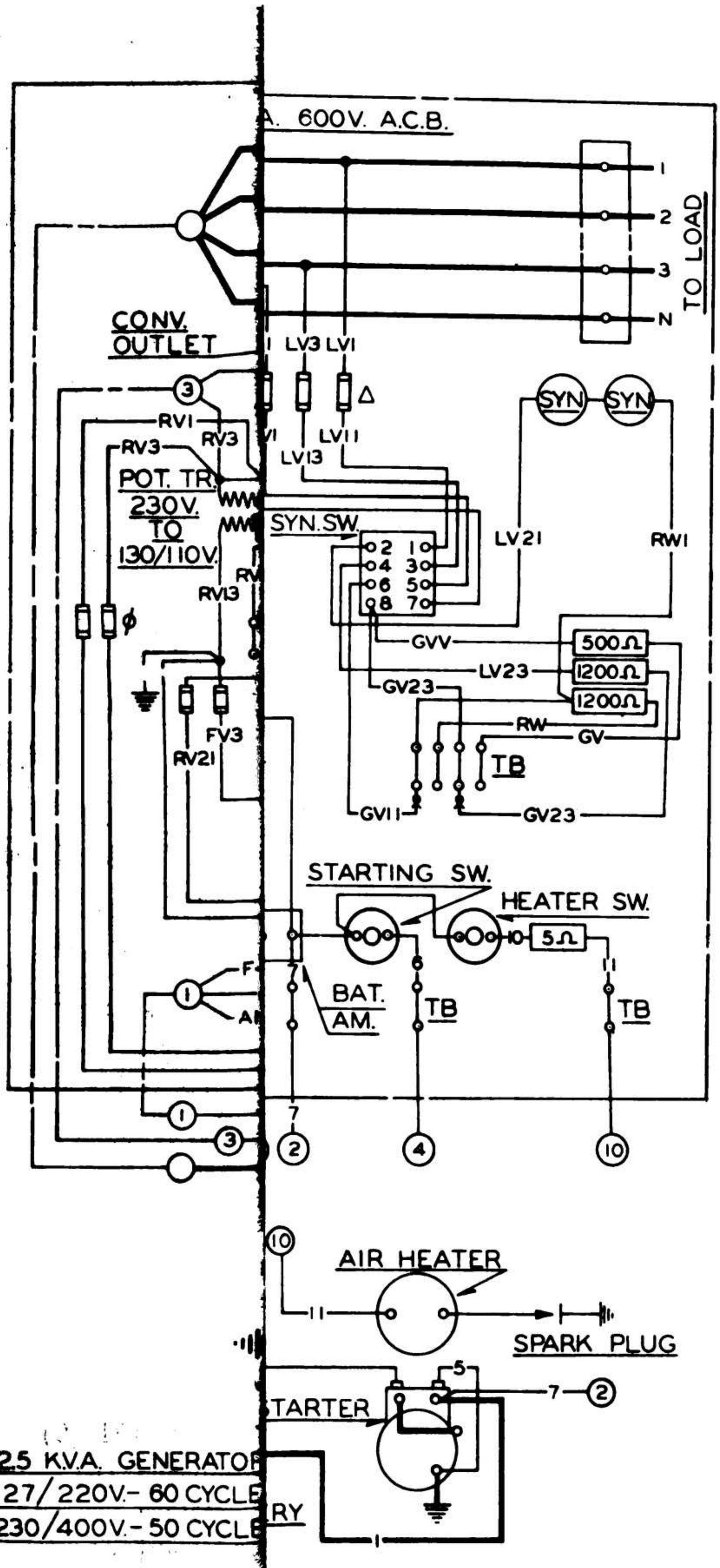
a. Cleaning and Inspection.

(1) Wipe the brushes (3, fig. 58) and brush holders (4) clean when the generator unit is shut down.

(2) Check each brush to see that it moves freely in its holder. Make sure the brush rigging is fastened securely. See that the brush holder is not cracked or broken. Examine the brush leads for loose connections and good condition.

b. Replacement.

(1) Replace brushes (3) that are worn to less than $^{11}/_{16}$-inch



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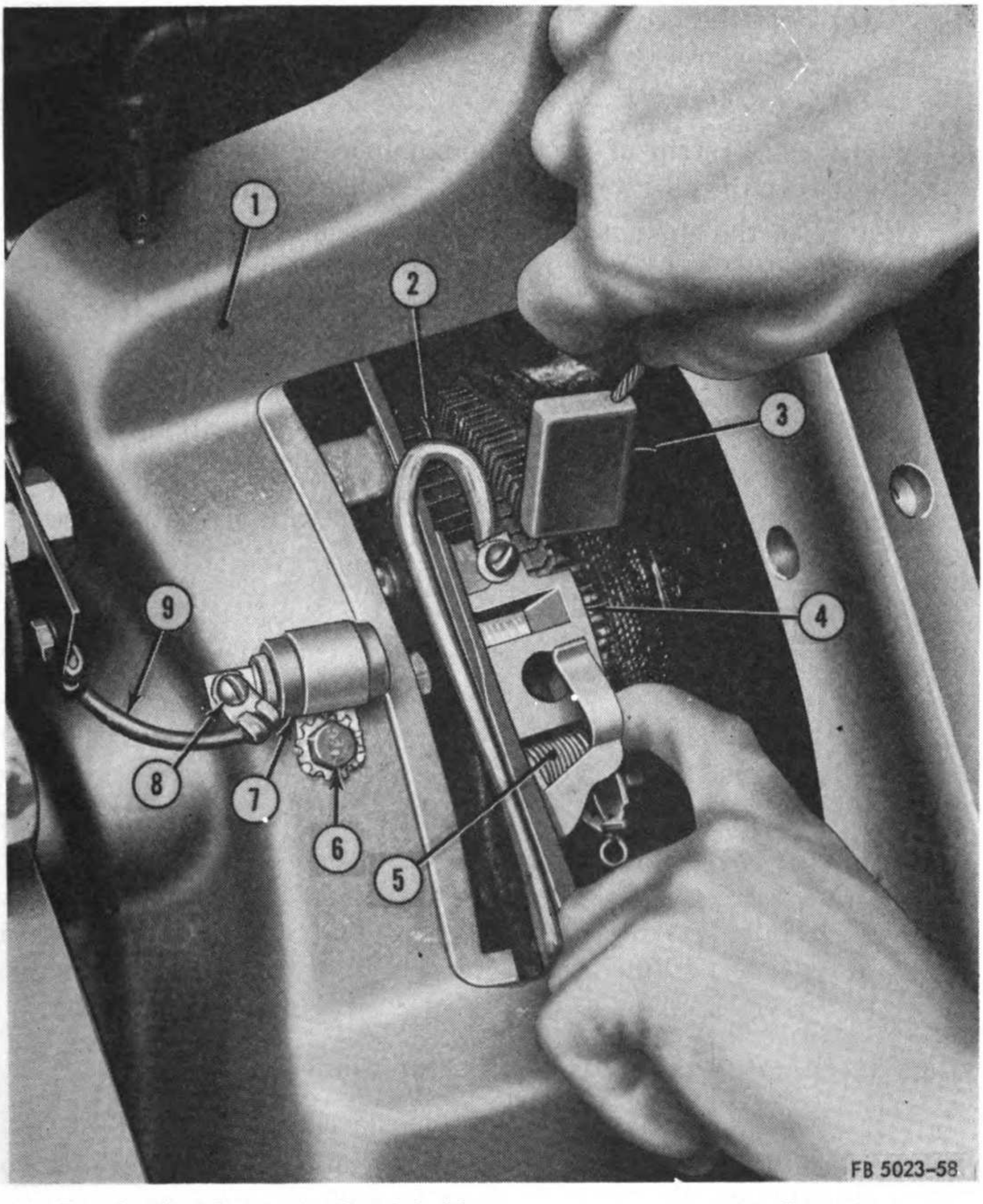


1	Bearing bracket	4	Brush holder	7	Capacitor
2	Commutator	5	Brush spring	8	Terminal screw
3	Exciter brush	6	Capacitor mounting cap screw	9	Capacitor lead

Figure 58. Removing exciter brush.

long as brushes are then too short to deliver correct brush pressure, even if spring tension is correct.

(2) If brushes require replacement, proceed as follows:

(*a*) Disconnect the brush lead at the brush holder (4) and remove the brush.

(*b*) Place the new brushes (3) in the holders (4) and connect the brush leads. Position the spring (5) on the brush (3).

(*c*) Seat the brushes (*c* below) and check the spring tension (*d* below).

c. Seating Brushes.

(1) Place a strip of coarse sandpaper, abrasive side up, between the positioned brush (3) and commutator (2).

(2) With the spring (5) exerting pressure on the brush (3); slide the sandpaper back and forth to shape the brush end to the curved surface of the commutator (2).

(3) After the brush is roughly shaped, substitute a strip of fine sandpaper (00) and draw the sandpaper in the direction of commutator rotation. This prevents brush tips from becoming rounded.

(4) Use dry compressed air (10 psi maximum) to remove all sand and carbon dust.

d. Checking Brush Spring Tension.

(1) Hook a small, spring-type scale to the curve of the spring (5), positioned above the brush (3), and pull directly in line with the brush holder (4). Correct tension for the spring is 12 to 12.5 ounces.

(2) If spring tension is not sufficient, replace the brush springs since there is no adjustment.

Note. After commutator, brushes, and spring tension are correct, the sparking may be the result of an open circuit in the armature. If this condition exists, report the condition to the proper authority.

104. Alternator Brushes and Collector Rings

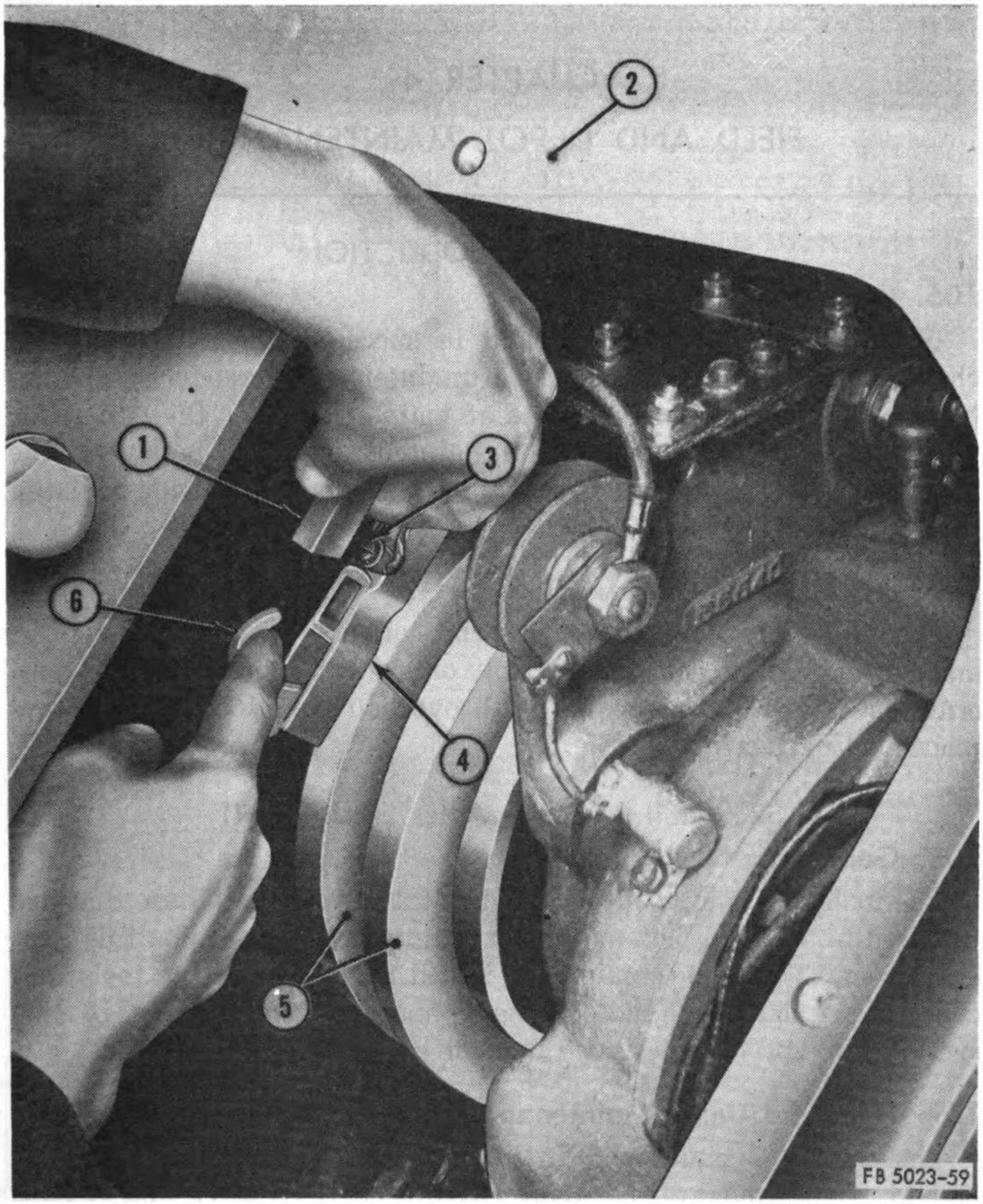
a. General. Maintenance for the alternator brush assembly (fig. 59) and collector rings is identical to that of the exciter. Refer to paragraph 103 for complete maintenance instructions with two following exceptions which are outlined in *b* and *c* below.

b. Replacement. Replace brushes that are worn to less than 5/8-inch long.

c. Brush Spring Tension. Correct brush tension for the collector ring brushes is 7 to 9 ounces.

105. Windings

a. Inspection. The small inspection openings permit only a limited inspection of the windings. Inspect the alternator and exciter windings for excessive dirt or moisture. A normal amount of dirt and dust may be expected and should not interfere with opera-



1 Collector ring brush
2 Bearing bracket
3 Terminal screws
4 Brush holder
5 Collector ring
6 Brush tension arm

Figure 59. Removing collector ring brushes.

tion of the unit. Inspect the windings for melted varnish; this will indicate overheating and the condition must be reported to the proper authority.

b. Cleaning. Use suction to clean the windings. If a suction device is not available, use dry compressed air (10 psi maximum). If grease or sticky dirt is present the generator must be partially disassembled for cleaning. Report this condition to the proper authority.

CHAPTER 4

FIELD AND DEPOT MAINTENANCE

Section I. INTRODUCTION

106. General

Instructions in this section and in succeeeding sections of this chapter are published for the use of maintenance personnel responsible for third and higher echelons of maintenance for the generator set. They contain information on maintenance which is beyond the scope of the tools, equipment, or supplies normally available to using organizations.

107. 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

108. General

The tools and equipment as listed in this section are those that are required to perform field and depot maintenance service 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.

109. Field and Depot Maintenance Tools and Equipment

The tools and equipment in table IV bearing identification are listed in Department of the Army ENG 3–41, ENG 5–41, and ENG 6 supply manuals or in ORD 6 SNL–G27. 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 IV. Field and Depot Maintenance Tools and Equipment

Item	Stock No.	References		Use
		Fig.	Par.	
Extractor	41–E–538	64	111*n*	Removing fuel injection pump delivery valve.
Growler	17–5550.500.100	117	187*a*	Testing starting motor armature and field coils.

Table IV. Field and Depot Maintenance Tools and Equipment—Continued

Item	Stock No.	References		Use
		fig.	par.	
Holder	41–H–2374	62	111*f*	Removing fuel injection pump tappet.
Insulation breakdown tester	17–9041.100.999	127	197*b*	Testing alternator stator and exciter field coils.
Lifter	41–L–1399	63	111*j*	Removing fuel injection pump tappet.
Puller	41–P–2905–12	66	111*p*	Removing fuel injection pump camshaft outer bearing race.
Puller	41–P–2905–18	65	111*p*	Removing fuel injection pump camshaft inner bearing race.
Reamer	41–R–490–25		112*b* (1)	Reaming control rack bushings.
Sleeve	17–S–7747	73	123*d*	Centering nozzle.
Stand	17–S–15545	68	114	Testing fuel injection pump.
Stand	17–S–15550	74	124*a*	Testing fuel injector.
Test unit	17–9048.500.500	126	197*a*	Testing alternator, rotor, stator, and exciter armature for shorts.
Undercutter	40–9470.500.000	120	187*a*	Undercutting mica on generator and starting motor commutator.
Undercutter	17–3230.200.999	129	198*a*	Undercutting mica or exciter commutator.
Wrench	41–W–869–350		112*b* (1)	Removing fuel injection pump control rack bushings.
Aligner	41–1070.500.500	107	174*e*	Checking connecting rods.
Cutter	41.2513.600.645	102	174*a*	Removing ring ridge.
Expander	41–3160.800.057	103	174*b*	Removing piston rings.
Indicator	41–4788.950.150			Checking cylinder compression.
Press	40.7105.100.000		127*g*, 129	Removing and installing accessory drive gears and bearings.
Puller	41–6272.300.600	109	175*a*, 175*c*	Removing and installing cylinder sleeves.

Section III. FUEL INJECTION PUMP

110. Description

The injection pump (12, fig. 17) delivers accurately metered fuel through injection tubes under high pressure to the injection nozzles

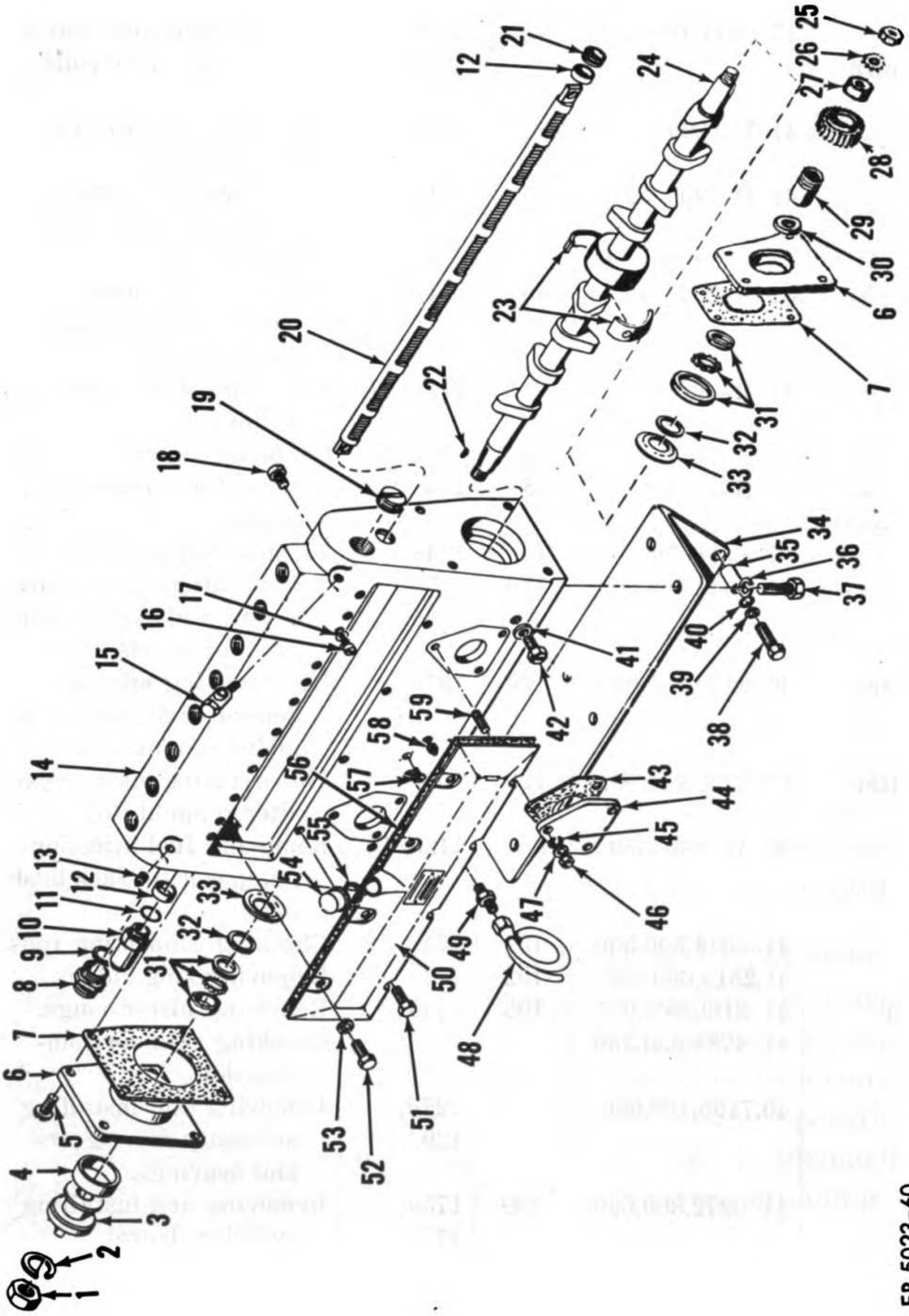


Figure 60. Fuel injection pump, exploded view.

FB 5023-60

1 Camshaft nut (1 rqr)
2 Camshaft nut lockwasher (1 rqr)
3 Coupling flange
4 Oil seal
5 End plate screw (4 rqr)
6 End plate
7 End plate gasket
8 Fuel inlet fitting
9 Inlet fitting gasket
10 Control rack cover
11 Control rack cover gasket
12 Control rack bushing
13 Pipe plug
14 Injection pump housing
15 Overflow valve assembly
16 Locating screw (8 rqr)
17 Locating screw gasket
18 Locating screw (1 rqr)
19 Sump closing plug
20 Control rack
21 Control rack outer bushing
22 Woodruff key (1 rqr)
23 Camshaft center bearing
24 Camshaft
25 Shoulder nut (1 rqr)
26 Shoulder nut lockwasher (1 rqr)
27 Rubber bushing
28 Governor drive gear
29 Sleeve spacer
30 Oil seal
31 Camshaft end bearing
32 Adjusting washer
33 Oil slinger
34 Pump bracket
35 Bracket pin
36 Lockwasher, ⅜ (6 rqr)
37 Cap screw, ⅜ x 1¼ NC (6 rqr)
38 Cap screw, ½ x 1¼ NC (4 rqr)
39 Lockwasher, ½ (4 rqr)
40 Washer, flat, ½ (6 rqr)
41 Plug gasket
42 Drain plug
43 Gasket
44 Cover
45 Plain washer, 5/16 (6 rqr)
46 Nut, hex, 5/16 (6 rqr)
47 Lockwasher, 5/16 (6 rqr)
48 Drain line
49 Drain line connector
50 Inspection cover
51 Cap screw, lower (4 rqr)
52 Cap screw, upper (4 rqr)
53 Lockwasher, (4 rqr)
54 Breather cap
55 Breather cap gasket
56 Inspection cover gasket
57 Securing screw
58 Pipe plug
59 Stud

Figure 60—Continued.

at precise intervals. Any excess fuel is returned from the nozzles through the nozzle drip manifold, overflow, and fuel valves to the tank. For further description, refer to paragraph 75*a*.

111. Fuel Injection Pump Disassembly

a. Remove the fuel injection pump (par. 75*b*).

b. Remove the drain plug (42, fig. 60) and gasket (41) from the housing (14) and drain the oil from the camshaft compartment.

c. Remove the inspection cover (50) by removing the eight cap screws (51 and 52) and lockwashers (53). Remove and discard the cover gasket (56).

d. Invert the pump and clamp it in a vise at the hexagon sections

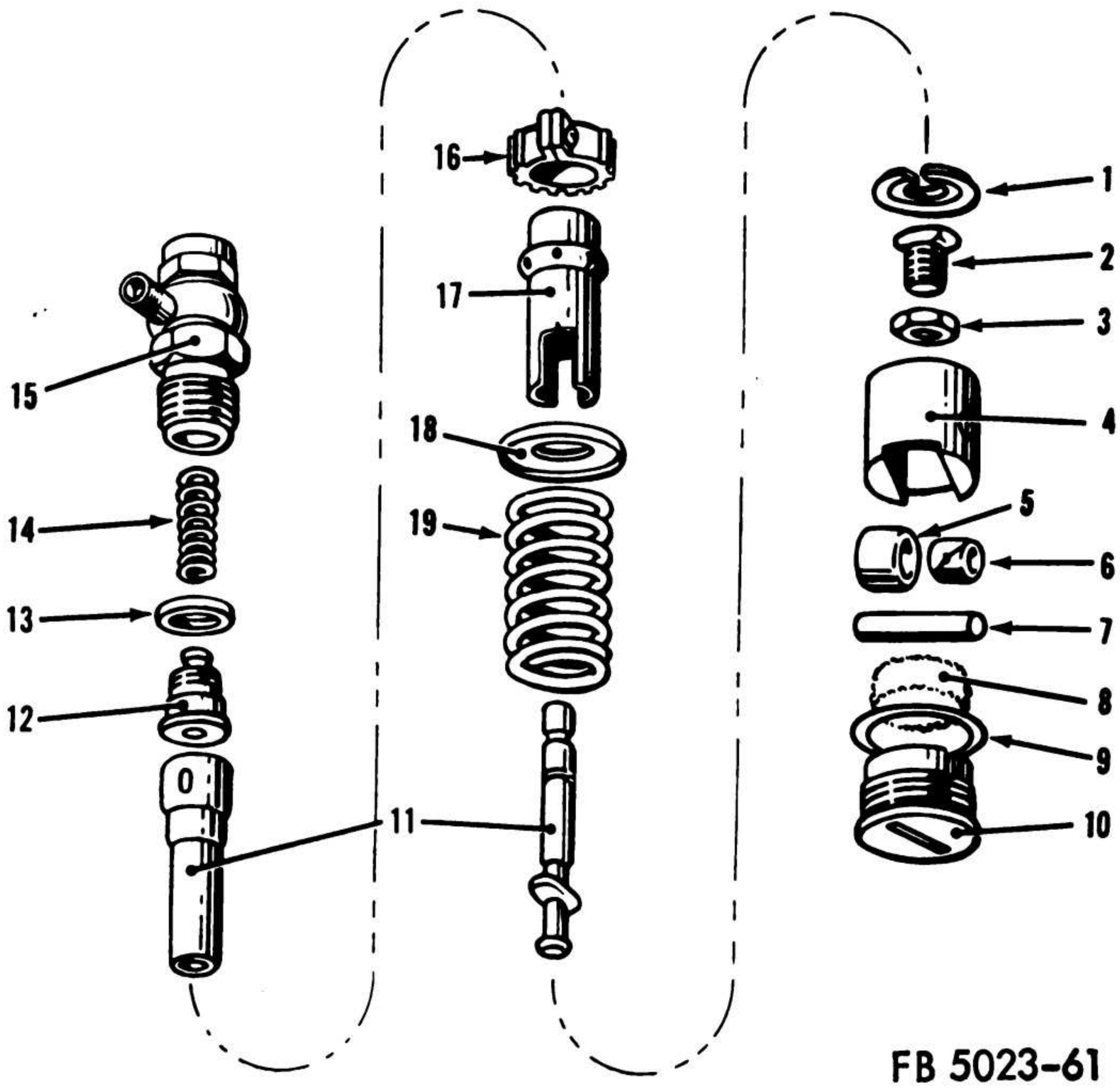
of the delivery valve holders (15, fig. 61). Use a lead jaw vise to protect the delivery valve holders.

e. Using a screwdriver attachment on a socket wrench, remove the plugs (10), gaskets (9), and felt wipers (8).

f. Rotate the camshaft (1, fig. 62) and as each tappet comes to the top of the stroke, insert a tappet holder (3) on the tappet screw (4). This relieves the camshaft of the spring pressure.

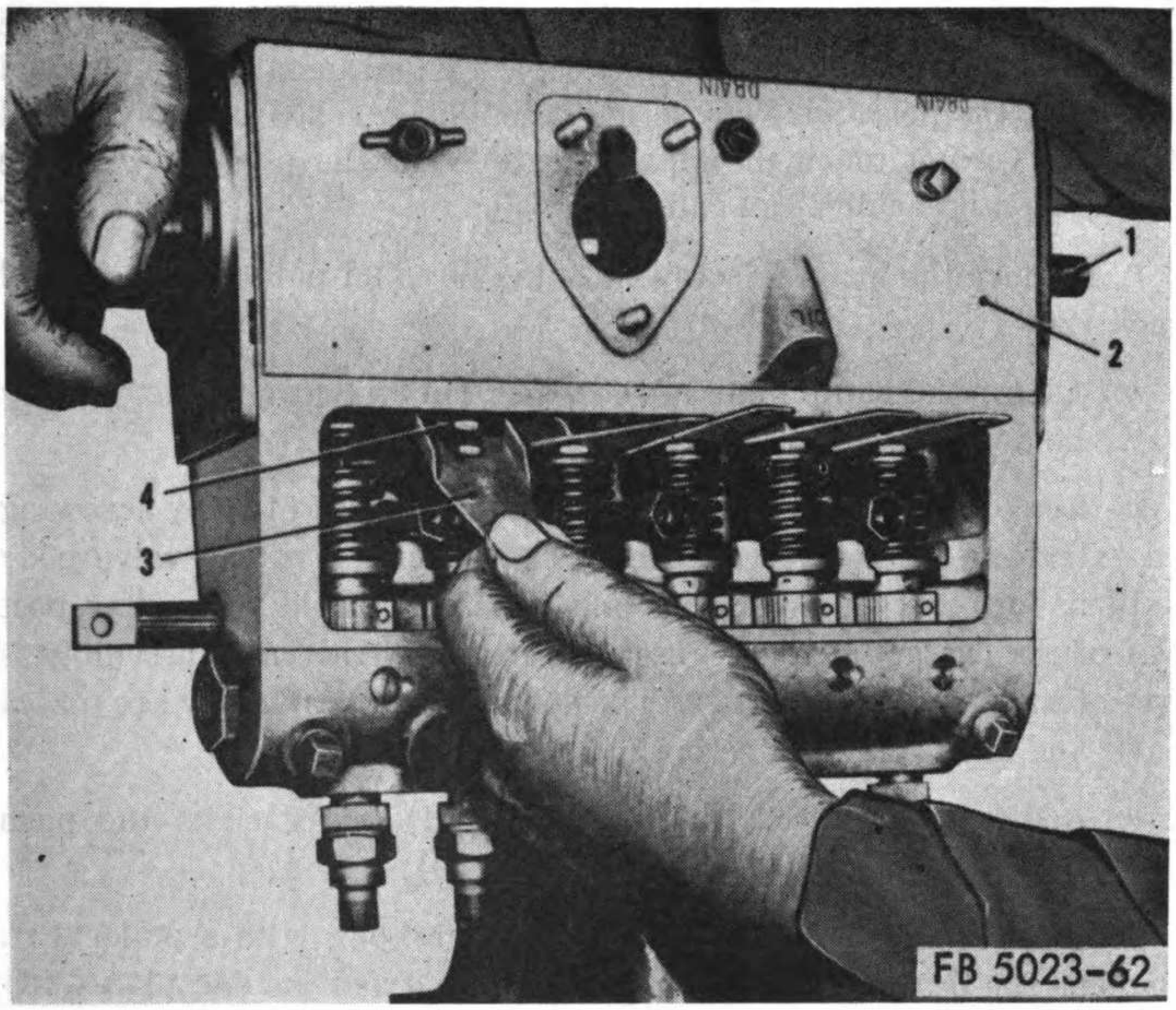
Caution: Do not remove end plates (6, fig. 60) until the tappet holders are in position.

g. Remove the screws (5) securing the drive end and plates (6). Remove the plates and discard the plate gaskets (7).



1	Lower plunger spring seat	7	Tappet pin	14	Valve spring
2	Tappet adjusting screw	8	Felt wiper	15	Valve holder assembly
3	Locknut (8 rqr)	9	Plug gasket	16	Segment gear
4	Tappet shell	10	Closing plug	17	Control sleeve
5	Tappet roller	11	Plunger and barrel assembly	18	Upper plunger spring seat
6	Roller bushing	12	Delivery valve assembly	19	Plunger spring
		13	Holder gasket		

Figure 61. Fuel injection pump cylinder assembly, exploded view.



1 Camshaft
2 Fuel injection pump housing
3 Tappet holder
4 Tappet screw

Figure 62. Inserting tappet holders.

Note. The oil seals (4) and bearing (31) outer races will come off with the end plates (6).

h. Draw the camshaft (24) out of the pump housing (14) taking care not to damage the cam surfaces, ball bearings, or oil slingers (33).

i. Mark one end of the camshaft so it can be installed in the same position.

j. Insert a tappet lifter (1, fig. 63) through the closing plug opening. Press downward on the tappet roller and remove the tappet holder (4). Lift up the tappet assemblies (2) and remove them from the pump.

k. Remove the plunger of the plunger and barrel assemblies (11, fig. 61), lower spring seats (1), spring (19), upper seats (18), and the control sleeves (17) with the segment gears (16) attached.

Note. Do not separate the sleeves and gears unless a replacement is to be made.

Caution: The plunger and barrel are mated units and cannot be interchanged. Keep each assembly separate and install in its original location. Do not strike or scrape the plunger against any metal surface. Do not touch the lapped surfaces of the plunger with the hands, as mild acidity can cause corrosion.

l. Remove the locating screw (18, fig. 60) and pull out the control rack (20).

m. Clamp the pump in an upright position and remove the delivery valve holders (15, fig. 61).

n. Remove the delivery valves (12) and gaskets (13) by screwing an extractor (5, fig. 64) on the threaded portion of the valve body until it bottoms; then back off one-half turn. Hold the center post (1) of the extractor, and tighten the nut until the valve assembly is free of the pump housing (2). The delivery valve and body are mated parts and must be kept together.

o. Remove the barrel locating screws (4) and gaskets and push the barrels (3) out of the pump housing (2).

p. Remove the bearing inner races (2, fig. 65) with a puller (3). Remove the bearing outer races (2, fig. 66) from the end plates (3) with a puller (1).

q. Measure the thickness of the adjusting washers (32, fig. 60) on each end of the camshaft, and remove the washers (32) and slingers (33).

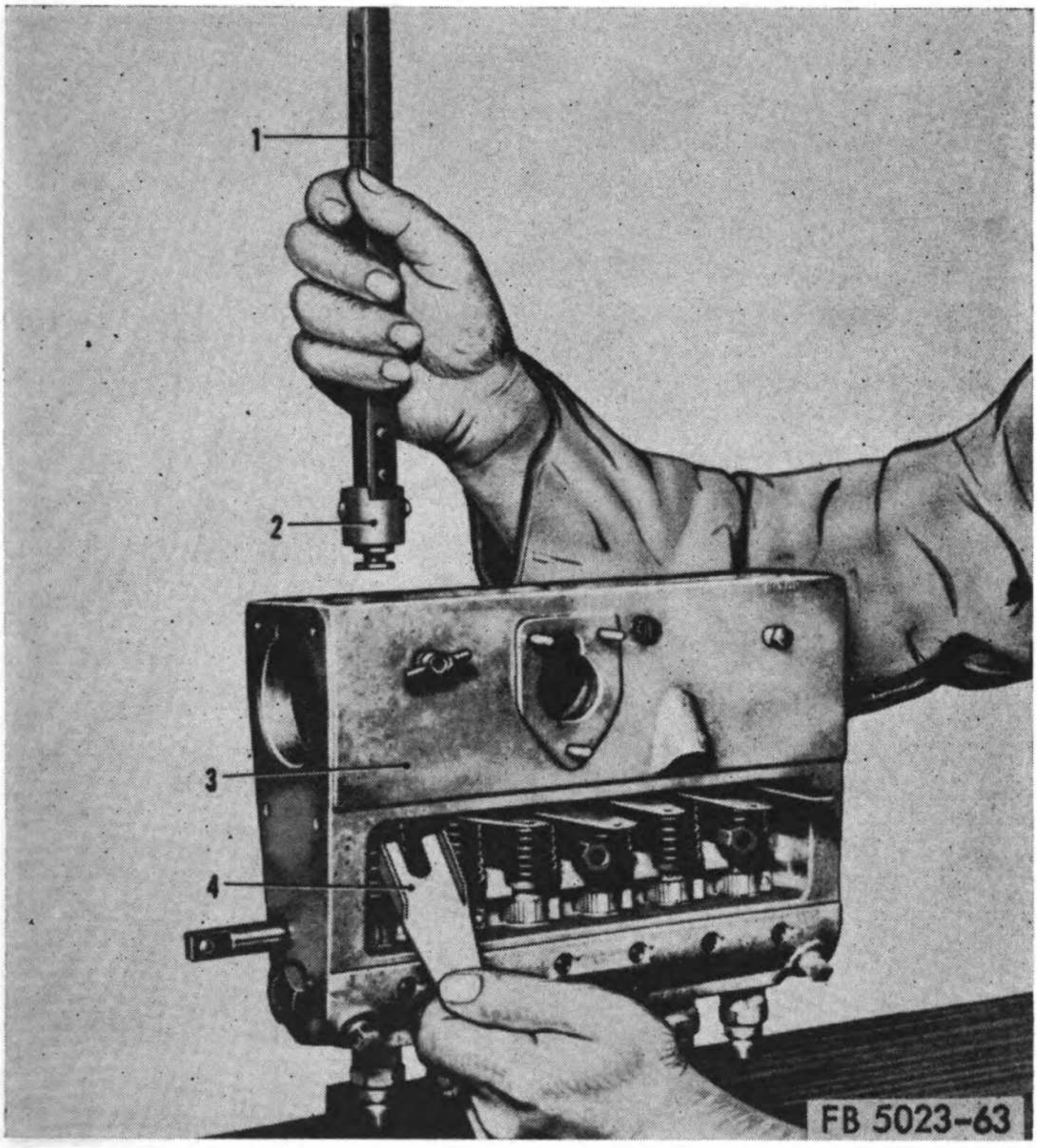
r. Remove the plug (19), the drain line assembly (48), control rack cover (10), gasket (11) and center bearing screw (57). Remove the center bearing (23).

112. Fuel Injection Pump Cleaning and Inspection

a. Cleaning. Wash all parts except the plunger and barrel assemblies thoroughly and carefully in cleaning solvent or fuel oil. Wash the plunger and barrel assemblies in clean fuel oil only. Blow dry with compressed air that is filtered and free of water. Be careful not to mar or damage the plunger, barrel, or delivery valve assemblies by striking them against other parts during the cleaning process. *Use only a soft bristle brush to clean injection parts.*

Caution: Do not use tools or abrasives of any kind to clean injection pump parts.

After washing the parts, lay them on a clean surface, preferably paper.



1 Tappet lifter
2 Tappet assembly
3 Fuel injection pump
4 Tappet holder

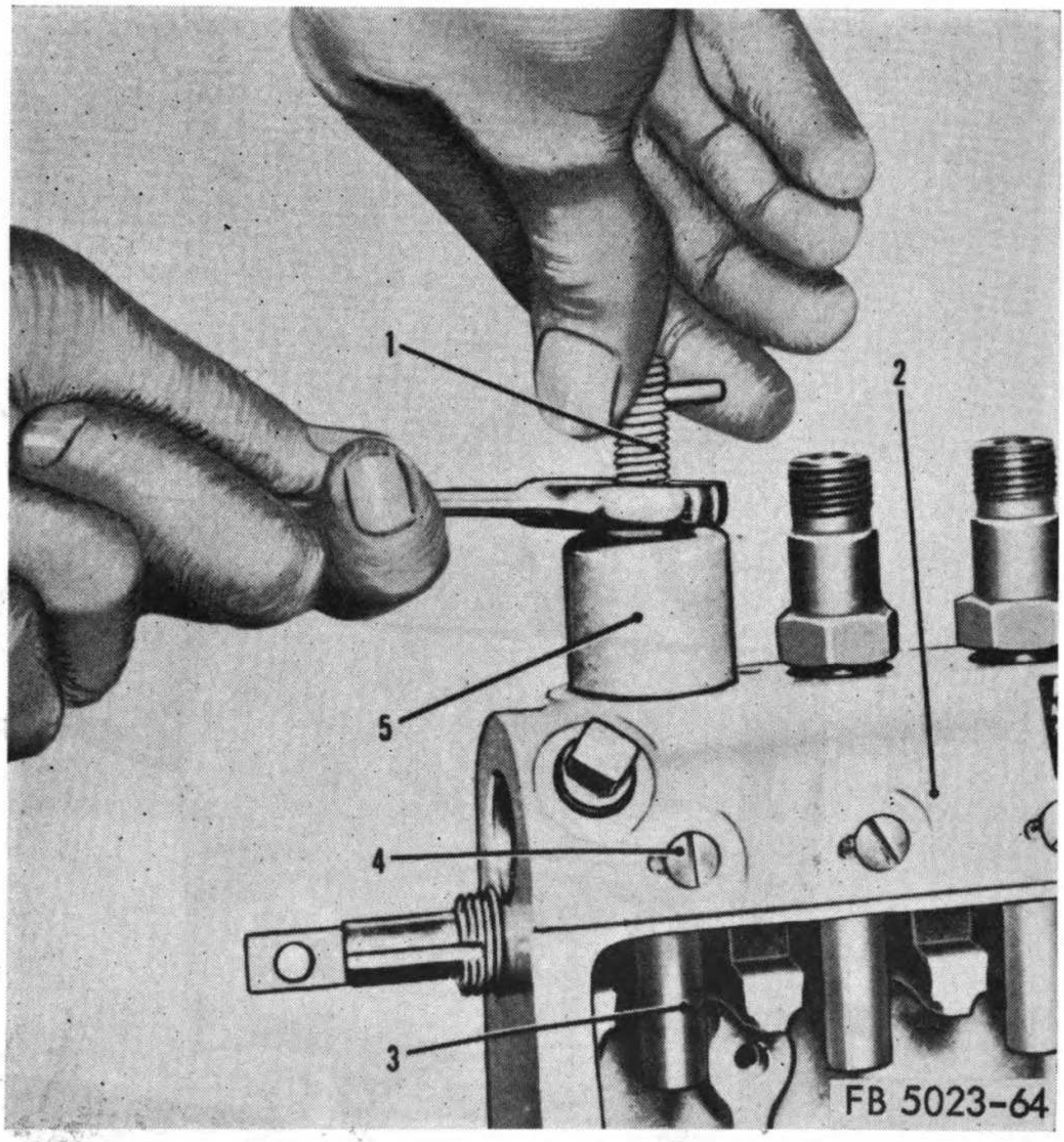
Figure 63. Removing tappets.

b. Inspection.

(1) *Pump housing.* Inspect the housing (14, fig. 60) for cracks and damaged threads. Replace a defective housing. If the control rack bushings (12) are worn or scored, replace by using a wrench (table II) and line ream with a reamer (table II).

(2) *Camshaft.* Inspect the cam lobes for pits, scratches, or corrosion. Check the threads and keyways for damage or wear. Replace a defective camshaft (24).

(3) *Bearings.* Examine the bearings (31) for wear, indicated



1 Center post
2 Fuel injection pump housing
3 Barrel
4 Barrel locating screw
5 Delivery valve extractor

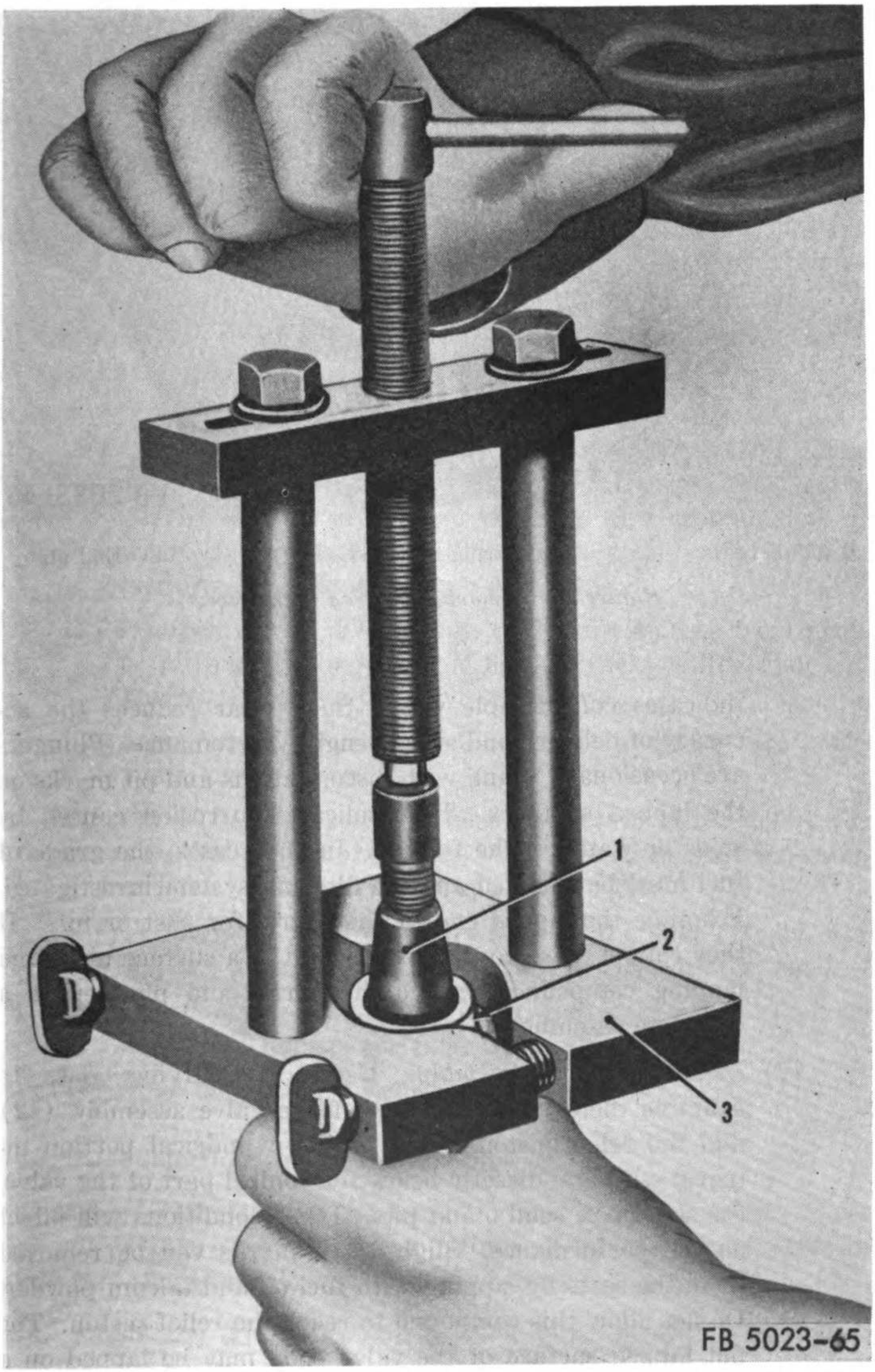
Figure 64. Removing delivery valves.

by pits, scoring, and fine metal chips in the races. Replace a defective bearing.

(4) *Oil seals.* Inspect the oil seals (4) for wear and cuts. Replace defective oil seals.

(5) *Tappet assembly.* Inspect the tappet assemblies (fig. 61) for wear on the heads of the tappet screws (2) and for play in the pins (7) and rollers (5). Replace defective assemblies.

(6) *Plunger and barrel assembly.* With a magnifying glass, examine the plunger assemblies (11) for scratches, scuff marks, and dull appearance of the lapped surfaces which



1 Camshaft 2 Bearing inner race 3 Puller

Figure 65. Removing bearing inner race.

Wash the valve assembly thoroughly and recheck it. Replace the complete assembly if any part is defective.

(8) *Delivery valve holder and spring.* Examine the holder (15) for damaged threads and the spring (14) for nicks and pits. Bending the spring with the fingers will show up any cracks. Replace a defective holder or spring.

(9) *Control rack.* Check the teeth of the control rack (20, fig. 60). Replace the rack if the teeth are chipped or show extensive localized wear.

(10) *Plates.* Inspect the end plates (6) for cracks or rough machined surfaces. Clean any roughness, or replace a cracked plate.

(11) *Control sleeve and segment gear.* Examine the teeth of the segment gear (16, fig. 61) and the slots in the control sleeve (17) for wear and damage. A slight amount of wear is normal and will not appreciably affect engine performance. Replace worn parts.

(12) *Plunger spring.* The spring (19) must be free from nicks or pitting. If the spring is flexed, cracks will become apparent. Replace a defective spring.

(13) *Spring seats.* If the spring seats (1) and (18) are badly worn, replace them.

(14) *Barrel locating screw.* Check the screw (16, fig. 60) for a mutilated head or damaged threads. If the spill deflecting end shows signs of wear, replace the screw.

(15) *Closing plug and felt wiper.* Replace the plug (10, fig. 61) and felt wiper (8) if plug threads or slots are damaged.

(16) *Overflow valve.* Examine the valve (15, fig. 60) for damage and wear. Replace the valve if it is defective.

(17) *Plugs and fittings.* Replace damaged plugs and fittings.

113. Fuel Injection Pump Reassembly

Use new gaskets when reassembling the injection pump. Make sure all parts are perfectly clean. Rinse all internal pump parts in clean fuel oil. Assemble without drying them.

a. Mount the injection pump housing (14, fig. 60) upright in a soft jaw of a vise.

b. Install the plug (19), drain line assembly (48), control rack cover (10), gasket (11), center bearing (23), and securing screw (57).

Wash the valve assembly thoroughly and recheck it. Replace the complete assembly if any part is defective.

(8) *Delivery valve holder and spring.* Examine the holder (15) for damaged threads and the spring (14) for nicks and pits. Bending the spring with the fingers will show up any cracks. Replace a defective holder or spring.

(9) *Control rack.* Check the teeth of the control rack (20, fig. 60). Replace the rack if the teeth are chipped or show extensive localized wear.

(10) *Plates.* Inspect the end plates (6) for cracks or rough machined surfaces. Clean any roughness, or replace a cracked plate.

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(12) *Plunger spring.* The spring (19) must be free from nicks or pitting. If the spring is flexed, cracks will become apparent. Replace a defective spring.

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(14) *Barrel locating screw.* Check the screw (16, fig. 60) for a mutilated head or damaged threads. If the spill deflecting end shows signs of wear, replace the screw.

(15) *Closing plug and felt wiper.* Replace the plug (10, fig. 61) and felt wiper (8) if plug threads or slots are damaged.

(16) *Overflow valve.* Examine the valve (15, fig. 60) for damage and wear. Replace the valve if it is defective.

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a. Mount the injection pump housing (14, fig. 60) upright in a soft jaw of a vise.

b. Install the plug (19), drain line assembly (48), control rack cover (10), gasket (11), center bearing (23), and securing screw (57).

c. Place the slingers (33) on the camshaft (24) and washers (32) to the same thickness as measured when the inner races of the bearings (31) were pulled off.

d. Press the inner races of the bearing (31) on the camshaft, and the oil seals (4) and outer races in the end plates (6).

e. Separate the plunger and barrel assemblies (11, fig. 61), keeping the plungers in order so that each one can be inserted in its respective barrel.

f. Insert the barrels into the housing (14, fig. 60) so that the elongated holes in the barrels face the locating screw holes.

g. Install the barrel locating screws (16) and gaskets (17) and tighten the screws firmly. The ends of the screws must engage the elongated holes in the barrels but must not bind the barrels. It should be possible to move the barrels up and down slightly with the fingers.

h. Insert the delivery valve assemblies (12, fig. 61), gaskets (13), and springs (14), and screw the holders (15) into the pump.

i. Clamp the pump in an inverted position so that it is held at the hexagon sections of the delivery valve holders.

j. Insert the control rack (20, fig. 60) in the position it was in before disassembly, and install and tighten the locating screw (18).

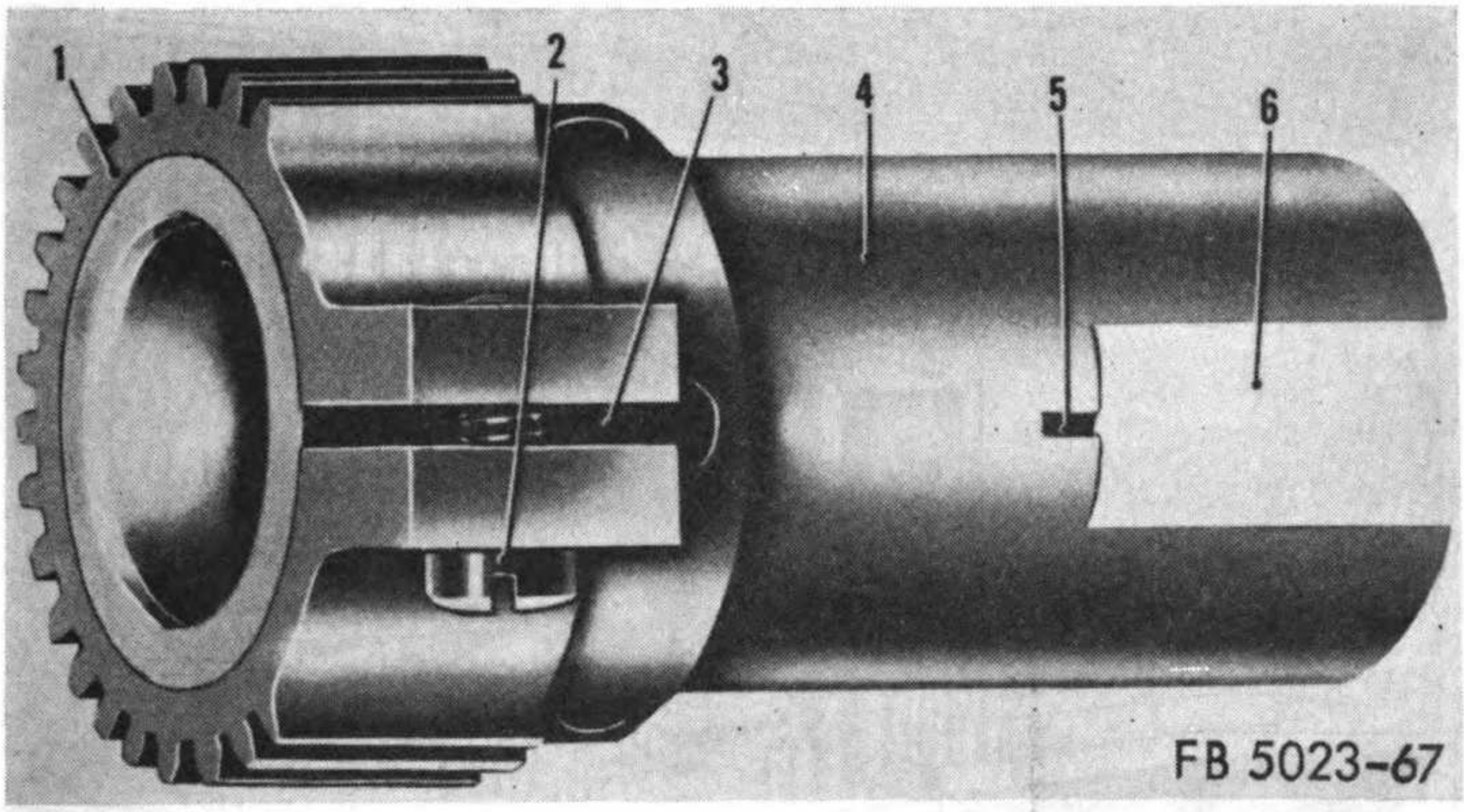
k. Delete all calibration marks on the control sleeves (17, fig. 61) with a fine cut file. A new mark will be installed after the pump has been calibrated. If a segment gear (1, fig. 67) or control sleeve (4) has been replaced, clamp the gear so that the gear split (3) is in line with the mark (5) above the plunger guide slot (6) of the sleeve.

l. Position the control rack (20, fig. 60) so that the punch marks at each end protrude slightly from the side of the housing (14) and mesh with the segment gears (1, fig. 67) with the split (3) at right angles to the control rack.

m. See that the rack moves freely, and slip the upper spring seats (18, fig. 61) and springs (19) on the sleeves.

n. Insert the proper plunger, with the lower spring seats (1) in place, into each barrel. The assembly marks on the plunger flange and the sleeve guide slot must coincide. Do not force when inserting the plunger. It must slide freely into the barrel.

o. Insert the tappet assemblies (2, fig. 63) through the closing plug opening. Press the tappets down with a tappet lifter (1) and place the tappet holders (4) in position.



1 Segment gear
2 Clamping screw (8 rqr)
3 Gear split
4 Control sleeve
5 Control sleeve mark
6 Plunger guide slot

Figure 67. Control sleeve and segment gear.

p. Install the camshaft (24, fig. 60) in the same position as before disassembly and secure the gaskets (7) and end plates (6) to the pump housing. Secure the coupling end plate (6) with the screws (5). Temporarily install the governor end plate (6) and tap into position with a rawhide mallet.

Note. The governor and end plate will be permanently secured when the governor is secured to the injection pump.

q. Check the camshaft end thrust. Permissable tolerance is 0.004 to 0.008 inch. If the tolerance is beyond these limits, enough adjusting washers (32) must be removed or added to bring the tolerance within specified limits. Care must be taken to prevent the camshaft from shifting too far to one side and causing the lobes to strike the tappet shells.

r. Rotate the camshaft and remove the tapped holders.

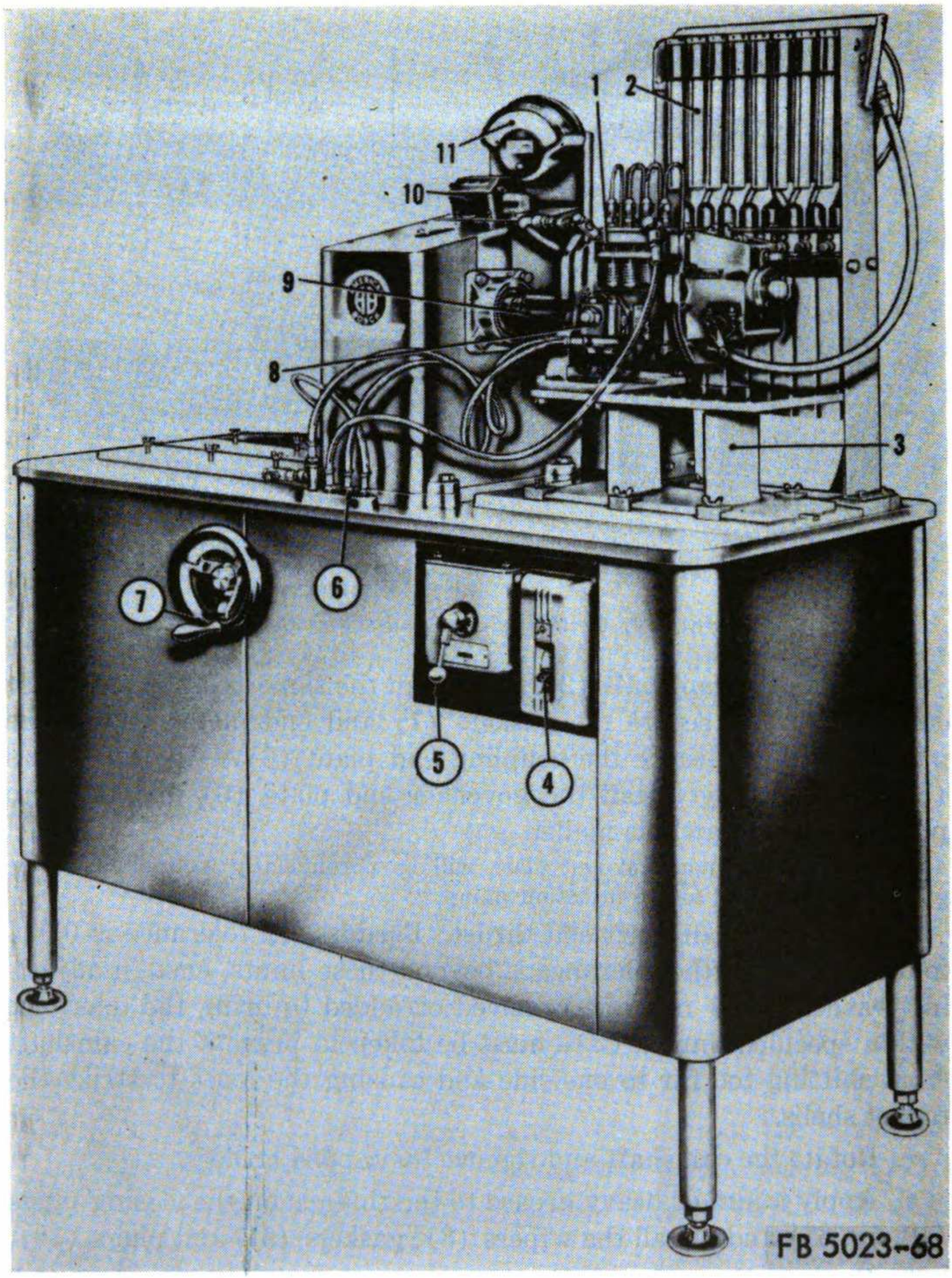
s. Apply a film of heavy grease to the threads on the closing plugs (10, fig. 61) and install the wipers (8), gaskets (9), and plugs (10).

t. Remove the pump from the vise, and install the gasket (56, fig. 60) and inspection cover (50). Secure with the short cap screws (52) and lockwashers (53) at the top, and the long cap screws (51) and lockwashers (53) at the bottom.

u. Install the fuel transfer pump (par. 72*d*) overflow valve (par. 68*c*(3)).

v. Install the drain plug (42) and gasket (41).

w. Install the pump bracket (par. 75*c*(1)), rear coupling flange (par. 75*c*(2)), governor drive gear (par. 75*c*(8 and 9)), and governor adapter (par. 74*c*(1)).



1	Fuel injection pump	7	Speed regulating handwheel
2	Graduated test tubes	8	Fuel transfer pump
3	Mounting block	9	Intermediate disk
4	Master switch	10	Counter
5	Reversing switch	11	Tachometer
6	Fuel connections		

Figure 68. Typical injection pump test stand.

x. Lubricate the pump. Refer to LO 5–5023.

y. Test the pump (par. 114) and calibrate (par. 115) if necessary.

114. Fuel Injection Pump Test Stand

After overhaul, it is essential that the pump be tested and calibrated on a test stand as shown in figure 68, which is one of several types.

a. Secure the pump to a mounting block (3) of the correct height, and connect the pump (1) to the test stand drive through an intermediate disk (9).

b. Fuel connections (6) are provided for the fuel transfer pump (8), injection pump inlet line, and return line. Connect the high pressure tubing to each pump cylinder.

c. Install the control rack positioning divice and connect it to the control rack of the pump.

d. The test stand is driven by an electric motor energized through the master switch (4). The motor can be reversed by using the switch (5). Speed is regulated by a handwheel (7) and indicated on a tachometer (11). The counter (10) can be set to measure the number of plunger strokes.

115. Fuel Injection Pump Calibration

a. Move the pump control rack to midposition and run the pump (4, fig. 69) at a speed of 225 rpm for several minutes to allow the system to fill with oil and bleed out all the air.

b. Set the control rack positioning device (9) to zero when the control rack (6) is in the full stop position.

c. Slowly turn the knurled wheel (8) to move the control rack to increased fuel position. When a movement of 3 to 4 millimeters has been reached, a slight lift of the feeler pin (2) in the nozzle holder (1) should be felt. This initial movement is known as dead travel. The lifting of the pin indicates that fuel is being discharged from the nozzle. If such action occurs before or after the rack has reached the 3 to 4 millimeter setting, adjust the control sleeve to obtain fuel discharge at this setting (*j*–*m* below).

d. Adjust the positioning device (9) to 9 millimeters and lock the knurled wheel with the lock wheel (7).

e. Set the counter (3) for 100 strokes and collect the fuel discharge in the graduated tubes (5).

f. Record the quantity of fuel from the number 1 element of that pumping unit adjusted for the 3 to 4 millimeters dead travel. This quantity will be used as a reference.

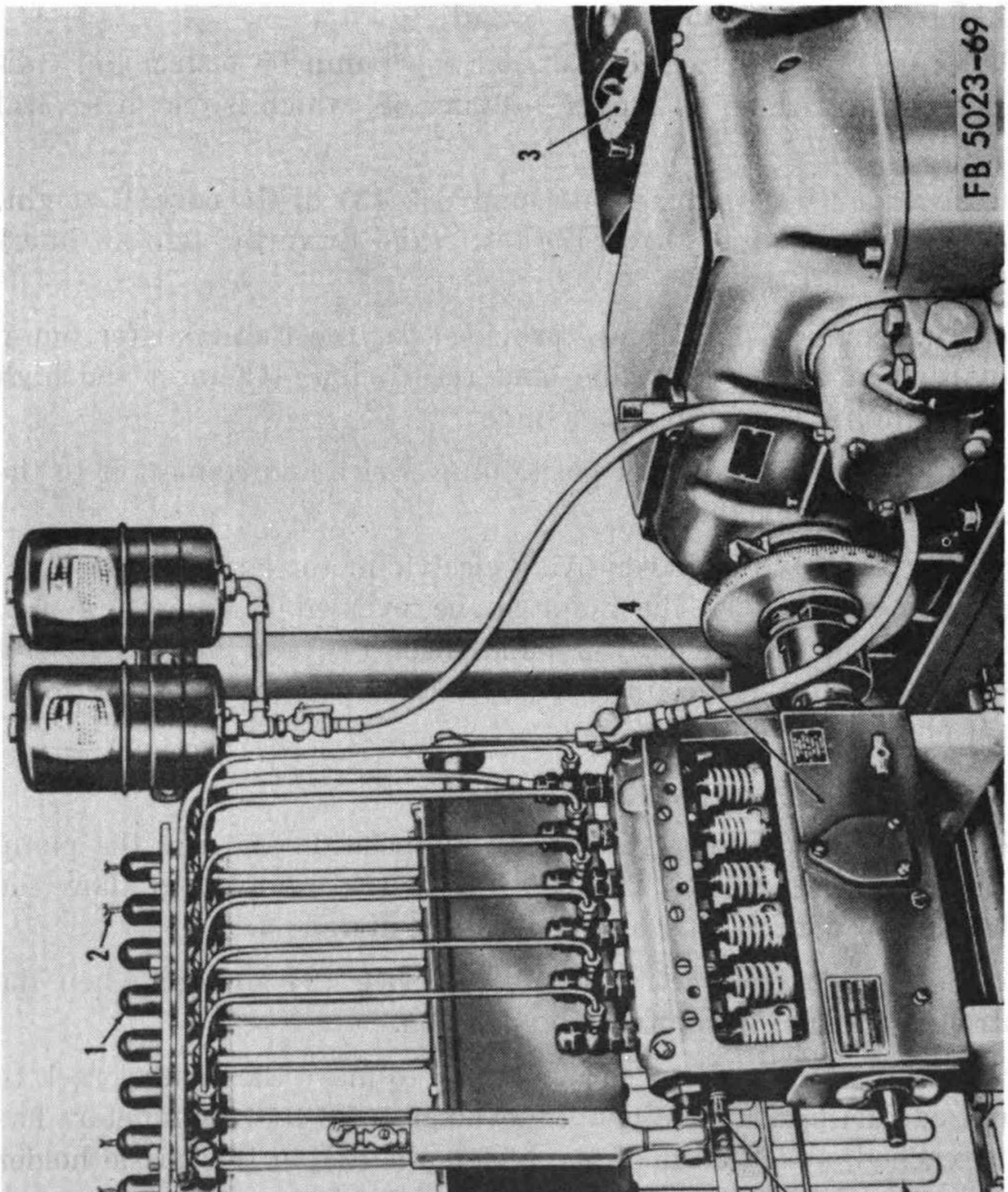


Figure 69. Calibrating injection pump.

1 Nozzle
2 Feeler pin
3 Counter
4 Injection pump
5 Graduated test tubes
6 Control rack
7 Lock wheel
8 Knurled wheel
9 Control rack positioning device

Figure 69—Continued.

g. Adjust the remaining pumping units to within 1 millimeter of the above noted figure.

h. Move the control rack to the 12-millimeter position and set the speed of the stand at 600 rpm. At this speed and control rack setting, and using the fuel quantity established in *f* above, the pumping elements should be adjusted to within an overall 4 per cent of the reference fuel draw if new plungers have been installed, or within 8 per cent if the original plungers are used. A typical fuel draw for an eight-cylinder pump may be 9.6, 9.7, 9.8, 9.5, 9.4, 9.6, 9.5, and 9.8 millimeters. The greatest difference between the pumping elements is 0.4 millimeter. This figure divided by the highest fuel draw of 9.8 millmeters equals a 4 per cent permissable variation between the pumping elements.

i. If the quantity of fuel draw varies by more than 4 or 8 per cent, adjust the control sleeves (1, fig. 70).

j. To adjust the control sleeves, set the control rack in the full stop position, allowing the test stand to continue operating.

k. Loosen the clamping screw (3) in the segment gear (2).

l. Holding the segment gear in position, rotate the sleeve (1) toward the full stop position of the control rack to increase fuel flow or toward the full load position to decrease fuel flow.

m. Tighten the segment clamping screw and recheck for fuel delivery within the permissable variations.

n. Reduce the speed to 225 rpm and move the control rack (6, fig. 69) to the full stop position. There should be no fuel delivery from the nozzle.

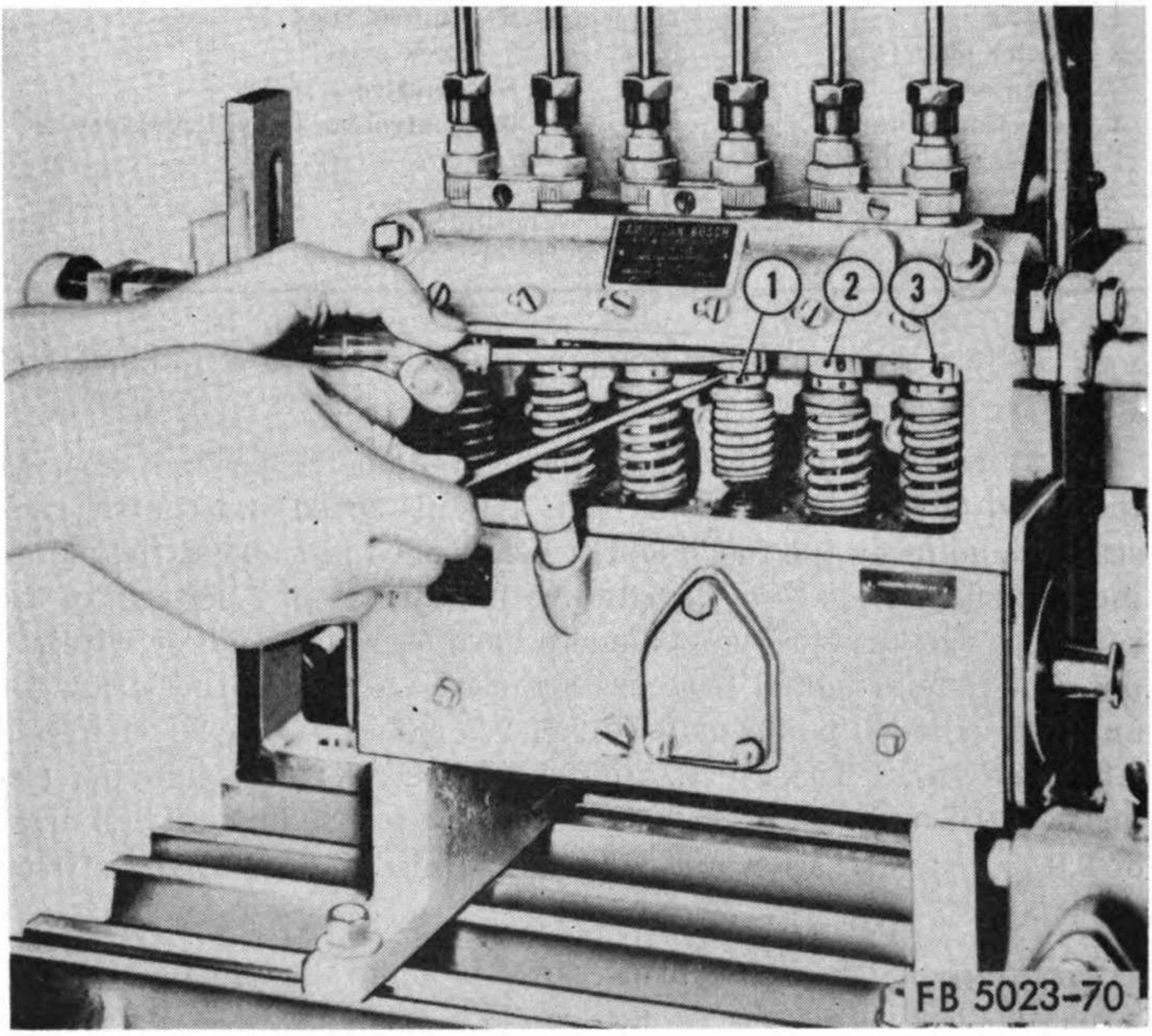
o. Place a calibration mark on the control sleeve to coincide with the mark on the segment gear, and firmly tighten all clamping screws.

p. Install the fuel injection pump (par. 75*c*(3 and 9)), and governor (par. 74*c*).

q. Time the fuel injection pump by flow method.

(1) Rotate the engine (par. 75*c*(3)).

(2) Remove the injection line (18, fig. 17) from the delivery



1 Control sleeve 2 Segment gear 3 Clamping screw (8 rqr)

Figure 70. Adjusting control sleeve.

valve holder (6) at the number one pump cylinder (number one pump cylinder is nearest the coupling end).

(3) Hold the stop control lever (4, fig. 29) in the full-stop position.

(4) Remove the number one delivery valve holder, delivery valve, and spring only. Use a delivery valve extractor to remove the valve. Reinstall the delivery valve holder (6, fig. 17) fingertight.

(5) Remove the two cap screws (1, fig. 32) lockwashers and plain washers from the coupling (14, fig. 17). The rear hub (5, fig. 32) and the pump camshaft can now be rotated while the front hub (8) will remain stationary.

(6) Set the throttle in full throttle position and hold in this position.

(7) Operate the hand primer (16, fig. 17). Fuel should now flow out of the delivery valve holder (6). If fuel does not flow, slowly rotate the rear hub (5, fig. 32) until the fuel appears.

(8) Continue to rotate the rear hub toward the engine until the fuel just stops.

Note. Continue to operate the hand primer during this entire operation.

(9) Carefully rotate the rear hub (5) until the fuel just barely flows, then turn it back to where the fuel is just barely shut off. The graduated marks (3) on the adjusting flange (7) will aid in locating this point. Repeat until a movement of less than one-sixty-fourth circumference of the rear hub (5) is the difference between fuel flowing and not flowing.

(10) Install the cap screws (1), lockwashers, and plain washers, and tighten. Observe if any slight movement of the rear hub (5), while tightening the cap screws, has started fuel flowing. If fuel begins to flow, repeat the procedures in (5) through (9) above. No fuel should flow when the cap screws are tight.

(11) Hold the stop control lever (4, fig. 29) at the closed position and remove the delivery valve holder (6, fig. 17).

(12) Clean the valve and spring before installing back into the delivery valve holder. Install assembled valve holder (6) in the injection pump (12) and tighten firmly.

(13) Install the injection line (18) to the delivery valve holder (6) and secure.

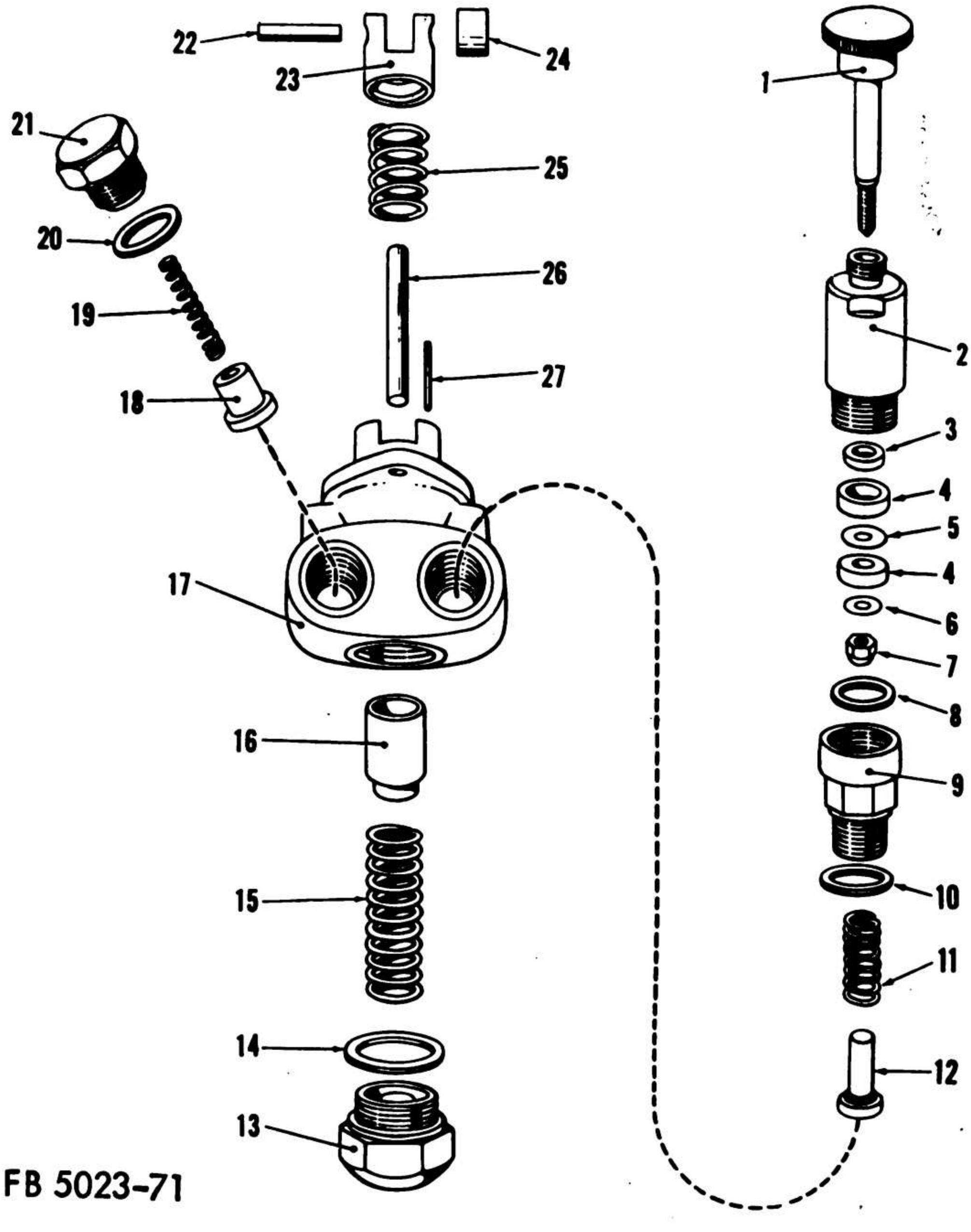
Note. If a new pump is installed with a new coupling, enlarge the front hub (8) mark and put a corresponding mark on the rear hub (5) with a light chisel and hammer. This is done so that, in the future, the injection pump can be timed without the need of flowing the pump by lining up these marks.

(14) Vent the system (par. 15*b*).

Section IV. FUEL TRANSFER PUMP

116. Description

The transfer pump (13, fig. 17) is a variable, self-regulating, plunger-type pump which builds pressure up to a predetermined point. As the pump plunger (15, fig. 71) is operated by the injection pump camshaft, fuel is drawn through the inlet valve (12) into the pump housing (17) by the suction created in front of the plunger. At the same time, fuel is forced under pressure from behind the plunger into the outlet line to the secondary filter. When the plunger movement is reversed, fuel in front of the plunger is expelled through the outlet valve (18) into the chamber behind the plunger. This pumping action continues as long as



1	Plunger stem assembly	15	Plunger spring
2	Barrel	16	Plunger
3	Stem spacer	17	Transfer pump housing
4	Stem packing	18	Outlet valve
5	Washer	19	Valve spring
6	Nut washer	20	Screw gasket
7	Nut	21	Spring retaining screw
8	Primer gasket	22	Wrist pin
9	Adapter	23	Tappet shell
10	Adapter gasket	24	Tappet roller
11	Inlet valve spring	25	Tappet spring
12	Inlet valve	26	Spindle
13	Spring retaining screw	27	Tappet securing pin
14	Screw gasket		

Figure 71. Fuel transfer pump, exploded view.

the injection pump uses fuel fast enough to keep fuel pressure from equalling the force exerted by the plunger spring (15). When this happens, the plunger is held against its spring and prevents further pumping action until the pressure drops.

117. Fuel Transfer Pump Disassembly (fig. 71)

a. Remove the fuel transfer pump (par. 72*c*).

b. Remove the valve spring retaining screw (21), gasket (20), spring (19), and outlet valve (18). Remove the priming pump parts (1) through (9), gasket (10), spring (11) and inlet valve (12).

c. Remove the plunger retaining screw (13), gasket (14), spring (15) and plunger (16).

d. Drive out the securing pin (27) and remove the tappet assembly (22–24), spring (25), and spindle (26).

e. Disassemble the priming pump as follows:

(1) Unscrew the adapter (9) from the barrel (2).

(2) Remove the primer gasket (8).

(3) Remove the nut (7), washer (6), packings (4), washer (5), and spacer (3) from the plunger stem (1) and pull the stem from the barrel.

118. Fuel Transfer Pump Cleaning and Inspection (fig. 71)

a. Wash all parts in cleaning solvent and dry thoroughly.

b. Inspect the springs (11, 15, 19, and 25) to see that they are free from nicks or pits. Cracks will become apparent if the springs are flexed.

c. Inspect the valves (12 and 18) and plunger (16) for signs of wear on the seating and wearing surfaces.

d. Inspect the pins (22 and 27), shell (23), roller (24), and spindle (26) for wear, cracks, breaks, and distortion.

e. Replace all parts found to be defective. Replace the priming pump assembly (1–9) as an assembly if any component part is defective.

119. Fuel Transfer Pump Reassembly (fig. 71)

a. Reassemble the priming pump as follows:

(1) Insert the plunger stem (1) into the barrel (2).

(2) Install the spacer (3), packing (4), washer (5), packing (4), and nut washer (6) on the stem. Secure with the nut (7).

(3) Place the gasket (8) in the adapter (9) and screw the barrel into the adapter.

b. Insert the spindle (26), spring (25), and tappet assembly (22–24) into the rear of the transfer pump housing (17) and secure with the pin (27).

c. Install the plunger (16), spring (15), gasket (14), and retaining screw (13) in the pump.

d. Install the inlet valve (12), spring (11), gasket (10), and priming pump assembly (1–9) in the pump. Make sure the priming pump is mounted over the transfer pump inlet valve (12).

e. Install the outlet valve (18), spring (19), gasket (20), and retaining screw (21) on the outlet side.

f. Install the fuel transfer pump (par. 72*d*).

Section V. FUEL INJECTORS

120. Description

The injectors (fig. 28) are of the closed differential-needle, hydraulically-operated type. They utilize a spring-loaded valve with a seat at the spray orifice. The valve closes off the orifice after each injection of fuel into the combustion chamber. The valve is operated hydraulically by fuel pressure from the injection pump. The nozzle (8) consists of two parts which are lapped to form a mated assembly. The lapped fit is so close that measurement is impractical with ordinary instruments. The nozzle parts cannot be interchanged and must be kept together at all times.

121. Fuel Injector Disassembly (fig. 72)

a. Provide a clean work area and do not disassemble unless a test stand is available to adjust the opening pressure after reassembly.

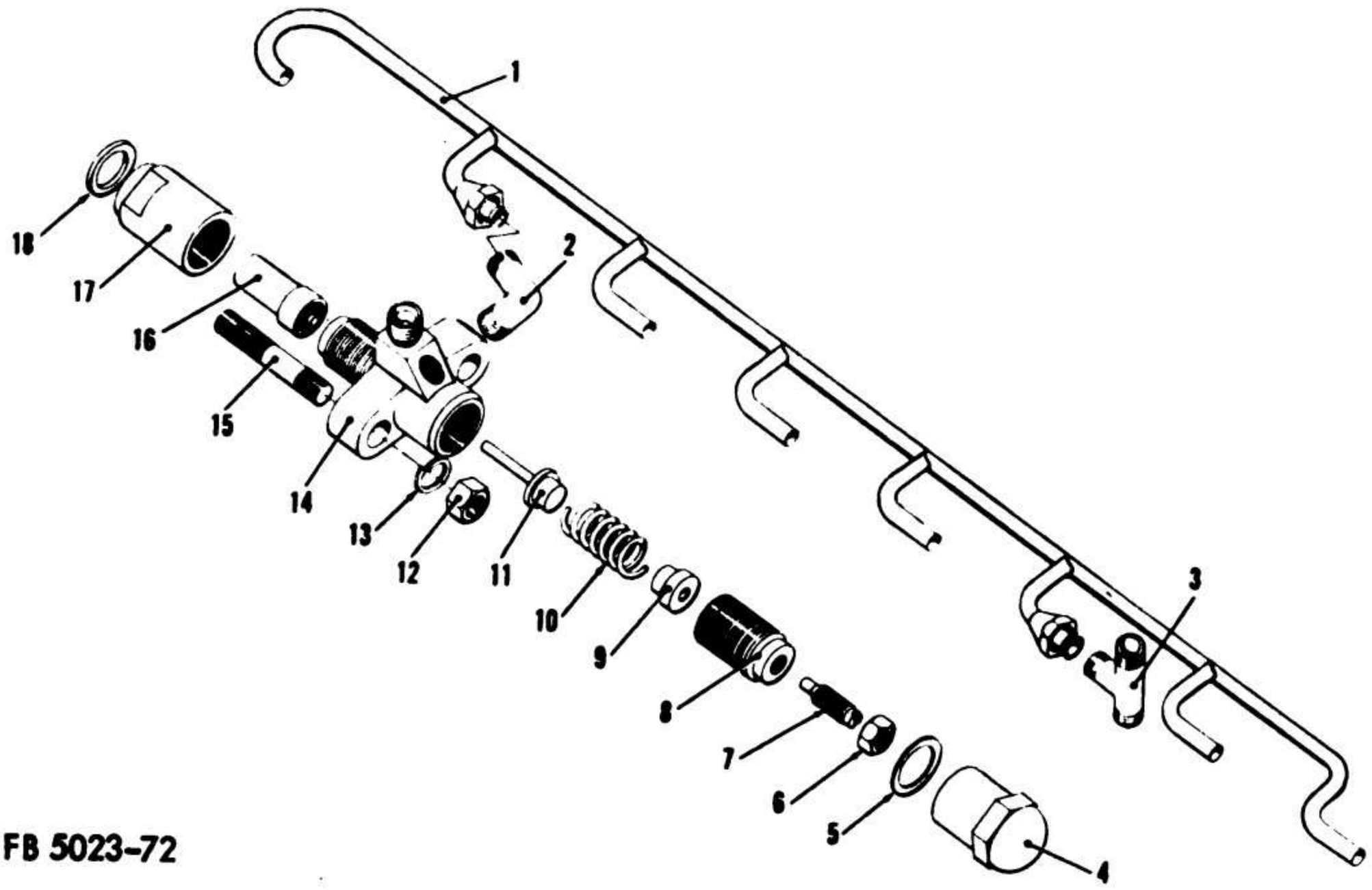
b. Remove the fuel injector (par. 73*c*) and clean all external dirt and carbon from the assembly.

Caution: To prevent damage to the fuel injectors, use a vise with lead jaws or a proper holding jig.

c. Clamp the holder body (14) in a vise.

d. Unscrew the nozzle capnut (17) and lift out the nozzle (16).

Note. Keep the pintle and nozzle together, as they are mated parts.



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1 Nozzle drip tube assembly
2 Tube elbow
3 Two-way tee
4 Protection cap
5 Gasket
6 Locknut (8 rqr)
7 Adjusting screw
8 Capnut
9 Upper spring seat
10 Adjusting spring
11 Spindle
12 Nut, hex, ⅜ NF (16 rqr)
13 Lockwasher, ⅜ (16 rqr)
14 Holder body
15 Nozzle stud
16 Nozzle and seat
17 Capnut
18 Gasket

Figure 72. Fuel injector, exploded view.

e. Remove the elbow (2) and reverse the position of the holder.

f. Remove the protection cap (4), gasket (5), locknut (6), adjusting screw (7), spring retaining capnut (8), upper spring seat (9), spring (10), and spindle (11) with the attached lower spring seat.

122. Fuel Injector Cleaning and Inspection (fig. 72)

a. Clean all injector parts with clean fuel oil.

b. Clean the interior of the nozzle (16) with a soft piece of oil-soaked wood having its end shaped to correspond to the angle of the pintle seat.

c. Clean the spray hole with a wood splinter.

d. Clean the pintle with a soft, lintless, oil-soaked rag.

Caution: Do not use abrasives, hard or sharp tools, emery paper, or crocus cloth on the injector parts.

e. Inspect the nozzle (16) for distortion, due to overheating or corrosion caused by acids in the fuel. Inspect the pintle seating

surfaces for wear or corrosion. If either part is defective, replace both since they are not interchangeable.

f. Check the small end of the spindle (11) for any irregularities where it contacts the pintle stem. If the contact surface is pitted or rough, replace the spindle.

g. Check the lower spring seat for tightness to the spindle, cracks, or worn spots. Replace the spindle if the seat is defective.

123. Fuel Injector Reassembly

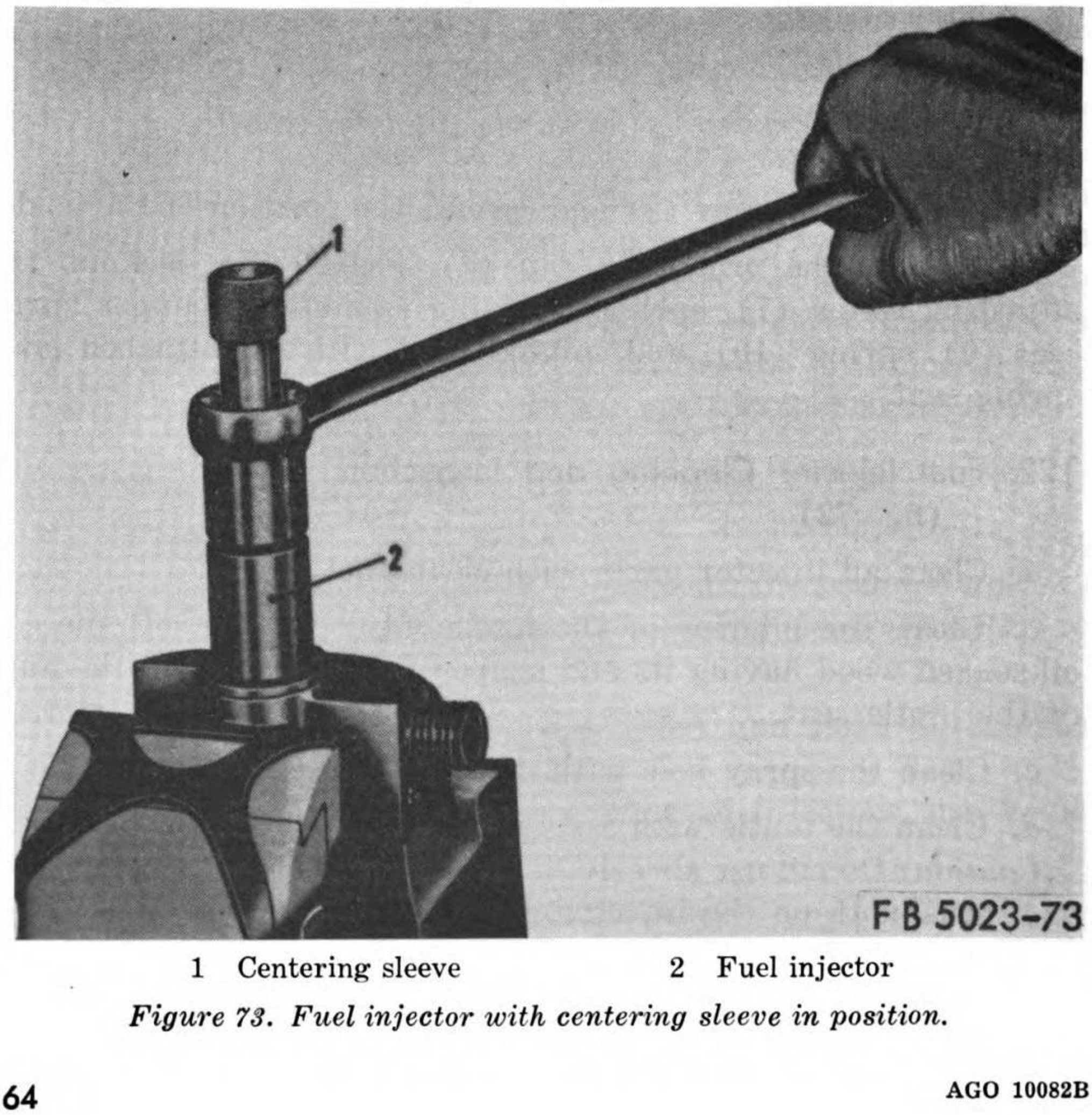
a. Apply a film of clean fuel oil to all parts.

b. Install the spindle (11, fig. 72), spring (10), upper spring seat (9), spring retaining capnut (8).

c. Install the elbow (2) and clamp the holder in a vise with the nozzle opening up.

d. Install the nozzle (16) and nozzle capnut (17) on the body, using a centering sleeve (1, fig. 73) to center the nozzle within the capnut.

e. Test the injector and adjust the opening pressure (par. 124).



1 Centering sleeve 2 Fuel injector

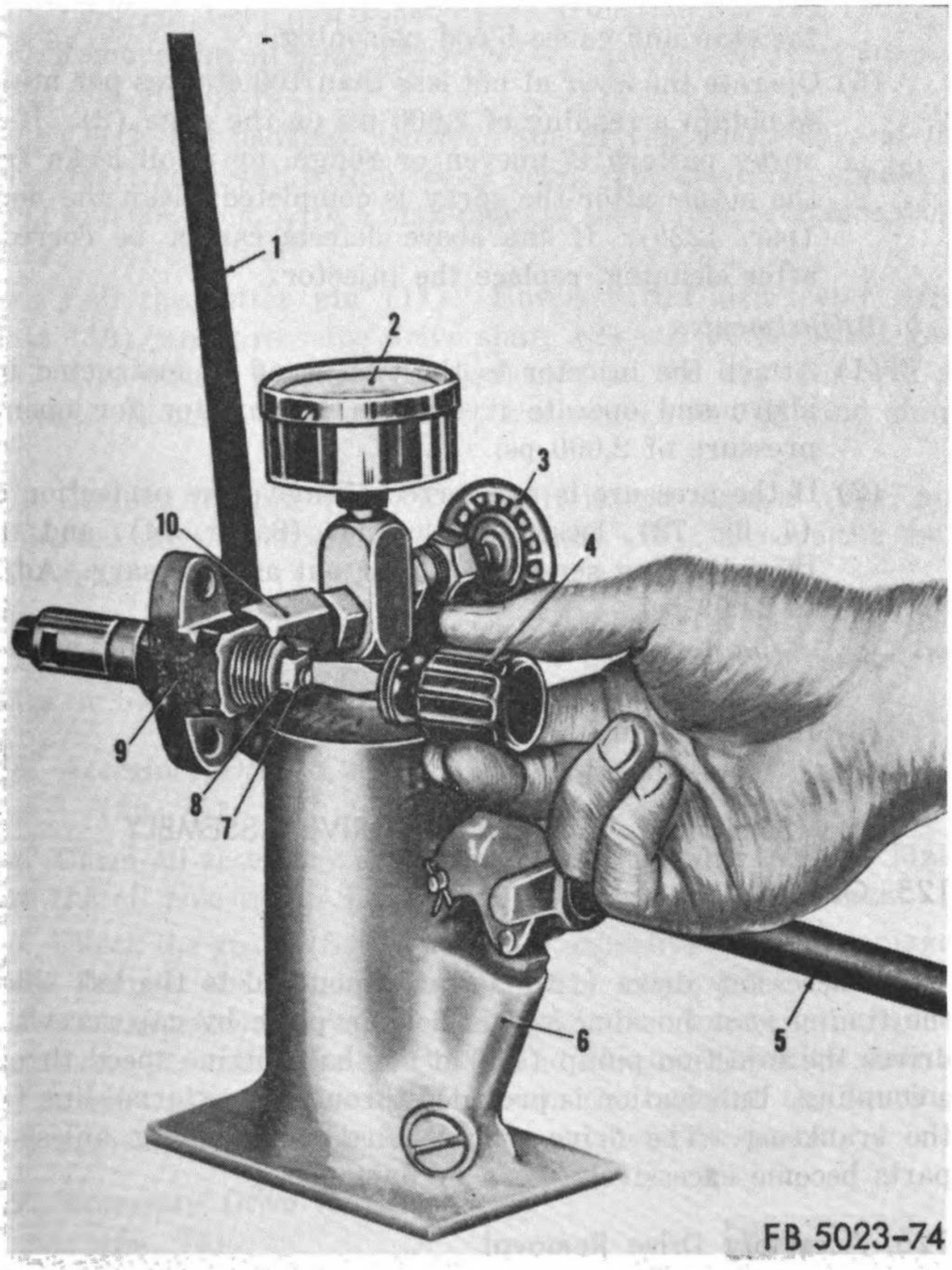
Figure 73. Fuel injector with centering sleeve in position.

124. Fuel Injector Testing and Adjustment

a. Testing.

(1) Fill the test stand (6, fig. 74) with clean fuel oil.

(2) Remove the cover on the adapter fitting (10) and pump the lever (5) until oil runs out of the fitting.



1	Oil supply line	6	Fuel injector test stand
2	Gage	7	Adjusting screw
3	Gage valve	8	Locknut, (8 rqr)
4	Screwdriver	9	Injector
5	Operating lever	10	Adapter fitting

74. Adjusting injector pressure.

(3) Secure the injector (9) under test to the adapter fitting.

(4) Close the valve (3) and make a few quick strokes of the lever. If the lever operates extremely hard, it indicates a plugged nozzle. Clean the nozzle (par. 122*b*).

Caution: When testing the fuel injectors, do not allow the hands or any part of the body to be in line with the spray pattern. The pressure is great enough to penetrate the skin and cause blood poisoning.

(5) Operate the lever at not less than 100 strokes per minute to obtain a reading of 2,000 psi on the gage (2). If the spray pattern is uneven or rough, or if oil leaks from the nozzle after the spray is completed, clean the nozzle (par. 122*b*). If the above defects cannot be corrected after cleaning, replace the injector.

b. Adjustment.

(1) Attach the injector to the test stand as instructed in *a* above and operate it to test the injector for opening pressure of 2,000 psi.

(2) If the pressure is not correct, remove the protection cap (4, fig. 72), loosen the locknut (8, fig. 74), and turn the adjusting screw (7) in or out as necessary. Adjust to 2,000 psi.

Caution: Never attempt to adjust injector pressure without a test stand.

(3) Install the fuel injector (par. 73*e*).

Section VI. ACCESSORY DRIVE ASSEMBLY

125. General
(fig. 4)

The accessory drive (12) is flange mounted to the left side of the timing gear housing and is held in place by cap screws. It drives the injection pump (11) at one-half engine speed through a coupling. Lubrication is provided through an external line from the crankcase. The drive will require no servicing unless the parts become excessively worn or damaged.

126. Accessory Drive Removal
(fig. 75)

a. Remove the fuel injection pump (par. 75*b*), and disconnect the external oil line assembly (35) at the accessory drive.

b. To remove the accessory drive and gasket (33), remove the cap screws (32) and lockwashers (26).

127. Accessory Drive Disassembly (fig. 75)

a. Remove the screw (16) and lockwasher (17) securing the coupling hub (18) and flange (19) to the driven shaft (29). Pull off the coupling members.

b. Remove the cap screws (25) and lockwashers (26). Separate the cover (27) and gasket (28) from the housing (30).

c. Remove the oil seals (12 and 24), tachometer drive adapter (23), and gasket (22).

d. Check the backlash between the driven gear (6) and the drive shaft gear (9) with a feeler gage. The clearance should be 0.002 to 0.006 inch, with a maximum of 0.010 inch. Replace worn gears.

e. Pull the cotter pin (11). Unscrew the tachometer drive shaft (10), and press the drive shaft (2) out of the shaft gear (9). The thrust washer (8) is slotted so the key (1) will go through. Remove the key, thrust washers (4 and 8), and shims (7).

f. Remove the pin (36), nut (37), thrust washer (38), and laminated shim (7) from the driven shaft (29). Remove the shaft and thrust washer (4) from the housing (30).

g. Do not remove the gears (3 and 6) or the bearings (31) unless they are to be replaced. Use an arbor press to remove the gears or bearings, and pull the keys (1).

128. Accessory Drive Cleaning and Inspection (fig. 75)

a. Clean all accessory drive parts with cleaning solvent. Make sure the oil hole in the housing between the shafts is clear.

b. Check the gears (3, 6, and 9) for excessive wear or damaged teeth. Inspect the housing (30) and the cover (27) for cracks, and the thrust washers (4, 8, and 38) for excessive wear or roughness. Examine the shafts (2 and 29) for excessive wear at the thrust washer surfaces. Maximum clearance of the bearings (31) to the shafts is .010 inch. Replace any defective parts.

129. Accessory Drive Reassembly (fig. 75)

a. If new bearings (31) are needed, press them into the housing (30), and line ream to provide a clearance of 0.0015 to 0.002 inch with the shafts (2 and 29).

b. If the gears (3 and 6) have been removed, install the keys (1) in the shafts and press the new gears on.

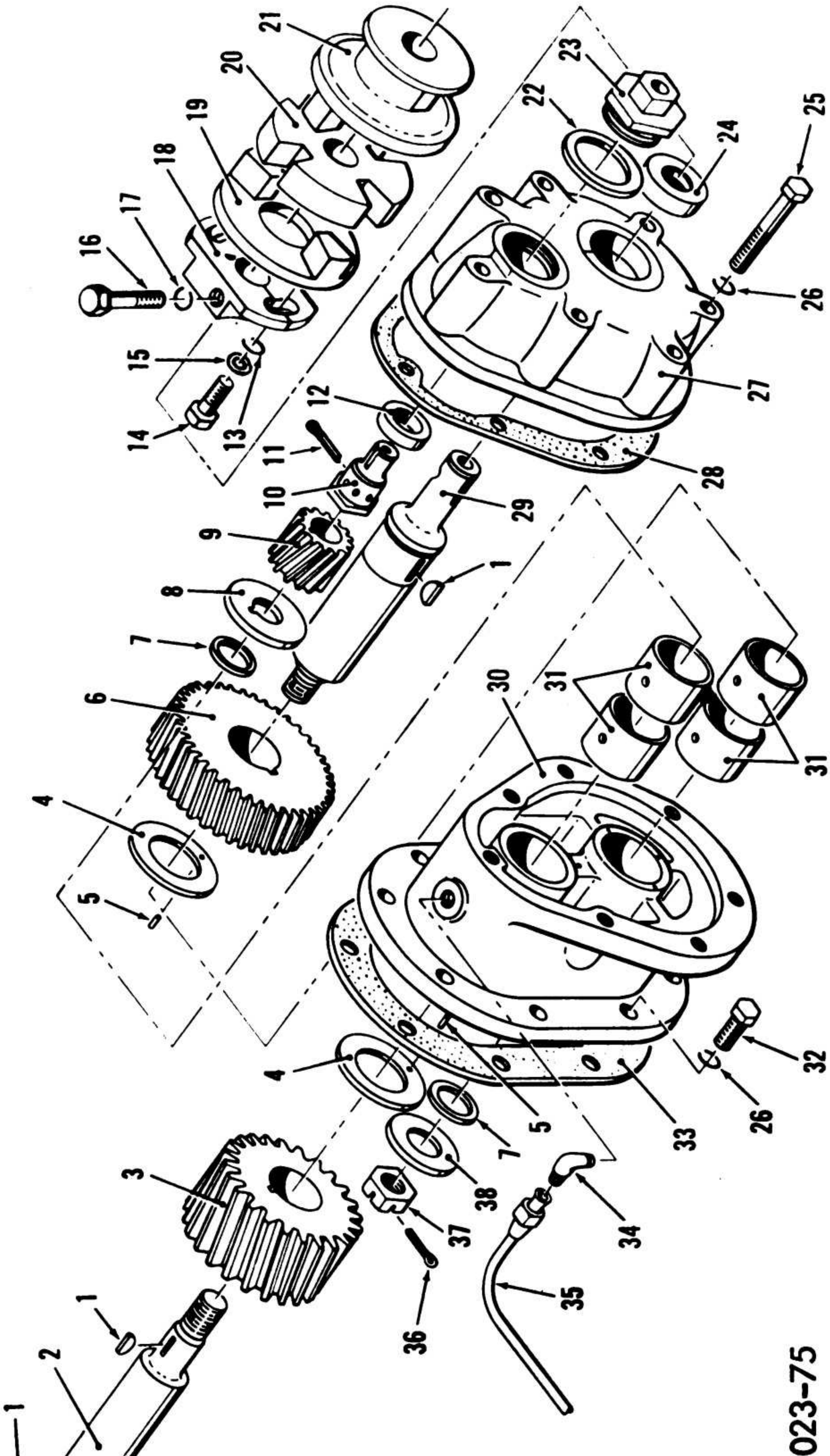


Figure 75. Accessory drive, exploded view.

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1 Key, woodruff, No. 9 (3 rqr)
2 Drive shaft
3 Drive gear
4 Thrust washer
5 Dowel pin
6 Driven gear
7 Laminated shim
8 Gear thrust washer
9 Drive shaft gear
10 Tachometer drive shaft
11 Pin, cotter, ⅛ x 1⅝ (1 rqr)
12 Oil seal
13 Lockwasher
14 Flange cap screw
15 Washer
16 Coupling hub screw
17 Lockwasher
18 Coupling hub
19 Coupling flange
20 Intermediate disk
21 Coupling
22 Adapter gasket
23 Tachometer drive adapter
24 Oil seal
25 Cap screw, ⅜ x 2½ NC (7 rqr)
26 Lockwasher, ⅜ (15 rqr)
27 Drive housing cover
28 Cover gasket
29 Driven shaft
30 Drive housing assembly
31 Housing bearing
32 Cap screw, ⅜ x 1 NC (8 rqr)
33 Mountnig gasket
34 Oil line elbow
35 Oil line assembly
36 Pin, cotter, ⅛ x 1¼ (1 rqr)
37 Driven gear nut
38 Thrust washer

Figure 75—Continued.

c. Place a thrust washer (4) on the driven shaft (29) and insert the shaft in the housing. Install enough shims (7) to obtain an end thrust clearance of 0.002 to 0.005 inch. Secure with the thrust washer (38), nut (37), and cotter pin (36).

d. Install the drive shaft (2) with a thrust washer (4) next to the drive gear (3) in the housing. Add enough shims (7) on the shaft to obtain an end thrust clearance of 0.002 to 0.005 inch. To save time when checking this clearance, substitute a nut spacer on the shaft and install the tachometer drive shaft (10). After the correct clearance is obtained, remove the nut spacer. Insert the key (1) in the drive shaft and press on the gear. Screw on the tachometer drive shaft (10) and secure with the cotter pin (11).

e. Install the oil seals (12 and 24), gasket (22), and tachometer drive adapter (23) in the cover (27).

f. Secure the cover (27) and gasket (28) to the housing (30) with the cap screws (25) and lockwashers (26).

g. Press the coupling hub (18) and flange (19) on the driven shaft (29). Secure with the screw (16) and lockwasher (17).

130. Accessory Drive Installation

a. Rotate the engine until the number 1 piston nears the end of the compression stroke and the fuel injection pump timing mark (1, fig. 31) is centered in the timing hole.

b. Turn the accessory drive so that the flange (7, fig. 32) will be in a position to mate with the hub (5) on the injection pump and the coupling alining marks (4) will be in line.

c. Secure the accessory drive and gasket (33, fig. 75) to the timing gear housing with the cap screws (32) and lockwashers (26).

d. Connect the external oil line assembly (35) to the drive and install the fuel injection pump (par. 75*c*).

Section VII. VALVE SEAT INSERTS AND VALVE GUIDES

131. Description

The cylinder heads (14, fig. 43) have valve guides and exhaust valve inserts pressed into them which provide long wearing removable surfaces for the valves.

132. Valve Guide Removal and Installation

a. Remove the cylinder head (par. 98*a*) and valves (par. 98*b*).

b. Drive the valve guides out of the cylinder heads with a driver (fig. 76).

Note. For identification purposes, the exhaust valve guide differs from the intake by two small holes drilled in the side of the exhaust valve guide.

c. Press the new guides into the cylinder heads.

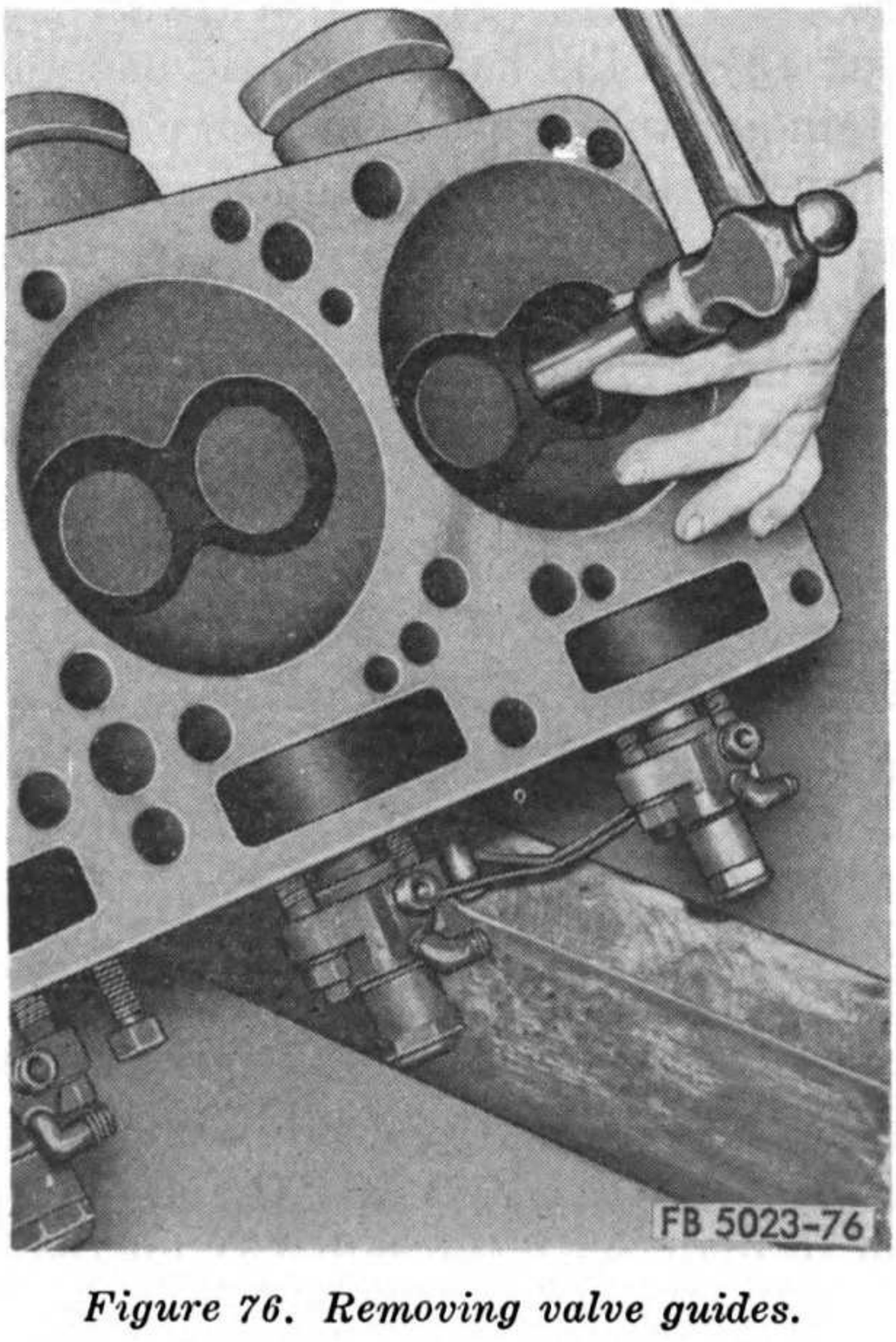


Figure 76. Removing valve guides.

d. If necessary, ream the guides to obtain a clearance of 0.002 to 0.003 inch on the intake and 0.004 to 0.005 on the exhaust.

e. Install the valves (par. 98*f*) and cylinder heads (par. 98*g*).

133. Exhaust Valve Seat Removal and Installation

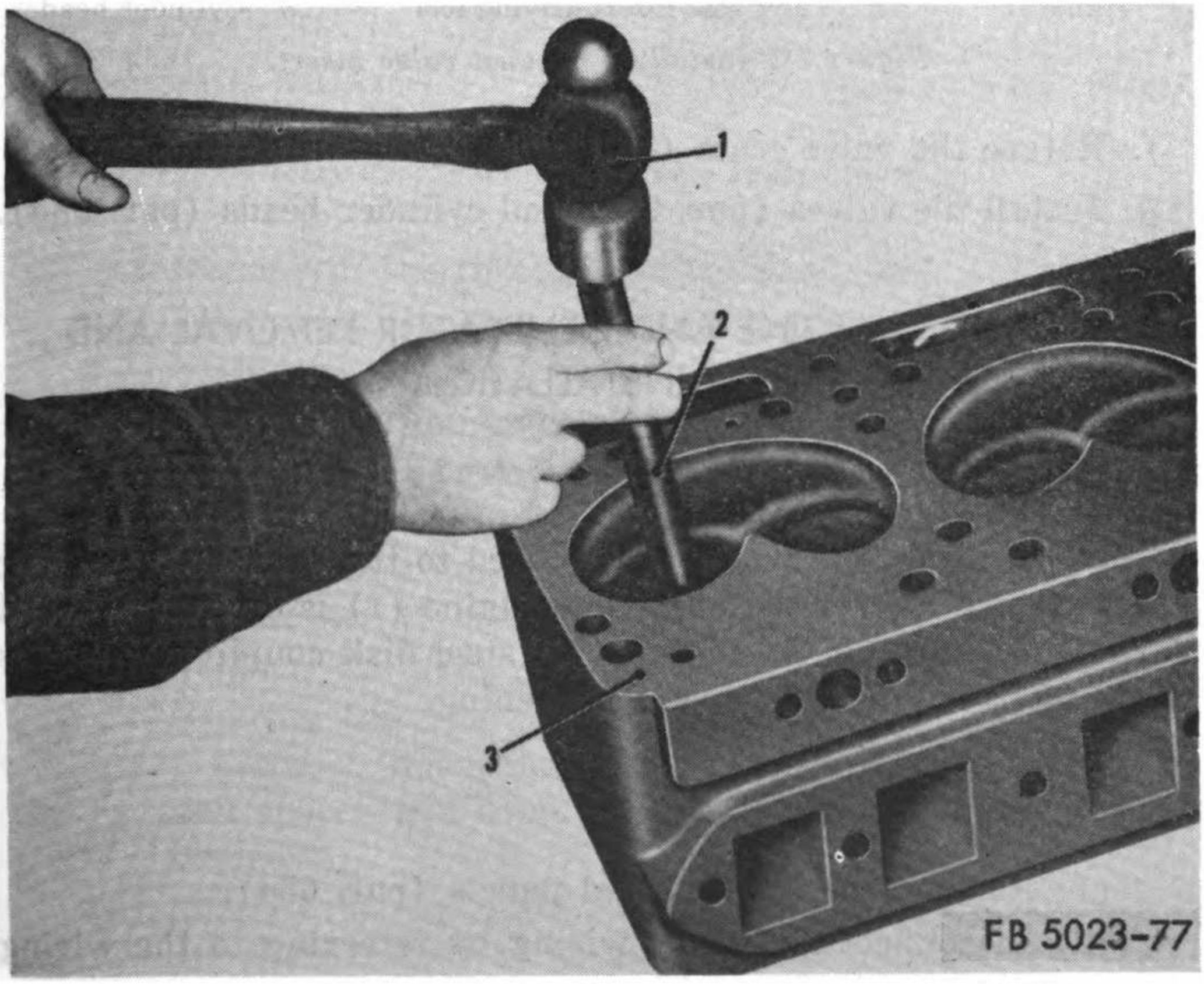
a. Remove the cylinder heads (par. 98*a*) and valves (par. 98*b*).

b. Place a hookshaped extracting tool (2, fig. 77) in the valve opening and catch the bottom edge of the insert with the tool. Strike the side of the tool sharply with a hammer (1) to unseat the insert.

c. Make sure there is no carbon or foreign matter in the recesses to prevent the insert from seating.

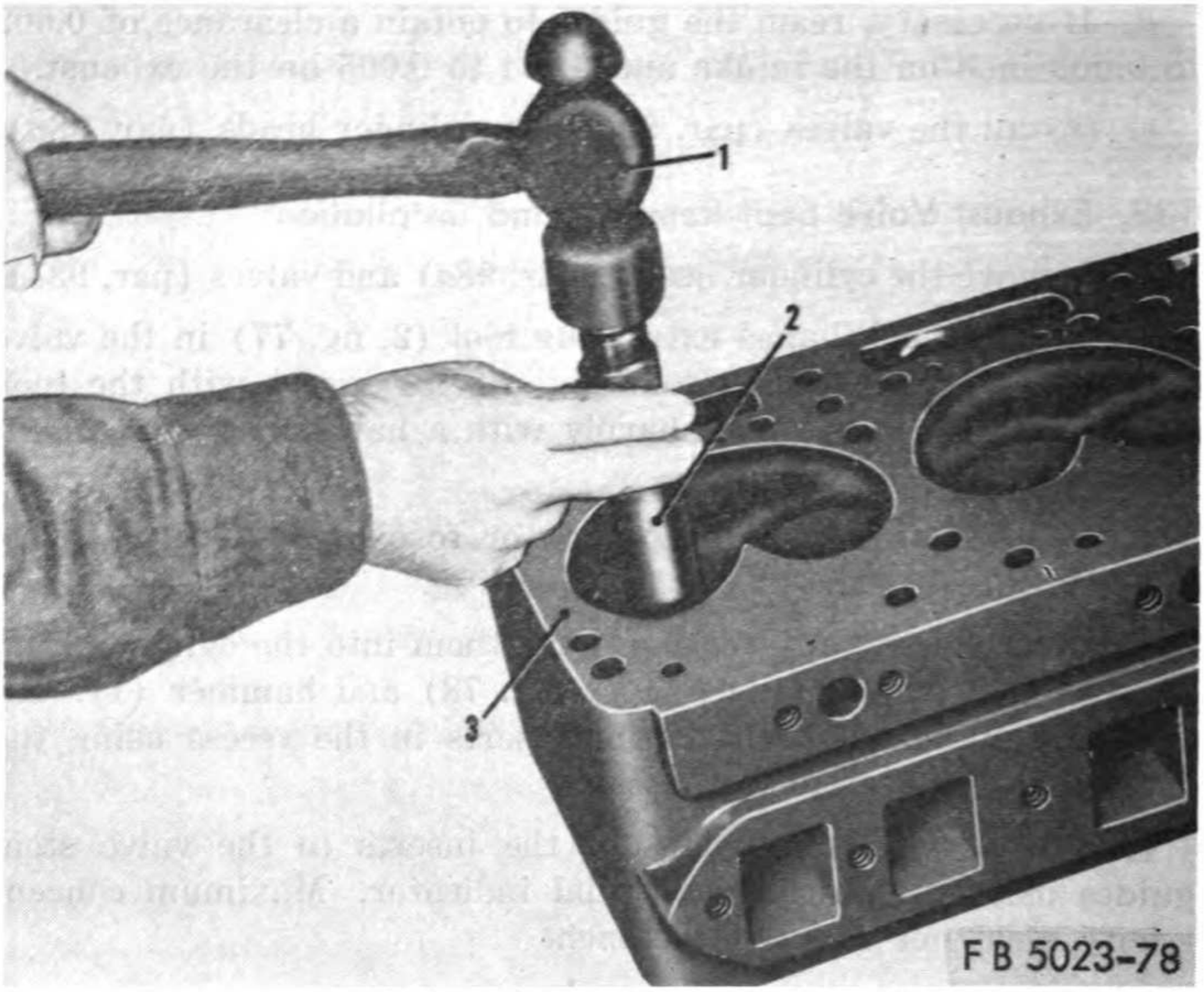
d. Chill the new inserts and drive them into the cylinder head recesses with the driving tool (2, fig. 78) and hammer (1). An alternate method is to press the inserts in the recess using the driving tool and an arbor press.

e. Check the concentricity of the inserts to the valve stem guides using a pilot bar or a dial indicator. Maximum concentricity must not exceed 0.002 inch.



1 Hammer 2 Extracting tool 3 Cylinder head

Figure 77. Removing exhaust valve insert.



1 Hammer 2 Valve seat insert driving tool 3 Cylinder head

Figure 78. Installing exhaust valve insert.

f. Reface the valve seats (par. 98*e*).

g. Install the valves (par. 98*f*) and cylinder heads (par. 98*g*).

Section VIII. ENGINE AND GENERATOR REMOVAL AND AND INSTALLATION

134. General
(fig. 79)

The engine and generator are secured to the subbase providing a firm foundation for the unit. The engine (1) is directly coupled to the generator (7) by means of a steel disk coupling which is accessible through the inspection opening.

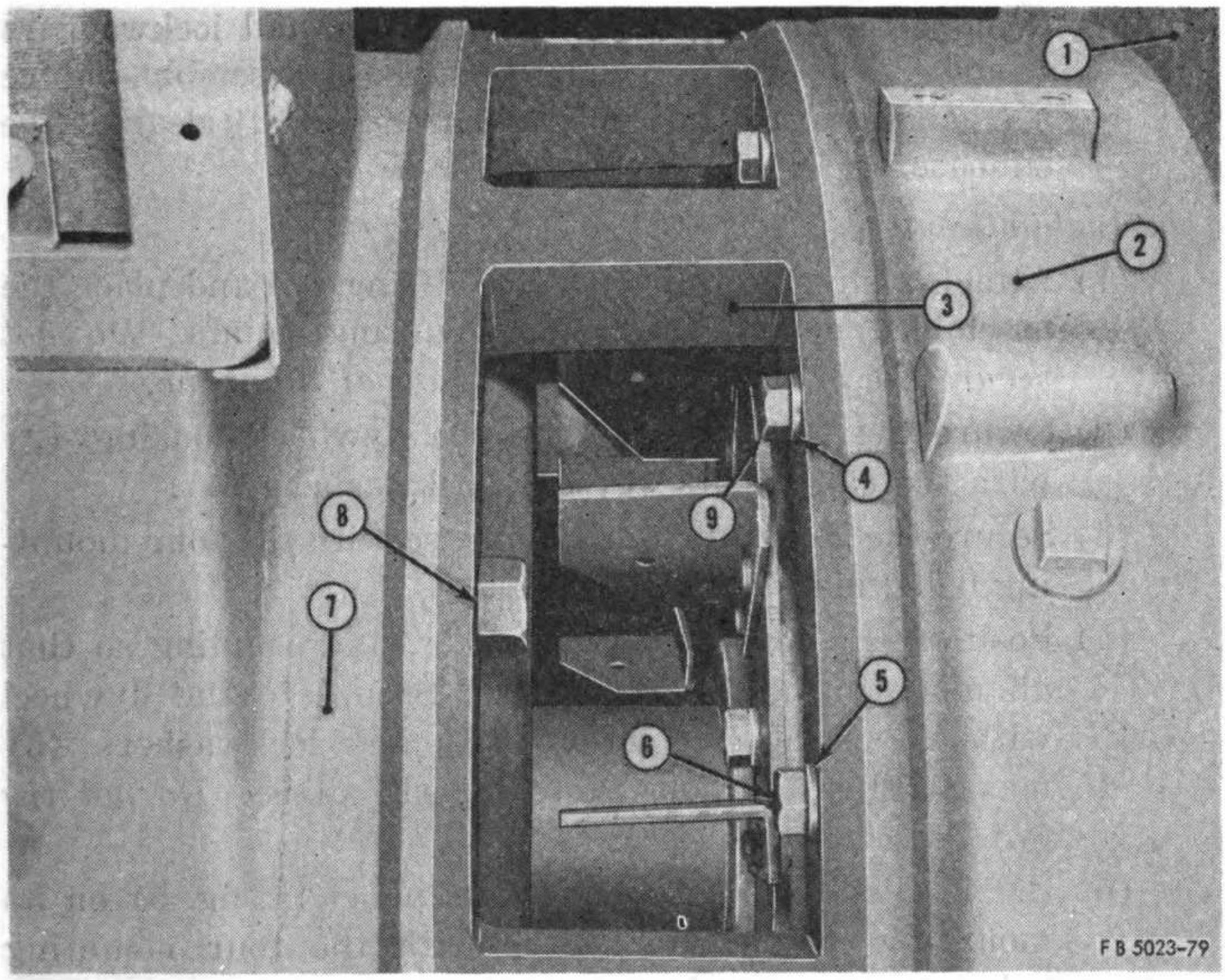
135. Generator

a. Removal.

(1) Remove the housing and panels (par. 65*a*).

(2) Disconnect necessary wiring by referring to the wiring diagram in figure 57.

(3) Disconnect the engine stop knob (17, fig. 16).



1	Engine	6	Cap screw, ½ x 3¼ NC (8 rqr)
2	Flywheel housing	7	Generator
3	Adapter	8	Adapter bolt, ⅞ x 3 NC (4 rqr)
4	Lockwasher, ⅝ (16 rqr)	9	Cap screw, ⅝ x 1¾ NC (16 rqr)
5	Lockwasher, ½ (8 rqr)		

Figure 79. Generator coupling removal points.

(4) Disconnect the throttle control knob (16).

(5) Disconnect the fuel line and ignition wire at the air heater (par. 85*b*).

(6) Remove the four mounting bolts at the base of the control panel (1, fig. 5) and, using a suitable hoist, lift the control panel clear of the subbase (9).

(7) Remove the coupling inspection cover and screen from the adapter (3, fig. 79).

(8) Remove the eight cap screws (6) and lockwashers (5) securing the fan, spacer and coupling to the flywheel.

Caution: When the last cap screw is removed, the fan and spacer will drop. Use care not to damage the fan blades.

(9) Remove the cap screws (9) and lockwashers (4) securing the adapter (3) to the flywheel housing (2).

(10) Attach a sling to the generator lifting eye and pull the sling taut.

(11) Remove the four mounting bolts, nuts, and lockwashers securing the generator to the subbase assembly. Move the generator away from the engine and lift clear of the subbase.

b. Installation.

(1) Attach a sling to the generator lifting eye and place the assembled generator on its mounting points. *Do not secure the generator to the subbase at this time.*

(2) Secure the generator (7) to the flywheel housing (2) with the cap screws (9) and lockwashers (4).

(3) Secure the generator to the subbase with the four mounting bolts, nuts and lockwashers.

(4) Position the generator fan, spacer, and coupling so that all mounting holes are alined. Secure to the flywheel with the eight cap screws (6) and lockwashers (5) making sure the holes are properly alined. *Do not try to force the cap screws.*

(5) Use a hoist and place the control panel (1, fig. 5) on its mounting points and secure with the four mounting bolts, nuts, and lockwashers.

(6) Connect the fuel line and ignition wire at the air heater (par. 85*d*).

(7) Connect the throttle control knob (16, fig. 17) and engine stop knob (17).

(8) Connect the wiring which was disconnected during removal and refer to the wiring diagram (fig. 57) to facilitate installation.

(9) Install the inspection cover and screen on the adapter (3, fig. 79).

(10) Install the housing and panels (par. 65*c*).

136. Engine

a. Removal.

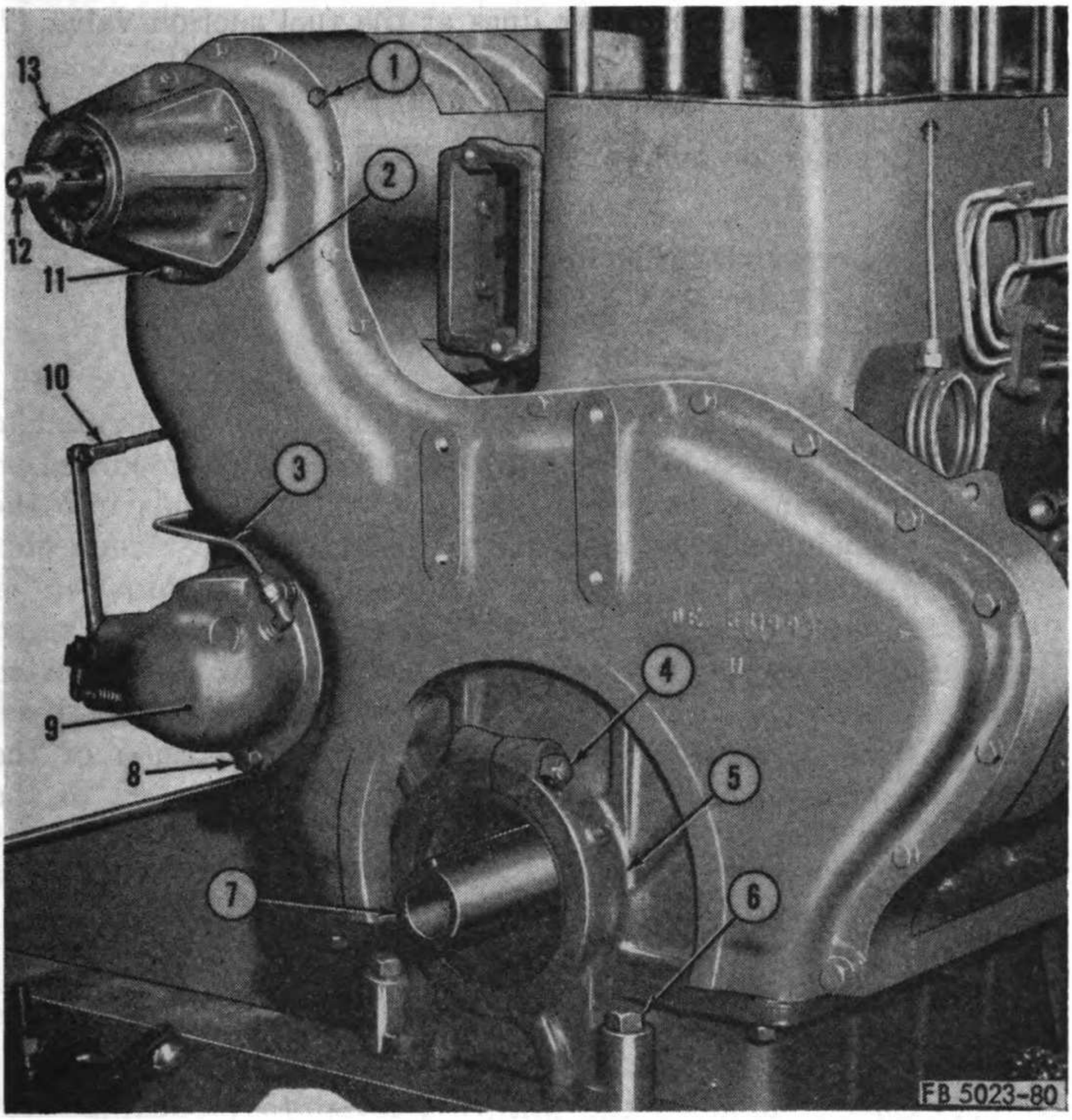
(1) Attach a lifting bracket and sling to the front and rear cylinder head stud nuts (6, fig. 53). Pull the sling taut.

(2) Remove the generator (par. 135*a*).

(3) Remove the radiator (par. 77*c*).

(4) Disconnect the fuel tank line at the fuel suction valve (7, fig. 24) and the return valve (4).

(5) Remove the two cap screws (6, fig. 80) securing the front of the engine to the subbase.



1	Cap screw, ½ NC	8	Cap screw, ⅜ x 1¼ NC
2	Timing gear cover	9	Overspeed governor
3	External oil line	10	Overspeed governor linkage
4	Clamp bolt	11	Nut, hex, ⅜ NC
5	Front support bracket	12	Supercharger drive shaft
6	Cap screw, ⅝ x 3½ NC	13	Supercharger drive shaft housing
7	Crankshaft		

Figure 80. Timing gear cover, installed view.

Note. The front support bracket (5) need not be removed to remove the engine.

(6) Lift the engine from the subbase.

b. Installation.

(1) Use a suitable hoist and place the engine on its mounting points.

(2) Secure the front of the engine at the front support bracket (5) by installing the two cap screws (6).

(3) Install the radiator (par. 77*f*).

(4) Connect the fuel tank lines at the fuel suction valve (7, fig. 24) and the return valve (4).
(5) Install the generator (par. 135*b*).
(6) Remove the hoist or sling.

Section IX. ENGINE SPEED GOVERNOR

137. Description (fig. 29)

The governor (5) is a fully inclosed unit, rigidly mounted to one end of the injection pump (15). A large gear is mounted on the end of the injection pump camshaft which extends into the governor housing adapter and drives the smaller gear connected to the governor flyweight shaft. Through this combination of gears, the flyweight shaft is caused to travel at a higher speed than the injection pump camshaft. The centrifugal force exerted by the revolving weights causes a movement of the sleeve assembly. This movement is opposed by the compression of the governor springs. The governor is internally connected to the injection pump control rod.

138. Engine Speed Governor Disassembly (fig. 81)

a. Remove the governor (par. 74*b*).

b. Disassemble the governor in the following manner.

(1) *Cover.* Remove the pin (6), lever (5), packing (4), spring (11), arm (12), swivel pin (7), and setscrew (8). Unscrew the oilcup (3).

(2) *Auxiliary lever.* Unhook the spring (16) from the pin (61). Remove the clip (57) and pin (61) to release the lever (54) from the clevis (60). Remove the shoulder screw (65) and lockwasher (64). Lift out the lever (54).

Note. Before disassembly of the clevis and screw assembly, measure the length between the pin hole centers of the clevises (55) and (60) so that this assembly can be adjusted to the same length when reassembling the governor.

Remove the clevises and nuts (26) and (58) from the screw (59).

(3) *Speed adjusting screw.* Remove the governor spring (16) and pin (19). Remove the adjusting screw (18), washer (20), and the adjusting block (63) from the body (36). Drive out the pin (24) and remove the adjusting knob (25) and nut (26) from the screw. Remove the pivot pin (17) from the adjusting block.

(4) *Rocker arm.* Remove the plugs (29). Insert a small pin punch in these holes and drive out the pins (68). Remove the plugs (35), snap rings (34), rocker shaft (32), and bearings (33). Remove the pins (67) and the connector assembly (15) from the rocker arm.

(5) *Shaft and spider assembly.* Disassemble the shaft and spider assembly (40) by removing the clips (42), weight pins (43), weight assemblies (41), and pin (51). Pull the gear (45) and bearing (44) off the shaft. Slide the thrust sleeve (39) off the shaft and pull the bearing (38) from the sleeve.

(6) *Governor body and base.* Disassemble the body (36) and base (50) by removing the bracket (21), swivel nut (27), and plug (28). Press the bearing (37) and pin (62) from the body. Remove the draincock (47) and plug (48) from the base.

139. Engine Speed Governor Inspection (fig. 81)

a. Check the auxiliary lever (54) for wear at the pin (67), contact point, and at the shoulder screw (65) mounting. Replace a worn lever.

b. Inspect the bearings (33, 38, and 44) for wear. Excessive noise, binding of the races, or signs of metal chips indicate excessive wear and the need to replace worn parts.

c. Check the pins (67) for wear at the thrust bearing (38) contact points. Replace worn pins.

d. If the screw threads or spring of the connector assembly (15) are damaged, replace the entire assembly.

e. Check the weight pins (43) and the pin holes in the spider and weights (41) for wear. Replace a defective part.

f. Inspect the weight noses for wear at the thrust sleeve (39) contacts. Replace worn weights.

g. Inspect the thrust sleeve (39) for wear inside and at the contacts of the weight noses. Replace defective sleeves.

h. Inspect the gear (45) for worn or damaged teeth. Replace a defective gear.

i. Inspect the shaft and spider assembly (40) for wear at the thrust sleeve area and at the bearing (37) end. Replace a worn assembly.

j. Check the bearing (37) for wear. Bearing clearance with the shaft should be 0.002 to 0.003 inch. Replace a worn bearing.

k. Examine the springs (16) for pits and nicks. Cracks will become apparent if the spring is flexed. Replace defective springs.

l. Inspect the body (36) and base (50) for cracks, breaks, and damaged threads. Replace a defective part.

140. Engine Speed Governor Reassembly
(fig. 81)

a. Reassemble the governor in the following manner.

(1) *Governor body and base.* Install the draincock (47) and plug (48) in the base (50). Install the bracket (21), and pin (62). Press the bearing (37) into the body (36). Install the plug (28) and the swivel nut (27).

(2) *Shaft and spider assembly.* Press the bearing (44) and

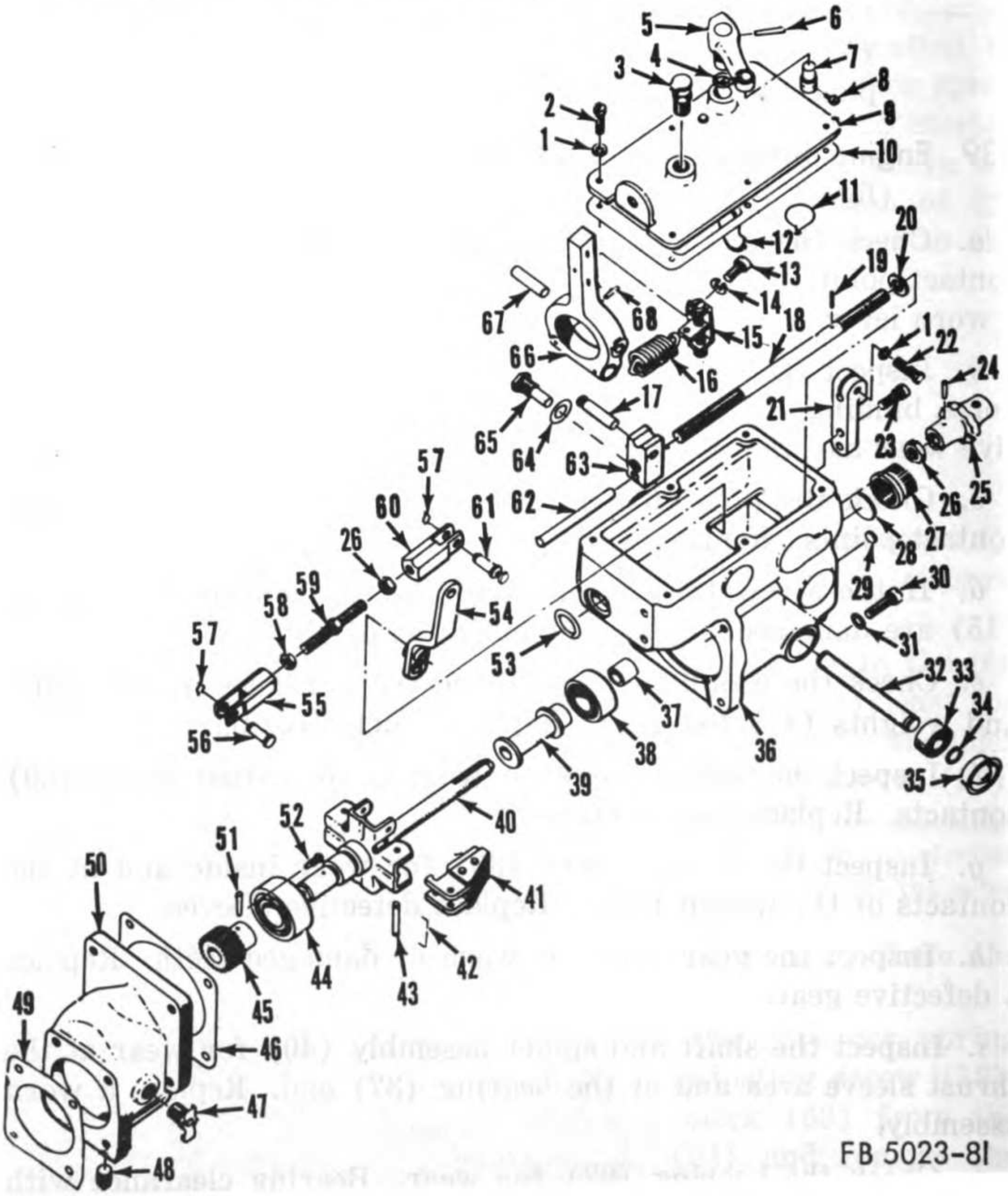


Figure 81. Engine speed governor, exploded view.

1 Lockwasher, #10 (7 rqr)
2 Screw, fil hd, #10 x ⅜ NC (6 rqr)
3 Oilcup
4 Packing
5 Stop lever
6 Pin taper, 1 x ¾ (1 rqr)
7 Swivel pin
8 Screw, fil hd, #8 x ¼ NC (1 rqr)
9 Cover and hub assembly
10 Cover gasket
11 Torsion spring
12 Arm and shaft assembly
13 Cap screw, ¼ x ¾ NF (1 rqr)
14 Lockwasher, ¼ (1 rqr)
15 Connector assembly
16 Governor spring
17 Pivot pin
18 Adjusting screw
19 Roll pin
20 Washer, flat ⅝ (1 rqr)
21 Body bracket
22 Cap screw, #10 x ⅝ NC (1 rqr)
23 Sems fastener
24 Groove pin
25 Speed adjusting knob
26 Nut, hex, $\frac{5}{16}$ NF (1 rqr)
27 Swivel nut
28 Welsh plug
29 Welsh plug
30 Screw, fil hd, ¼ x ¾ NC (4 rqr)
31 Lockwasher, int-teeth, ¼ (4 rqr)
32 Rocker shaft
33 Ball bearing
34 Snap ring
35 Plug
36 Governor body
37 Oilite bearing
38 Ball bearing
39 Thrust sleeve
40 Shaft and spider assembly
41 Weight assembly
42 Clip
43 Weight pin
44 Ball bearing
45 Driven gear
46 Body gasket
47 Draincock
48 Plug, pipe, sq hd, ⅛ (1 rqr)
49 Plate gasket
50 Governor base
51 Pin, straight, ⅛ x $\frac{13}{16}$ (1 rqr)
52 Sems fastener
53 Packing
54 Auxiliary lever assembly
55 Left-hand clevis
56 Clevis pin
57 Hairpin clip
58 Left-hand hex nut
59 Adjusting screw
60 Right-hand clevis
61 Shouldered clevis pin
62 Pin, straight, ¼ x 2⅜
63 Adjusting block
64 Lockwasher, int-teeth ⅜ (1 rqr)
65 Shoulder screw
66 Rocker arm
67 Pin, straight, ¼ x $1\frac{1}{16}$ (2 rqr)
68 Groove pin

Figure 81—Continued.

the gear (45) on the shaft and spider assembly (40). Insert the pin (51) and peen the ends. Attach the weights (41) with the pins (43) and secure with the clips (42). The weights must move freely on the pins and in the spider. Press the bearing (38) on the thrust sleeve (39) and slide the sleeve on the shaft.

(3) *Rocker arm.* Attach the connector assembly (15) to the rocker arm (66) and press in the pins (67). Place the arm in the body (36) and insert the shaft (32) into the arm. Install the bearings (33), rings (34), and plugs (35). Drive the pins (68) into the arm and install the plugs (29) in the body.

(4) *Speed adjusting screw.* Install the pivot pin (17) in the adjusting block (63) and the nut (26) and knob (25)

on the screw (18). Secure the knob with the pin (24). Place the block on the pin (62). Insert the adjusting screw (18) in the body (36); place the washer (20) on it and turn the screw into the block. Drive the pin (19) into the screw. Attach the spring (16) to the connector (15).

(5) *Auxiliary lever.* Assemble the clevises (55 and 60), the nuts (26 and 58), and the screw (59) to the same length as measured at disassembly (par. 138*b*(2)), and attach to the lever (54) with the pin (61) and clip (57). Place the lever in the body (36) and secure with the lockwasher (64) and the shoulder screw (65). Attach the spring (16) to the pin (61).

(6) *Cover.* Attach the screw (8) and pin (7) to the lever (5); the oilcup (3), spring (11), arm (12), packing (4), and lever (5) to the cover (9). Secure the lever with the pin (6).

Note. Do not install the cover (9) at this time.

b. Install the governor (par. 74*c*) and adjust the governor (par. 141).

141. Engine Speed Governor Adjustment
(fig. 81)

a. Secure the specified engine speed of 1,200 rpm with the speed adjusting knob (25). Clockwise rotation decreases the governed speed. Lock with the locknut (26).

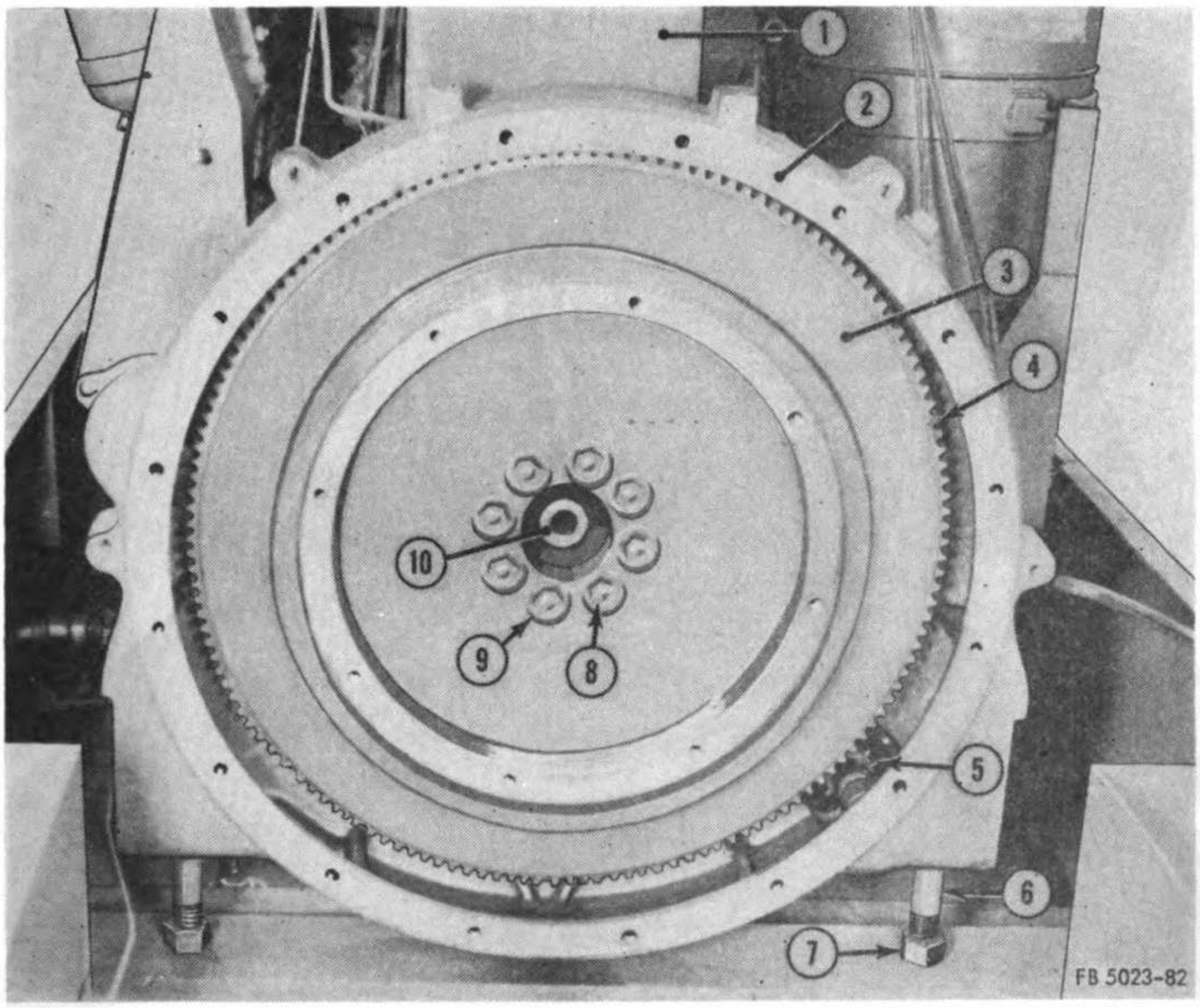
b. Regulation is controlled by increasing or decreasing the existing tension or the governor spring by means of an adjusting screw on the connector assembly (15). Clockwise rotation of the screw tends to control load surge, and counterclockwise rotation makes the governor more sensitive to load changes.

c. Install the cover (par. 74*c*).

Section X. FLYWHEEL AND HOUSING

142. General
(fig. 82)

The flywheel (3), attached to the crankshaft flange (10), maintains an even rotating crankshaft speed. The ring gear (4), which meshes with the starting motor pinion gear (5) to turn the engine over, is shrunk on the forward circumference of the flywheel. The housing (2) is a covering for the flywheel and bolts to the crankcase (1) to form the rear support for the engine.



1	Crankcase	6	Engine rear mounting stud
2	Flywheel housing	7	Mounting stud nut
3	Flywheel	8	Nut, hex, ⅝ NF
4	Flywheel ring gear	9	Lockwasher, ⅝ (8 rqr)
5	Starting motor pinion gear	10	Crankshaft flange

Figure 82. Flywheel, installed view.

143. Flywheel and Ring Gear

a. Flywheel Removal.

(1) Remove the generator (par. 135*a*).

(2) Remove the nuts (8, fig. 82) and washers (9) securing the flywheel (3) to the crankshaft flange (10).

(3) Screw a ½-inch NC eyebolt in a tapped hole of the flywheel (3) and remove the flywheel using a suitable lifting device as illustrated in figure 83.

b. Flywheel Cleaning and Inspection (fig. 82).

(1) Wash the flywheel (3) and ring gear (4) in cleaning solvent. Dry thoroughly.

(2) Inspect the flywheel (3) for elongated mounting holes and stripped threads in the capped holes. Replace a defective flywheel, making sure that the timing marks are identical and in the same position.

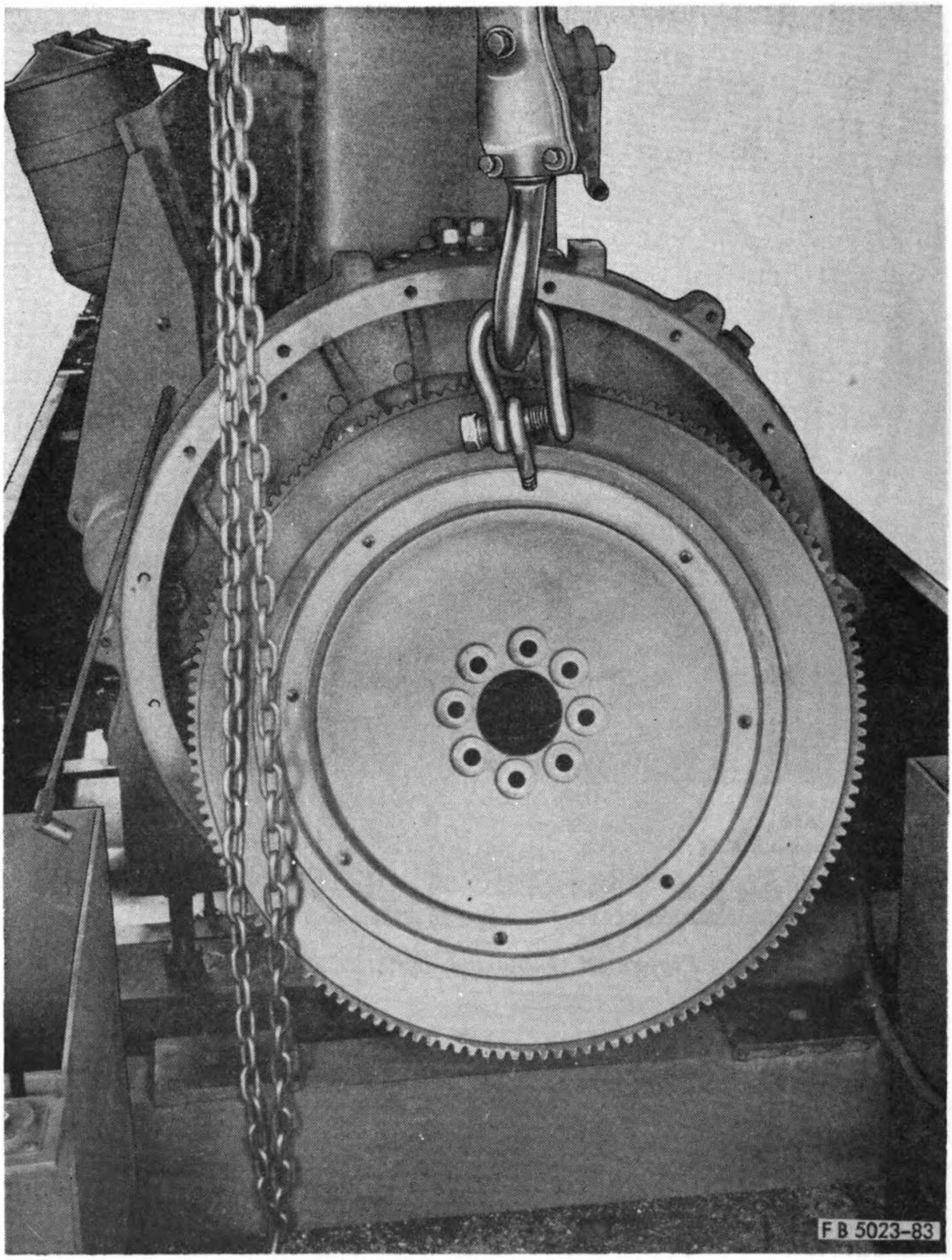


Figure 83. Removing flywheel.

(3) Inspect the ring gear (4) for broken or worn teeth. Replace a defective ring gear (*c* below).

c. Flywheel Ring Gear Replacement.

(1) Drill two or more holes through the ring gear (4) in line with and parallel to the teeth. Split the gear at this point and remove from the flywheel.

(2) Boil the new ring gear in oil for 15 minutes or heat it evenly to a temperature of 500° to 600° F. Place the

gear on the flywheel (3) with the tooth chamfer facing toward the front of the engine. Seat the gear firmly on the flywheel and allow it to cool to a shrink fit.

d. Flywheel Installation.

(1) Lift the flywheel (3) in the same manner as in *a*(3) above and install it on the crankshaft flange (10). Secure with eight nuts (8) and lockwashers (9). Tighten the nuts to 150 to 160 ft-lb-torque.

(2) Install the generator (par. 135*b*).

144. Flywheel Housing

a. Removal.

(1) Remove the flywheel (par. 143*a*).

(2) Measure the distance from the flywheel housing at the mounting studs (5, fig. 84) to the subbase (7). Make a notation of the measurement at each side.

(3) Attach a lifting bracket to the rear cylinder head studs nearest the flywheel housing. Use a sling and hoist to relieve the weight of the engine from the flywheel housing.

(4) Remove the 10 cap screws (1) and lockwashers (2). Lift the flywheel housing (3) from the subbase.

b. Cleaning and Inspection.

(1) Wash the flywheel housing (3) in cleaning solvent and dry thoroughly.

(2) Inspect the housing for cracks, breaks, and damaged threads. Replace a defective housing.

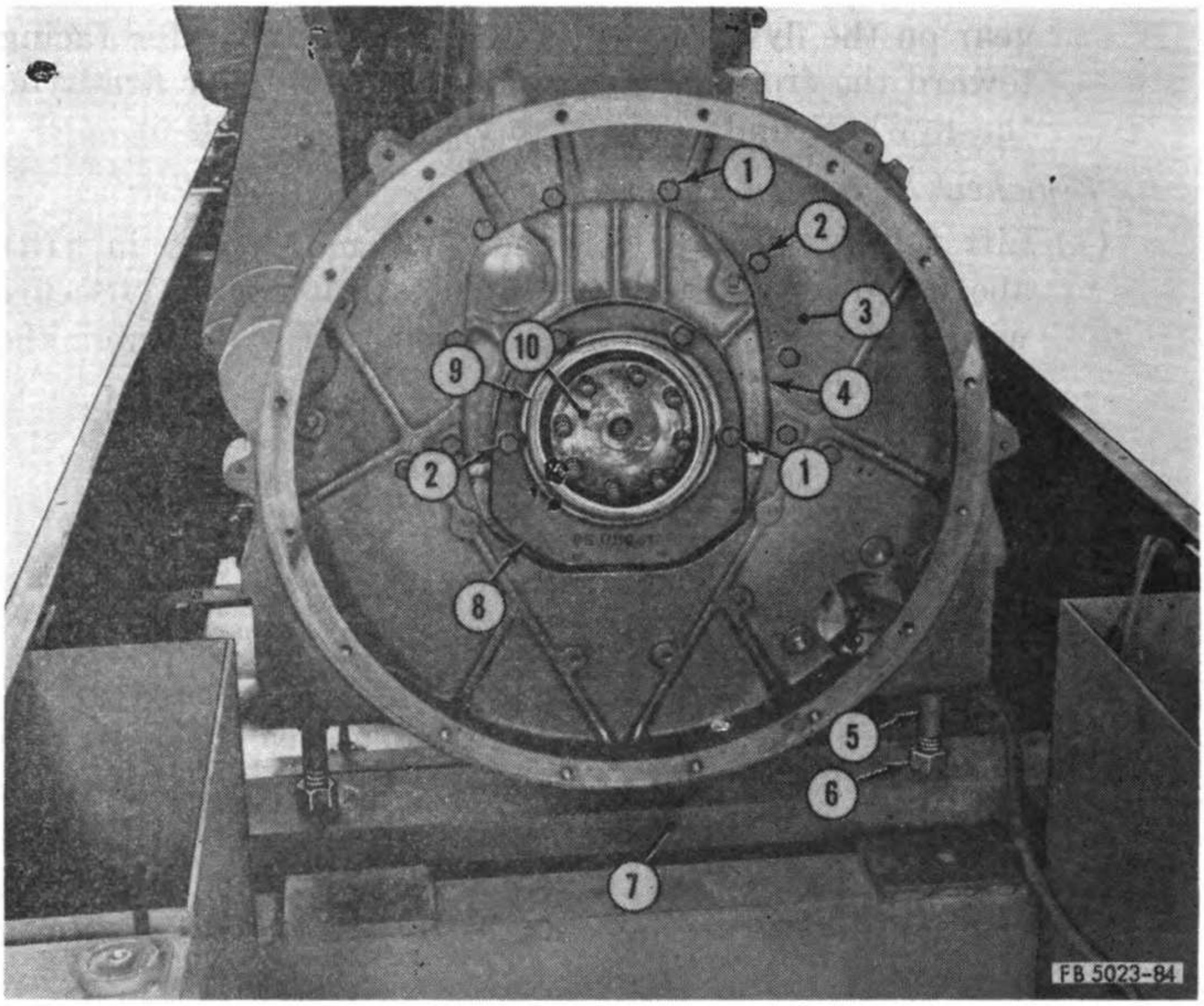
(3) Inspect the studs (5) and nuts (6) for cracks, breaks, and stripped threads. Replace defective parts.

c. Installation.

(1) Install the flywheel housing (3) on the subbase (7) so that the mounting studs (5) fit into the subbase holes. Aline the housing with the crankcase (4) and secure with 10 cap screws (1) and lockwashers (2).

(2) Attach a dial indicator to the flywheel and position the indicator to contact the flywheel housing bolting flange. Turn the flywheel slowly and watch the indicator. If the housing is out of round more than 0.010 inch, remove it (*a*(4) above) and check the mating surfaces of the housing and crankcase for dirt and burs. The surfaces must be clean and smooth.

(3) Install the housing ((1) above and recheck (2) above).



1	Cap screw, ½ x ¼ NC (14 rqr)	6	Mounting stud nut
2	Lockwasher, ½ (14 rqr)	7	Subbase
3	Flywheel housing	8	Oil seal retainer
4	Crankcase	9	Crankshaft rear oil seal
5	Engine rear mounting stud	10	Crankshaft

Figure 84. Flywheel housing, installed view.

(4) Release the weight of the engine onto the flywheel housing. Remove the sling and lifting bracket.

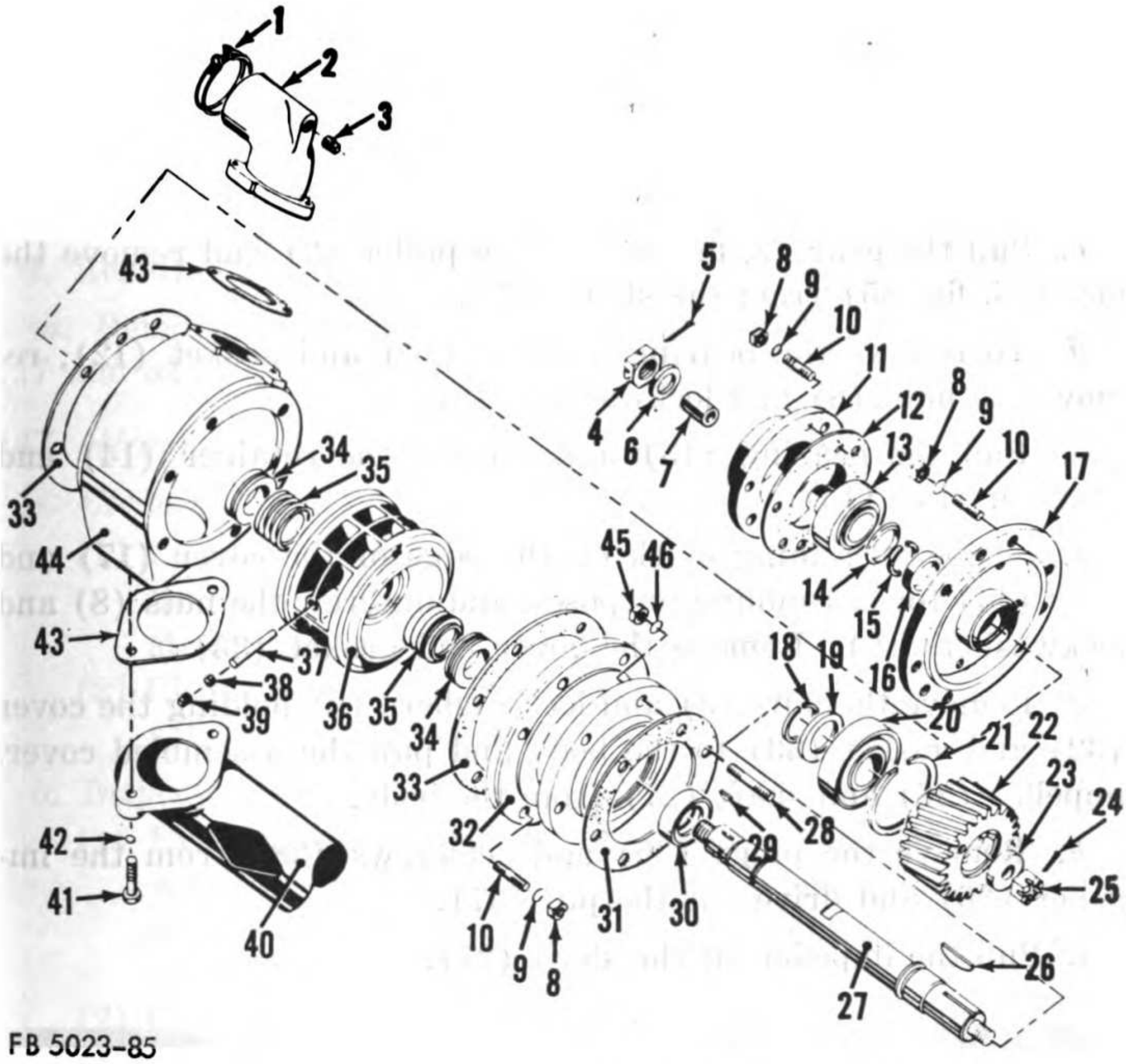
(5) Turn the nuts (6) up or down on the studs (5) until the housing-to-subbase measurement is correct (*a*(2) above).

(6) Install the flywheel (par. 143*d*).

Section XI. WATER PUMP

145. Description

The water pump (6, fig. 48) is of the centrifugal type and is flange mounted on the timing gear case. The pump gear (22, fig. 85) meshes with the idler gear, which drives the pump at 1.5 times crankshaft speed. The pump shaft is made of corrosion proof material and runs on two ball bearings. The front bearing is oiled from the timing gear housing and the rear bearings are packed with grease through the chambers.



FB 5023-85

1 Hose clamp
2 Inlet elbow
3 Pipe plug, ⅜
4 Nut, hex, ⅜ NF (6 rqr)
5 Pin, cotter, ⅛ x 1
6 Lockwasher, ⅜ (6 rqr)
7 Spacer
8 Nut, hex, $\frac{5}{16}$ NF (16 rqr)
9 Lockwasher, $\frac{5}{16}$ NF (16 rqr)
10 Water pump stud
11 Rear bearing housing
12 Housing gasket
13 Rear ball bearing
14 Bearing ring retainer
15 Bearing shoulder ring
16 Water slinger
17 Cover
18 Bearing shoulder ring
19 Shoulder ring retainer
20 Front ball bearing
21 Snap ring
22 Drive gear
23 Gear washer
24 Pin, cotter, $\frac{3}{32}$ x 1
25 Nut, castle, ½ NF
26 Gear key
27 Shaft
28 Housing stud
29 Key, woodruff, No. 9
30 Oil seal
31 Mounting gasket
32 Cover
33 Cover gasket
34 Floating seat
35 Seal assembly
36 Impeller
37 Impeller locking pin
38 Setscrew
39 Pipe plug, ½ (2 rqr)
40 Outlet elbow
41 Cap screw, $\frac{7}{16}$ x 1¼ NC (4 rqr)
42 Lockwasher, $\frac{7}{16}$ (4 rqr)
43 Elbow gasket
44 Body
45 Nut
46 Lockwasher

Figure 85. Water pump, exploded view.

146. Water Pump Disassembly

a. Remove the water pump (par. 82*b*).

b. Pull the cotter pin (24, fig. 85) and remove the nut (25) and washer (23) from the drive gear end of the pump.

c. Pull the gear (2, fig. 86) with a puller (3) and remove the key (26, fig. 85) from the shaft (27).

d. To remove the bearing housing (11) and gasket (12), remove the nuts (8) and lockwashers (9).

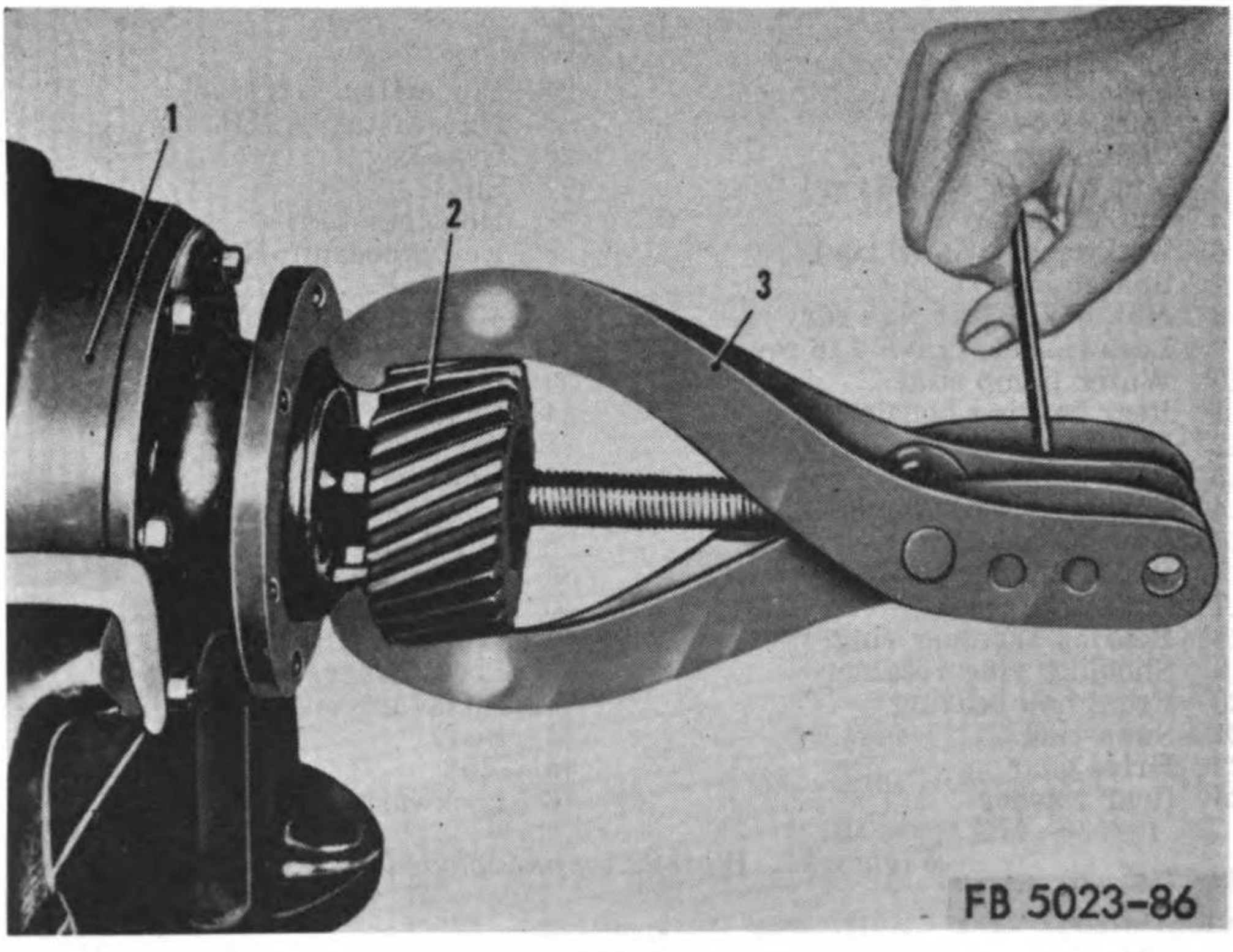
e. Pull the bearing (13) and remove the retainer (14) and shoulder ring (15).

f. Scribe an alining mark on the edge of the cover (17) and body (44) for assembling purposes, and unscrew the nuts (8) and lockwashers (9). Remove the cover and gasket (33).

g. Remove the nuts (8) and lockwashers (9) holding the cover (32) and gasket (33) to the body and pull the assembled cover, impeller (36) and shaft (27) from the body.

h. Remove the plugs (39) and setscrews (38) from the impeller (36) and drive out the pin (37).

i. Pull the impeller off the shaft (27).



1 Water pump 2 Drive gear 3 Puller

Figure 86. Removing water pump drive gear.

j. Remove the snap ring (21) and press the bearing (20) and shaft out of the cover.

k. Press the shaft out of the bearing and remove the retainer (19) and shoulder ring (18).

l. Remove the seats (34) and seals (35) from the impeller.

m. Remove the oil seal (30) and slinger (16) from the covers (17 and 32).

147. Water Pump Cleaning and Inspection

a. Cleaning.

(1) Clean all metal parts with a solvent. Do not dip the bearings (13 and 20, fig. 85) in solvent as this will destroy their factory packed lubricating qualities.

(2) Clean the outer bearing surfaces only by wiping with a solvent moistened cloth.

b. Inspection.

(1) Examine the shaft (27) for crossed or mutilated threads, worn keyways, signs of a loose impeller (36), and a groove worn by the oil seal (30). Replace a defective shaft.

(2) Check the fit of the bearings (13 and 20). The bearings must be a press fit on the shaft and a snug fit in the bearing housing (11) and cover (32). Replace the shaft if the bearings are loose.

(3) See that the bearings operate smoothly and quietly and that there is no metallic dust in the races. Replace a worn or noisy bearing.

(4) Check the oil seal (30) for signs of leakage and wear. Replace a defective seal.

(5) Inspect the impeller (36) for cracks and corrosion, and for fit on the shaft. Replace the impeller if it is defective or worn.

(6) Examine the water seals (35) for sufficient spring tension and damage. Check the seats (34) for wear ridges or nicks. Replace a defective seal or seat.

(7) Check the body (44), bearing housing (11), and covers (17 and 32) for cracks and corrosion. See that the oil seal fits tightly and that the machined surfaces in the covers, against which the seats (34) bear, are smooth. See that the outer bearing races are a snug fit in the cover (32) and bearing housing. Replace a defective body, housing, or cover.

(8) Make sure the drive gear (22) is a press fit on the shaft.

See that the gear teeth are not worn or damaged. Replace a defective gear.

148. Water Pump Reassembly

a. Install the oil seal (30, fig. 85) slinger (16) in the covers (17 and 32).

b. Oil both faces of the water seals (35) and place the seals and seats (34) in the impeller (36).

c. Place the retainer (19) and shoulder ring (18) on the shaft (27) and press the shaft into the bearing (20).

d. Press the bearing and shaft into the cover (32) and install the snap ring (21).

e. Press the impeller with the seals in place on the shaft.

f. Attach the assembled impeller, shaft, and cover to the body (44) and gasket (33) with the nuts (8) and lockwashers (9).

g. Line up the locating marks on the cover (17) and body, and secure the cover and gasket (33) with the nuts (8) and lockwashers (9).

h. Install the shoulder ring (15) and retainer (14) on the shaft (27) and press the bearing (13) on, supporting the shaft to prevent damage to internal pump parts.

i. Secure the gasket (12) and bearing housing (11) to the cover (17) with the nuts (8) and lockwashers (9).

j. Place the key (26) in the shaft (27) and press the gear (22) on. Support the shaft to prevent damage to internal pump parts.

k. Secure the gear with the washer (23), nut (25), and cotter pin (24).

l. Move the impeller (36) on the shaft (27) until there is a dimension of $^{3}/_{32}$-inch or 0.094-inch between the edge of the impeller and the innermost edge of the cover (32), measured at a point close to the shaft.

m. Drive in the pin (37) to secure the impeller to the shaft and install the setscrews (38). Be sure to put the setscrew over the large end of the pin first, to prevent forcing the pin out.

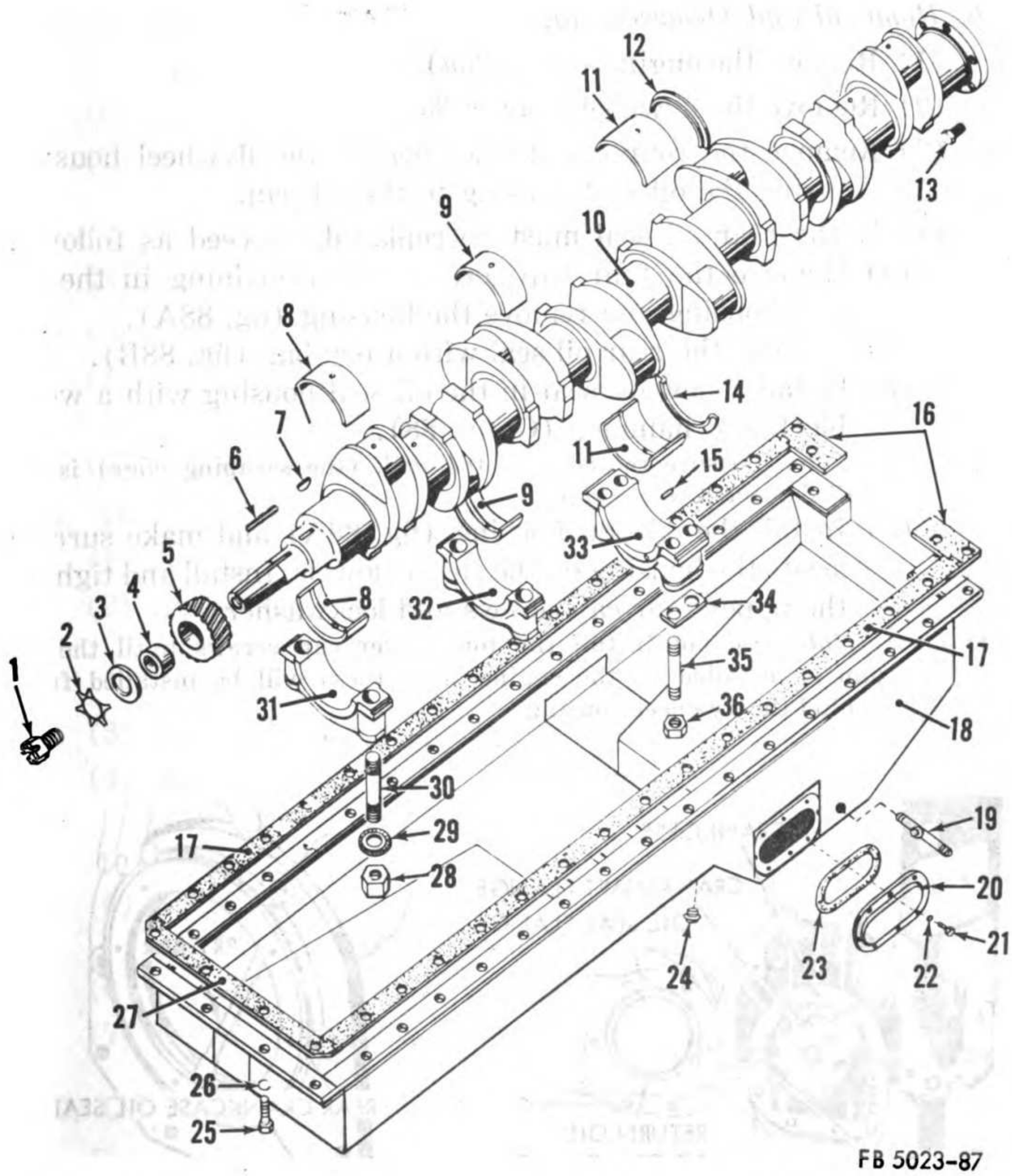
n. Install the plugs (39).

o. Install the water pump (par. 82*c*).

Section XII. OIL PAN, OIL PUMP, AND OIL PRESSURE REGULATING VALVE

149. Oil Pan

a. Description. The oil pan (18, fig. 87) serves as a cover for the bottom of the engine and also acts as an oil reservoir. The reservoir is filled with oil and is ventilated through a breather pipe. An oil level gage in the block, measures the oil level in the pan.



1 Crank jaw
2 Locking washer
3 Pulley washer
4 Retaining sleeve
5 Crankshaft gear
6 Pulley key
7 Key, woodruff, No. 25
8 Upper and lower front and rear main bearing
9 Upper and lower intermediate main bearing
10 Crankshaft
11 Upper and lower center main bearing
12 Upper thrust flange
13 Flywheel bolt
14 Lower thrust flange
15 Dowel pin, ¼ x ⅝ (4 rqr)
16 Rear oil pan gasket
17 Side oil pan gasket
18 Oil pan assembly
19 Drain pipe and valve
20 Clean-out cover plate
21 Cap screw, ¾–16 x ¾ (16 rqr)
22 Lockwasher, ⅜ (16 rqr)
23 Cover plate gasket
24 Drain plug
25 Cap screw, ½ x 1⅛ NC (42 rqr)
26 Lockwasher, ½ (42 rqr)
27 Front oil pan gasket
28 Stud nut (16 rqr)
29 Stud lockwasher
30 Main bearing stud
31 Front and rear main bearing cap
32 Intermediate main bearing cap
33 Center main bearing cap assembly
34 Locking plate
35 Main bearing stud
36 Stud nut (4 rqr)

Figure 87. Crankshaft and oil pan, exploded view.

b. Removal and Disassembly.

(1) Remove the engine (par. 136*a*).

(2) Remove the flywheel (par. 143*a*).

(3) Remove the four cap screws behind the flywheel housing securing the oil seal housing to the oil pan.

(4) If the rear oil seal must be replaced, proceed as follows:

(*a*) Remove the four cap screws still remaining in the oil seal housing and remove the housing (fig. 88A).

(*b*) Remove the rear oil seal with a pry bar (fig. 88B).

(*c*) Install a new oil seal in the oil seal housing with a wood block and hammer (C, fig. 88).

Note. Be sure the edge of the seal, (the scraping edge) is installed toward the engine.

(*d*) Install the oil seal housing (fig. 88A) and make sure to locate the housing on the sleeve dowels. Install and tighten the upper four cap screws and lockwashers.

Note. Do not install the four lower cap screws until the oil pan is installed on the engine since these will be installed from behind the flywheel housing.

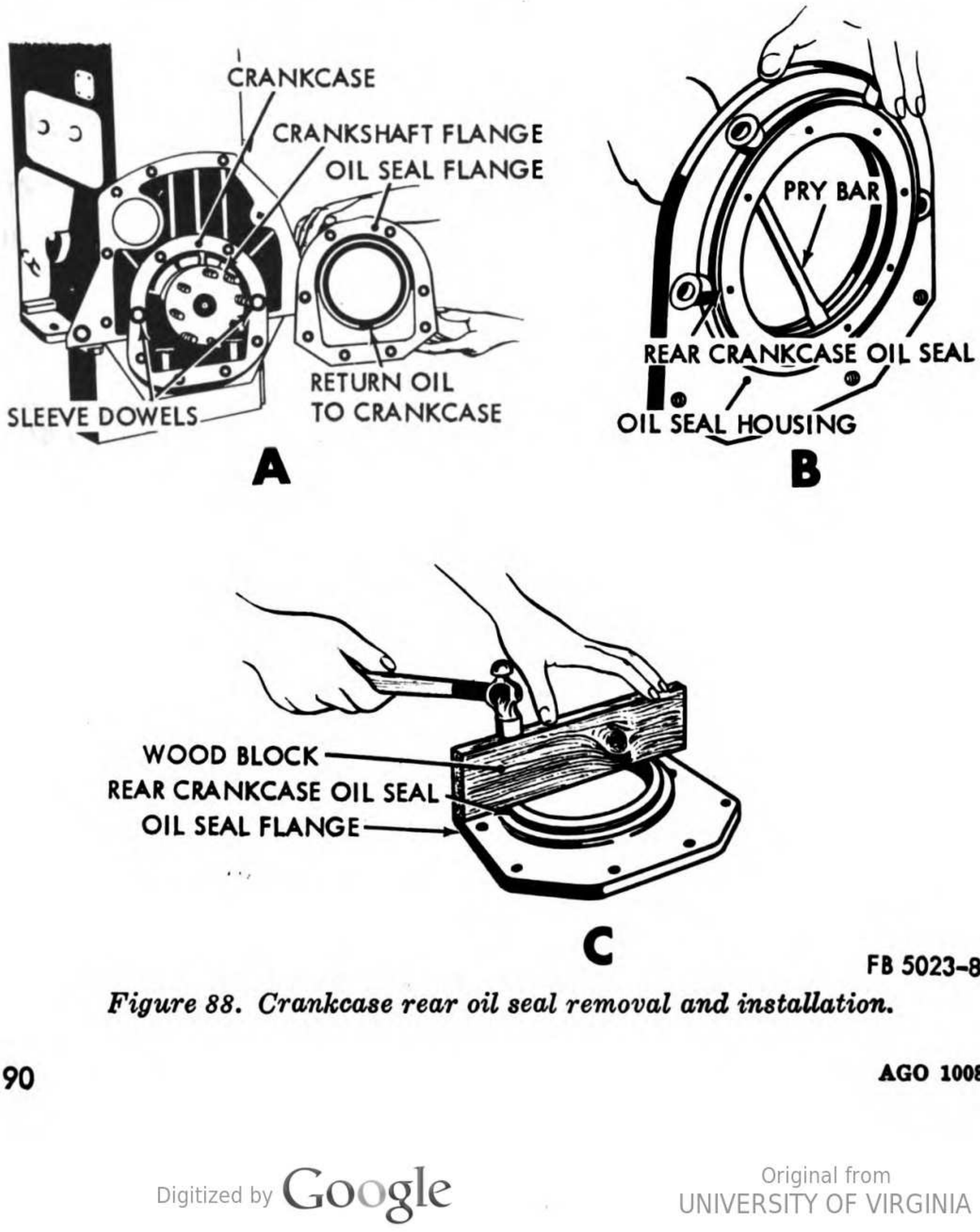


Figure 88. Crankcase rear oil seal removal and installation.

(5) Remove the cap screws (25, fig. 87) and lockwashers (26) and remove the oil pan (18) and discard the gaskets (16, 17, and 27).
(6) Remove the drain pipe and valve (19).
(7) Remove the cap screws (21) and lockwashers (22) securing the clean-out cover plate (20) to the oil pan (18). Remove the cover plate and discard the cover gasket (23).
(8) Remove the drain plug (24).

c. Cleaning and Inspection.

(1) Clean the oil pan (18) with cleaning solvent and check for breaks and cracks.
(2) Replace or weld a defective oil pan.

d. Reassembly and Installation.

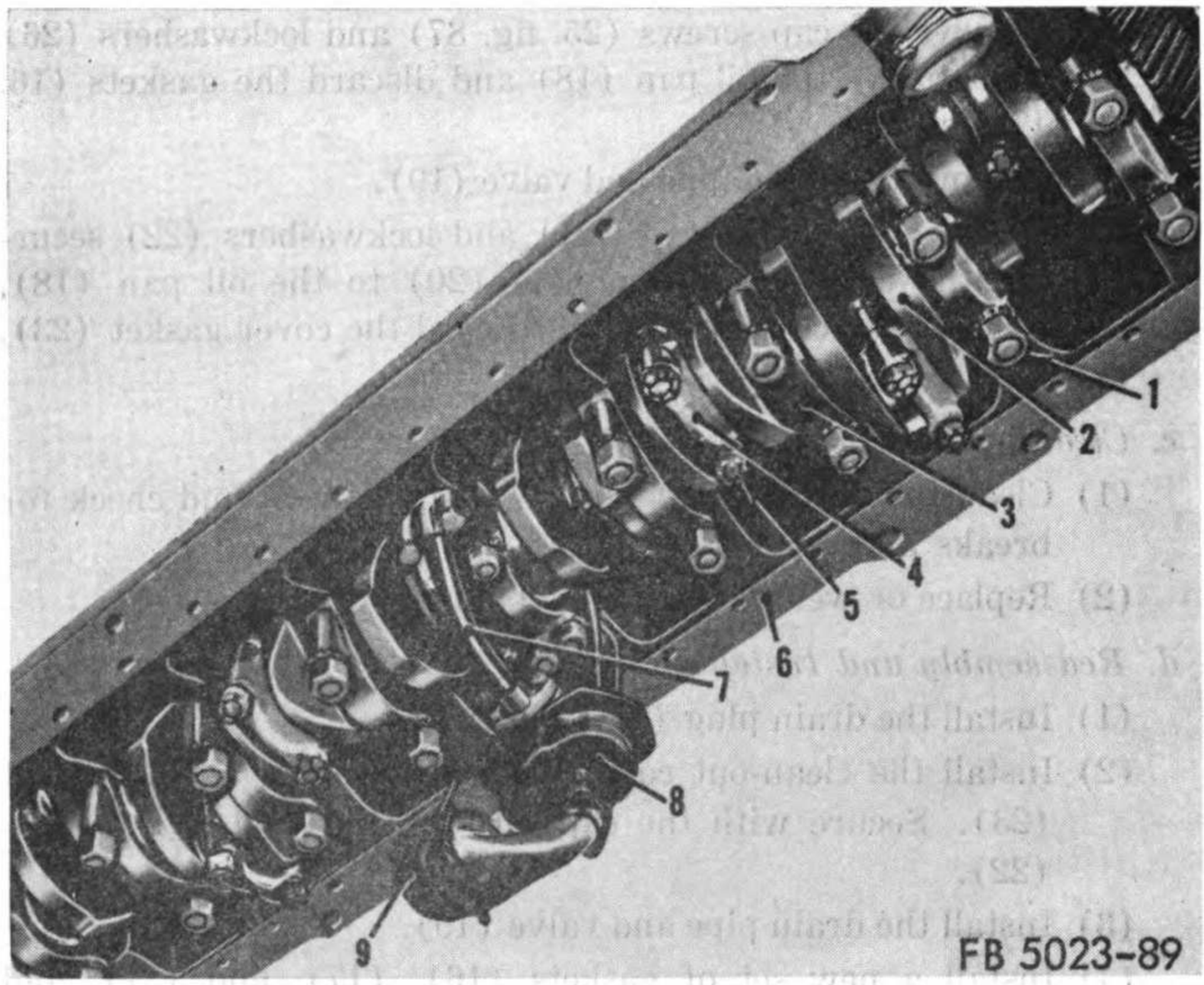
(1) Install the drain plug (24).
(2) Install the clean-out cover plate (20) using a new gasket (23). Secure with the cap screws (21) and lockwashers (22).
(3) Install the drain pipe and valve (19).
(4) Install a new set of gaskets (16), (17), and (27), and secure the oil pan (18) to the bottom of the crankcase with the cap screws (25) and lockwashers (26).
(5) Install the four cap screws and secure the rear of the oil pan to the oil seal housing (see NOTE in *b* (4) above).
(6) Install the flywheel (par. 143*d*).
(7) Install the engine (par. 136*b*).

150. Oil Pump

a. Description. The oil pump (8, fig. 89) is attached to the underside of the block (6) and is driven by a gear integral and at the center of the camshaft. The pump extends into the oil pan and oil is drawn into the pump through a screen assembly (9) which prevents coarse dirt from entering the oil pump. A discharge line assembly (7) connects the oil pump to a drilled oil pasage in the block.

b. Removal.

(1) Remove the oil pan (par. 149*b*).
(2) Cut the lockwire, and remove the cap screws and lockwashers securing the discharge line assembly (7) and gasket to the block (6).
(3) Remove the cap screw and lockwasher securing the pump (8) to the block, and carefully withdraw the pump out of its recess.



1 Main bearing capnut (20 rqr)
2 Crankshaft
3 Main bearing cap
4 Connecting rod cap
5 Connecting rod capnut (16 rqr)
6 Cylinder block
7 Discharge line assembly
8 Oil pump
9 Screen assembly

Figure 89. Bottom of engine with oil pan removed.

c. Disassembly.

(1) Remove the cap screws (26, fig. 90) and lockwashers (18) attaching the discharge line assembly (29) and gasket (30) to the oil pump body (2).

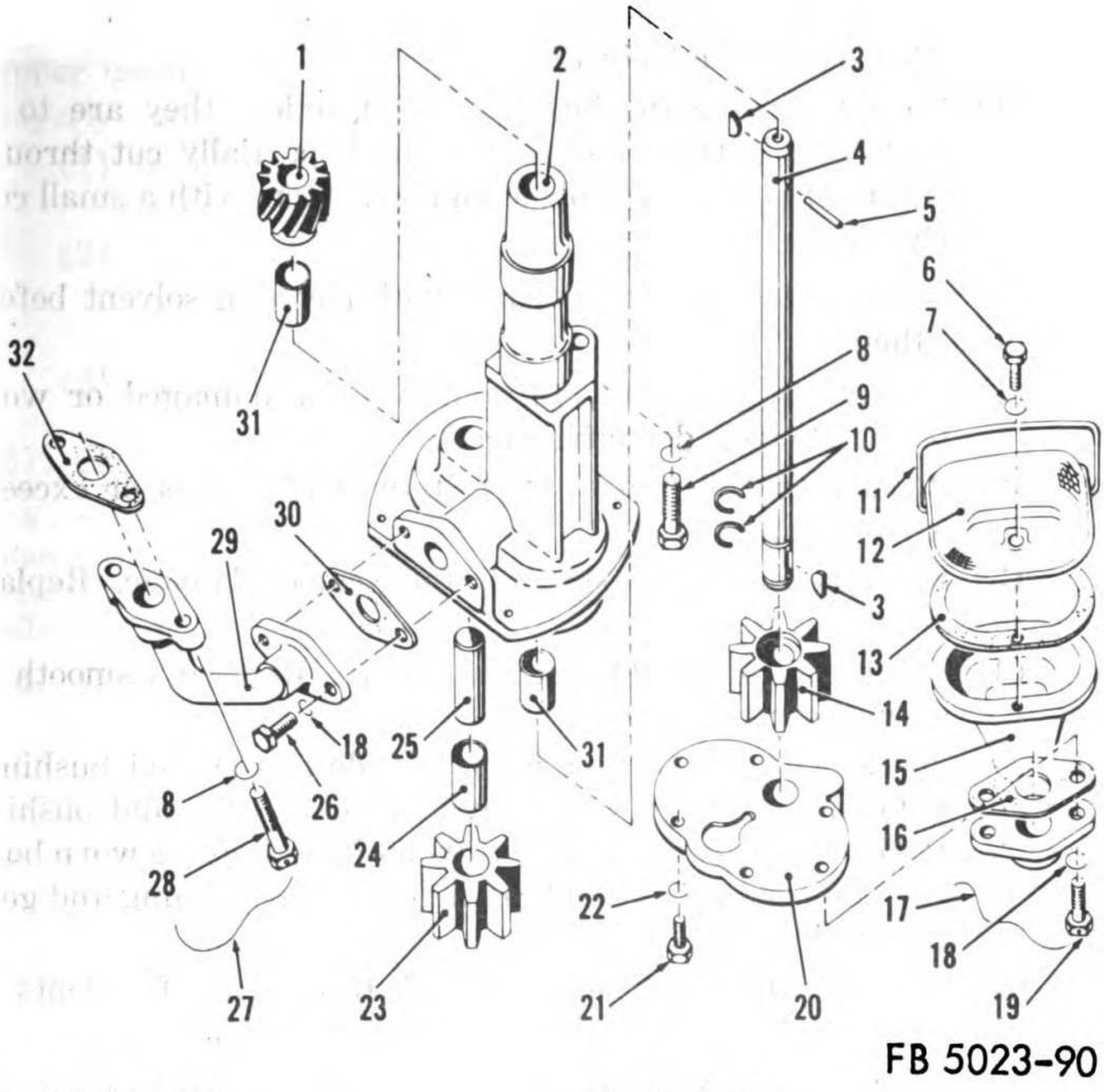
(2) Cut the lockwire (17), and remove the cap screw (19) and lockwashers (18) securing the screen elbow (15) and gasket (16) to the cover (20).

(3) To remove the cover (20), remove the cap screws (21) and lockwashers (22).

(4) Check the clearance between the gear (14) and the body (2). It should not exceed 0.005 inch.

(5) Lay a straightedge across the bottom of the pump body, and check the clearance between the gear (14) and straightedge. Clearance should not exceed 0.005 inch.

(6) Check the idler gear (23) backlash. It should not exceed 0.015-inch.



1	Driving gear	17	Lockwire
2	Pump body assembly	18	Lockwasher, ⅜ (4 rqr)
3	Woodruff key, No. 7 (2 rqr)	19	Cap screw (20 rqr)
4	Driving shaft	20	Body cover
5	Pin, straight, $\frac{3}{16}$ x 1⅛	21	Cap screw, ¼ x ⅞ NC (6 rqr)
6	Cap screw	22	Lockwasher, ¼ (6 rqr)
7	Lockwasher	23	Idler gear assembly
8	Lockwasher, ½ (3 rqr)	24	Idler gear bushing
9	Cap screw, ½ x 1¾ NC	25	Gear shaft
10	Snap ring	26	Cap screw, ⅜ x ⅞ NC (2 rqr)
11	Retainer ring	27	Lockwire
12	Oil screen	28	Cap screw, ⅜ x 2 NC (2 rqr)
13	Gasket	29	Discharge line assembly
14	Driver gear	30	Discharge line gasket
15	Screen elbow	31	Body bushing
16	Screen gasket	32	Discharge line gasket

Figure 90. Oil pump, exploded view.

Note. Do not further disassemble the pump unless the checks in steps (4, 5 and 6) above indicate excessive wear.

(7) Drive out the pin (5) and pull the driving gear (1) and key (3).

(8) Pull the shaft (4) and driver gear (14) out of the body (2).

(9) Remove the snap ring (10) below the driver gear, and pull the gear and key (3) from the shaft.

(10) Remove the idler gear (23), and press the idler gear shaft (25) out of the body (2).

(11) Do not remove the bushings (31) unless they are to be replaced. If they must be replaced, partially cut through them with a hacksaw blade and split them with a small cold chisel.

d. Inspection. Clean all pump parts with cleaning solvent before inspecting them.

(1) Inspect the gears (1, 14, and 23) for damaged or worn teeth. Replace defective gears.

(2) Replace the idler gear (23) if the backlash is or exceeds 0.015-inch.

(3) Examine the pump body (2) for wear or damage. Replace a defective body.

(4) Check the cover (20) for gear wear. Replace a smooth or worn cover.

(5) Check the clearance between the shaft (4) and bushings (31), and between the idler gear shaft (25) and bushing (24). Maximum clearance is 0.005-inch. Replace worn body bushings or shafts. Replace the idler gear bushing and gear as a unit.

(6) Examine the screen assembly (6–13 and 15) for dents or damage. Replace a defective screen assembly.

e. Reassembly.

(1) If the body bushings (31) were removed, press new bushings in the body and line ream to obtain 0.0015-inch bushing-to-shaft clearance.

(2) Press the idler gear shaft (25) into the body, and install the idler gear (23) on the shaft.

(3) Place the key (3) in the shaft (4), and press the driver gear (14) on the shaft until it seats against the upper ring (10). Install the lower ring (10).

(4) Insert the gear and shaft into the body (2).

(5) Place the key (3) in the shaft, and press the driving gear (1) on until the pin holes line up. Install the pin (5).

(6) Install the cover (20) and secure it with the cap screws (21) and lockwashers (22).

(7) Install the gasket (16) and screen elbow (15) on the cover, and secure with the cap screws (19), lockwashers (18), and lockwire (17).

(8) Install the gasket (30) and discharge line assembly (29) on the body (2), and secure with the cap screws (26) and lockwashers (18).

f. Installation.

Caution: **Be sure the camshaft and oil pump drive gears are in proper mesh and that the mounting flange of the oil pump body is properly seated before applying tension to the mounting cap screws.**

(1) Insert the pump (8, fig. 89) carefully into its recess and secure it to the block (6) with the cap screw and lockwasher.

(2) Attach the discharge line assembly (7) and gasket to the block. Secure with the cap screws, lockwashers, and lockwire.

(3) Install the oil pan (par. 149*d*).

151. Oil Pressure Regulating Valve

Note. **Due to the location of the valve, the supercharger must be removed before any maintenance can be performed on the oil pressure regulating valve. Refer to the appropriate paragraphs in this chapter for removal and installation of the supercharger.**

a. Adjustment.

(1) Open the side doors and run the engine until operating temperature is reached.

(2) Remove the capnut (4, fig. 91) and loosen the locknut (3).

(3) Turn the adjusting screw (2) clockwise to increase the pressure; turn counterclockwise to decrease it. Normal oil pressure at 1,200 rpm is 35 to 45 psi.

(4) Tighten the locknut (3) and install the capnut (4). Stop the engine (par. 17).

b. Removal.

(1) Remove the capnut (4), adjusting screw (2), locknut (3), and a copper gasket (7) on each side of the locknut.

(2) Pull the spring and piston out of the recess in the cylinder block (1).

c. Cleaning and Inspection.

(1) Wash the valve parts and the seating surface of the piston in the block with cleaning solvent.

(2) Check the spring tension. Free spring length is 2½ inches. When compressed to 1 27/32-inch, the pressure should be slightly over 11 pounds. Replace a weak spring.

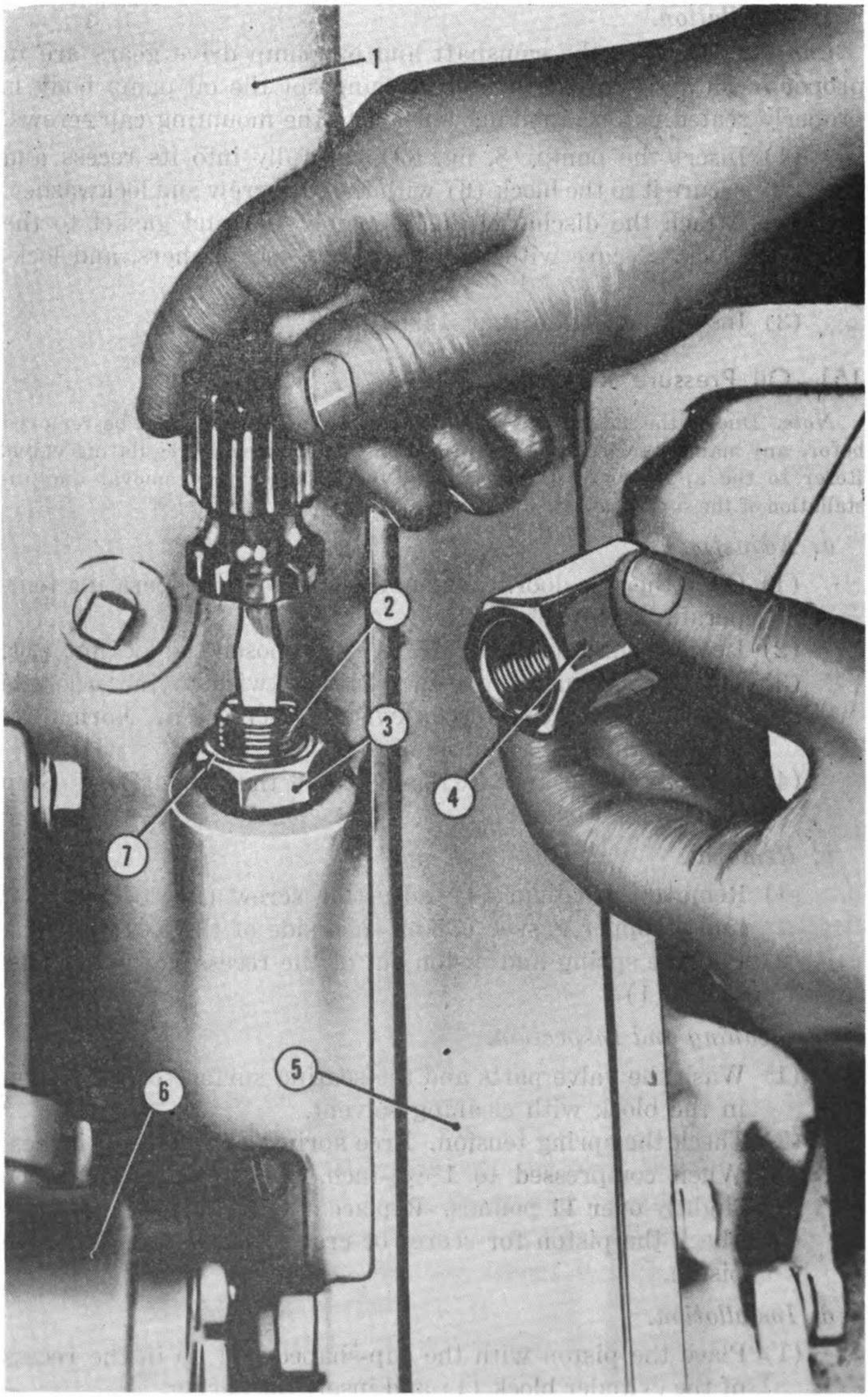
(3) Check the piston for scores or cracks. Replace a defective piston.

d. Installation.

(1) Place the piston with the cup-shaped end up in the recess of the cylinder block (1) and insert the spring.

(2) Install the adjusting screw (2), and the locknut (3) with a copper gasket (7) on each side of it.

(3) Adjust the oil pressure (*a* above).



1 Cylinder block
2 Adjusting screw
3 Locknut
4 Capnut
5 Timing gear housing
6 Water pump
7 Gasket

Figure 91. Adjusting oil pressure regulating valve.

Section XIII. TIMING GEAR COVER, GEARS, AND HOUSING

152. Description

The timing gear cover (2, fig. 80) houses the gear train at the front of the engine. The gear train consists of the crankshaft gear, an idler gear, camshaft gear, accessory drive gear, and water pump drive gear. The timing gear also holds the front support bracket (5) which serves to support the front of the engine.

153. Timing Gear Cover

a. Removal.

(1) Remove the housing and panels (par. 65*a*).

(2) Remove the radiator (par. 77*c*).

(3) Remove the fan bracket (par. 81*b*).

(4) Remove the nut (17, fig. 42) and lockwasher. Pull the supercharger drive pulley (18) and remove the key from the supercharger drive shaft (12, fig. 80).

(5) Remove the six nuts (11) and lockwashers from the drive shaft housing (13) studs. Remove the housing and gasket from the timing gear cover (2).

(6) Remove the external oil line (3).

(7) Remove the nut (16, fig. 42) from the control rod ball joint. Unscrew the ball joint stud from the overspeed governor arm (13).

(8) Remove the two cap screws and lockwashers securing the governor spring anchor to the timing gear housing.

(9) Remove the three cap screws (8, fig. 80) and lockwashers. Remove the assembled overspeed governor housing (9) and gasket from the timing gear cover (2).

(10) Remove the starting jaw nut (7, fig. 42) and remove the vibration damper and pulley assembly (5) from the crankshaft. Remove the key.

(11) Attach a lifting bracket and sling to the front cylinder head stud nuts. Pull the sling taut to support the engine before removing the front support bracket (5, fig. 80).

(12) Remove the clamp bolt (4) by removing the nut and cotter pin from the oposite end. Remove the shim.

(13) Remove the two cap screws (6), nuts, and washers securing the front support bracket (5) to the subbase.

(14) Remove the cover cap screws (1) and four oil pan cap screws, and remove the timing gear cover and gasket.

(15) Remove the oil seal (31, fig. 92) from the cover with a hammer and chisel.

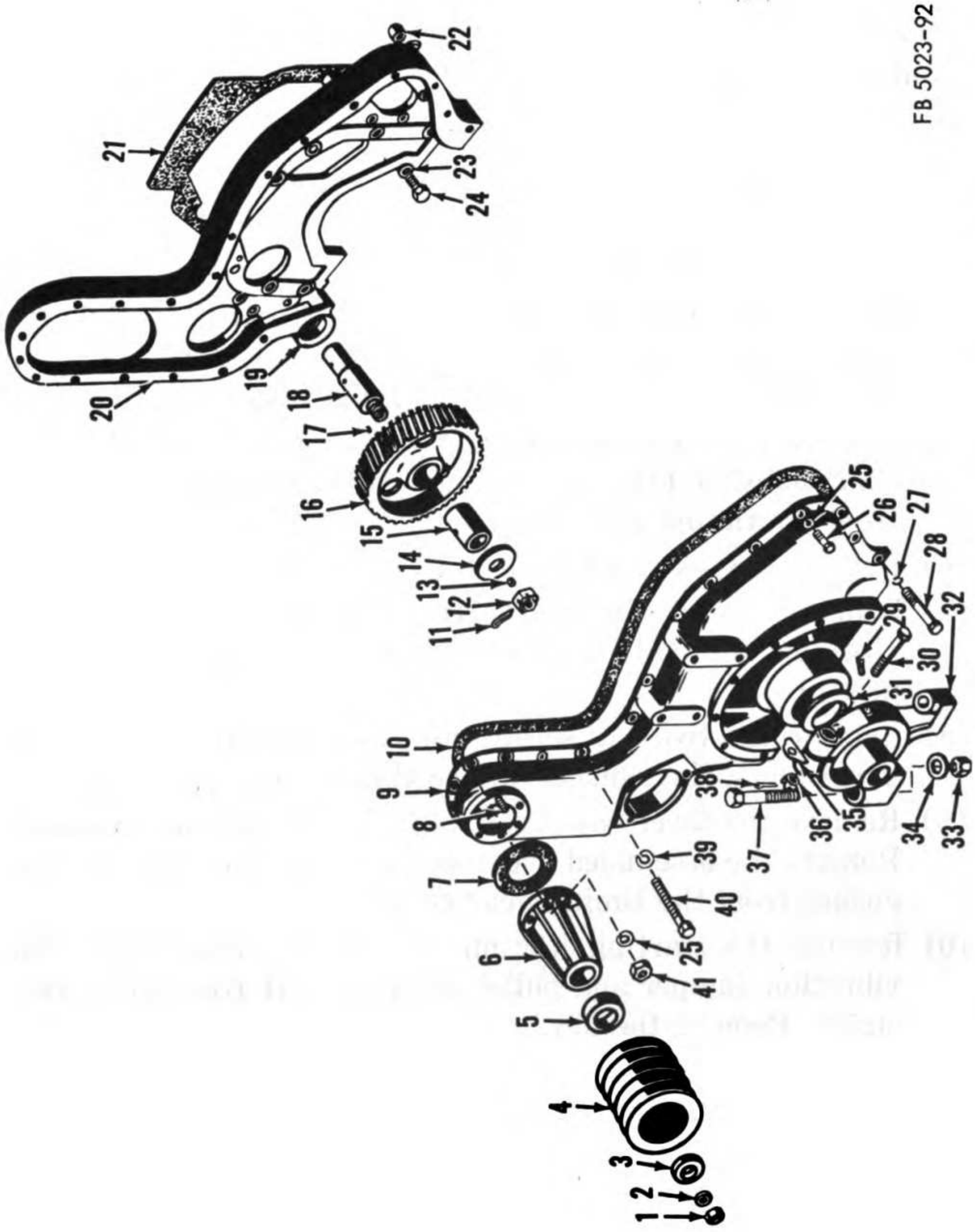


Figure 92. Timing gear cover, housing, and idler gear, exploded view.

1 Pulley nut, ¾–16
2 Pulley lockwasher, ¾
3 Pulley washer, ¾
4 Supercharger driven pulley
5 Bearing housing oil seal
6 Bearing housing
7 Bearing housing gasket
8 Housing stud, (6 rqr)
9 Timing gear cover
10 Cover gasket
11 Pin, cotter, ⅛ x 1¼
12 Nut, castle, hex, ¾ NF
13 Idler gear dowel
14 Front thrust washer
15 Idler gear bushing
16 Idler gear assembly
17 Pin, dowel, $\frac{3}{32}$ x ½
18 Idler gear shaft
19 Rear thrust washer
20 Timing gear housing
21 Housing gasket
22 Housing dowel
23 Lockwasher, ½ (8 rqr)
24 Cap screw, ½ x 1¼ NC (8 rqr)
25 Lockwasher, ⅜ (14 rqr)
26 Cap screw, ⅜ x 1½ NC
27 Lockwasher, ½ (2 rqr)
28 Cap screw, ½ x 3¼ NC (2 rqr)
29 Cap screw
30 Clamp bolt
31 Oil seal
32 Front support bracket
33 Nut, hex, ⅝ NC (2 rqr)
34 Washer, plain, ⅝ (2 rqr)
35 Front support shim
36 Nut, hex, ½ NF
37 Cap screw, ⅝ x 3½ NC
38 Pin, cotter, $\frac{3}{32}$ x 1
39 Lockwasher, $\frac{5}{16}$ (10 rqr)
40 Cap screw, $\frac{5}{16}$ x 4¾ NC (10 rqr)
41 Nut, hex, ⅜ NC (6 rqr)

Figure 92—Continued.

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b. Inspection.

(1) Check the cover (9) for cracks or mutilation. Replace a defective cover.

(2) Examine the front support bracket (32) for mutilation or thread damage. Replace a defective bracket.

c. Installation.

(1) Install a new oil seal (31) in the timing gear cover (9) making sure the edge of the leather or spring side is toward the engine.

Note. Check the crank gear retaining sleeve for a groove from the old oil seal. If a groove is present, replace the sleeve.

(2) Install the timing gear cover (9) and a new gasket (10) and secure with the cover cap screws (26 and 28) and lockwashers (25 and 27).

Note. Be sure to install the oil pan cap screws securing the timing gear cover to the oil pan. Tighten only fingertight.

(3) Sufficiently lower the engine and install the front support bracket and secure with the two cap screws (6, fig. 80), nuts, and washers.

(4) Install the clamp bolt (30, fig. 92) and secure with the nut (36) and cotter pin (38) at the opposite end making sure to install the shim (35).

(5) Install the vibration damper and pulley assembly (5, fig. 42) with the key on the crankshaft and secure with the pully hub retaining nut (7).

(6) Install the assembled overspeed governor housing (9, fig.

80) and gasket on the timing gear cover (2) and secure with the three cap screws (8) and lockwashers.

(7) Install the governor spring anchor and secure with the two cap screws and lockwashers.

(8) Screw the ball joint stud in the overspeed governor arm (13, fig. 42).

(9) Install the nut (16) on the control rod ball joint.

(10) Install the external oil line (3, fig. 80).

(11) Install the supercharger drive shaft housing (13) and gasket and secure the housing to the timing gear cover (2) with the six nuts (11) and lockwashers.

(12) Tighten the oil pan to timing gear cover cap screws.

(13) Install the supercharger drive pulley (18, fig. 42) and key on the drive shaft (12, fig. 80) and secure with the nut (17, fig. 42) and lockwasher.

(14) Install the fan bracket (par. 81*d*).

(15) Install the radiator (par. 77*f*).

(16) Install the housing and panels (par. 65*c*).

154. Timing Gears

a. Inspection.

(1) Remove the timing gear cover (par. 153*a*).

(2) Check the backlash of the gears (9, 12, and 16, fig. 93) with a dial indicator.

(3) If the backlash is 0.010 inch or more, replace the worn gears.

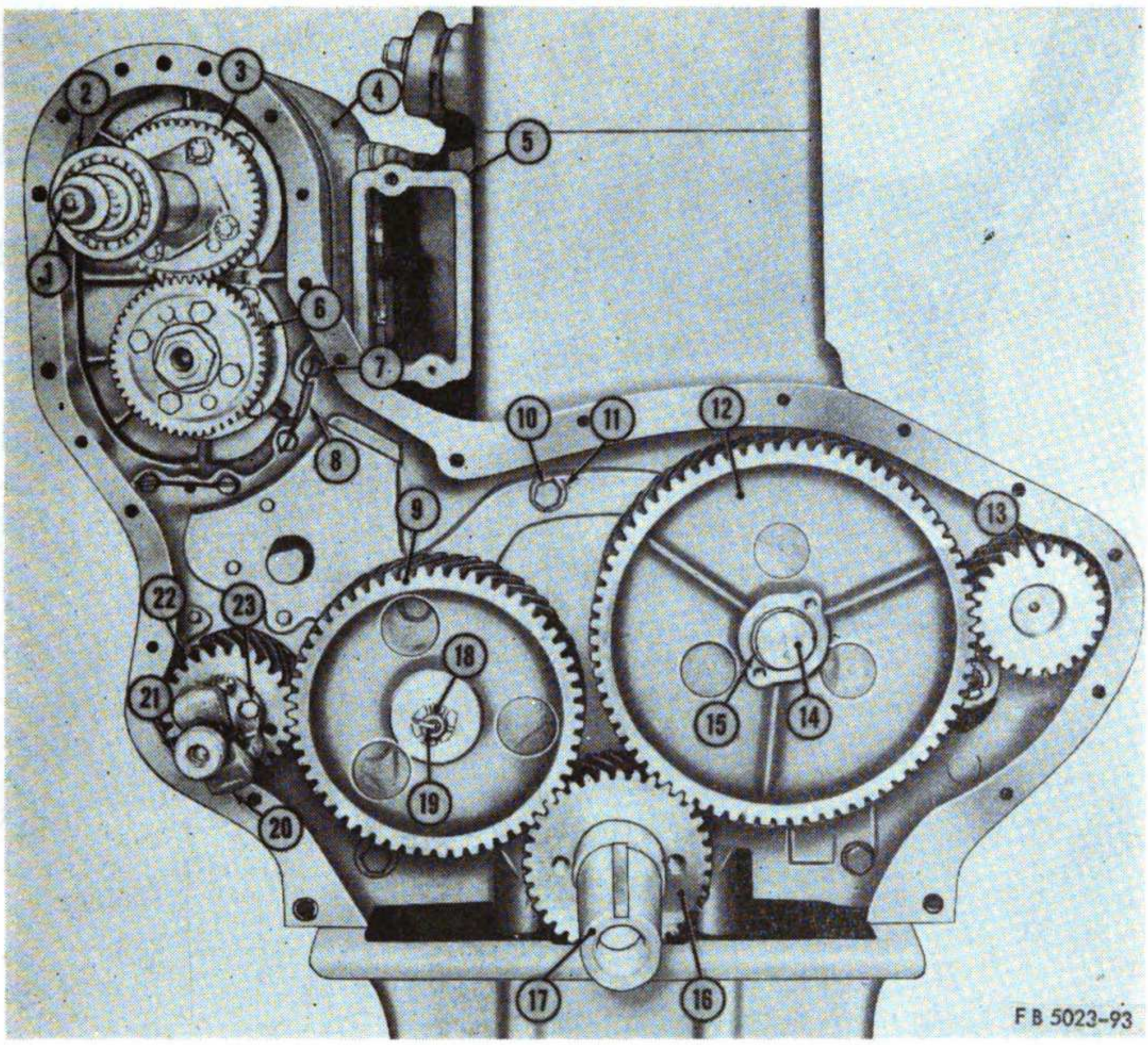
(4) Check the end thrust of the idler gear (2, fig. 94) with a feeler gage (1) between the thrust washer (3) and gear.

(5) If the end thrust is 0.015 inch or more, replace the thrust washers (14 and 19, fig. 92). If the idler gear (2, fig. 94) wobbles or has 0.004 inch clearance between the shaft (18, fig. 92) and bushing (15), replace the gear and bushing assembly rather than rebush the gear.

Caution: If conditions necessitate replacing the bushing, it must be bored in a lathe to a running fit in the shaft with a clearance of 0.002- to 0.003-inch. Hand reaming will not be accurate and will cause a gear to run out.

b. Idler Gear Assembly.

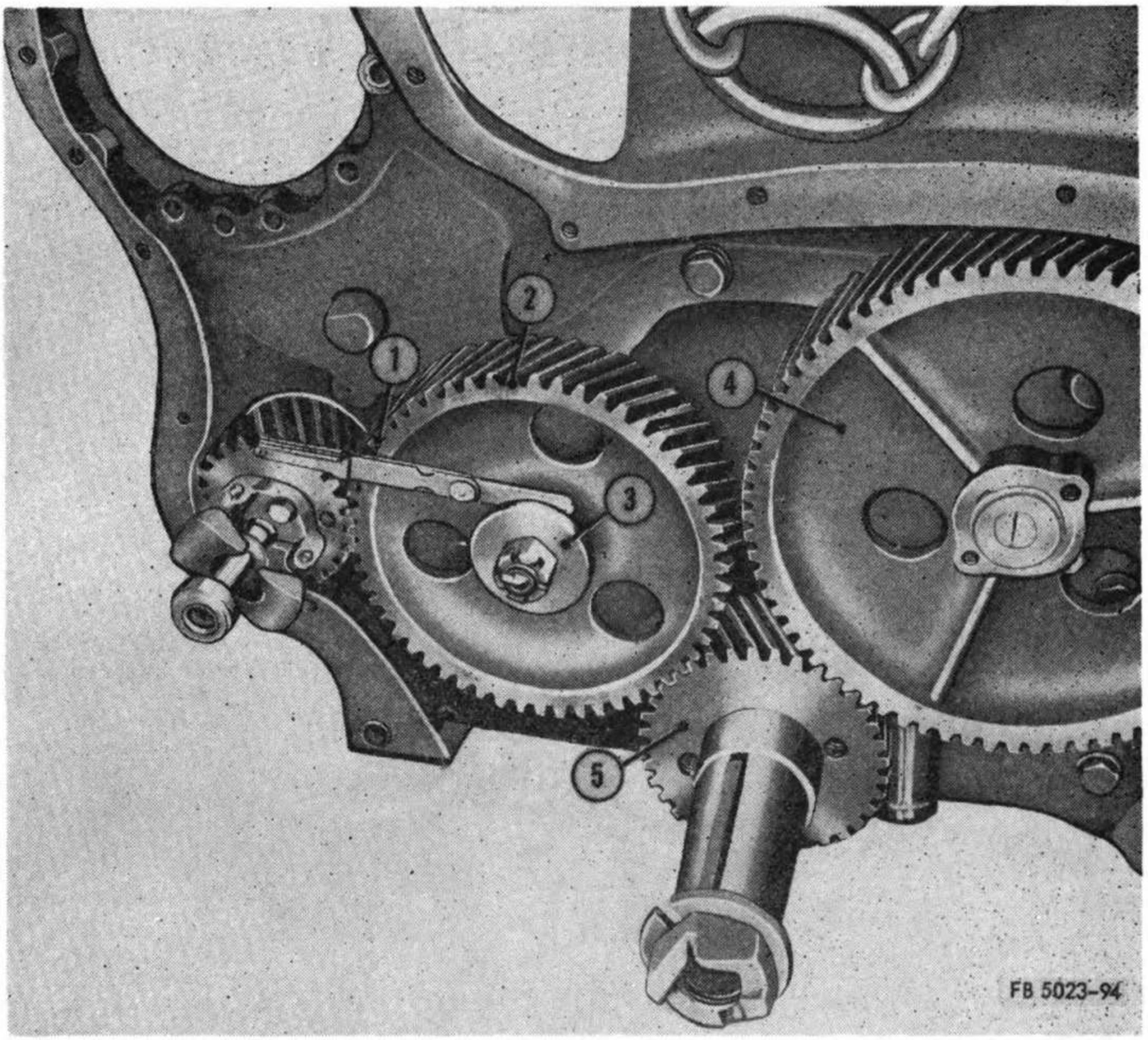
(1) *Removal.* Remove the cotter pin (11, fig. 92), nut (12), front thrust washer (14). Remove the nut, gasket, and lockscrew located in the cylinder block directly behind the housing (20) which secure the shaft (18) in the block. Pull out the shaft.



1	Supercharger drive shaft
2	Supercharger drive shaft bearing
3	Supercharger drive gear
4	Supercharger
5	Supercharger air outlet
6	Supercharger driven gear
7	Drilled head cap screw
8	Lockwire
9	Idler gear
10	Cap screw, ½ x 1¼ NC (8 rqr)
11	Lockwasher, ½ (8 rqr)
12	Camshaft gear
13	Accessory drive gear
14	Camshaft oil plug
15	Camshaft retainer ring
16	Crankshaft gear
17	Crankshaft
18	Slotted nut
19	Cotter pin, $\frac{3}{16}$ x 1½
20	Overspeed governor flyweight
21	Overspeed governor thrust bearing
22	Water pump gear
23	Cap screw, ¼ x 1½ NF (2 rqr)

Figure 93. Timing gear train, installed view.

(2) *Installation.* Position the shaft (18) in the cylinder block through the hole in the housing (20). Position so that the locking screw holes line up and install the lockscrew, gasket, and nut. Install the rear thrust washer (19) and mesh the gear (16) so that the timing marks are alined. Place the front thrust washer (14) on the shaft and secure with the nut (12) and cotter pin (11). Check for a correct backlash of 0.002 to 0.004 inch. If a new gear without timing marks is being installed, transfer the timing marks as outlined in (3) below.



1 Feeler gage
2 Idler gear
3 Front thrust washer
4 Camshaft gear
5 Crankshaft gear

Figure 94. Checking idler gear end thrust.

(3) *Transferring timing marks.* Lay the old idler gear (1, fig. 95) on the new idler gear (4), and use a small steel bar (2) to aline the keyways of the gears. Place a ruler (3) vertically against the gears and in line with the old timing marks, and indicate the point at which to punch the new mark.

c. Camshaft Gear.

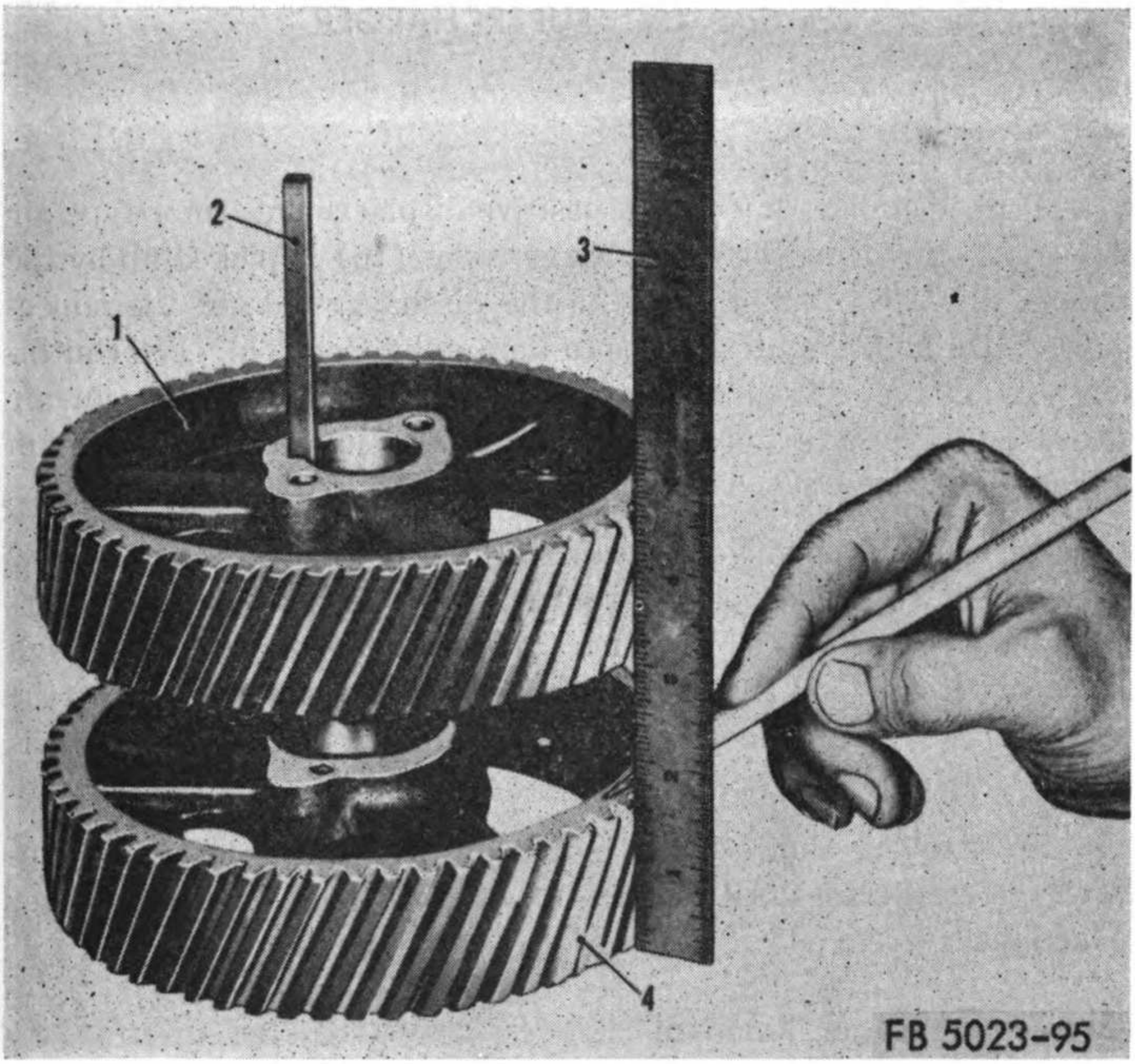
(1) *Removal.* Remove the camshaft (par. 181*a*) and retainer ring and press the camshaft out of the gear (12, fig. 93).

(2) *Installation.* If a new gear is being installed, tranfer the timing marks (*b*(3) above). Press the gear (12) on the camshaft. Check the end thrust (*a*(5) above). Install the retainer ring and the camshaft (par. 181*e*). Check for a correct backlash of 0.002 to 0.004 inch.

155. Timing Gear Housing

a. Removal.

(1) Remove the water pump (par. 82*b*), accessory drive (par.



1 Old idler gear
2 Steel bar
3 Ruler
4 New idler gear

Figure 95. Transferring timing marks.

126), timing gear cover (par. 153a), idler gear assembly (par. 154*b*(1)), supercharger (par. 157), and camshaft (par. 181*a*).

(2) Remove the housing cap screws (24, fig. 92) and lockwashers (23). Remove and discard the housing gasket (21). Remove the housing (20).

b. Installation.

(1) Install a new gasket (21) on the housing (20) and secure to the block with the housing cap screws (24) and lockwashers (23).

(2) Install the camshaft (par. 181*e*), supercharger (par. 162), idler gear assembly (par. 154*b*(2)), timing gear cover (par. 153*c*), accessory drive (par. 130), and water pump (par. 82*c*).

Section XIV. SUPERCHARGER

156. Description (fig. 96)

a. The supercharger (4) is a positive-displacement, rotor-type air blower. Air entering the supercharger inlet (16) is picked up by the lobes of the rotors and carried to the discharge side of the supercharger, through the intake pipe to the intake manifold. The continuous discharge of fresh air from the supercharger creates an air pressure of approximately 7 psi in the intake manifold at maximum engine speed.

b. An air shutter valve is located in the air inlet to stop the flow of air to the supercharger and thus stop the engine in case of overspeeding. The overspeed governor (10) actuates the valve through the control rod (15). In case the overspeed governor acts to stop the engine, the engine cannot be started until the valve lever (18) is reset.

c. Reset the air shutter valve by pushing the control lever (18) toward the crankcase until the tension of the spring (17) takes over to hold the lever.

157. Supercharger Removal

a. Remove the timing gear cover (par. 153*a*).

b. Loosen the clamp screws (21, fig. 42).

c. Remove the cap screws (15) and lockwashers from the discharge elbow (20) and remove the elbow.

d. Loosen the clamp screws and remove the air inlet hose (20, fig. 96).

e. Loosen the nut on the ball joint (7) stud next to the idler lever (25) and unscrew the ball joint stud from the lever.

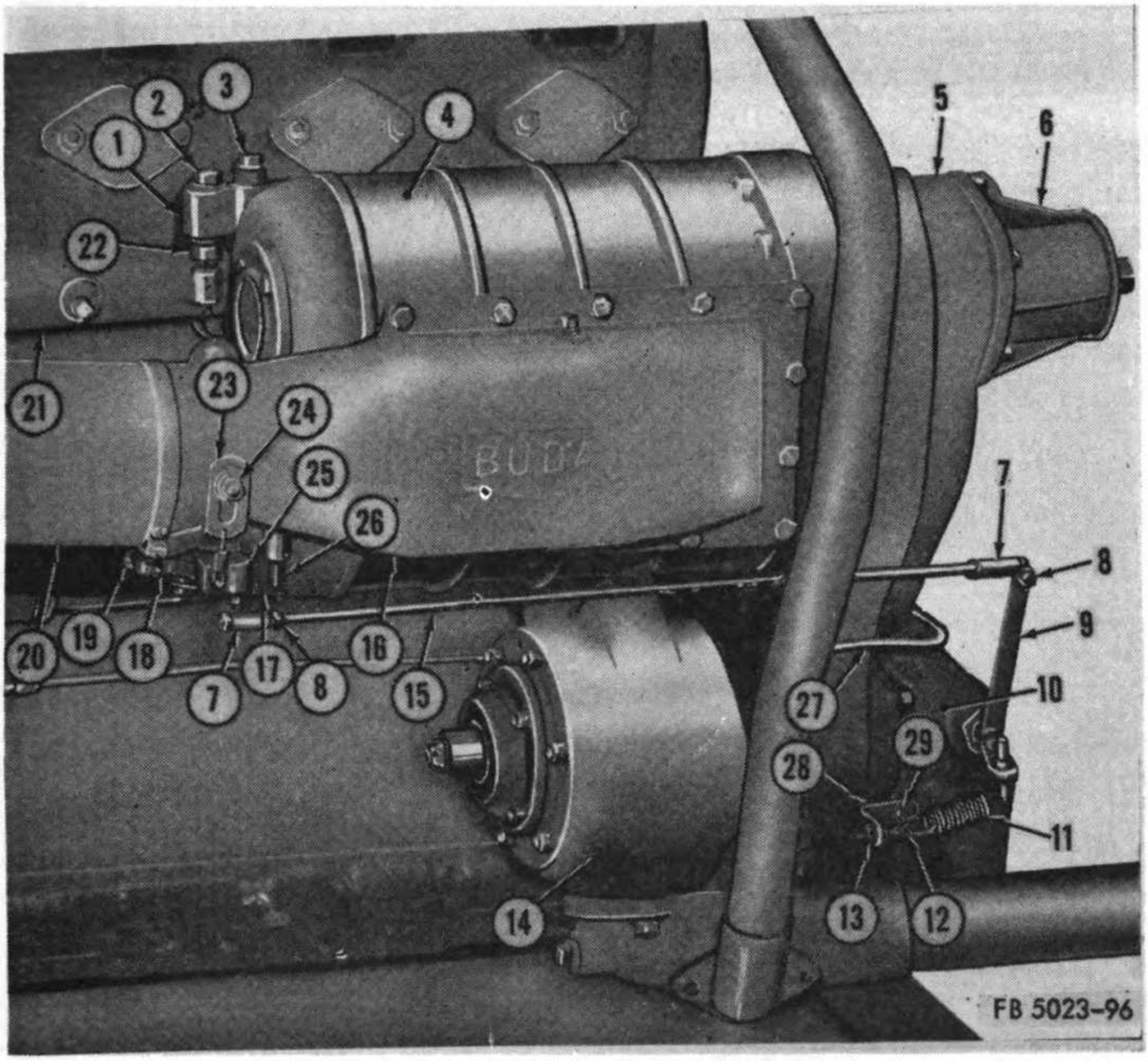
f. Attach a sling to the supercharger and pull it taut.

g. Remove the cap screw (2), nut (22), lockwasher, and flat washers, which attach the support bracket (1) to the water inlet manifold (21).

h. Cut the lockwires (8, fig. 93) and remove them.

i. Remove the four drilled-head cap screws (7).

j. Remove the supercharger (4) and mounting gasket from the timing gear housing.



1	Supercharger support bracket	16	Supercharger air inlet
2	Cap screw	17	Control lever spring
3	Cap screw	18	Air shutter valve control lever
4	Supercharger	19	Cap screw
5	Timing gear cover	20	Air cleaner hose
6	Supercharger drive shaft housing	21	Water inlet manifold
7	Ball joint	22	Nut, hex
8	Nut, hex, ¼ NC (4 rqr)	23	Spring anchor clip
9	Overspeed governor arm	24	Nut, hex, $\frac{5}{16}$ NC (1 rqr)
10	Overspeed governor	25	Idler lever
11	Governor spring	26	Spring anchor screw
12	Governor spring eyebolt	27	External oil line
13	Nut, hex, ⅜ NC (3 rqr)	28	Governor spring anchor
14	Water pump	29	Cap screw
15	Control rod		

Figure 96. Supercharger overspeed governor, installed view.

158. Supercharger Disassembly (fig. 97)

a. Remove the 12 cap screws (39) and lockwashers (5) from the air inlet (41). Remove the air inlet and gasket (37) from the housing (36).

b. Remove the cap screws (39 and 40) and lockwashers (5) from the air outlet (38). Remove the air outlet and gasket from the housing (36).

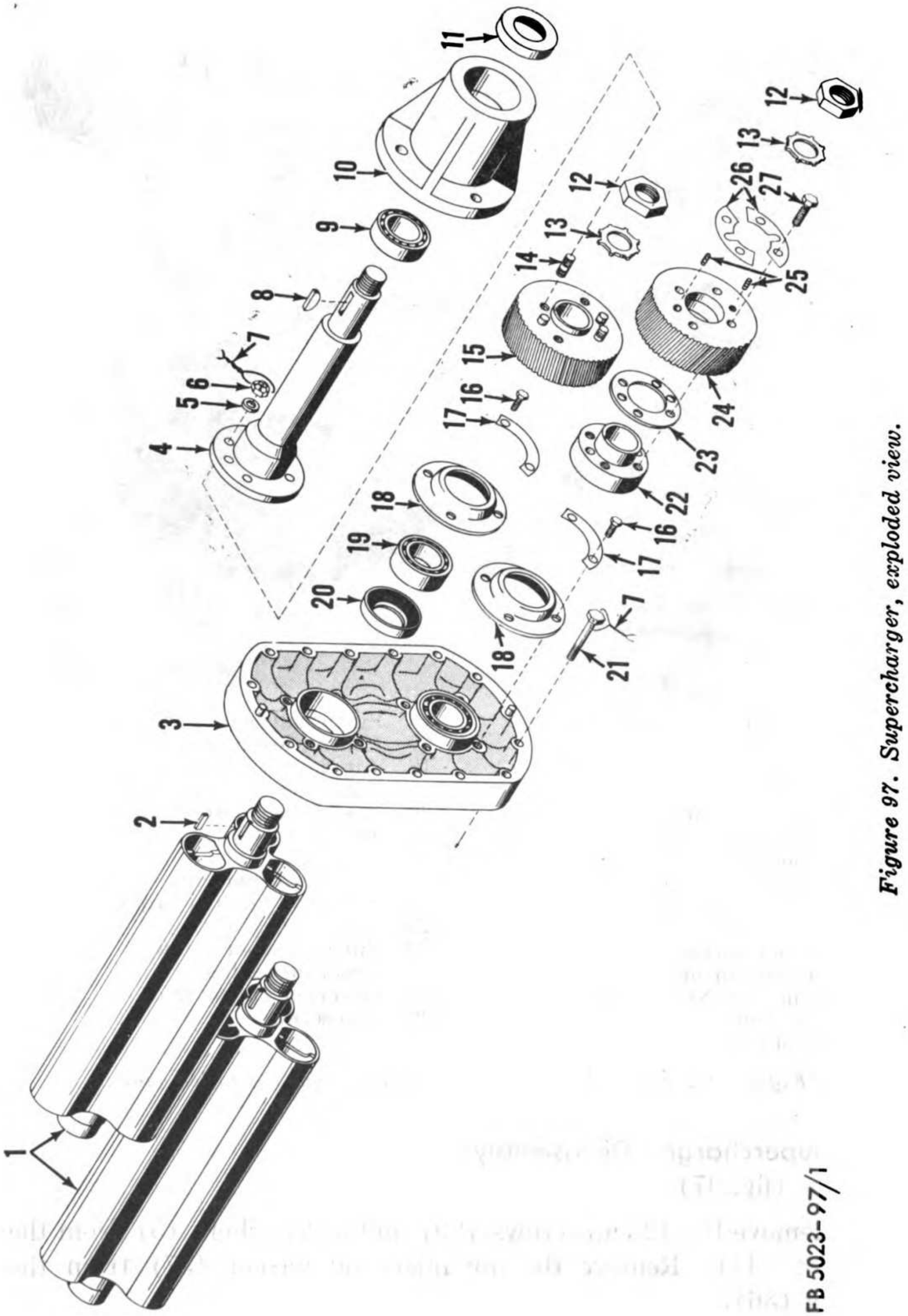


Figure 97. Supercharger, exploded view.

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1 Rotor
2 Rotor gear key
3 Gear end casting
4 Supercharger drive shaft
5 Lockwasher, ⅜ (30 rqr)
6 Nut, castle, ⅜ NF (4 rqr)
7 Lockwire
8 Key, woodruff, ¼ x 1⅛ (1 rqr)
9 Drive shaft bearing
10 Drive shaft bearing housing
11 Drive shaft oil seal
12 Rotor nut
13 Rotor nut lockwasher
14 Drive gear stud
15 Drive gear
16 Cap screw, ⅝ x ¾ NC (8 rqr)
17 Bearing cover lock plate
18 Bearing cover
19 Rotor ball bearing
20 Rotor shaft oil seal cup
21 Drilled head cap screw
22 Driven gear hub
23 Laminated shim
24 Driven gear
25 Dowel pin
26 Driven gear lock plate
27 Driven gear cap screw

Figure 97—Continued.

c. Cut the lockwire (7) from the nuts (6) and remove it.

d. Remove the four nuts (6) and lockwashers (5) from the drive gear studs (14) and remove the drive shaft (4) and bearing (9) from the gear. Pull the bearing from the shaft.

e. Straighten the tangs on the lockwasher (13) and remove the nuts (12) and lockwashers from the rotor (1) shafts.

f. Straighten the corners of the lock plates (26) and remove the four cap screws (27). Remove the gear (24) and shims (23) from the hub (22). Mark the dowel pins (25) so that they can be installed in their original positions because they are selective fits and cannot be interchanged.

g. Pull the drive gear (15) and the hub (22) from the rotor shafts. Remove the keys (2).

h. Remove the four cap screws (28) and lockwashers (29) from each bearing cap (30) and remove the caps and gaskets (31).

i. Remove the end cover (32).

j. Remove the 16 cap screws (58) and lockwashers (29) from the closed end casting (35) and remove the casting.

k. Remove the bearings (33) and seals (34) from the casting.

l. Remove the gear end casting (3) and rotors (1) as an assembly from the housing (36).

m. Remove the rotors from the casting (3) by tapping the threaded ends of the rotors with a rawhide hammer.

n. Straighten the corners of the lock plates (17) and remove the four cap screws (16) and plates from each bearing cover (18). Remove the covers.

28 Cap screw, $\frac{5}{16}$ x $\frac{5}{8}$ NC (8 rqr)
29 Lockwasher, $\frac{5}{16}$ (23 rqr)
30 Closed end bearing cap
31 Bearing cap gasket
32 End cover
33 Rotor roller bearing
34 Felt oil seal
35 Closed end casting
36 Supercharger housing
37 Housing gasket
38 Air outlet
39 Cap screw, $\frac{3}{8}$ x 1 NC (24 rqr)
40 Special cap screw (2 rqr)
41 Air inlet
42 Spring anchor screw
43 Cap screw, $\frac{5}{16}$ x 1½ NC (2 rqr)
44 Nut, hex, $\frac{5}{16}$ NC (3 rqr)
45 Control lever spring
46 Pin
47 Control lever
48 Idler lever
49 Idler lever spring
50 Valve shaft washer
51 Air shutter valve shaft
52 Anchor screw
53 Anchor clip
54 Washer, flat, $\frac{5}{16}$ (1 rqr)
55 Screw, rd hd #10 x ¾ NC (2 rqr)
56 Lockwasher, #10 (2 rqr)
57 Air shutter valve
58 Cap screw, $\frac{5}{16}$ x 1 NC (14 rqr)

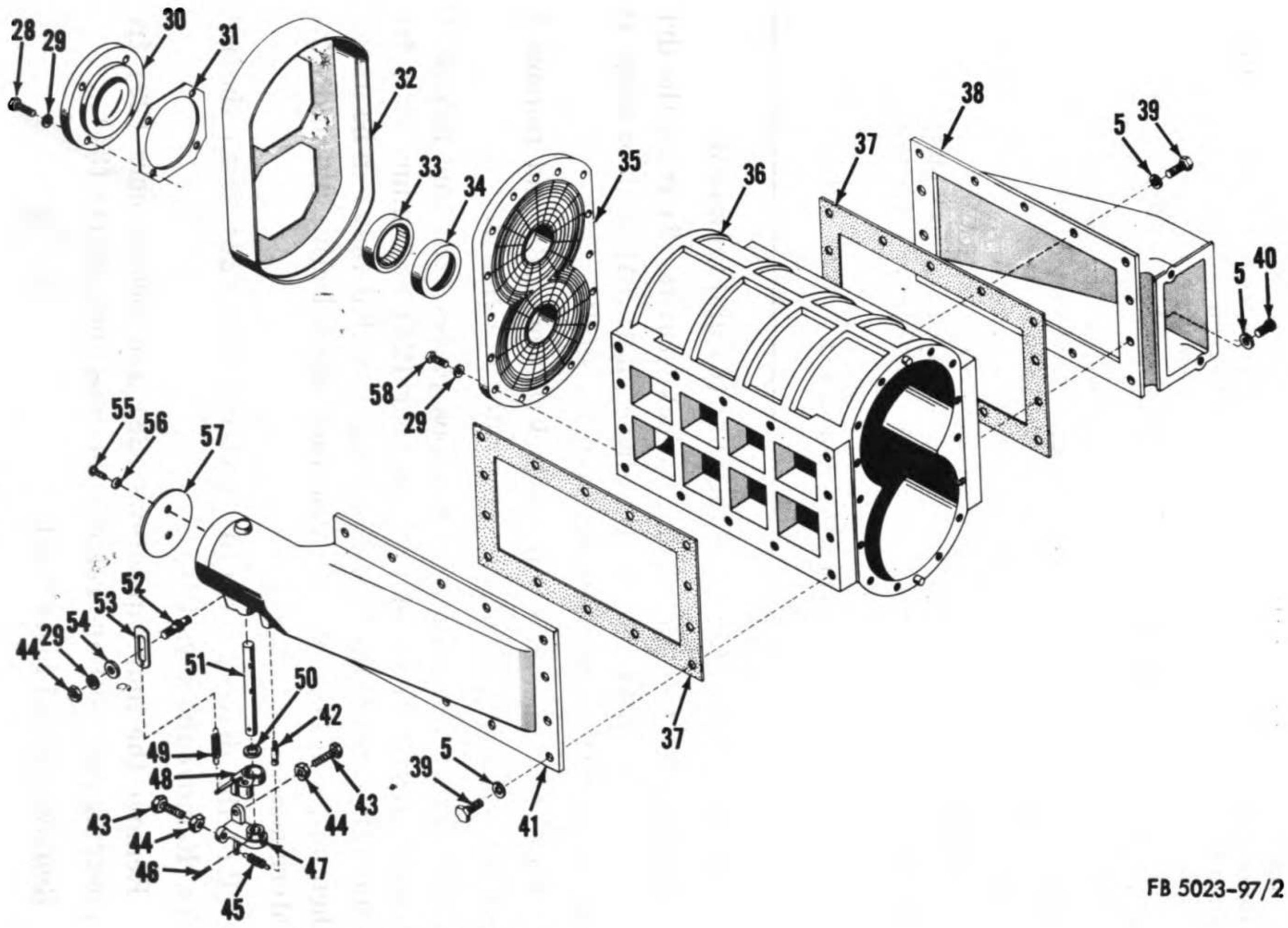


Figure 97—Continued.

o. Remove the bearings (19) and seal cups (20) from the end casting (3).

p. Remove the seal (11) from the drive shaft bearing housing (10).

q. Unhook and remove the springs (45 and 49).

r. Remove the screws (55) and lockwashers (56) from the valve (57) and shaft (51). Remove the valve and shaft from the air inlet.

s. Drive out the pin (46) and remove the control lever (47), idler lever (48), and washers (50) from the shaft.

t. Remove the nut (44), lockwasher (29), flat washer (54), and spring anchor clip (53) from the anchor screw (52). Remove the anchor screws (42) and (52).

159. Supercharger Cleaning, Inspection, and Repair

a. Replace all seals (11, 20, and 34) and gaskets (31 and 37).

b. Wash all other parts in cleaning solvent. Dry thoroughly with compressed air.

Warning: Do not allow the bearings to spin when drying with compressed air. Do not spin a dry bearing.

c. Lubricate the bearings (9, 19, and 33) with a few drops of OE 10.

d. Inspect the bearings for rough spots, damaged rollers, and loose races. Replace defective bearings.

e. Inspect the gears (15 and 24) for cracked, chipped, broken, and worn teeth. If either gear is defective, both must be replaced. The replacement gear set includes the gears (15 and 24), full laminated shim (23) and hub (22).

f. Inspect the housing (36) for cracks, breaks, stripped threads, and burs, in the rotor tunnel. If burs are present, remove them with 2/0 sandpaper. Replace the housing if otherwise damaged.

g. Inspect the rotors (1) for cracks, breaks, stripped threads, burs, and loose shaft. If any damage other than burs is evident, replace the rotor. Remove burs with 2/0 sandpaper. Replace the rotor if the bearing surfaces are scored or rough.

h. Inspect the closed end casting (35), gear end casting (3), and bearing caps (18 and 30). If any cracks, breaks, scoring, or stripped threads is evident, replace the defective part.

i. Inspect the air outlet (38) and inlet (41) for cracks, breaks, and stripped threads. Replace the defective part if any are found.

j. Inspect the springs (45 and 49) for breaks and distortion. In-

sert the valve shaft (51) in the air inlet (41) and check for wear at the bearing surfaces. Inspect the valve (57), levers (47 and 48), and anchor screws (42 and 52) for cracks, breaks, wear, or damage. Replace all defective parts.

160. Supercharger Reassembly (fig. 97)

When new gears, rotors, bearings, or gear end casting are used, the supercharger rotors must be retimed. If new parts are used, refer to paragraph 161 for rotor timing instructions. Timing must be done before the air inlet (41) and air outlet (38) are installed.

a. Lubricate the seal cups (20) thoroughly with OE 10 and install them in the gear end casting (3). Install the bearings (19) in the casting so that the stamped lettering on the bearing races faces the gear side of the casting.

b. Install the bearing covers (18) and lock plates (17) over the bearings (19). Secure each cover with four cap screws. Bend the corners of the lock plates to lock the screws.

c. Fasten the assembled gear end casting (3) to the housing (36) with a few cap screws. This is done, temporarily, to make reassembly easier.

d. Install the rotors (1) in the housing and through the end casting so that the open side of the keyways or both rotor shafts are facing in the same direction.

e. Lubricate the seals (34) thoroughly with OE 10 and install them in the closed end casting (35). Install the bearings (33) in the casting.

f. Install the closed end casting on the housing (36) so that the rotor shafts seat in the bearings. Secure the casting to the housing with 16 cap screws (58) and lockwashers (29).

g. Install the end cover (32) over the end casting. Lubricate bearings and install the bearing caps as instructed in paragraph 31*g* (2).

h. Install the keys (2) in the rotor shafts. Check the position of the rotors (*d* above).

i. Facing the gear end casting of the supercharger, with the inlet opening on the left side, install the drive gear (15) on the upper rotor (1) shaft so that it seats against the bearing (19) inner race. Install the lockwasher (13) and secure with a nut (12). Bend the tangs on the lockwasher to lock the nut.

j. Install the hub (22) on the lower rotor shaft so that it seats

against the bearing (19) inner race. Install the lockwasher (13) and nut (12), on the rotor shaft. Tighten the nut and bend the tangs on on the lockwasher to lock the nut.

k. Install the laminated shim (23) on the hub. Install the driven gear (24) against the shim and install the dowel pins (25) in the gear. The dowel pins must not be forced in. They are hand-press fits. If the dowel pins will not go into place, remove the drive gear and reduce the shim thickness until the holes in the gear and hub are alined.

l. Install the lock plates (26) over the dowel pins and secure the gear to the hub with four cap screws (27). Bend the corners of the plates to lock the cap screws.

m. Check the rotor timing and gear backlash (par. 161).

n. Install the bearing (9) on the drive shaft (4). Install the drive shaft on the drive gear studs (14). Secure with lockwashers (5), nuts (6), and lockwire (7).

o. Lubricate the seal (11) thoroughly with OE 10 and install it in the drive shaft housing (10).

p. Install the air outlet (38) and gasket (37) on the housing (36). Secure with cap screws (39) and (40) and lockwashers (5).

q. Install the flat washer (50) on the drilled end of the valve shaft (51), followed by the idler lever (48) and control lever (47). Secure the control lever to the shaft with a pin (46).

r. Install the shaft in the air inlet (41) and install the valve (57) on the shaft with two screws (55) and lockwashers (56).

s. Install the spring anchor screws (42) and (52) in the air inlet. Install the anchor clip (53) on the screw (52) and secure with a flat washer (54), lockwasher (29), and nut (44).

t. Install the spring (49) between the clip (53) and idler lever (48). Install the spring (45) between the screw (42) and control lever (47).

u. Install the air inlet (41) and gasket (37) on the housing. Secure with 12 cap screws (39) and lockwashers (5).

v. Remove the cap screws which were temporarily installed (*c* above) in the gear end casting.

161. Supercharger Checking and Adjusting

a. Gear Backlash.

(1) Check the backlash of the supercharger gears with feeler stock.

(2) The desired backlash is between 0.0005 and 0.0002 inch.

(3) The maximum permissible backlash is 0.0035 inch.
(4) If the backlash is not within the proper range, replace both gears and retime the rotors.

b. Rotor Timing.

(1) Check the rolling clearance between the rotors with 0.006 inch feeler stock.
(2) Place feelers between the lobes of the rotors and turn the rotors toward the mesh at the center to find the closest point.
(3) Repeat the clearance check on the opposite side of the rotor lobes.
(4) The two sets of clearance readings should be approximately equal when the rotors are properly timed. The desired clearance is 0.005- to 0.007-inch. The maximum permissible clearance is 0.011-inch.
(5) If the rotor clearance is not within the proper range, check the gear backlash (*a* above). If the gear backlash is satisfactory, retime the rotors as follows:
(*a*) Remove the drive gear and shims (par. 158*f*).
(*b*) Remove one lamination from the shim (23, fig. 97) for each 0.0015-inch change in rotor clearance desired.
(*c*) Install the shims and drive gear (par. 160*k*) after each change in shim thickness and recheck the timing ((1–4) above).
(*d*) Repeat adjustment and check ((*a*–*c*) above) until the clearance is satisfactory.

162. Supercharger Installation

a. Attach a sling to the supercharger. Use a new gasket against gear end casting and lift the supercharger in position against the timing gear housing.

b. Place the support bracket (1, fig. 96) on the lug of the water inlet manifold (21) and install the cap screw (2), flat washers, lockwashers, and nuts (22). Do not tighten.

c. Install the four drill-head cap screws (7, fig. 93) and tighten securely. Install new lockwires (8) in the cap screws.

d. Tighten the support bracket cap screw (3, fig. 96) and nut (22) securely.

e. Remove the sling.

f. Screw the ball joint (7) end into the idler lever (25). Secure the ball joint end to the lever with a nut (8).

g. Install the air inlet hose (20) and tighten the hose clamps securely.

h. Insert the hose end of the discharge elbow (20, fig. 42) in the hose (22).

i. Use a new gasket and install the discharge elbow (20) on the supercharger air outlet using lockwashers and cap screws (15).

j. Check the air shutter valve adjustment (par. 163).

k. Center the hose (22) over the gap between the pipe (1) and elbow (20). Tighten the clamp screws (2) securely.

l. Install the timing gear cover (par. 153*c*).

163. Supercharger Air Shutter Valve Adjustment

a. Reset the air shutter valve (par. 156*c*).

b. Remove the air cleaner hose (20, fig. 96).

c. Look into the air inlet (16) opening and check the position of the valve.

d. If the valve is not in the fully-open position, loosen the nut (24) on the cap screw (19) in the top lug of the control lever (18). Turn the screw in or out until the valve is in the proper position. Tighten the nut.

e. Trip the shutter valve and check the position of the valve.

f. If the valve is not in the fully-closed position, loosen the nut on the cap screw (19) in the end of the control lever (18). Turn the screw in or out until the valve is in the proper position. Tighten the nut.

g. Install the air cleaner hose (20).

Section XV. WATER INLET MANIFOLD

164. Description

The water inlet manifold (1, fig. 48) is mounted on the right side of the cylinder block. It serves as a distributing chamber for coolant pumped to the various passages in the block. A lug is provided on the front section of the manifold to attach the mounting bracket of the supercharger.

165. Water Inlet Manifold Removal

a. Remove the supercharger (par. 157).

b. Remove the oil cooler and bypass assembly (par. 94*b*).

c. Remove the twelve cap screws (14, fig. 48) and lockwashers securing the water inlet manifold (1) to the cylinder block. Remove and discard the manifold gaskets.

166. Water Inlet Manifold Inspection and Cleaning

a. Check the manifold (1, fig. 48) for cracks or breaks. Replace a defective manifold.

b. Clean out scale or deposits from inside the manifold with a cleaning solvent.

c. Clean the mating surafces of the manifold and cylinder block.

167. Water Inlet Manifold Installation

a. Secure the water inlet manifold (1, fig. 48) to the cylinder block with the twelve cap screws (14) and lockwashers. Use new manifold gaskets.

b. Install the oil cooler and bypass assembly (par. 94*d*) and install the supercharger (par. 162).

Section XVI. OVERSPEED GOVERNOR

168. Description

a. The overspeed governor (10, fig. 96) is a flyweight-type, centrifugal governor whose function is to stop the engine in case of overspeeding. The governor main shaft is driven by, and attached to, the water pump gear inside the timing gear cover. The governor housing is attached to the front of the timing gear cover (5).

b. Refer to paragraph 156*b* and *c* for further details relative to the overspeed governor operation.

169. Overspeed Governor Disassembly

a. Remove the overspeed governor housing (par. 153*a*(6–9)) and control rod (par. 157*e*).

b. Remove the two cap screws (23, fig. 93) and lockwashers securing the governor main shaft assembly to the water pump gear (22). Remove the assembled main shaft.

c. Remove the spring (8, fig. 98) from the eyebolts (9).

d. Remove the nuts (12) from the eyebolt (9) and remove the eyebolts from the arm (4) and anchor (13).

e. Remove the cap screws (17) and lockwashers (5) from the yoke (16) and rocker shaft (7). Remove the yoke.

f. Use a small drift to drive the pin (6) from the arm (4) and rocker shaft (7). Remove the arm.

g. Remove the clip (28) from the shaft at the arm end of the shaft.

h. Use a rawhide mallet and drive the shaft through the housing (15) to knock out the expansion plug (27).

1 Control rod ball joint
2 Nut, hex ¼ NC (4 rqr)
3 Control rod
4 Overspeed governor arm
5 Lockwasher ¼ (6 rqr)
6 Pin
7 Rocker shaft
8 Spring
9 Spring eyebolt
10 Cap screw ⅜ x ¾ NC (2 rqr)
11 Lockwasher ⅜ (5 rqr)
12 Nut, hex ⅜ NC (3 rqr)
13 Spring anchor
14 Rocker shaft ball bearing
15 Overspeed governor housing
16 Yoke
17 Cap screw ¼ x ¾ NC (2 rqr)
18 Thrust bearing
19 Thrust sleeve
20 Flyweight
21 Weight pin clip
22 Weight pin
23 Main shaft
24 Thrust bearing and sleeve
25 Cap screw, ¼ x 1½ NF (2 rqr)
26 Elbow
27 Expansion plug
28 Rocker shaft clip
29 Cap screw ⅜ x 1¼ NC (3 rqr)

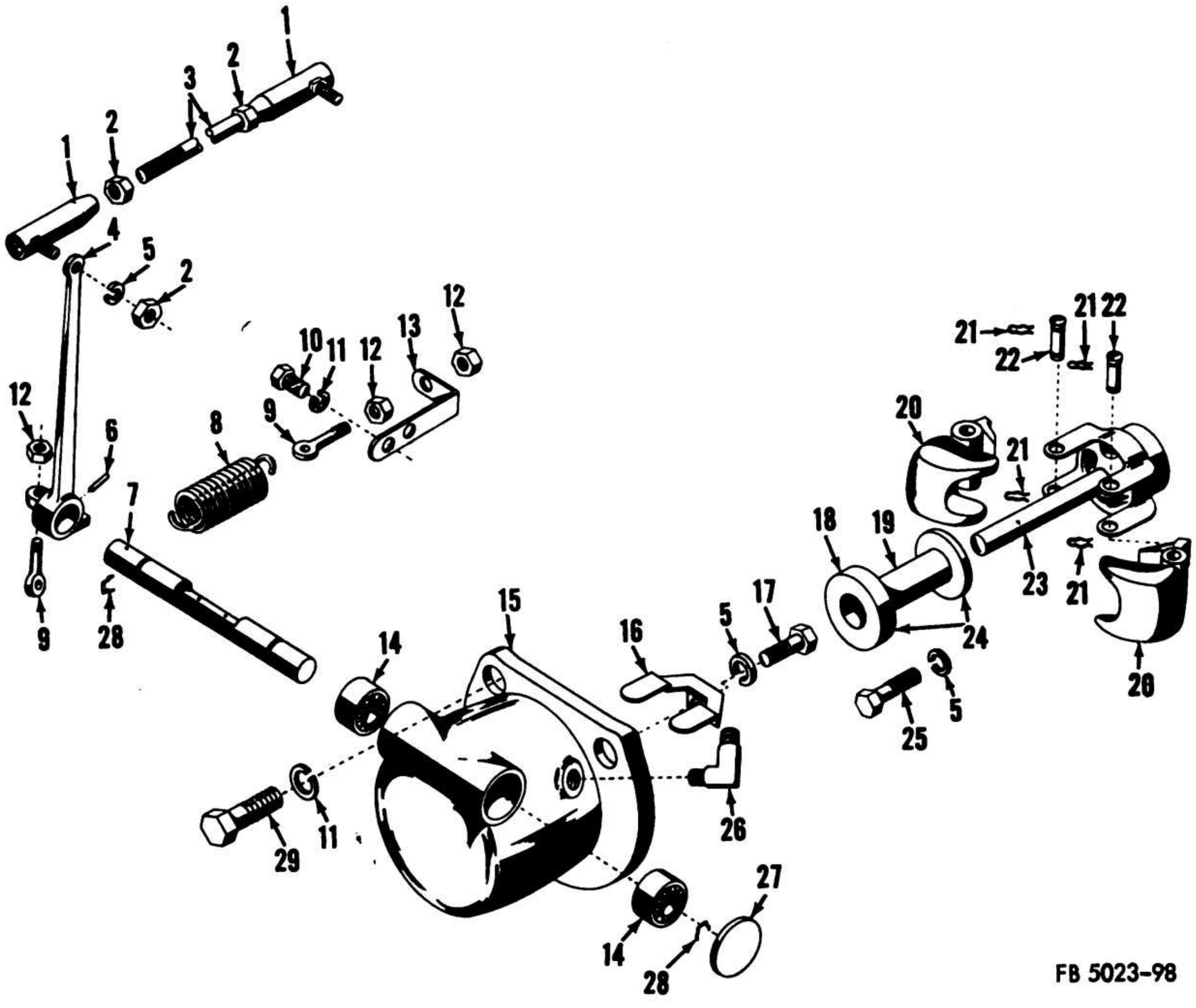


Figure 98. Overspeed governor, exploded view.

i. Remove the shaft (7) from the housing (15) and remove the other clip (28) from the shaft.

j. Remove the bearings (14) from the housing (15).

k. Slide the thrust bearing and sleeve (24) from the main shaft (23).

l. Remove the clips (21) from the weight pins (22).

m. Remove the weight pins and separate the flyweights (20) from the main shaft (23).

170. Overspeed Governor Cleaning and Inspection (fig. 98)

a. Replace the pin (6), and expansion plug (27).

b. Wash all other parts in cleaning solvent and dry thoroughly, with compressed air.

Warning: Do not allow the bearings to spin when drying with compressed air. Do not spin a dry bearing.

c. Lubricate the bearings (14 and 18) with a few drops of OE 10.

d. Inspect the bearings (14 and 18) for rough spots, loose races, and binding. Replace the bearings (14) if they are defective. If the thrust bearings (18) is defective, replace it and the thrust sleeve (24) as an assembly.

e. Inspect the housing (15) for cracks, breaks, and distortion. Replace if defective. If the oil line elbow is broken, cracked, distorted, or has stripped threads, remove it and install a new one.

f. Inspect the rocker shaft (7) and arm (4) for bends, breaks, and stripped threads. Replace if defective.

g. Inspect the ball joints (1) and control rod (3) for cracks, bends, breaks, and loose or stripped ball joint studs. If either ball joint or the rod is defective, replace the defective part as follows:

(1) Measure the distance between the centers of the ball joint stud socket.

(2) Loosen the nuts (2) locking the ball joints (1) on the rod (3).

(3) Unscrew the ball joints from the rod. Remove the nuts.

(4) Install the nuts (2) on the rod (3) and screw the ball joints (1) on the rod.

(5) Turn the ball joints on the control rod until the distance between the stud socket centers ((1) above) is correct and the studs face in the same direction. Tighten the nuts (2) against the ball joints.

h. Inspect the eyebolts (9) for bends, breaks, stripped threads, and wear in the eyes. Replace if defective.

i. Inspect the spring (8) for cracks, breaks, or distortion. Replace if defective.

j. Inspect the yoke (16) for wear, cracks, breaks, and distortion. Replace if defective.

k. Inspect the thrust sleeve (19) for wear on the flanged end and inside. Slip the sleeve on the main shaft (23) to check the inside fit. If the sleeve binds or is too loose, replace the sleeve, shaft, or both sleeve and shaft as necessary to obtain proper fit.

l. Insert the weight pins (22) in the weights (20) and mainshaft (23) to check for wear. Replace all worn, broken, or distorted parts.

m. If any of the clips (21 and 28) are broken, or distorted, replace them.

n. Replace all cap screws and lockwashers which are defective.

171. Overspeed Governor Reassembly

a. Install the flyweights (20, fig. 98) on the main shaft (23). Secure with weight pins (22) and clips (21).

b. Install the thrust bearing and sleeve (24) on the main shaft with the flanged end of the sleeve toward the weights.

c. Install the bearings (14) in the housing (15) with the shielded side of the bearings toward the outside of the housing.

d. Place a clip (28) in the groove of the rocker shaft (7) nearest the drilled end.

e. Install the opposite end of the shaft through the bearings (14) from the arm (4) side of the housing.

f. Install the other clip (28) in the groove of the shaft (7) where it protrudes through the bearing. Install the expansion plug (27).

g. Install the yoke (16) on the shaft so that the forks of the yoke will be up. Secure with cap screws (17) and lockwashers (5).

h. Install the arm (4) on the shaft so that the long part of the arm will face in the same direction as the forks of the yoke. Aline the holes and secure the arm with a pin (6). Peen the ends of the pin.

i. Screw the eyebolt (9) in the arm (4) from the bottom side. Install a nut (12) on the eyebolt and tighten against the arm.

j. Install a nut (12) on the other eyebolt (9) and install the eyebolt in the spring anchor (13). Install another nut on the eyebolt and tighten against the anchor.

k. Hook the spring (8) between the eyebolts (9).

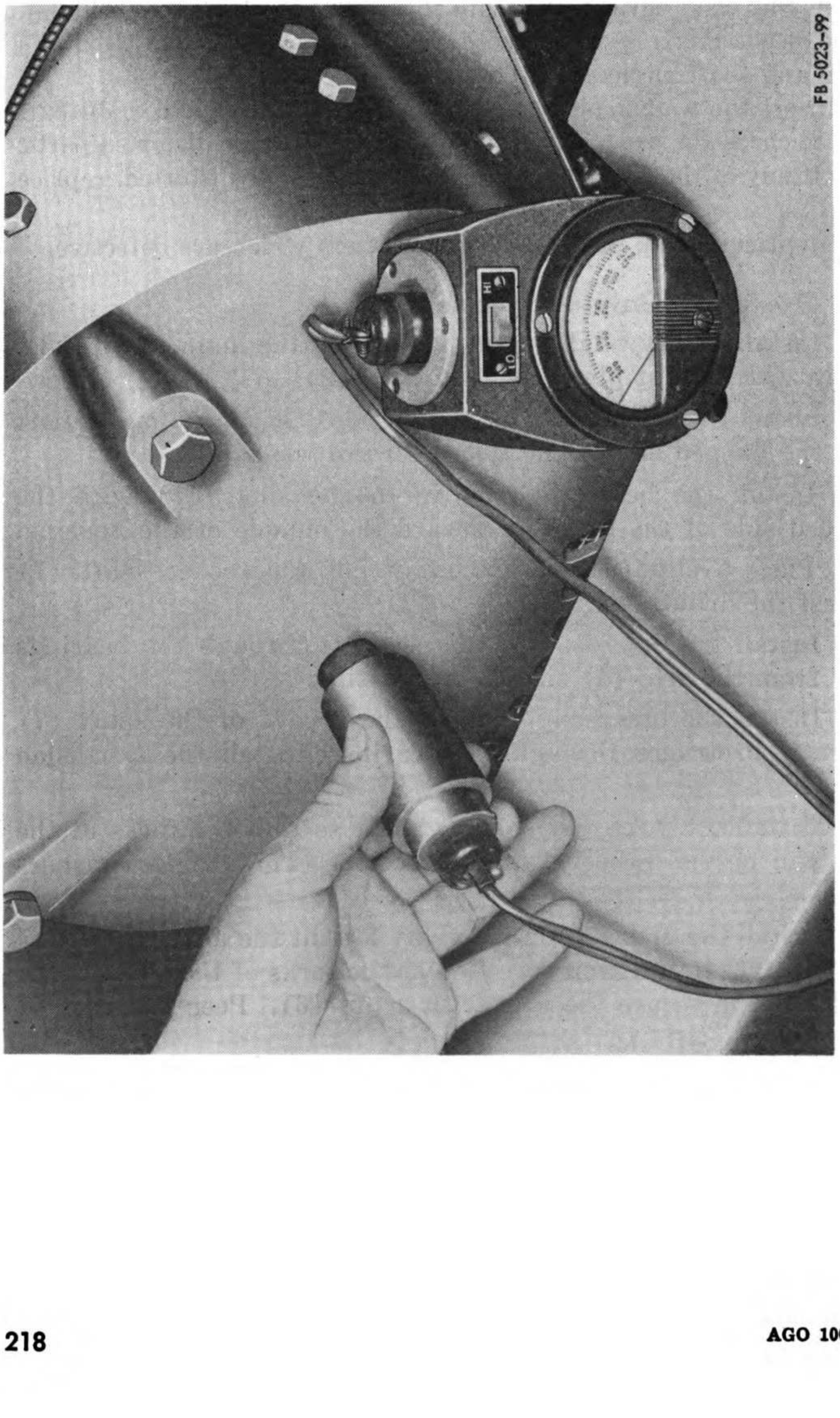


Figure 99. Checking engine speed with tachometer.

l. Install the assembled main shaft on the water pump gear (22, fig. 93) and secure with two cap screws (23) and lockwashers.

m. Install the assembled overspeed governor housing (par. 153*c*(6–10)) and control rod (par. 162*f*).

n. Adjust the overspeed governor (par. 172).

172. Overspeed Governor Adjustment

The overspeed governor must be adjusted to stop the engine between 1,750 and 1,800 rpm.

a. Start the engine (par. 15*c*) and set the throttle to give a 62-cycle reading on the frequency meter.

b. Remove the plug from the exciter end bell cover and insert the drive end of a tachometer against the rotor shaft as shown in figure 99.

c. Watch the tachometer and increase the engine speed until the engine stops, but do not exceed 1,800 rpm.

d. If the engine stops between 1,750 and 1,800 rpm, the overspeed governor adjustment is correct.

e. If the governor does not stop the engine, adjust the governor as follows:

(1) Set the engine speed at 1,800 rpm (*c* above).

(2) Loosen the nut (13, fig. 96) next to the eye end of the eyebolt (12) and tighten the other nut to increase the spring (11) tension until the engine stops. Tighten the loose nut against the anchor brackets.

f. Remove the tachometer and install the plug in the exciter end bell cover.

g. Reset the air shutter valve (par. 156*c*).

Section XVII. CONNECTING RODS, PISTONS, AND CYLINDER SLEEVES

173. General

The connecting rods (8, fig. 100) and caps (7) are matched pairs and cannot be interchanged. The bearings (5) are of the precision type and require no shims or scraping. The aluminum alloy pistons (2) have five rings (1); the upper three rings are compression rings, and the lower two rings are oil control rings. The top of the piston is very thick in order to uniformly transfer heat to the rings and piston skirt. The rod and piston are removed from the block as a unit. The removable, wet type cylinder

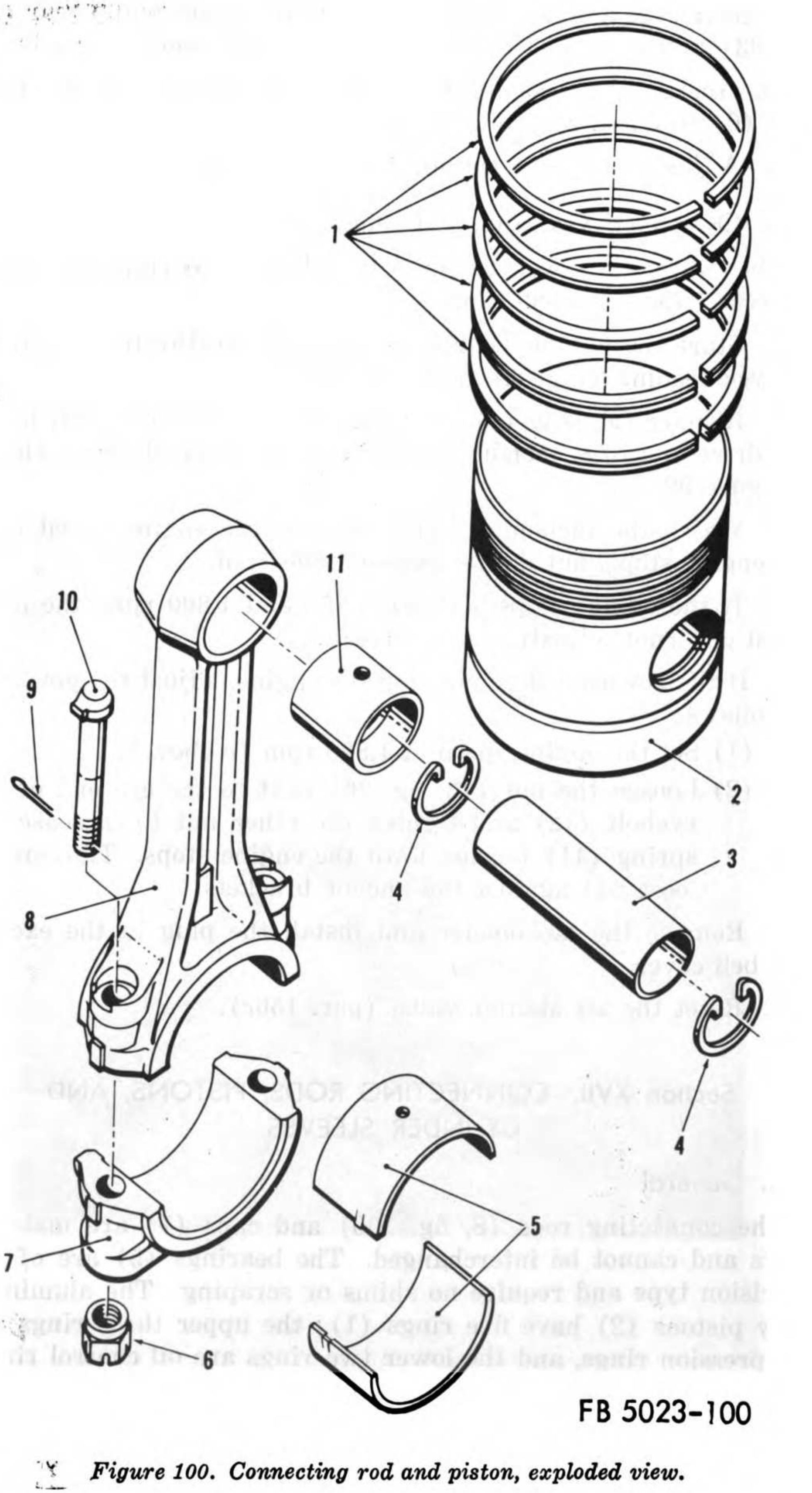


Figure 100. Connecting rod and piston, exploded view.

1 Piston ring set
2 Piston
3 Piston pin
4 Pin retainer
5 Connecting rod bearing
6 Slotted nut (16 rqr)
7 Rod cap
8 Connecting rod
9 Pin, cotter, ⅛ x 1¼ (16 rqr)
10 Connecting rod bolt
11 Connecting rod bushing

Figure 100—Continued.

sleeves (10, fig. 101) are made of alloyed cast iron. Two packing rings (11) fitting into grooves in the lower outside end 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 block (8).

174. Connecting Rods and Pistons

a. Removal.

(1) Remove the engine (par. 136*a*).

(2) Remove the cylinder heads (par. 98*a*) and the oil pan (par. 149*b*).

(3) Clamp or bolt a piece of 2 x 4 lumber on the block to hold the cylinder sleeves in place.

(4) Rotate the crankshaft (2, fig. 89) until two of the pistons are at bottom dead center. Remove the cotter pins, nuts (5), caps (4), and lower halves of the bearings.

(5) Remove the piece of 2 x 4 and position a ring ridge cutting tool (2, fig. 102) in the cylinder sleeve (3). Expand the cutting blades and rotate the tool with a socket wrench (1) to remove the carbon and ring ridge. Remove the tool and clean out all carbon and metal chips.

(6) Wrap or tape the ends of the connecting rods, and push the rod and piston assemblies out through the cylinders.

(7) Repeat the above steps for the remaining rod and piston assemblies.

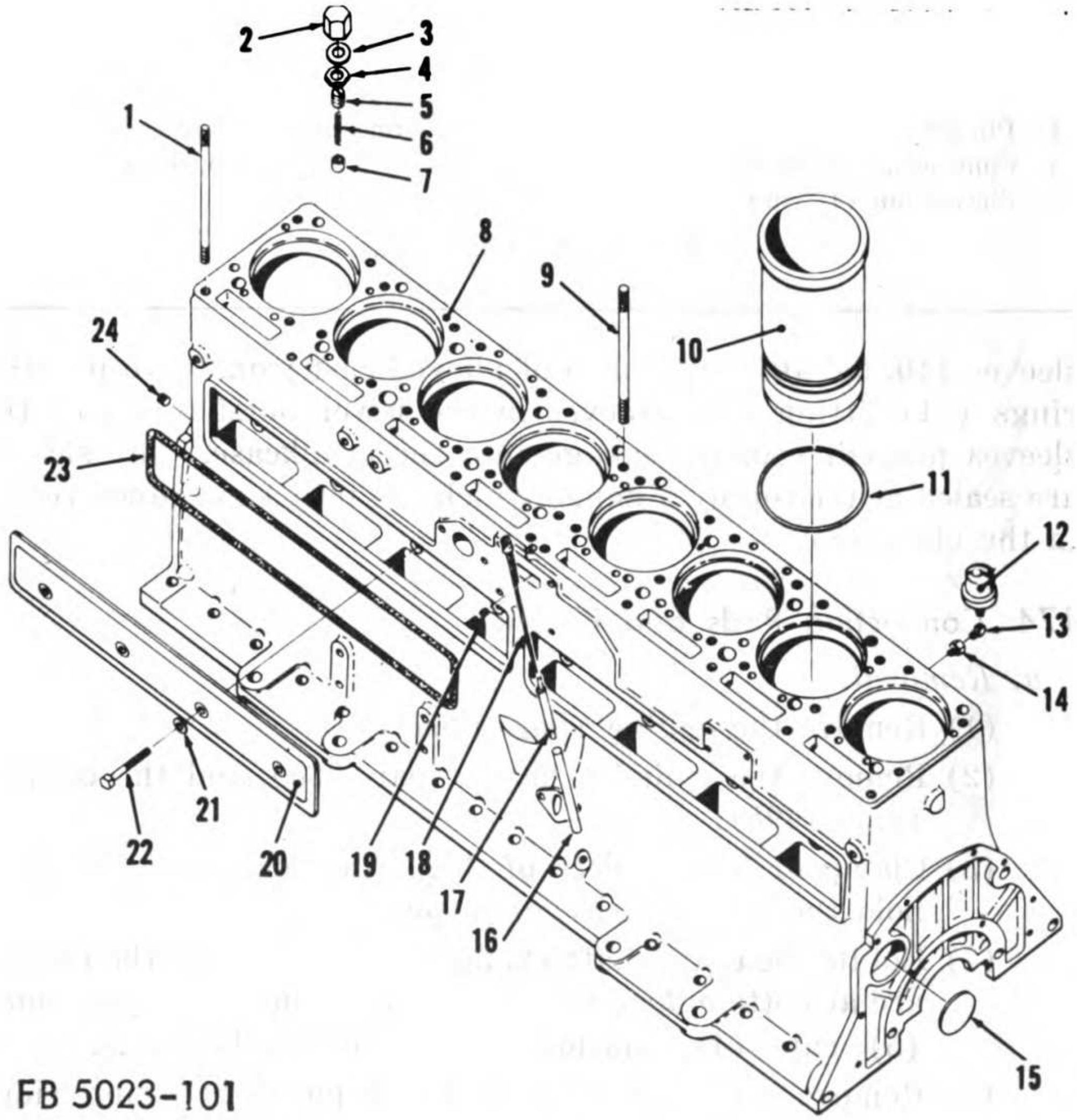
b. Disassembly.

(1) Remove the rings (1, fig. 103) with a ring expander (2).

(2) Remove the upper half of the bearings (5, fig. 100) and the bolts (10).

(3) Match mark each piston and rod assembly so that the pistons and connecting rods can be reassembled as originally matched.

(4) Remove the retainers (3, fig. 104) and push out the piston pin (2).



FB 5023-101

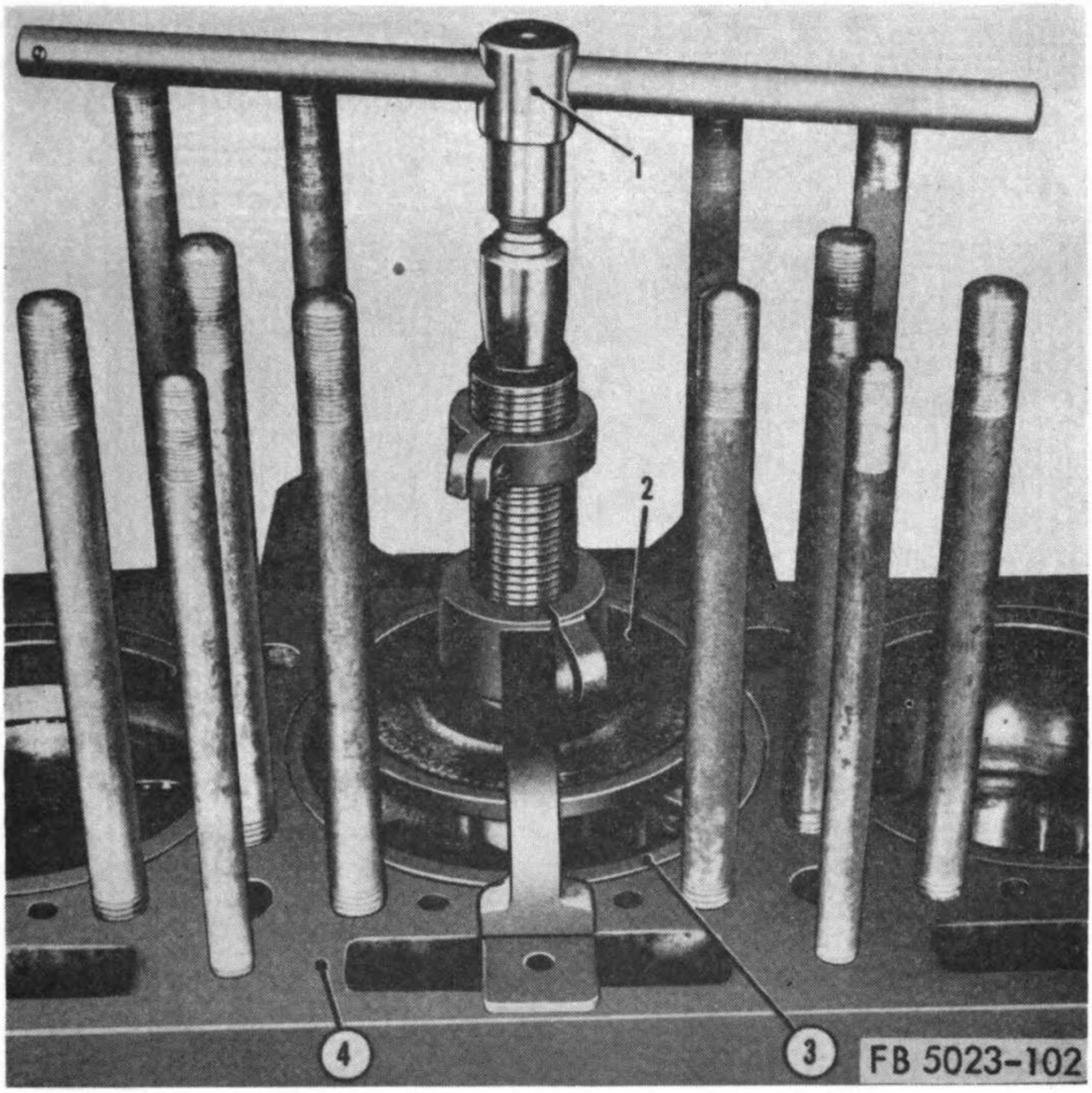
1 Cylinder head stud
2 Cap nut (1 rqr)
3 Cap nut gasket
4 Nut, hex, ¾ NF (1 rqr)
5 Regulator screw
6 Valve piston spring
7 Relief valve piston
8 Cylinder block and crankcase assembly
9 Cylinder head stud
10 Cylinder sleeve
11 Packing ring
12 Oil pressure sending unit
13 Street elbow
14 Reducing bushing
15 Expansion plug
16 Gage tube
17 Gage adapter
18 Oil level gage
19 Pipe, plug, ⅛ (10 rqr)
20 Push rod cover
21 Lockwasher, ½ (8 rqr)
22 Cap screw, ½ x 2½ NC (8 rqr)
23 Cover gasket
24 Pipe, plug, ½ (2 rqr)

Figure 101. Cylinder block, exploded view.

(5) Lift off the piston (2, fig. 100) and press the bushing (11) out of the rod (8).

c. Inspection. Clean carbon and dirt from all parts with an approved solvent, and clear the oil passages before inspection.

(1) Inspect the connecting rod journals on the crankshaft (10, fig. 87) for roughness or scoring. Polish the jour-



1 Socket wrench
2 Ridge cutting tool
3 Cylinder sleeve
4 Cylinder block

Figure 102. Removing ring ridge.

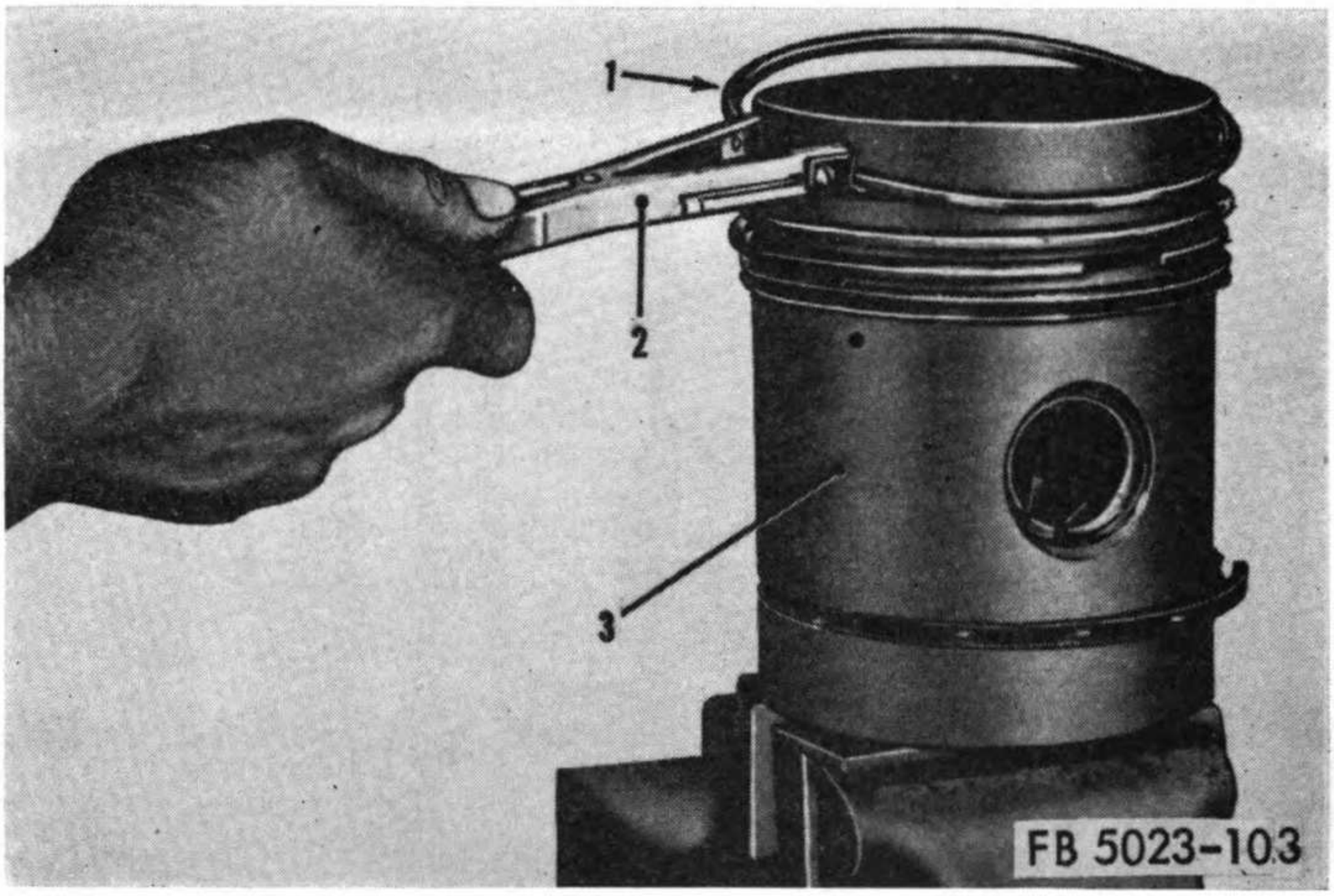
nals with crocus cloth to remove any marks and clean thoroughly.

(2) Check the bearings (5, fig. 100) for excessive wear (*f* below). Oil clearance in excess of the manufacturer's specification is the true indication of bearing journal wear.

(3) Inspect the piston pin (3) and bushing (11) for excessive wear. Maximum clearance is 0.0025-inch. Replace a pin or bushing that is excessively worn.

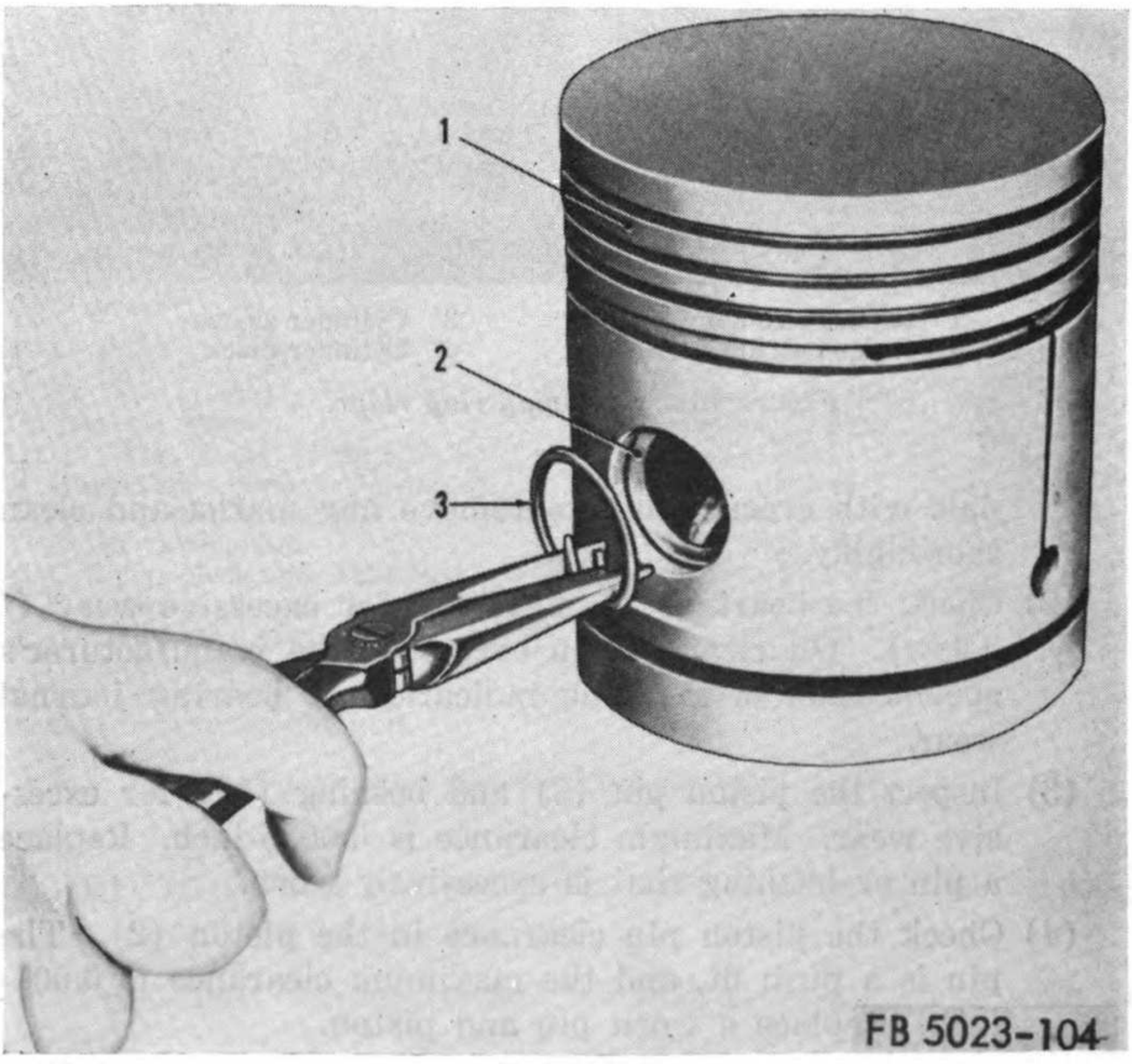
(4) Check the piston pin clearance in the piston (2). The pin is a push fit, and the maximum clearance is 0.001-inch. Replace a worn pin and piston.

(5) Inspect the piston for cracks or damage. Replace a defective piston. If a new piston is used, check the clear-



1 Rings 2 Ring expander 3 Piston

Figure 103. Removing piston rings.



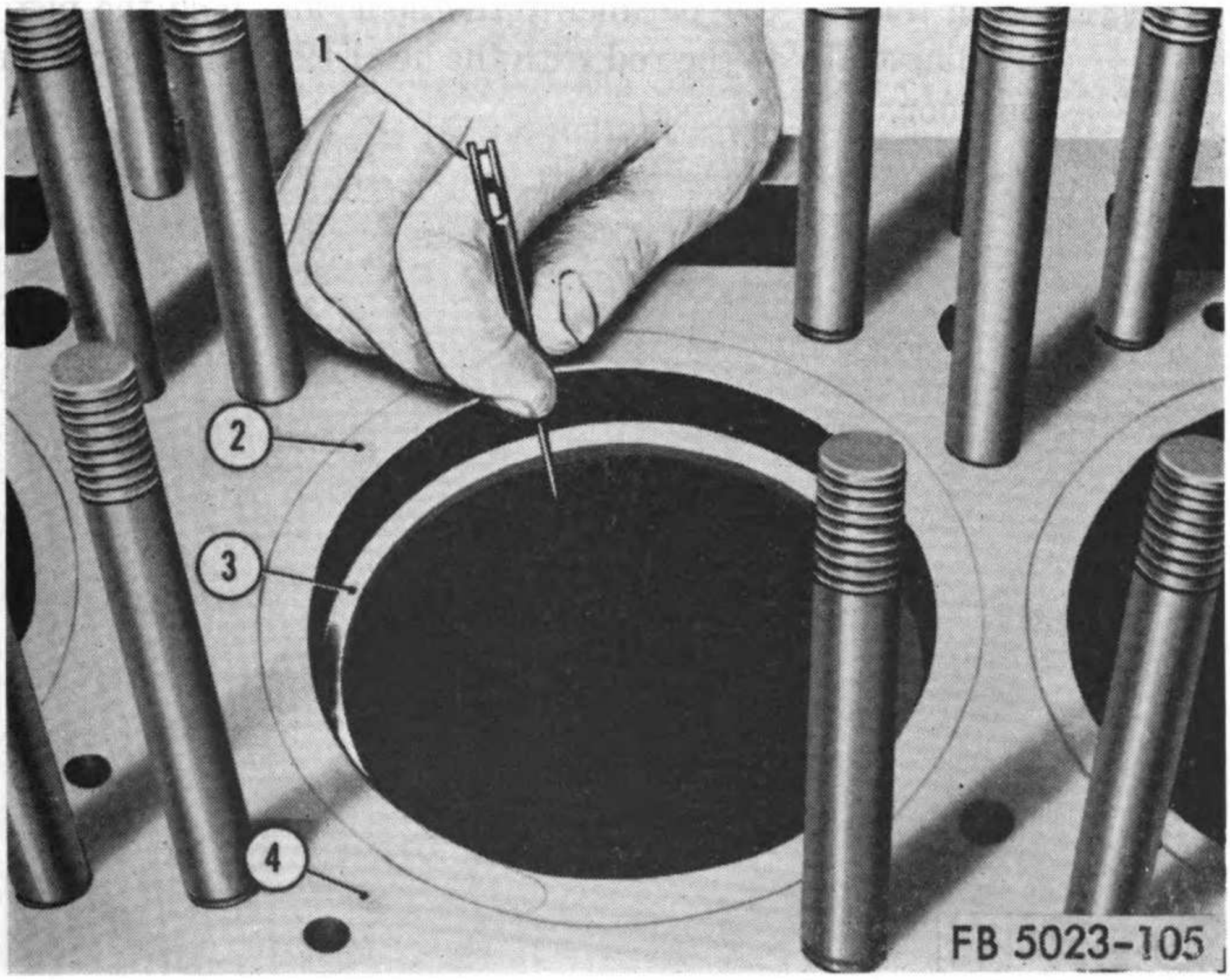
1 Piston 2 Piston pin 3 Retainer

Figure 104. Removing piston pin retainer.

ance of the lower part of the skirt with the cylinder sleeve. Correct clearance is 0.009 to 0.011-inch.

(6) Check the rings (1) for excessive wear and proper gap. Compression ring gap is 0.020 to 0.035-inch, and oil ring gap is 0.015- to 0.030-inch. 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 (2, fig. 106) with a feeler gage for groove clearance. Proper groove clearance for the top ring is 0.004 to 0.006-inch, with a maximum of 0.012-inch. Proper clearance for the next two compression rings is 0.0015 to 0.0035-inch, with a maximum of 0.010-inch. For the oil rings, proper clearance is 0.0015 to 0.003-inch, with a maximum of 0.010-inch. If new rings are used, roll them completely around their respective grooves in the piston to check for free movement. If the rings are tight, they can be lapped slightly on very fine



1 Feeler gage
2 Cylinder sleeve
3 Piston ring
4 Block

Figure 105. Checking piston rings for gap.

emery cloth laid on a flat surface. Use a light uniform pressure.

(8) Inspect the bolts (10, fig. 100) and caps (7) for damage. Replace a defective part.

d. Reassembly.

(1) Press the bushing (11) into the rod (8), and ream to a clearance of 0.001 to 0.0018-inch fit with the piston pin (3).

(2) Heat the piston (2) in boiling water for 5 minutes. Assemble the rod (8) to the piston with the piston pin, and install the retainers (4).

(3) Check the connecting rod alinement (*e* below).

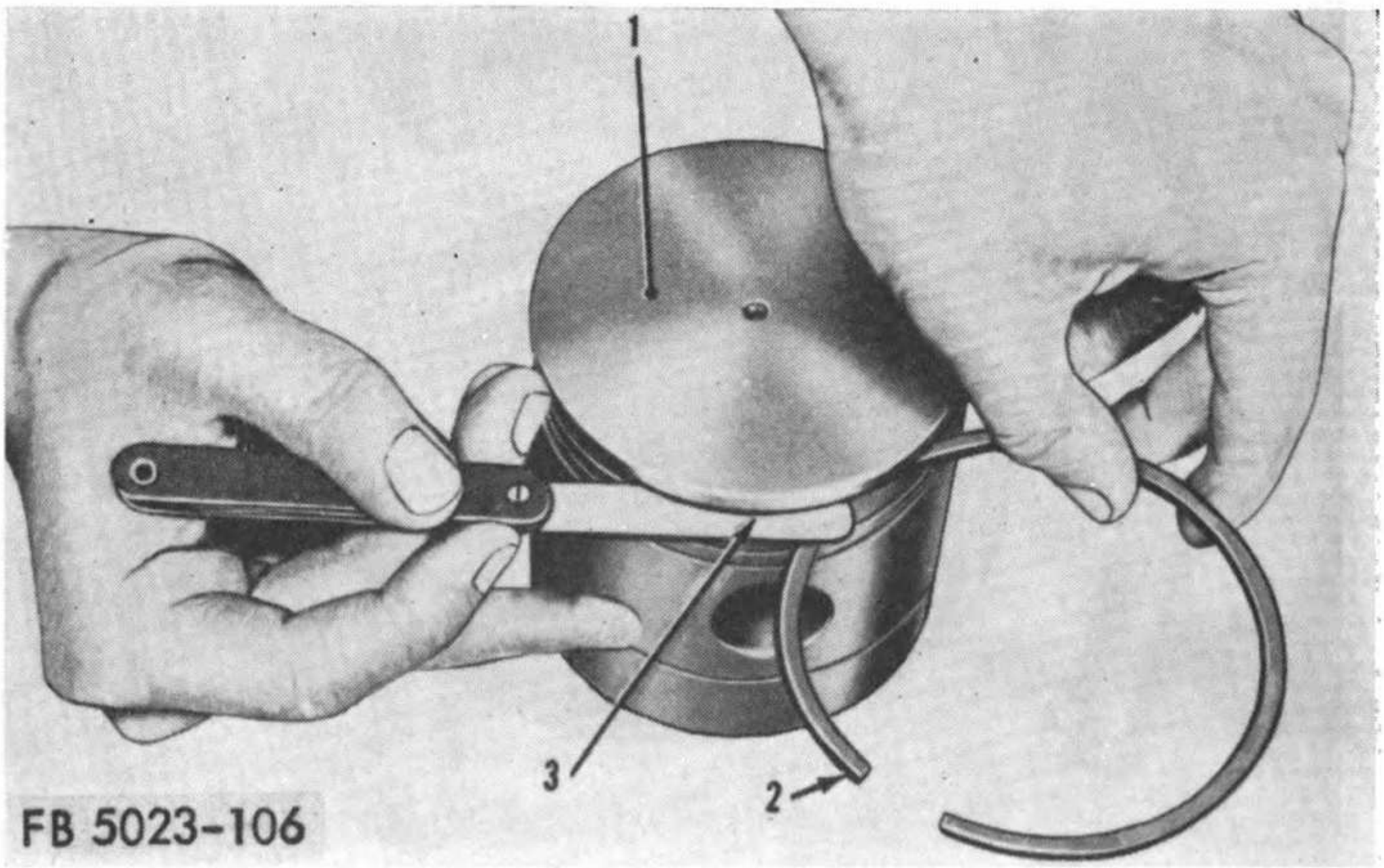
(4) Install the rings (1, fig. 103) with the ring expander (2) staggering the gaps around the piston.

(5) Insert the bolts (10, fig. 100) in the rod.

e. Connecting Rod Alinement.

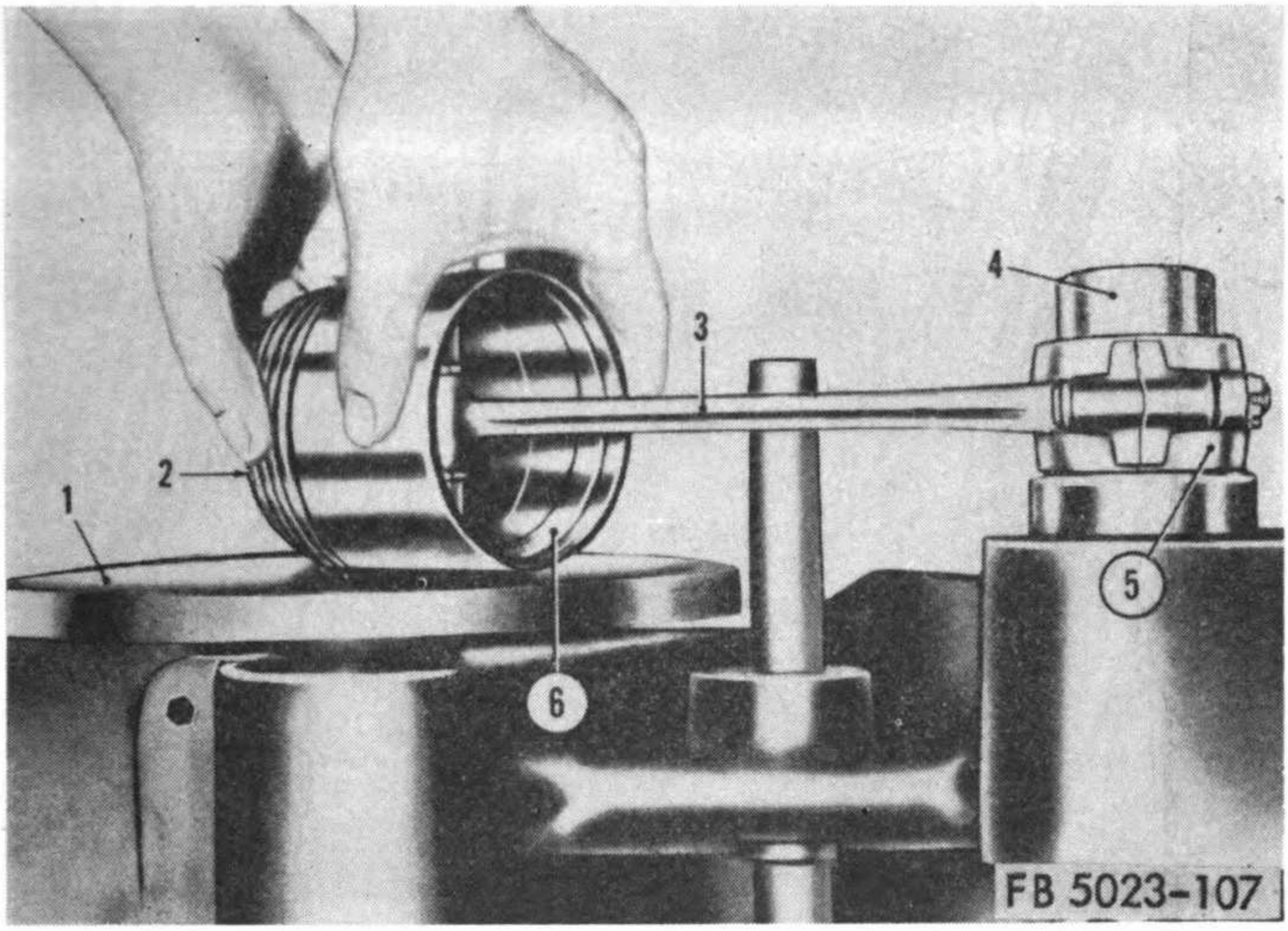
(1) Clamp the rod and piston assembly without the piston rings on the mandrel (4, fig. 107) of the alining fixture, with the connecting rod bearings in place.

(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.



1 Piston 2 Ring 3 Feeler gage

Figure 106. Checking piston ring groove clearance.



1 Surface plate
2 Piston
3 Connecting rod
4 Mandrel
5 Connecting rod cap
6 Piston

Figure 107. Checking connecting rod alinement.

(3) Check the gap between the surface plate (1) and 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 head, the rod is twisted.

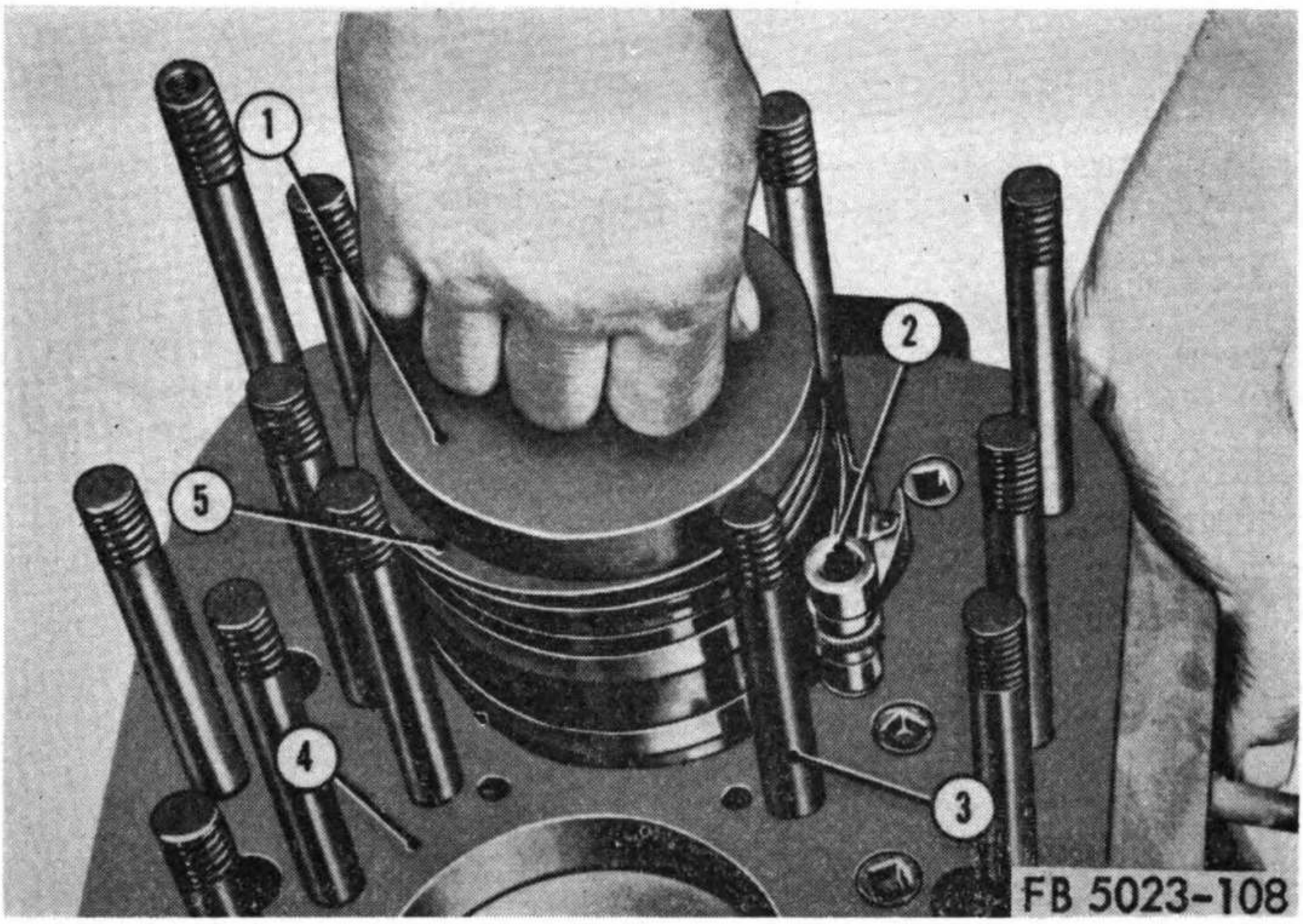
(4) A twisted rod sometimes can be straightened by using a large wrench. If badly twisted, replace the rod.

(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 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 ring surfaces with engine oil.

(2) Install a ring compressor (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. The compressor will be free when the piston is pushed into place.



1 Piston
2 Ring compressor
3 Stud
4 Cylinder block
5 Ring

Figure 108. Installing piston and rod assembly in cylinder.

Note. The ring compressor shown in figure 108 is not wide enough to compress all the rings at the same time. The piston must be pushed into the sleeve in successive steps by releasing the compressor and moving it up to compress the remaining rings.

(3) Insert the upper half of the bearing (5, fig. 100) in the rod (8) and pull the rod down on the crankshaft (2, fig. 89).

(4) Place a ¼ x ¼ x 0.006-inch piece of feeler stock between the cap (4) and the lower half of the bearing.

(5) Assemble the cap to the rod and secure with the nuts (5).

(6) Tighten the nuts to a tension of 150 to 160 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 which is 0.0021 to 0.0045-inch. If the clearance is 0.0065-inch or more, replace the bearings (*g* below). If the clearance is still excessive with new bearings installed, grind the crankshaft and use undersize bearings.

(7) Check the rod for proper side clearance of 0.004 to 0.009-inch.

(8) Loosen the cap (4) and remove the piece of feeler stock.

(9) Tighten the nuts to the proper tension ((6) above) and try the side movement of the rod. It should move easily.

(10) Install the cotter pins in the nuts.

(11) Install the oil pan (par. 149*d*) and the heads (par. 98*g*).
(12) Install the engine (par. 136*b*).

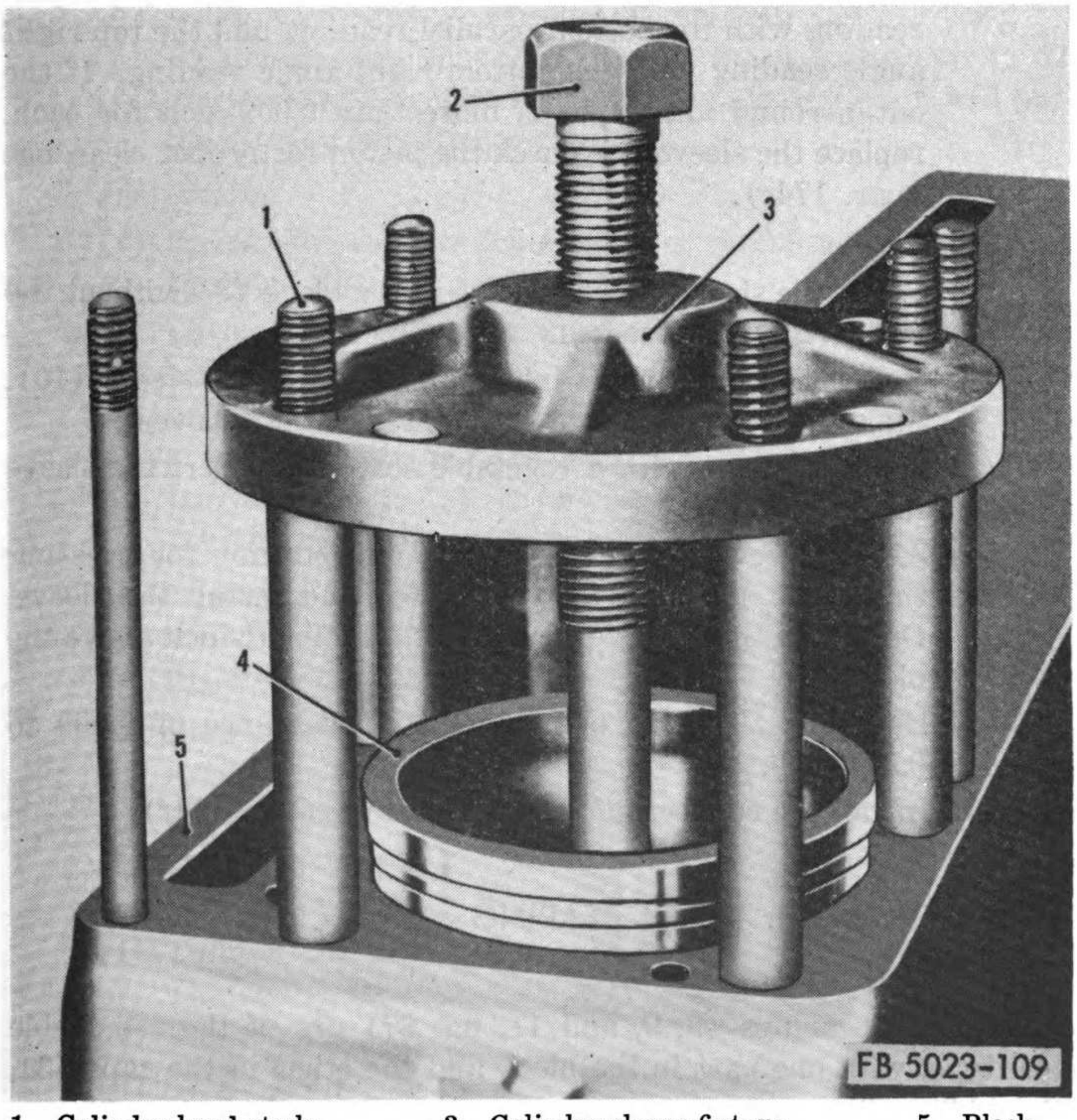
g. Connecting Rod Bearing Replacement.

(1) Detach the rods (*a*(1–4) above) and remove the upper half of the bearing (5, fig. 100).
(2) Place the new bearings (5) in the rods and caps and install the rods (*f*(3–12) above).
(3) Break in the engine (par. 184).

175. Cylinder Sleeves

a. Removal.

(1) Remove the connecting rods and pistons (par. 174*a*).
(2) 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).



1 Cylinder head studs
2 Fixture screw
3 Cylinder sleeve fixture
4 Cylinder sleeve
5 Block

Figure 109. Removing cylinder sleeve.

(3) Turn the screw (2) and pull up the sleeve.

(4) Remove the packing rings (11, fig. 101), being careful not to mar the grooves in the sleeve.

b. Inspection. Inspection of the cylinder sleeves (10, fig. 101) requires prior removal of the connecting rods and pistons (par. 174*a*).

(1) Check the sleeves (10) for excessive wear, scores, and scratches. Maximum clearance with the pistons is 0.020-inch. Replace a defective sleeve.

(2) Correct bore diameter is 5.250 to 5.251 inches.

(3) 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 0.009-inch for each, replace the sleeve and check the piston for proper clearance (par. 174*c*).

c. Installation.

(1) Check the sleeve (10, fig. 101) in the block (8) without the rings (11) for freedom.

(2) Roll the packing rings into the grooves in the sleeve (10). Make sure the rings are not twisted in the grooves.

(3) Soap the rings with a 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-inch above the block.

(5) Hone the sleeve to obtain a piston clearance of 0.009 to 0.011-inch.

(6) Install the connecting rods and pistons (par. 174*f*).

Section XVIII. MAIN BEARINGS AND CRANKSHAFT

176. General

The main bearings (8, 9, and 11, fig. 87) are of the removable shell type, with one part in the block and the other in the caps (31, 32, and 33). The caps are very rigid castings securely fastened to the block by studs (30 and 35). The crankshaft (10) 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.

177. Main Bearings

a. Removal. Remove one cap at a time when replacing bearings. The instructions given below are typical for all the bearings except the center bearing cap (33, fig. 87) which has locking plates (34) and thrust flanges (12 and 14) installed on it.

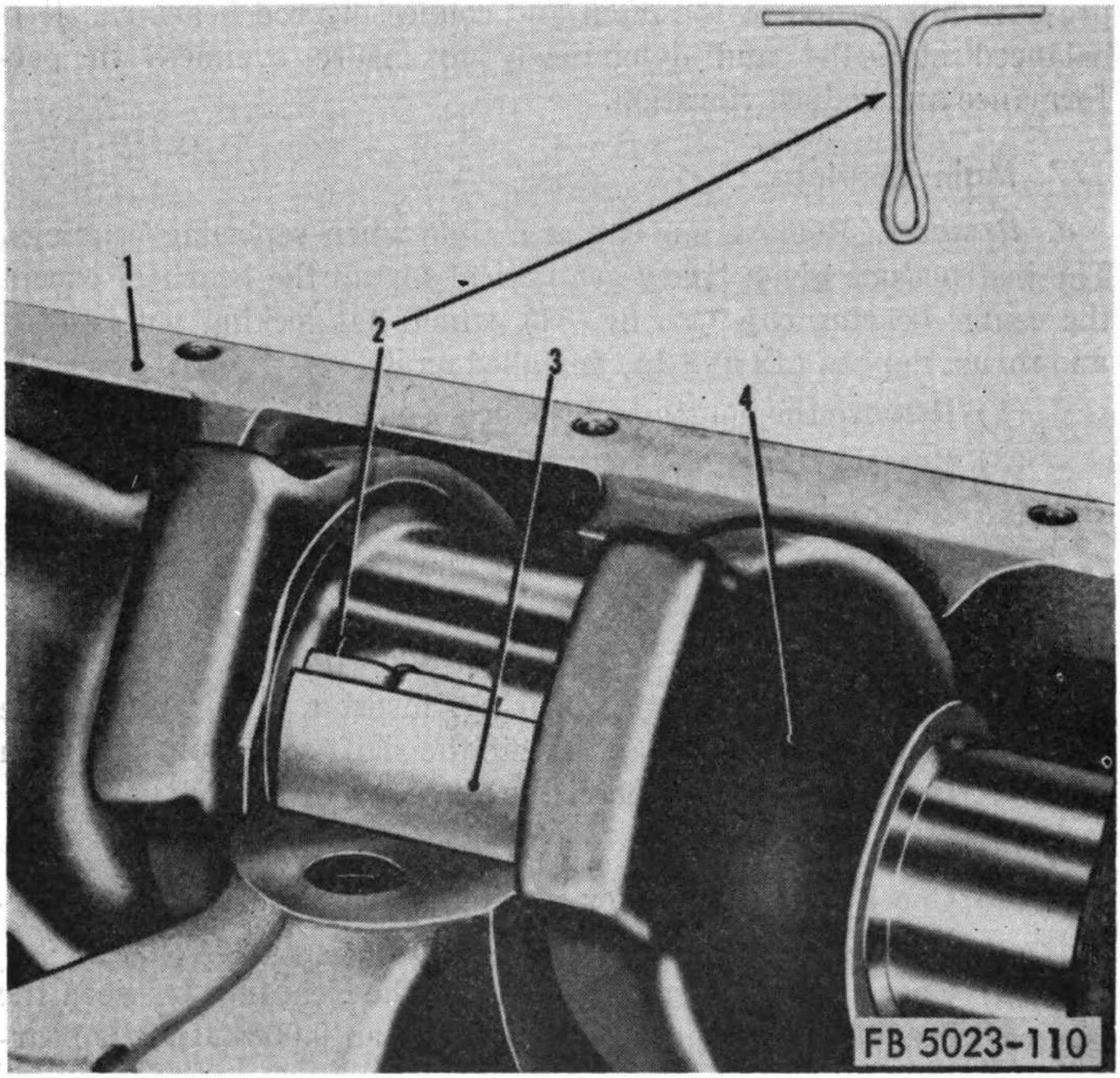
(1) Remove the housing and panels (par. 65*a*).
(2) Remove the engine (par. 136*a*).
(3) Remove the oil pan (par. 149*b*).
(4) Remove the nuts (1, fig. 89) and lockwashers securing the cap (3) to the block (6).
(5) Remove the lower bearing from the cap.
(6) To remove the upper bearing, insert a cotter pin in the crankshaft oil hole and rotate the shaft so the pin will push the bearing out. Remove the pin.

b. Inspection.

(1) Check the bearings for scoring or discoloration from overheating. Replace damaged bearings.
(2) Check the bearings for wear. If the clearance between the bearings and crankshaft is more than 0.008-inch, the bearings must be replaced. If the clearance is still excessive after new bearings are installed, regrind the crankshaft journals and install undersize bearings. Journal diameter for a standard size crankshaft is 3.745 to 3.746-inch.

c. Installation. Lubricate the bearings and crankshaft bearing journals with OE 10 before installing the bearings.

(1) Place the bearing (3, fig. 101) on the journal.
(2) Insert a cotter pin (2) in the crankshaft oil hole, and rotate the shaft so that the pin will push the bearing in place. Remove the cotter pin.
(3) Install the cap (3, fig. 89) with the lower bearing in place, and secure with the nuts (1) and lockwashers.
(4) Tighten the nuts to a tension of 150 to 160 foot-pounds. The center bearing nuts require a tension of 245 to 275 foot-pounds.
(5) Check the bearings for proper oil clearance to the crankshaft (2). Correct clearance is 0.0025 to 0.0056 inch. It should be possible to rotate the crankshaft in the bearings by taking hold of the crank web of the shaft.



1 Cylinder block
2 Cotter pin
3 Bearing
4 Crankshaft

Figure 110. Installing main bearings.

(6) Install the oil pan (par. 149*d*) on the engine, and install the engine (par. 136*b*).

(7) Break in the engine (par. 184).

178. Crankshaft

a. Removal.

(1) Remove the housing and side panels (par. 65*a*).

(2) Remove the engine (par. 136*a*).

(3) Remove the timing gear cover (par. 153*a*).

(4) Remove the connecting rods and pistons (par. 174*a*) and flywheel housing (par. 144*a*).

(5) Remove the main bearing caps (par. 177*a*), and mark each lower bearing so that it can be replaced in its respective position.

(6) Lift out the crankshaft (10, fig. 87) and mark each upper bearing (8, 9, and 11) in the same manner as in subdivision (5) above. Remove the upper flanges (12).

b. Disassembly.

(1) Remove the flywheel bolts (13).

(2) The gear (16, fig. 93) is keyed and shrunk on the crankshaft (17). Do not remove the gear unless it is damaged or worn.

(3) Use an arbor press to remove the gear, or drill a ¼-inch hole parallel to and midway between the base of the teeth and the edge of the keyway and use a chisel to split the gear. Remove the key (7, fig. 87).

c. Inspection.

(1) 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 plane with the third reading of the other. Repeat this procedure for all the journals. If the journal wear exceeds 0.002-inch, regrind the journals to the nearest standard undersize. Journal diameters for a standard crankshaft are 3.745 to 3.746-inch.

(2) To check the alinement of the crankshaft (10), place V-blocks under the front and rear journals and check the runout of the main bearing journals with a dial indicator. This should not be more than 0.003-inch total indicator reading.

(3) Inspect the crankshaft flange for nicks. Smooth them if necessary. Check the flywheel bolts (13) for damaged threads, the flange holes for wear, and the crankshaft threads for damage. Clean all the oil passages. If magnafluxing equipment is available, check the crankshaft for cracks.

d. Reassembly.

(1) Transfer the timing mark from the old crankshaft gear to the new gear (par. 154*b*).

(2) Insert the key (7, fig. 87) in the crankshaft (10).

(3) Heat the gear (5) evenly to 450° F., or until it turns a pale straw yellow, and quickly press in place against the shoulder of the shaft. Allow the gear and shaft to cool.

(4) Install the flywheel bolts (13) in the crankshaft flange.

e. Installation.

(1) Install the upper flanges (12), and the upper bearings (8, 9, and 11) in the block.

(2) Place the crankshaft (10) in the block.

(3) Install the bearing caps (par. 177*c*).

(4) Check the end thrust of the crankshaft (10) by inserting a feeler gage between the flanges (12) and (14) and the crankshaft. Proper clearance is 0.005 to 0.007-inch and permissible clearance is 0.013.

(5) Install the connecting rods and pistons (par. 174*f*) and flywheel housing (par. 144*c*).

(6) Install the timing gear cover (par. 153*c*).

(7) Install the engine (par. 136*b*).

(8) Break in the engine (par. 184).

(9) Install the housing and side panels (par. 65*c*).

Section XIX. CAMSHAFT BEARINGS AND LIFTER ASSEMBLIES

179. General

The crankshaft (33, fig. 111) is driven by means of a gear (29) which meshes with the crankshaft gear, and is supported in the block by six removable bearings (27 and 41). The camshaft, through the lifters (37), push rods (12), and rocker arms (10, 13, 14, and 15), opens the valves (34 and 35) and permits them to close at the proper time in relation to the engine cycle. The camshaft also operates the oil pump by a gear which is part of the camshaft.

180. Lifter Assemblies

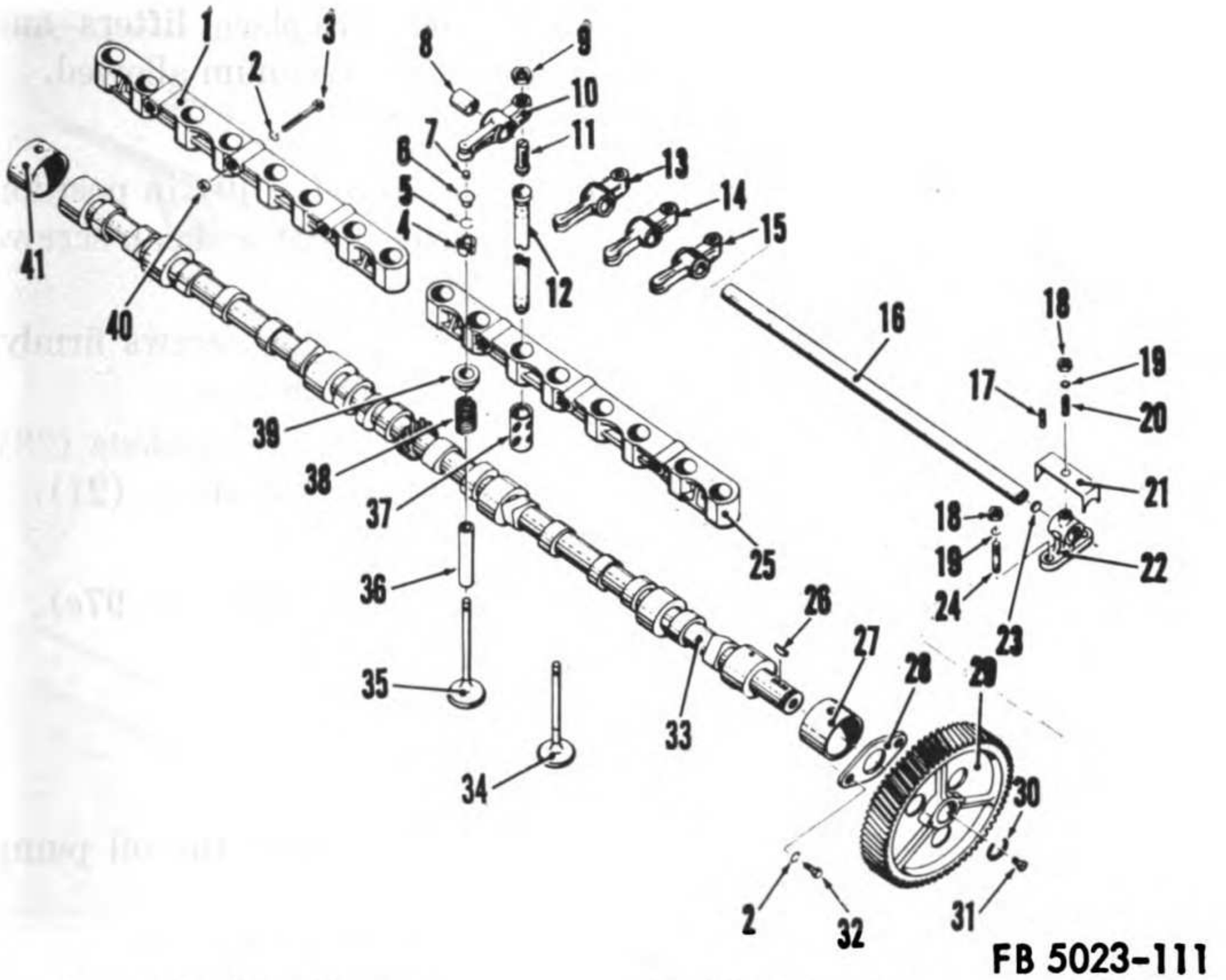
a. Removal.

(1) Remove the rocker arm assemblies (par. 97*b*).

(2) Remove the push rods (12, fig. 111).

(3) To remove the push rod covers (20, fig. 101), and gaskets (23) on the left side of the cylinder block (8), unscrew the cap screws (22), and lockwashers (21).

(4) Loosen the bracket cap screws (3, fig. 111) slightly, and pull the brackets (1 and 25) away from the block.



1	Rear valve lifter bracket	22	Shaft bracket
2	Lockwasher, ½ (8 rqr)	23	Expansion plug, ⅝ (2 rqr)
3	Cap screw, ½ x 2¾ NC (6 rqr)	24	Bracket stud
4	Valve spring lock	25	Front valve lifter bracket
5	Ball retainer	26	Woodruff key, No. 128
6	Rocker arm ball	27	Front camshaft bearing
7	Oil wick	28	Thrust plate
8	Bushing	29	Camshaft gear
9	Adjusting screw nut	30	Retainer ring
10	Rocker arm	31	Hole plug
11	Adjusting screw	32	Cap screw, ½ x 1 NC (2 rqr)
12	Push rod assembly	33	Camshaft
13	Rocker arm	34	Exhaust valve
14	Rocker arm	35	Intake valve
15	Rocker arm	36	Valve guide
16	Rocker arm shaft assembly	37	Valve lifter
17	Lockscrew	38	Valve spring
18	Nut, hex, ⅜ NF (24 rqr)	39	Spring retainer
19	Lockwasher, ⅜ (24 rqr)	40	Bracket dowel
20	Bracket stud	41	Intermediate and rear camshaft bearing
21	Spring clip		

Figure 111. Valve operating mechanism, exploded view.

(5) Remove the lifters (37) first; then the cap screws (3), lockwashers (2), brackets, and dowels (40).

Caution: Care must be taken to prevent the lifters and dowels from falling into the crankcase.

b. Cleaning and Inspection.

(1) Clean all parts with cleaning solvent.

(2) Check the lifters (37) for freedom of movement in the brackets (1 and 25). Maximum oil clearance between the

lifters and brackets is 0.004 inch. Replace lifters and brackets if the wear is more than the maximum allowed.

c. Installation.

(1) Place the brackets (1 and 25) and dowels (40) in position on the block and install the lockwashers (2) and cap screws (3). Tighten the screws fingertight.

(2) Install the lifters (37) and tighten the cap screws firmly. Make sure the lifters move freely in the brackets.

(3) Replace the push rod covers (20, fig. 101) and gaskets (23) and secure with the cap screws (22) and washers (21).

(4) Insert the push rods (12, fig. 111).

(5) Attach the rocker arm assemblies to the heads (par. 97*e*).

(6) Adjust the valve clearance (par. 97*g*).

181. Camshaft and Bearings

a. Removal.

(1) Remove the timing gear cover (par. 153*a*), the oil pump (par. 150*b*), and lifter assemblies (par. 97*b*).

(2) Check the camshaft bearing (2, fig. 112) to journal wear by inserting a feeler gage (4) between the bearing and journal before removing the camshaft.

(3) If the oil clearance is 0.012 inch or over, press the bearings (27 and 41, fig. 111) out of the block. Correct clearance is 0.003 to 0.007 inch.

(4) Remove the cap screws (32) and lockwashers (2) securing the thrust plate (28) to the block.

(5) Carefully pull the camshaft (33) out of the block, guiding it through the bearings (27 and 41).

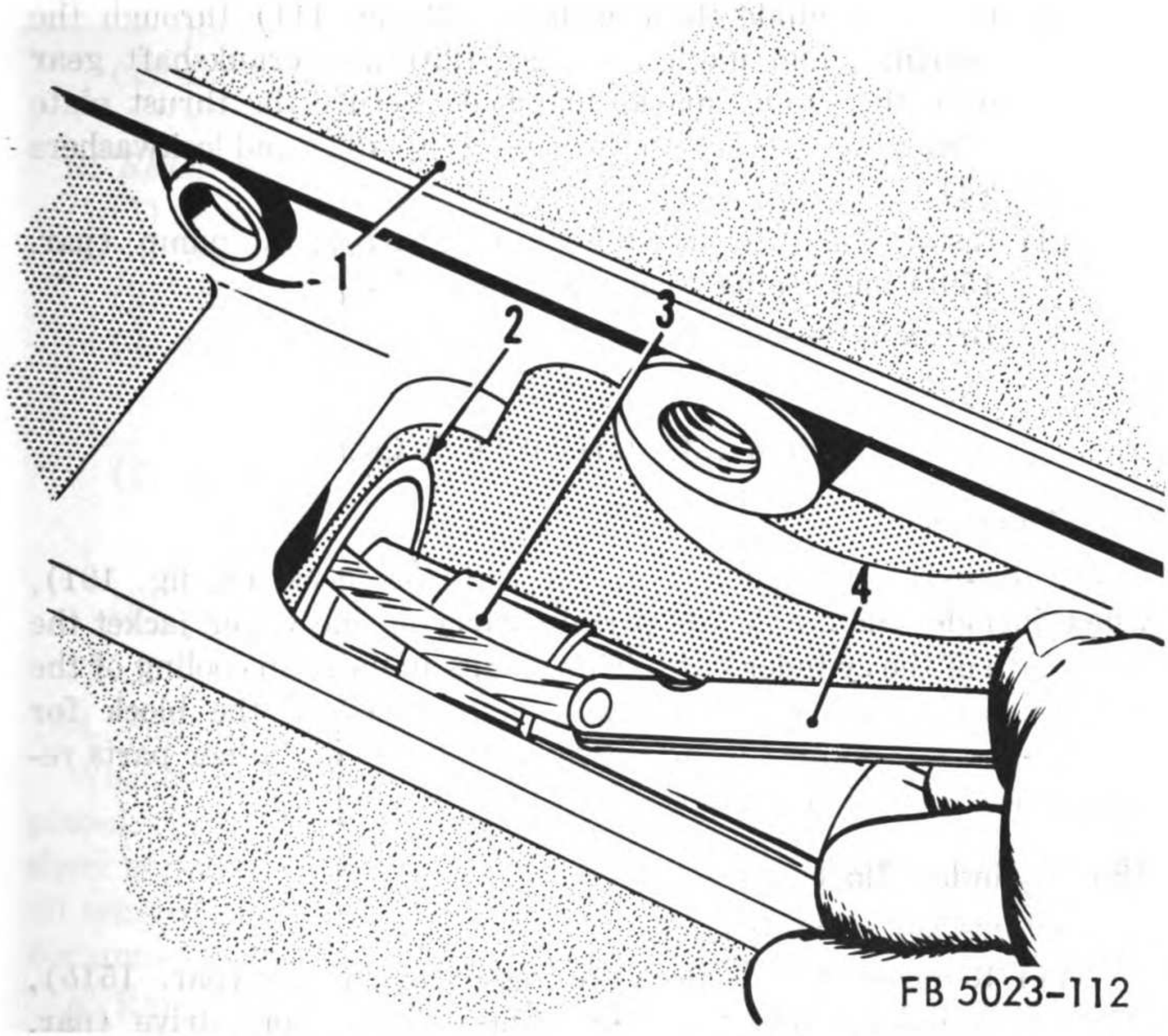
(6) Remove the flywheel housing (par. 144*a*) and the expansion plug (15, fig. 101).

(7) Before removing the camshaft (33, fig. 111) check the end thrust by inserting a feeler gage between the thrust plate (28) and the front camshaft journal. Correct end thrust is 0.003 to 0.009 inch, with a maximum of 0.015 inch. Replace the thrust plate if the maximum tolerance is exceeded.

b. Disassembly. Remove the retainer ring (30) and pull the gear (29) from the camshaft (33). Remove the key (26) and thrust plate (28).

c. Inspection.

(1) Check the gear (29) for worn or damaged teeth or excessive backlash (par. 154*a*). Replace a defective gear.



1 Cylinder block
2 Camshaft bearing
3 Camshaft
4 Feeler gage

Figure 112. Checking camshaft bearing oil clearance.

(2) Inspect the camshaft journals for scoring and wear, and the oil pump drive gear for damaged teeth. Replace a defective camshaft.

(3) If the bearings (27 and 41) as checked in *a* above are worn, replace them.

d. Camshaft Reassembly. Install the thrust plate (28) and key (26) on the camshaft (33). If a new gear is being installed, transfer the timing marks (par. 154*b*) and press the gear on. Check for correct end thrust in *a* above.

e. Installation.

(1) If new bearings (27 and 41) are being installed, press them into the block. Make sure the oil holes are lined up, and line ream the bearings to a clearance of 0.003 to 0.007 inch with the camshaft journals.

(2) Install the expansion plug (15, fig. 101) and the flywheel housing (par. 144*c*).

(3) Carefully guide the camshaft (33, fig. 111) through the bearings, and mesh the gear (29) and crankshaft gear with the timing marks matched. Secure the thrust plate (28) to the block with the cap screws (32) and lockwashers (2).

(4) Install the lifter assemblies (par. 97*g*), oil pump (par. 150*f*) and timing gear cover (par. 153*c*).

(5) Break in the engine (par. 184).

Section XX. CYLINDER BLOCK

182. General

The one-piece construction of the cylinder block (8, fig. 101), which includes the crankcase, permits carrying the water jacket the full length of the cylinder bore. This results in uniform cooling of the cylinder and piston wall. Passages are drilled in the block for carrying oil under pressure to the main bearings and other parts requiring forced feed lubrication.

183. Cylinder Block

a. Disassembly (fig. 101).

(1) Remove the oil pressure regulating valve (par. 151*b*), cylinder head (par. 98*a*), and the accessory drive (par. 126).

(2) Remove the timing gear housing (par. 155*a*), flywheel housing (par. 144*a*), and the oil pump (par. 150*b*).

(3) Remove the connecting rods and pistons (par. 174*a*), cylinder sleeves (par. 175*a*), crankshaft (par. 178*a*), and the camshaft (par. 181*a*).

(4) Remove the oil level gage (18), adapter (17), and tube (16).

(5) Remove all studs, expansion plug, pipe plugs, and fittings from the block (8).

b. Cleaning.

(1) Clean the block and fittings with an approved cleaning solvent.

(2) Thoroughly clean all oil lines and passages in the cylinder block (8).

c. Inspection.

(1) Check the block (8) for cracks. Replace a cracked block.

(2) Inspect the top of the block for damage. Resurface if necessary.

(3) Inspect the expansion plug (15) for damage or leakage. Replace a damaged or loose plug.
(4) Inspect all studs, pipe plugs, and fittings for thread damage and looseness. Replace defective studs, plugs, and fittings.

d. Reassembly.
(1) Install all the studs, expansion plug, pipe plugs, and fittings in the block.
(2) Install the tube (16), adapter (17), and oil level gage (18).
(3) Install the camshaft (par. 181*e*), crankshaft (par. 178*d*), cylinder sleeves (par. 175*c*), and the connecting rods and pistons (par. 174*f*).
(4) Install the oil pump (par. 150*f*), oil pan (par. 149*d*), flywheel housing (par. 144*c*), and the timing gear housing (par. 155*b*).
(5) Install the accessory drive (par. 130), cylinder head (par. 98*g*), and the oil pressure regulating valve (par. 151*d*).

184. Engine Break-In Period

Whenever the engine is overhauled or the piston rings are replaced, operate the engine with light loads and at lower speeds for a short period of time. Watch the water temperature gage (par. 11*b*), oil temperature gage (par. 11*c*), and oil pressure gage (par. 11*d*) for unusual readings during the operational schedule listed below.

a. Run the engine at idling speed and check for oil, fuel, and coolant leaks.

b. Run the engine for one hour at 600 rpm and no load.

c. Run the engine for one hour at 800 rpm and no load.

d. Run the engine for one hour at 800 rpm and 50 per cent load.

e. Run the engine for one hour at 1,200 rpm and 75 per cent load.

f. Run the engine for three hours at 1,200 rpm and full load.

g. After the end of the run, allow the engine to idle for a few minutes and cool slowly to avoid damage due to warping. Retighten the cylinder head nuts. Refer to note in paragraph 98*g* for tightening sequence and torque.

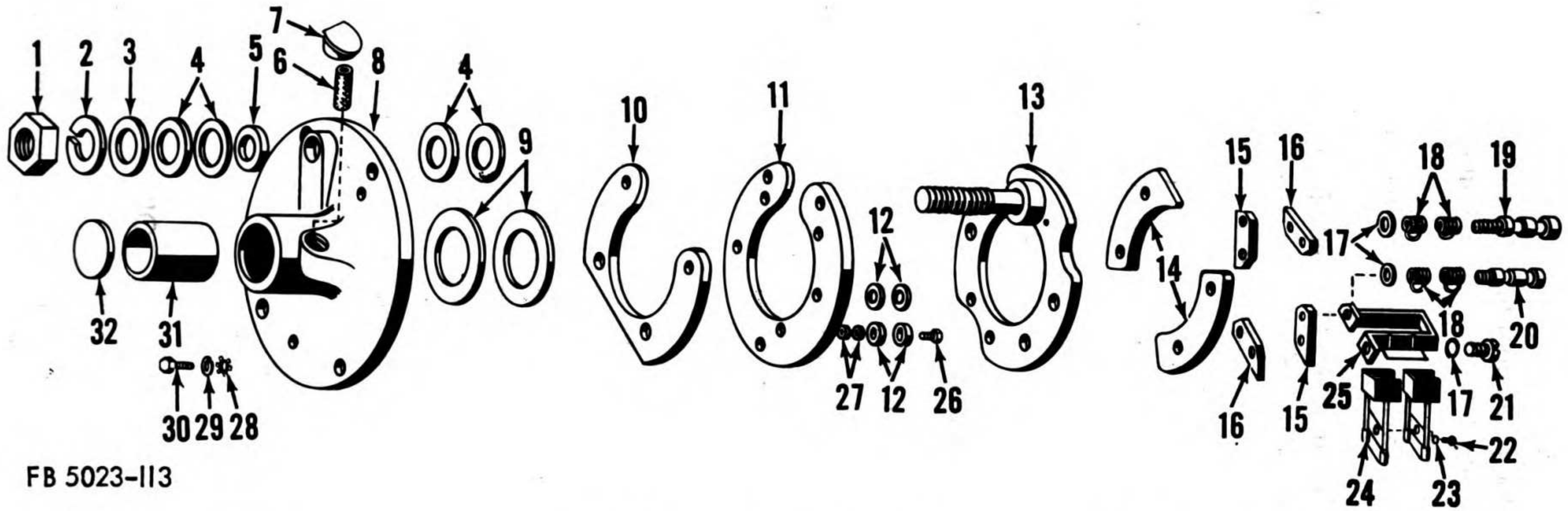
h. Check the entire engine for loosened nuts, bolts, and cap screws, particularly at the oil pan and manifolds.

i. Check the valve clearance (par. 97*f*).

Section XXI. STARTING MOTOR

185. Description

The starting motor (6, fig. 46) is a 12-brush, six-pole, relay-operated unit. It consists of five main subassemblies.



FB 5023-113

1	Terminal stud nut	12	Insulating bushing washer	23	Brush screw lockwasher
2	Terminal stud lockwasher	13	Plate and stud	24	Brush
3	Terminal stud plain washer	14	Brush holder insulator	25	Brush holder
4	Terminal stud insulating washer	15	Insulated holder space plate	26	Brush plate insulator screw
5	Terminal stud bushing	16	Grounded holder space plate	27	Insulator screw lockwasher
6	Oiler felt	17	Brush holder screw lockwasher	28	Tang washer
7	Oiler	18	Brush spring	29	End head screw flat washer
8	Commutator end head	19	Grounded brush holder screw	30	End head screw
9	Brake fiber washer	20	Insulated brush holder screw	31	End head bushing
10	Support plate	21	Brush holder screw	32	Plug, expansion, ⅞ (1 rqr)
11	Brush plate insulator	22	Brush screw		

Figure 113. Starting motor end frame assembly, exploded view.

a. Commutator End Frame Assembly (fig. 113). The commutator end frame consists of the end head (8) with a bushing (31) and brush plate and stud assembly (13). The brush plate assembly has six pair of brushes placed 60° apart. The end frame forms one end of the starting motor and supports the commutator end of the armature shaft.

b. Frame and Field Assembly (fig. 114). The frame and field assembly consists of the frame (1), field coil windings (11), and pole shoes (12). The coil windings supply the magnetic field which is necessary for producing torque. The frame and pole shoes supply the path for the magnetic field.

c. Armature (fig. 115). The armature (1) consists of a shaft on which laterally-slotted lamination is pressed. Windings are assembled in the laminated slots and connected to the commutator segments. The armature is supported on three bushings and the drive end of the shaft is spirally splined for the Dyer drive assembly.

d. Dyer Drive Assembly. The Dyer drive assembly consists of a shift sleeve (7), pinion guide (8), pinion spring (9), pinion stop collar (12), and pinion (10). The pinion engages the flywheel ring gear to crank the engine when the starting motor solenoid relay is energized.

e. Drive Housing. The drive housing (20) forms one end of the starting motor and provides the flange for mounting the starting motor. The bearing (21) in the housing supports the drive end of the armature shaft.

186. Starting Motor Disassembly

a. Remove the starting motor and solenoid switch (par. 91*c*).

b. Remove the cover band (3, fig. 114) and insulator (2) from the frame (1).

c. Lift the brush springs (18, fig. 113) and remove the brushes (24) from the holders (25).

d. Straighten the tangs on the lockwashers (25, fig. 115). Remove the screws (23), lockwashers (25), and flat washers (24).

e. Remove the assembled drive housing (20) and armature (1) from the frame.

f. Remove the screws (14) and lockwashers (13) securing the center bearing plate (3), to the drive housing (20). Remove the assembled armature (1), center bearing plate (3), and Dyer drive from the drive housing (20).

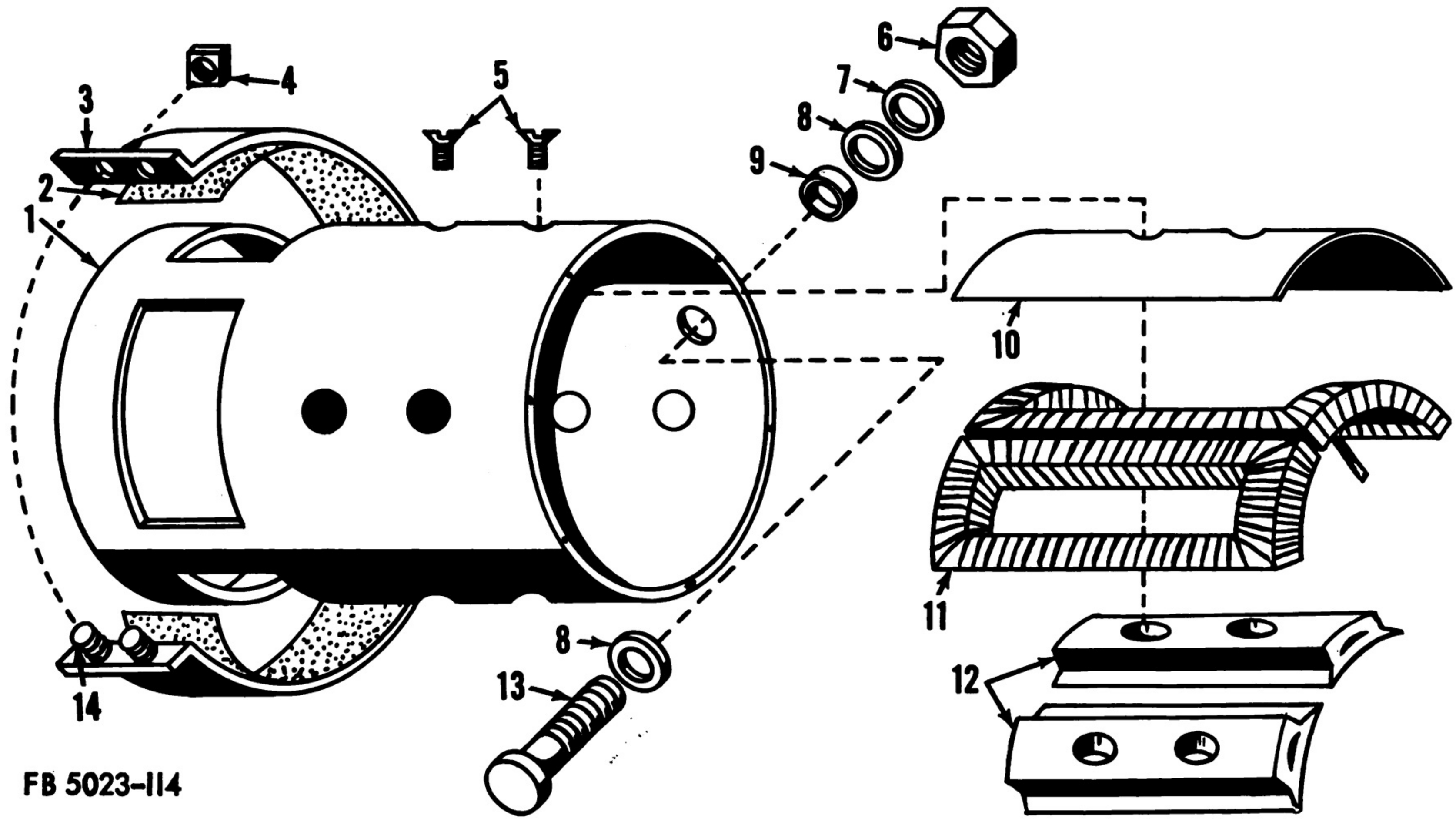


Figure 114. Starting motor frame and field, exploded view.

1 Field frame
2 Commutator cover insulator
3 Commutator cover
4 Nut, sq, #10 NC (2 rqr)
5 Pole shoe screw
6 Field terminal stud nut
7 Terminal stud plain washer
8 Terminal stud insulating washer
9 Terminal stud bushing
10 Field coil insulator
11 Field coil
12 Pole shoe
13 Field terminal stud
14 Screw, rd hd, #10 x 1 NC (2 rqr)

Figure 114—Continued.

g. Remove the screws (15) and lockwashers (16) from the shift lever cap (17) and remove the cap from the drive housing (20).

h. Lift the shift lever (19) out of the housing and remove the spring (18) from the lever.

i. Remove the cotter pin (11) from the pinion stop collar (12) and turn the pinion stop collar until it is in line with the splines on the armature shaft. Remove the pinion stop collar from the shaft.

j. Remove the pinion (10), spring (9), guide (8), sleeve (7), cup washers (5 and 6), and thrust washer (4) from the armature shaft.

k. Remove the center bearing plate (3) and spacer collar (2) from the armature shaft.

l. Disconnect the coil leads from the brushes by removing the three screws (22, fig. 113) and lockwashers (23).

m. Straighten the tangs on the lockwashers (28) and remove the screws (30), lockwashers (28), and flat washers (29) from the commutator end head (8).

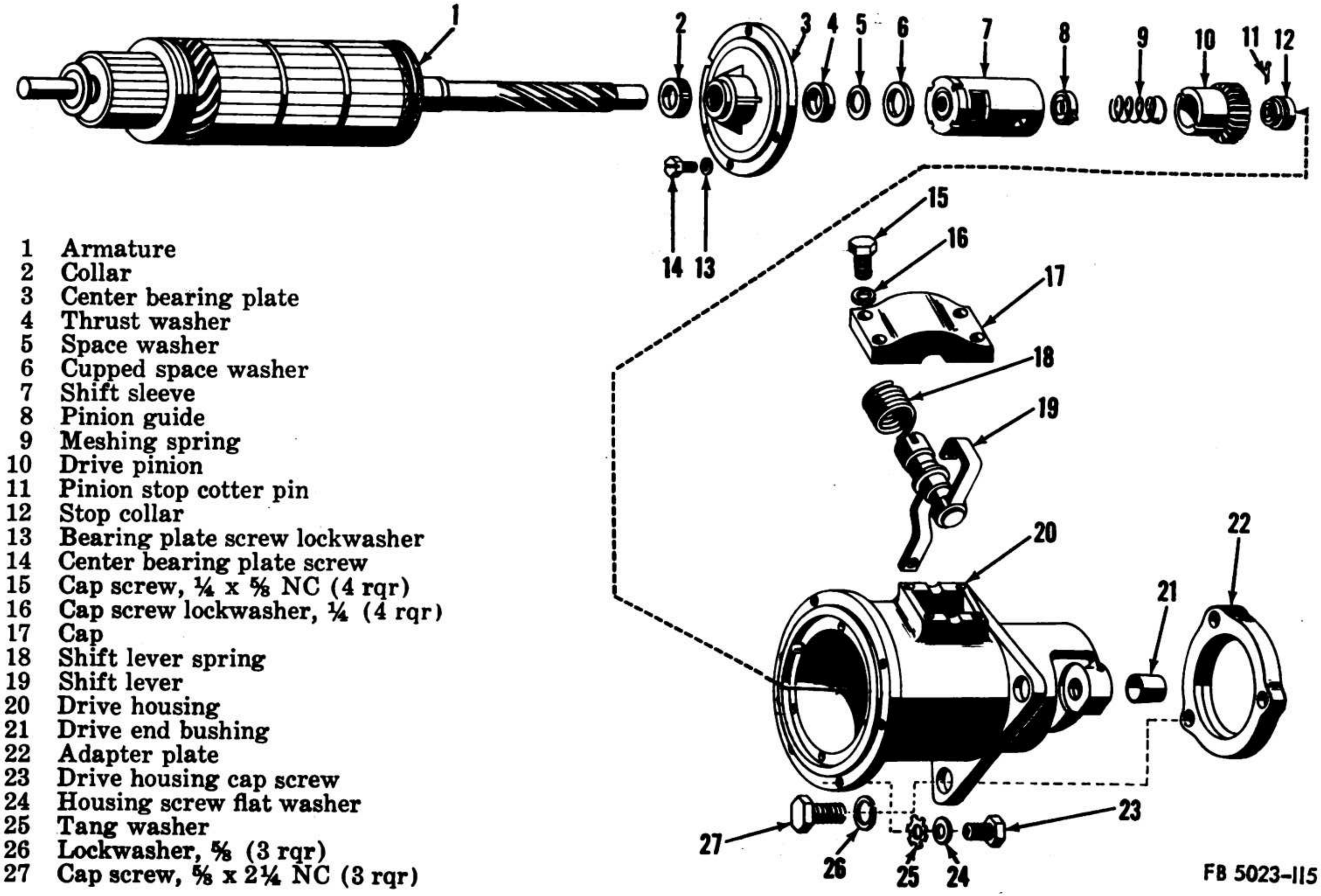
n. Remove the end frame assembly from the frame.

o. Remove the nut (1), lockwasher (2), flat washer (3), insulating washers (4), and bushing (5) from the brush plate terminal stud.

p. Remove the three brush plate insulator attaching screws (26) and lockwashers (27). Separate the brush plate insulator (11) from the end frame (8). Remove the terminal stud washers (4).

q. Remove the screws (19 and 21) and lockwashers (17) from the grounded brush holders (25). Remove the holders, space plates (15), and insulators (14). Remove the springs (18).

r. Remove the screws (20 and 21) and lockwashers (17) from the insulated brush holders (25). Remove the holders, insulated holder space plates (16), and springs (18).



1 Armature
2 Collar
3 Center bearing plate
4 Thrust washer
5 Space washer
6 Cupped space washer
7 Shift sleeve
8 Pinion guide
9 Meshing spring
10 Drive pinion
11 Pinion stop cotter pin
12 Stop collar
13 Bearing plate screw lockwasher
14 Center bearing plate screw
15 Cap screw, ¼ x ⅝ NC (4 rqr)
16 Cap screw lockwasher, ¼ (4 rqr)
17 Cap
18 Shift lever spring
19 Shift lever
20 Drive housing
21 Drive end bushing
22 Adapter plate
23 Drive housing cap screw
24 Housing screw flat washer
25 Tang washer
26 Lockwasher, ⅝ (3 rqr)
27 Cap screw, ⅝ x 2¼ NC (3 rqr)

Figure 115. Starting motor Dyer drive, and drive housing, exploded view.

s. Remove the brush plate and stud (13) and pull out the insulating bushing washers (12). Separate the brush holder support plate (10) from the brush plate insulator (11).

t. Remove the brush lead attaching screws (22) and lockwashers (23) to separate the brushes from the holders.

u. Remove the oiler (7) and oiler felt (6) from the end head (8).

187. Starting Motor Cleaning, Inspection, Testing, and Repair

a. Armature.

(1) Wipe dirt and dust from the armature (1, fig. 115) with a cloth dampened in cleaning solvent.

(2) Inspect the armature to make sure that all windings are pressed into core slots and are staked and soldered to commutator risers. Solder if necessary.

Caution: Never use acid flux or acid core solder when soldering electrical connections.

(3) Inspect the armature shaft bearing surfaces for scoring and wear. Replace the armature if the shaft is scored or worn.

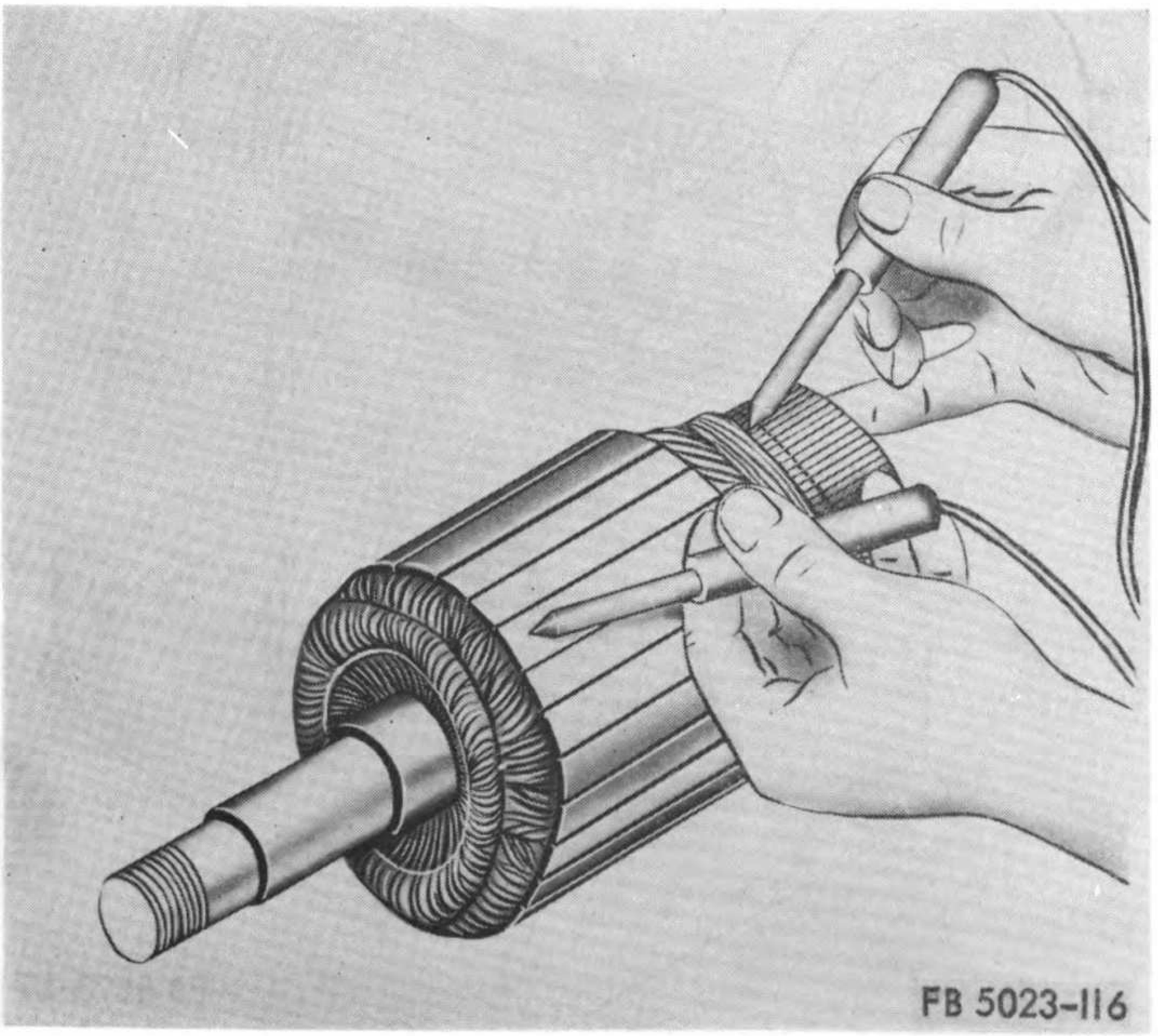


Figure 116. Testing armature for grounds.

(4) Check the armature for ground with test probes (fig. 116). Touch one test probe to the armature shaft and touch the other probe to each commutator riser. Do not touch the probes to bearing or brush surfaces as an arc would mar the finish. If the lamp lights, a ground exists and the armature must be replaced.

(5) Check the armature for shorts on a growler (fig. 117). Place the armature on a growler and hold a thin steel strip or hacksaw blade on the armature as shown in figure 117. Rotate the armature slowly through a complete revolution. If a short exists, the steel strip will vibrate. Replace a shorted armature.

(6) Inspect the armature commutator for rough, ridged, burned, or badly worn brush surfaces. Check the commuta-

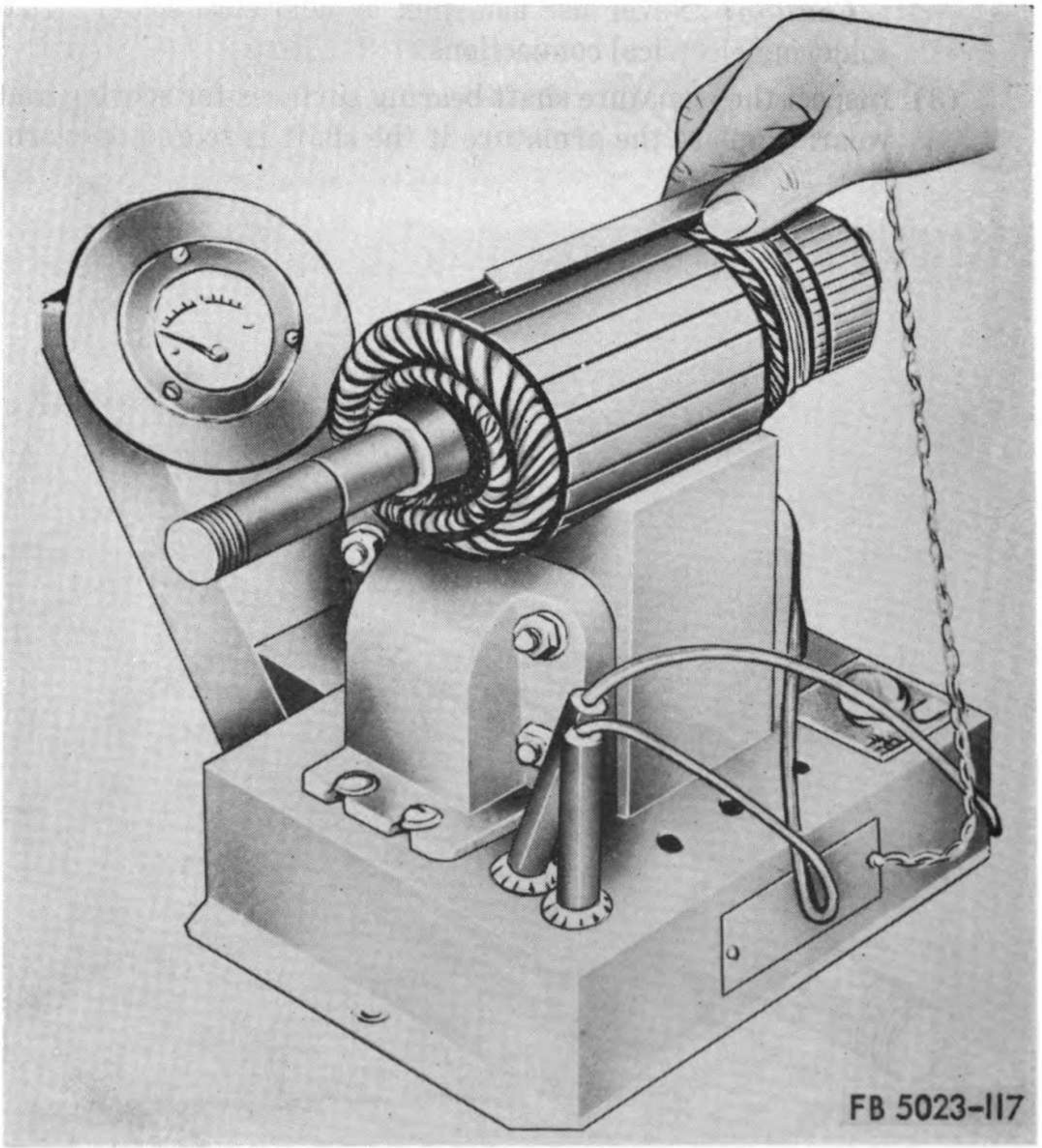


Figure 117. Testing armature on growler.

tor for concentricity by mounting the armature on V-blocks and setting a dial indicator on the commutator as shown in figure 118. If the commutator is not smooth and concentric within 0.003 inch, true the commutator and undercut the mica.

(*a*) True the commutator by placing the armature in a lathe (fig. 119). Take a light cut, or a succession of light cuts, over the entire surface of the commutator until a perfectly concentric surface is obtained.

(*b*) Undercut the mica to a depth of one-thirty-second to three-sixty-fourth inch. Place the armature on an undercutter and carefully force the cutting tool along the mica between the commutator segments as shown in figure 120. Center the tool carefully so as to obtain a good undercut (1, fig. 121). Be sure the mica is cut clean and square.

b. Drive Housing.

(1) Wash the drive housing (20, fig. 115) in cleaning solvent and dry thoroughly.

(2) Inspect the housing for cracks, breaks, and stripped threads. If any defects are found, replace the housing.

(3) Check the bronze bearing (21) for wear by placing the housing on the drive end of the armature shaft and ob-

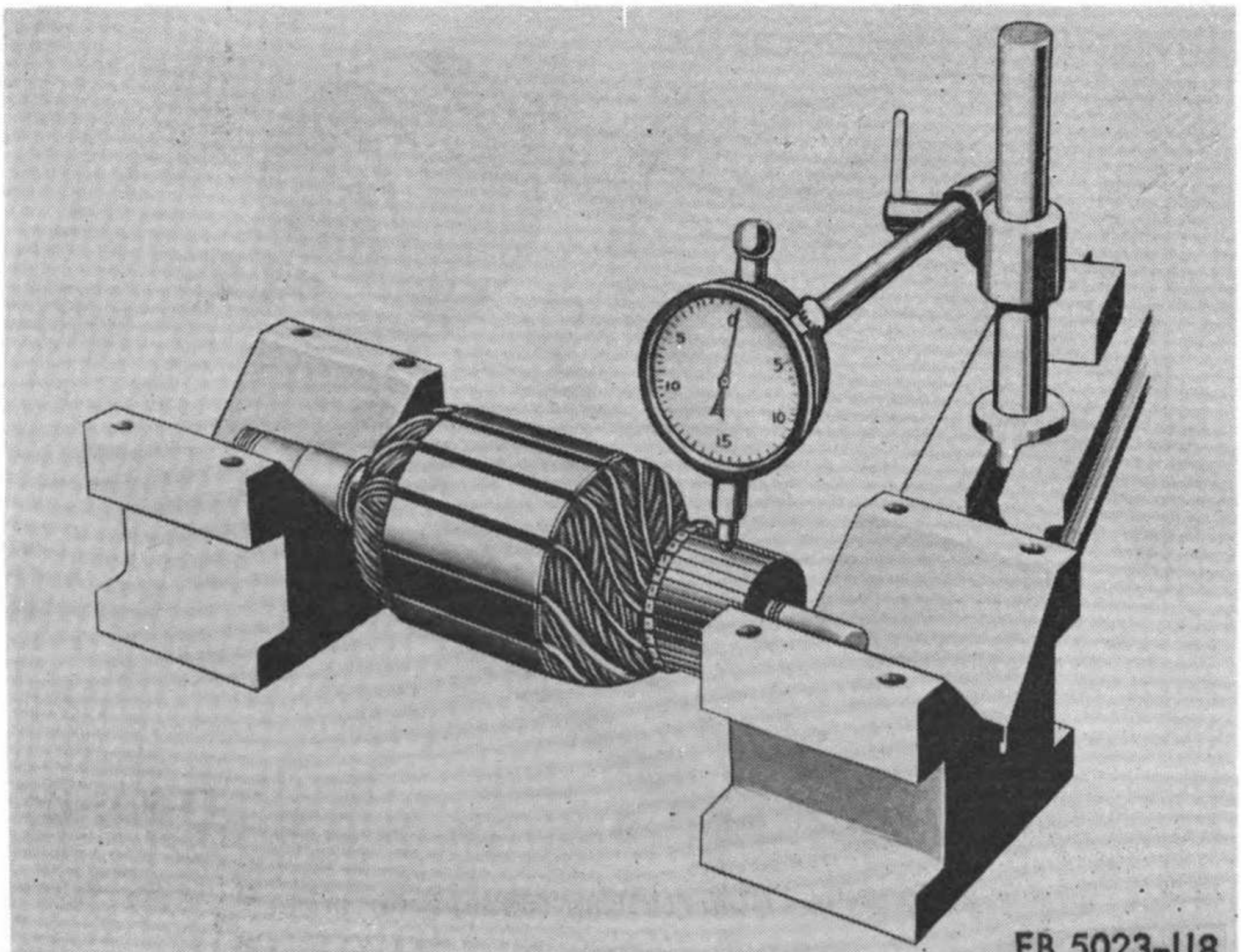


Figure 118. Checking concentricity of commutator.

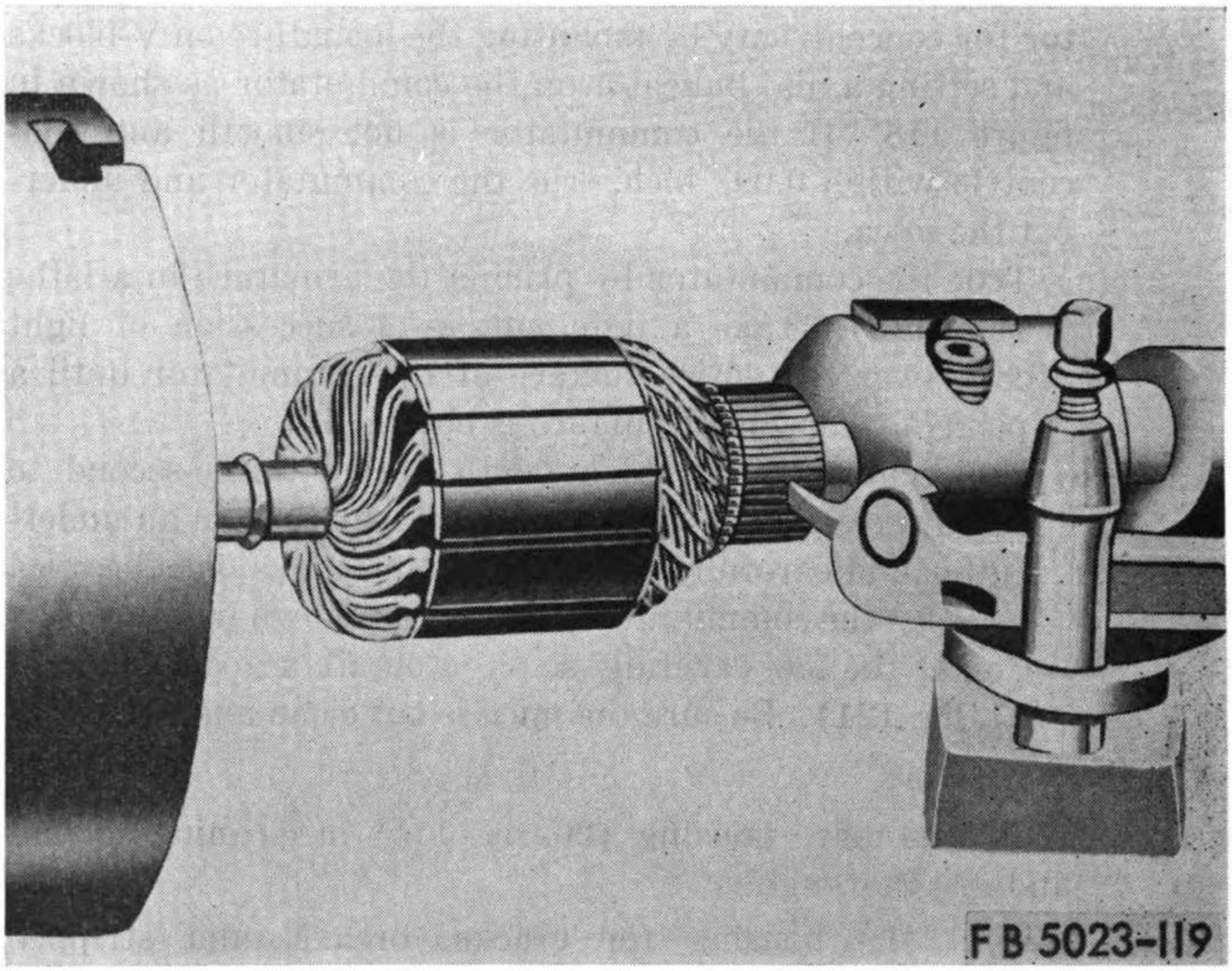


Figure 119. Truing commutator on a lathe.

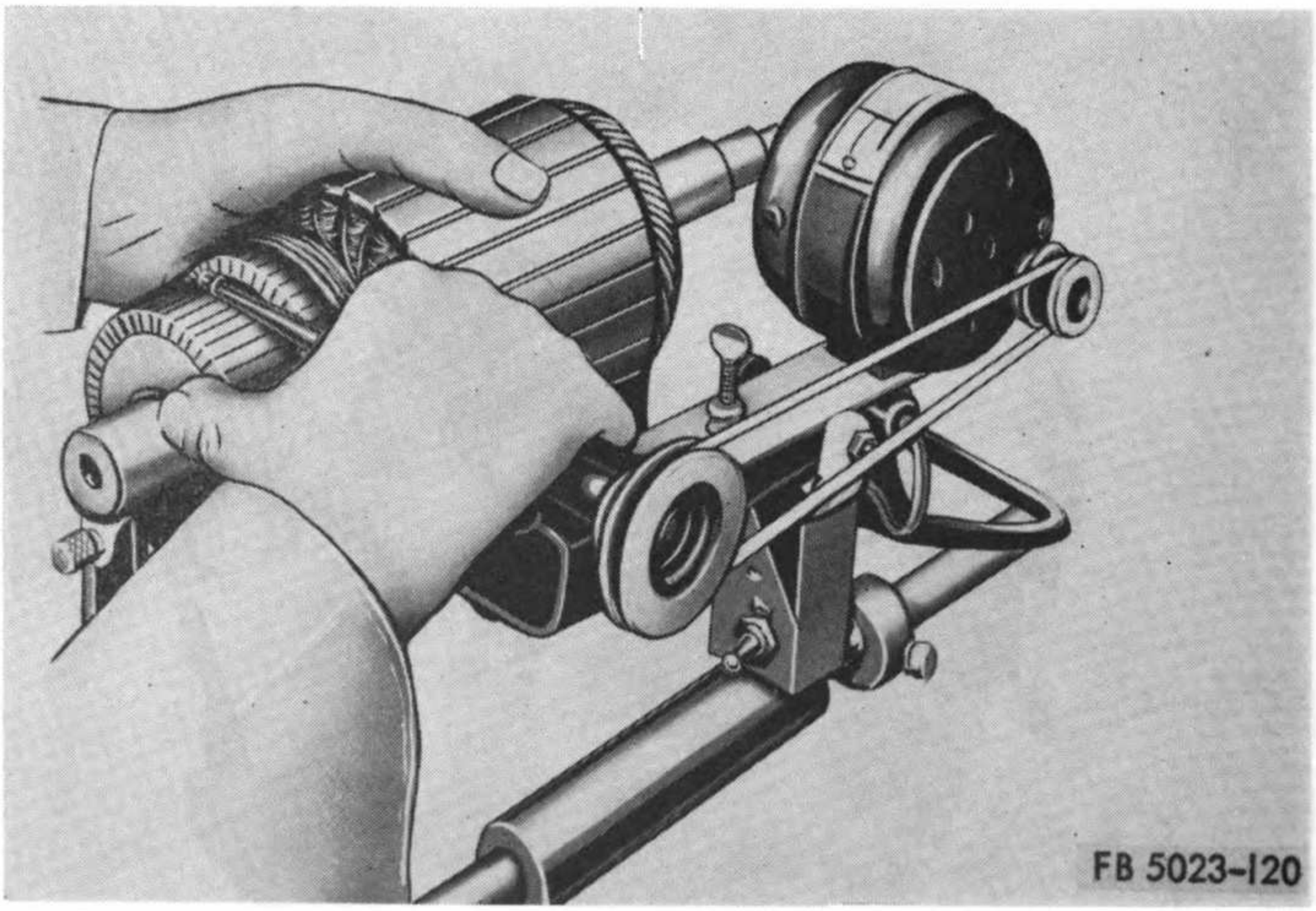
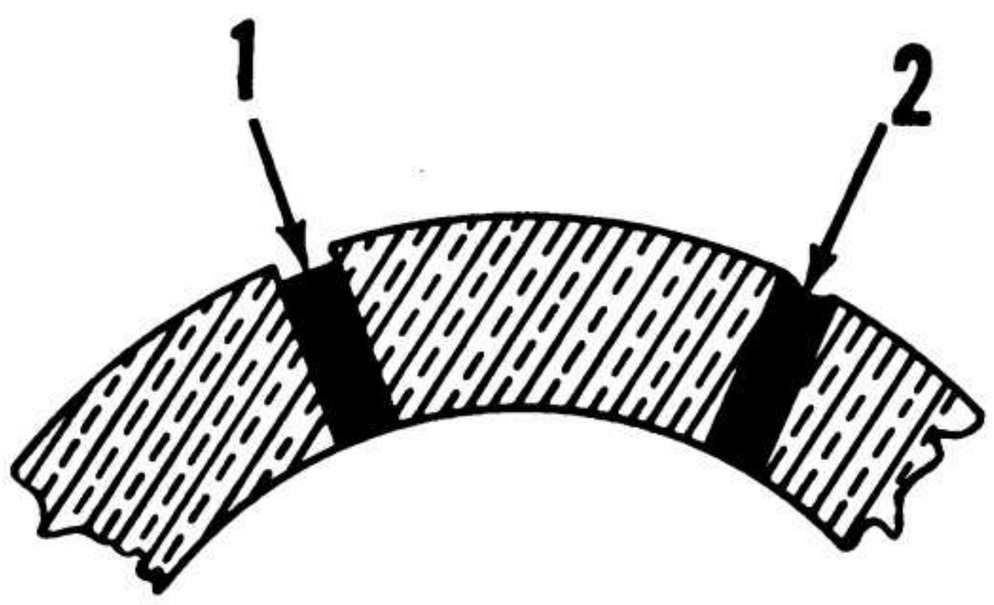


Figure 120. Undercutting commutator mica.



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1 Good undercut mica 2 Bad undercut mica

Figure 121. Examples of good and bad undercutting.

serving the fit. If it is loose, replace the bearing by pressing the old bearing out of the housing and pressing a new one in.

c. Intermediate Bearing. Clean, inspect, and repair the center bearing plate (3) in the same manner as for the drive housing (*b* above).

d. Commutator End Head and Brushes.

(1) Wash all parts except the brush plate (11, fig. 113), brushes (24), insulating washers (4), and bushing (5) in cleaning solvent and dry thorouglhy.

(2) Clean the brush plate, insulating washers, and bushings with a cloth dampened in cleaning solvent. Dry thoroughly.

(3) Clean the brushes with a clean, dry cloth.

(4) Replace the end head (8) if it is cracked, broken, or has damaged threads.

(5) Check the end head bushing (31) for wear by placing the end head on the commutator end of the armature shaft and observing the fit. If it is loose, remove the plug (32) and replace the bushing by pressing the old one out of the end head and pressing a new one in. Install a new plug.

(6) Inspect the brushes (24) for worn, pitted, or oil-soaked condition and defective leads. If any of these conditions exist or if the brushes are worn to less than one-fourth inch in length, replace them.

(7) Inspect the brush plate (13), brush holders (25) and springs (18) for breaks, damage, or defects. Replace all unserviceable parts.

e. Frame and Field.

(1) Wipe dirt and dust from the assembled frame and field with a cloth dampened in cleaning solvent.

(2) Inspect the field coils (11, fig. 114) for worn or frayed insulation, and for loose or broken connections. Repair damaged insulation and solder loose or broken connections.

(3) If the frame (1) is cracked or broken, replace the frame and field assembly.

(4) Test the field coil for grounds and continuity with test probes.

(*a*) *Ground test.*

1. Insulate the coil leads from the frame.

2. Touch one probe to an unpainted surface on the frame (1) and touch the other probe to the terminal post and coil leads successively. If the lamp lights, a ground exists.

(*b*) *Continuity test.* Touch one probe to the terminal post and touch the other probe to each of the coil leads successively. If the lamp fails to light when each coil lead is touched, an open circuit exists.

(5) If a grounded or open field coil cannot be readily repaired, replace the field coil.

(*a*) Unsolder the lead to the terminal stud (13). Remove the nuts (6), flat washers (7), insulating washers (8), insulating bushing (9), and terminal stud (13).

(*b*) Remove the pole shoe screws (5).

(*c*) Remove the pole shoes (12), field coil (11), and insulator (10) from the frame (1). Match mark the pole shoes and frame so that the pole shoes can be installed in the original position. Remove the pole shoes from the field coils.

(*d*) Place the insulating washer (8) and insulating bushing (9) on the terminal stud (13) and install the assembled stud in the frame (1) from the inside. Install the insulating washer (8) and flat washer (7), on the stud and secure with nut (6). Place the insulator (10) in position in the frame.

(*e*) Install the pole shoes (12) in a new field coil (11) and install the assembly in the frame so that the match marks on the shoes and frame are alined and install the insulators in the frame so that the coils will be insulated from the frame.

(*f*) Dip the screws (5) in oil and install them. As the screws are tightened, strike the frame (1) lightly with a rawhide hammer to aline the shoes and screws.

(*g*) Solder the coil lead to the terminal stud (13) using rosin core solder.

f. Drive Assembly.

(1) Wash the sleeve (7, fig. 115) guide (8), and spring (9), in cleaning solvent and dry thoroughly.

(2) Inspect Dyer drive parts carefully noting broken teeth on pinion, weak or broken pinion spring, broken internal splines on the pinion guide, and bent, misshapen or broken thrust washers. Replace any part of the Dyer drive which is found to be defective.

(3) Replace the shift lever (19) if inspection shows it to be bent, broken, worn, or otherwise defective.

188. Starting Motor Reassembly

a. Install the oiler felt (6, fig. 113) and oiler (7) in the end head (8).

b. Attach the brush leads to the holders (25, fig. 113) with screws (22) and lockwashers (23).

c. Aline the support plate (10), brush plate insulation (11), and brush plate (13), so that the stud passes through the stud opening in the insulator (11).

d. Place insulating bushing washers (12) in the large holes of the brush plate (13). Place insulated holder space plate (15) and insulator (14) against the brush holder (25) with holes of the three pieces alined. Place these parts against the brush plate (13) with the holes alined with the insulating washers (12).

e. Place the brush holder screw lockwasher (17) on the grounded holder screw (21) and thread the screw through the lined up parts and into the support plate (10). Attach the other grounded brush holders in the same way.

f. Place the lockwasher (17) on the grounded brush holder screw (19) and place two brush springs (18) over the body of the screw. Position the springs on the screw so that the straight end of the spring bears on the flat face of the brush holder (25). Thread the screw into the support plate (10) in the same manner as screw (21). Repeat for the other grounded brush holders.

g. Attach the insulated brush holders (25) in the same manner as above except that the insulator (14) and insulation washers (12) are omitted and the brush holder screws thread into the plate (13).

h. Place two insulating washers (4) over the brush plate stud and install the assembled brush plate (13) in the end head (8). Place a bushing (5), two insulating washers (4), flat washer (3), and lockwasher (2) on the stud. Secure with nut (1). From the brush holder side, secure the assembled brush holder to the end head with three screws (26) and lockwashers (27).

i. Install the assembled commutator end head on the field frame and secure with lockwashers (28), flat washers (29), and cap screws (30). Bend the tangs on the lockwashers (28) to lock the screws (30).

j. Connect the field coil leads to the brush holders with screws (22) and lockwashers (23).

k. Install the spacer collar (2, fig. 115) on the armature shaft, followed by the center bearing plate (3), thrust washer (4), space washer (5), cupped space washer (6), shift sleeve (7), pinion guide (8), spring (9), and pinion (10). Install the stop collar (12) on the splines of the armature shaft and turn it onto the shaft until it engages in the groove of the shaft. Aline the holes in stop collar (12) with the hole in the armature shaft and secure with the cotter pin (11).

l. Install the assembled armature and drive in the drive housing (20). Aline the center bearing plate (3) with the dowel pin in the housing and secure with screws (14) and lockwashers (13).

m. Install the shift lever (19) in the drive housing (20) so that it engages the shift sleeve (7). Install the cap (17) over the lever and secure with cap screws (15) and lockwashers (16).

n. Install the spring (18) on the lever (19) so that it engages the slot in the lever and the housing to keep the top of the lever pushed toward the flywheel end of the starting motor.

o. Install the assembled armature and drive housing in the frame and field assembly and secure with the screws (23), flat washers (24), and lockwashers (25). Bend the tangs on the lockwashers (25) to lock the screw (23).

p. Raise the brush springs (18, fig. 113) and install the brushes (24) in the holders (25).

q. Install the insulator (2, fig. 114) and cover (3) on the frame (1) and secure with the screws (14) and nuts (4).

r. Test the starting motor (par. 189).

189. Starting Motor Bench Tests

a. No-Load Test.

(1) Connect a 32-volt battery, ammeter, ammeter shunt,

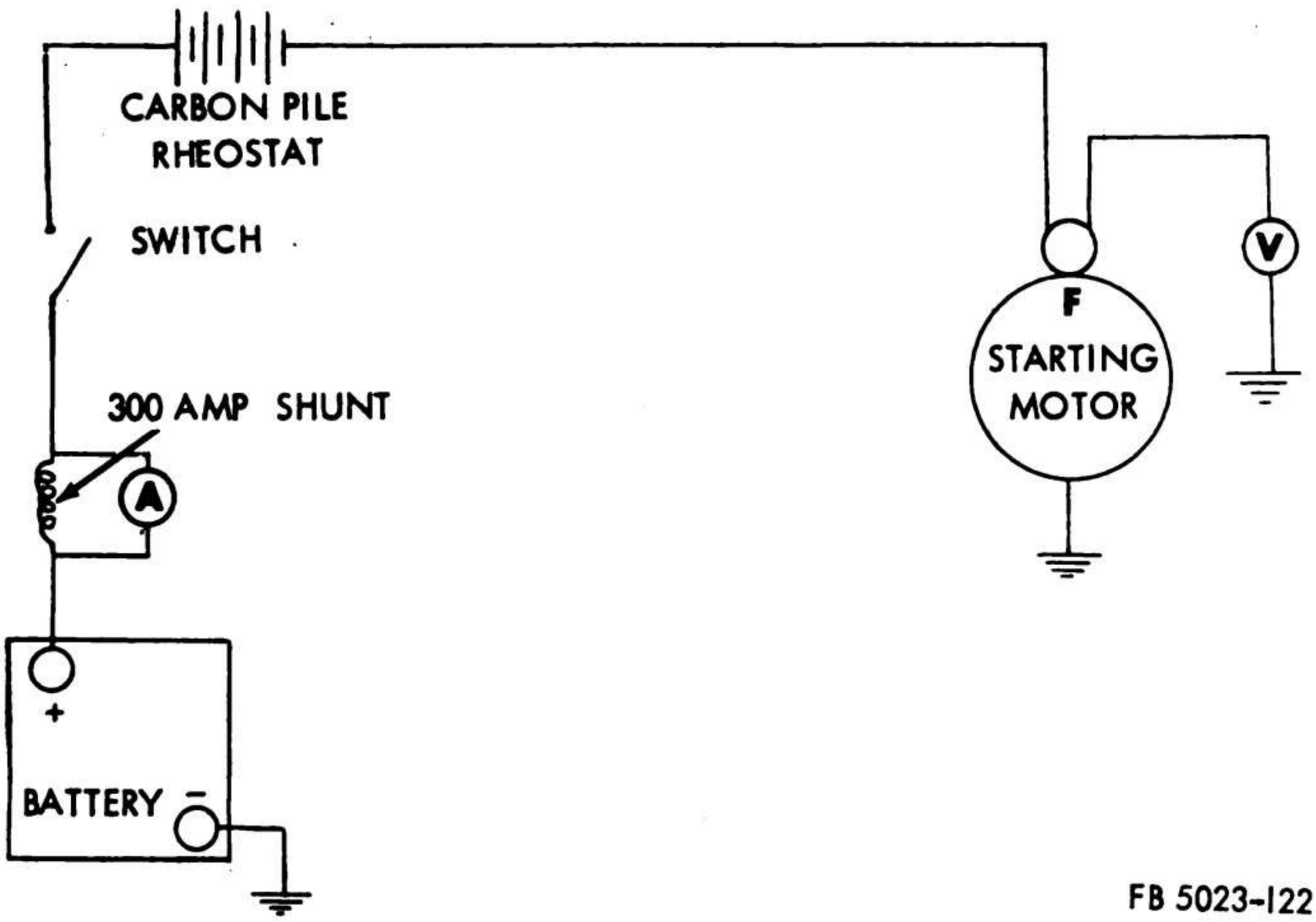

Figure 122. Wiring diagram for starting motor test.

carbon pile rheostat, voltmeter, and switch to the starting motor as shown in figure 122.

(2) Close the switch and adjust the rheostat to give a reading of 30.8 volts.

(3) Use a hand tachometer to check the speed and read the ammeter.

(4) The speed should be 8,000 rpm and the current draw should be 100 amperes. If the speed is low or the current is high, binding of the armature, misalinement, or an internal short is indicated. Low speed and low current indicates high resistance connections at the terminal stud, field coil, or brushes.

b. Stall-Torque Test.

(1) Clamp the starting motor in a vise and attach a torque arm and tension gage to the drive pinion.

(2) Make the test hookup as in *a*(1) above.

(3) Close the switch and adjust the rheostat to give a voltmeter reading of 5 volts.

(4) Read the tension gage and ammeter. The current draw should be 700 amperes and the minimum torque should be 56 ft-lb.

(*a*) To obtain the stall torque, multiply the tension gage reading (in pounds) by the length of the torque arm

(in feet). The product of this multiplication is the torque (in feet-pounds).

(*b*) High current or low torque indicates a shorted armature, shorted field coil, or improper assembly. Low current and low torque indicates poor brush seating, dirty commutator, or high resistance in internal connections.

(5) Install the starting motor (par. 91*d*).

Section XXII. STARTER SOLENOID SWITCH

190. Description

The starter solenoid switch (13, fig. 46), mounted on the starting motor (6), is an electrically-energized devise used in conjunction with the starting motor to crank the engine. When the starting button is pressed, the coil inside the sealed case (30, fig. 123) is energized. This creates a magnetic field which causes the plunger (3) to move. This movement of the plunger moves the disk (12) against the studs (14) to close the circuit between the batteries and starting motor field. At the same time, the plunger moves the starting motor shift yoke causing the drive pinion to engage the flywheel ring gear.

191. Starter Solenoid Switch Disassembly (fig. 123)

a. Remove the solenoid switch (par. 91*c*).

b. Remove the stud nuts (25), lockwashers (24), plain washers (23), small insulating washer (22), and large insulating washers (21) from end of the terminal studs (14).

c. Remove the terminal plate screws (20) and lockwashers (19); remove the terminal plate (18) from the case (30). Slide the insulating bushings (17) off the terminal studs (14). Remove the insulating plate (16) and terminal connector (15) from the terminal studs (14).

d. Pull the cotter pin (1) from the plunger shaft and unscrew the nut (13) from end of the plunger (3). Slide the contact disc (12), cupped washer (11), spring (10), plain washer (9) and slotted washer (8) off the end of the plunger shaft.

e. Pull the plunger (3) from the solenoid case (30).

f. Remove the terminal screw nuts (4), lockwashers (5), plain washers (6) and insulating washers (7) from the solenoid switch terminal screws (27); remove the solenoid switch terminal screws

(27) from the case (30) and slide the terminal screw insulating washers (26) off the solenoid switch terminal screws (27).

192. Starter Solenoid Switch Cleaning and Inspection (fig. 123)

a. Examine insulating washers, bushings, and plate (16) for charring, or deterioration. Replace parts if necessary.

b. Clean contact of terminal studs (14) with stiff wire brush. Replace studs if threads are damaged or worn.

c. If wires in case (30) are damaged beyond repair or broken off short, it will be necessary to replace the solenoid case. Replace the case if it is cracked or broken.

d. Replace plunger (3), as a unit, if damaged.

e. Replace spring (10) if it is elongated, lacks tension, or is distorted.

f. Replace damaged cap screws, terminal screws, and nuts if threads are worn or damaged. Replace damaged lockwashers, plain washers, and cotter pins.

193. Starter Solenoid Switch Reassembly (fig. 123)

a. Slide the terminal screw insulating washers (26) on the solenoid switch terminal screws (27); install the solenoid switch terminal screws (27) in the case (30), and secure with the insulation washers (7), plain washers (6), lockwashers (5) and terminal screw nuts (4).

b. Slide the plunger (3) in the case (30). Slide the slotted washer (8), plain washer (9), spring (10), and cupped washer (11) on the plunger shaft. Mount the contact disc (12) on the shaft, screw the nut (13) on the shaft and tighten. Secure with a new cotter pin (1).

c. Slide the terminal connector (15) on the terminal stud (14). Slide the insulating plate (16) over the terminal studs (14) and place the insulating bushings (17) on the studs (14). Place the terminal plate (18) over the terminal studs and mount this assembly on the solenoid case (30); secure with the terminal place screws (20) and lockwashers (19). Assemble the following pieces in turn over the terminal studs (14); large insulating washers (21), small insulation washers (22), plain washers (23), lockwashers (24), and secure with the terminal stud nuts (25).

d. Install the solenoid switch (par. 91*d*).

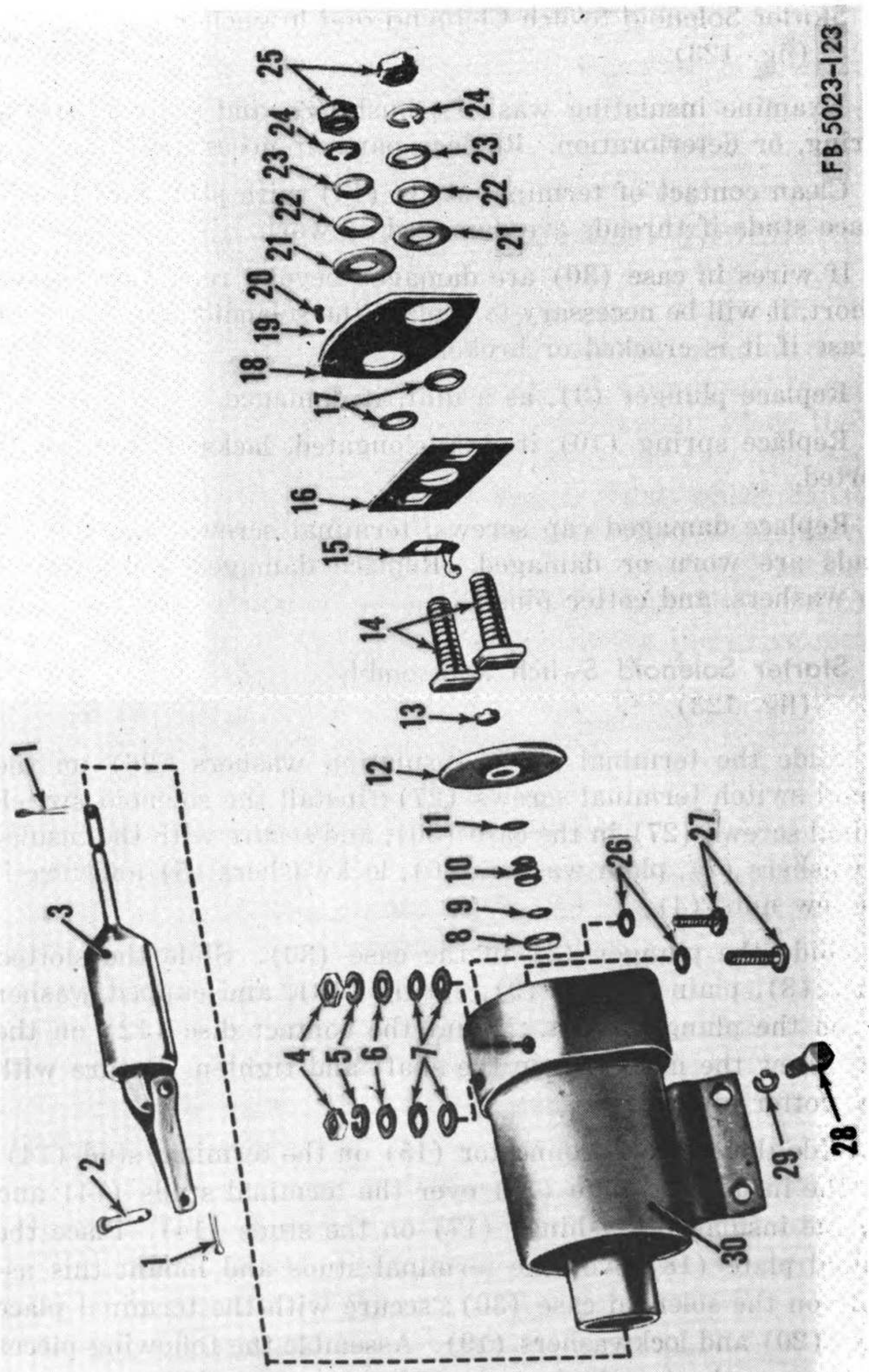

Figure 123. Starter solenoid switch, exploded view.

1	Pin, cotter, 1/16 x 3/4 (2 rqr)	17	Insulating bushings
2	Clevis pin	18	Terminal plate
3	Plunger	19	Lockwasher, #10 (4 rqr)
4	Nut, hex, 5/16 NC (2 rqr)	20	Screw, rd hd, #10 x 3/4 NC (4 rqr)
5	Lockwasher, 5/16 (2 rqr)	21	Insulating washers, large
6	Washer, flat, 5/16 (2 rqr)	22	Insulating washers, small
7	Insulating washers	23	Plain washers
8	Slotted washer	24	Lockwasher, 1/2 (2 rqr)
9	Plain washer	25	Nut, hex, 1/2 NC (2 rqr)
10	Spring	26	Insulating washers
11	Cupped washer	27	Terminal screws
12	Contact disc	28	Cap screw, 3/8 x 3/4 NC (4 rqr)
13	Slotted nut	29	Lockwasher, 3/8 (4 rqr)
14	Terminal studs	30	Case and coil assembly
15	Terminal connector		
16	Insulating plate		

Figure 123—Continued.

Section XXIII. GENERATOR ASSEMBLY

194. Description

a. Alternator. The field of the alternator, which is referred to as the rotor, consists of windings on the pole making electromagnets. The rotor is supplied with direct current excitation through the slipring assembly. Alternating current is generated in the stator windings and is tapped at the top change panel where voltage is selected. The rotor shaft is connected to the engine flywheel by a steel disk coupling and is supported by a bearing.

b. Exciter. The exciter is a conventional, self-excited, dc generator directly coupled to the rotor shaft. As the unit is brought up to operating speed, a voltage is generated in the exciter armature due to the residual magnetism of the poles in the exciter windings. The dc current generated is controlled by the exciter field rheostat and flows from the commutator through the exciter brushes and enters the rotor through the alternator brushes and sliprings. Changes in the dc excitation current will change the level of the generated ac current.

195. Main Generator Disassembly (fig. 124)

a. Remove the generator (par. 135*a*).

b. Remove the four cap screws (1) and lockwashers (2) securing the exciter end cover (3) to the field frame. Remove the end cover.

1 Cap screw, ½ x 3¼ NC **(24 rqr)**
2 Lockwasher, ½ (33 rqr)
3 End cover
4 Cap screw, ½ x 2¾ NC **(1 rqr)**
5 Washer, flat, ½ (4 rqr)
6 Armature
7 Exciter shunt field coil
8 Main field pole shim
9 Main field pole
10 Exciter interpole winding
11 Exciter field frame
12 Cap screw, ⅜ x 1½ NC **(16 rqr)**
13 Interpole winding shim

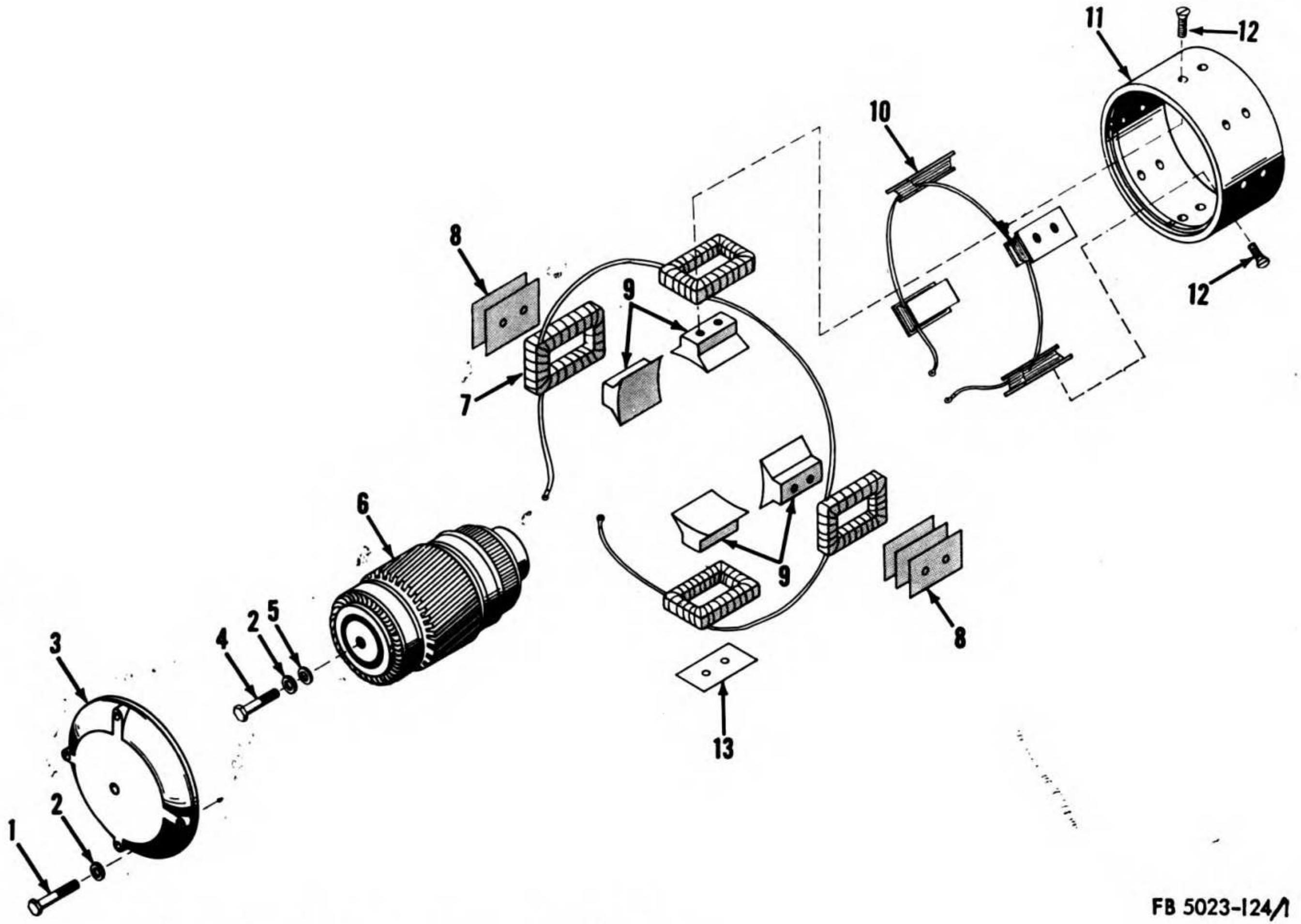

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Figure 124. Main generator, exploded view.

14 Brush holder spring plate
15 Commutator brush spring
16 Brush spring spacing washer (4 rqr)
17 Brush holder finger
18 Commutator brush
19 Screw, rd hd, #10 x ⅜ NC (8 rqr)
20 Lockwasher, int-ext teeth (4 rqr)
21 Brush holder insulator
22 Cap screw, ¼ x 1 NC (2 rqr)
23 Lockwasher, ¼ (18 rqr)
24 Brush holder yoke
25 Pipe plug ⅛ (2 rqr)
26 Grease pipe ⅛ (2 rqr)
27 Exciter end bracket
28 Elbow, pipe ⅛ x 90 (2 rqr)
29 Nipple, ⅛ x 1¾ (2 rqr)
30 Capacitor
31 Screw, rd hd, #10 x ⅝ (2 rqr)
32 Alternator stator
33 Lifting eye
34 Lockwasher, ⅞ (8 rqr)
35 Nut, hex, ⅞ NC (4 rqr)
36 Cap screw, ⅞ x 4 NC (8 rqr)
37 Cap screw, ½ x 1¾ NC (4 rqr)
38 Inspection cover wing screw
39 Inspection cover
40 Screw, fil hd, ¼ x ¾ NC (8 rqr)
41 Commutator brush holder
42 Screw, rd hd, ¼ x 1 NC (8 rqr)
43 Brush holder spring pin

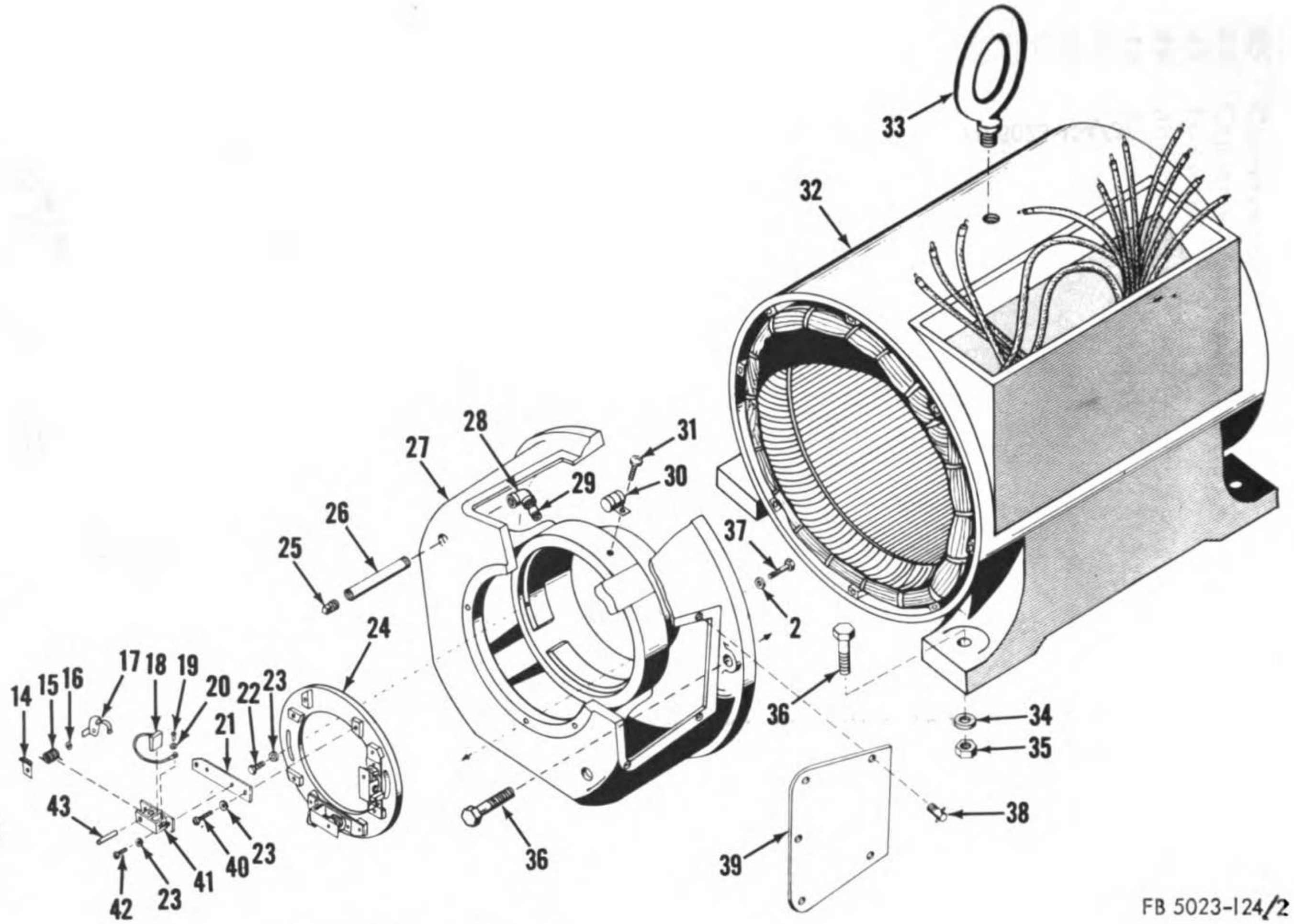

Figure 124—Continued.

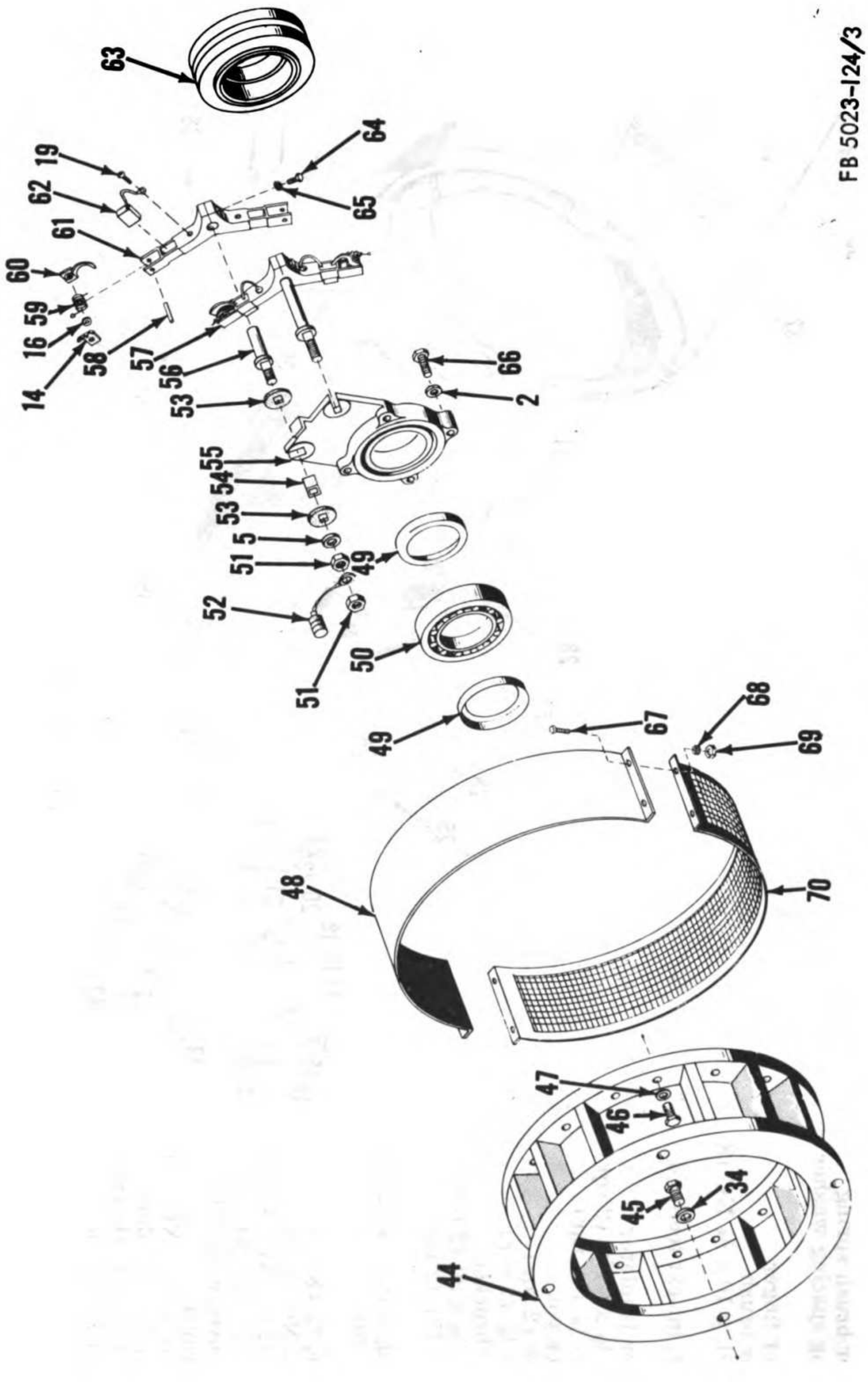

Figure 124—Continued.

44	Adapter	57	Alternator brush holder assembly
45	Cap screw, ⅞ x 1½ NC (4 rqr)	58	Brush holder spring pin
46	Cap screw, ⅝ x 1¾ NC (16 rqr)	59	Alternator brush spring
47	Lockwasher, ⅝ (16 rqr)	60	Brush holder finger
48	Adapter cover	61	Brush holder
49	Bearing grease slinger	62	Alternator brush
50	Ball bearing	63	Slipring
51	Nut, hex, ½ NF (4 rqr)	64	Cap screw, $\frac{5}{16}$ x ⅞ NC (2 rqr)
52	Capacitor	65	Lockwasher, $\frac{5}{16}$ (2 rqr)
53	Insulating washer (4 rqr)	66	Cap screw, ½ x 3½ NC (4 rqr)
54	Insulating bushing	67	Screw, fl hd, ¼ x 1¾ (4 rqr)
55	Brush holder yoke and bearing cap	68	Washer, flat, ¼ (4 rqr)
		69	Nut, hex, ¼ NC
56	Brush holder yoke stud	70	Adapter screen

Figure 124—Continued.

c. Remove the exciter and alternator brushes (pars. 103 and 104).

d. Remove the cap screw (4), lockwasher (2), and flat washer (5). Use a ¾–10 x 2¾ puller bolt and remove the armature and save the key (71).

e. Remove the cap screw (81) and lockwasher (2), and remove the drive disk plate (80) and drive disk (79) from the drive hub (77).

f. Remove the fan spacer (76) and fan (75).

g. Remove the cap screws (37) and lockwashers (2) securing the exciter field frame assembly to the exciter end bracket (27). Remove the assembled exciter field frame.

h. Check the outer edge of the brush holder yoke (24) and the end bell bracket (27) near one of the cap screws (22) to see that a match mark is visible on both parts. This mark locates the zero position of the brush yoke. Match mark the yoke and bracket if the original marking is illegible.

i. Remove the cap screws (22) and lockwashers (23) securing the assembled brush yoke (24) to the end bracket (27) and remove the yoke.

j. Remove the four cap screws (66) and lockwashers (2) securing the yoke (55) to the end bell bracket (27).

k. Remove the cap screws (36) securing the end bell bracket (27) to the stator (32) and remove the end bell bracket.

l. Support the exciter end of the rotor and use a suitable hoist to remove the assembled revolving field (73), brush holder yoke and bearing cap (55), and bearing (50).

71 Key, sq, ½ x 2¼ (1 rqr)
72 Key, sq, ½ x 1 15/16 (1 rqr)
73 Revolving field assembly
74 Key, sq, ¾ x 3 (1 rqr)
75 Fan
76 Fan spacer
77 Drive hub
78 Setscrew
79 Drive disk
80 Drive disk plate
81 Cap screw, ½ x 2¼ NC (12 rqr)

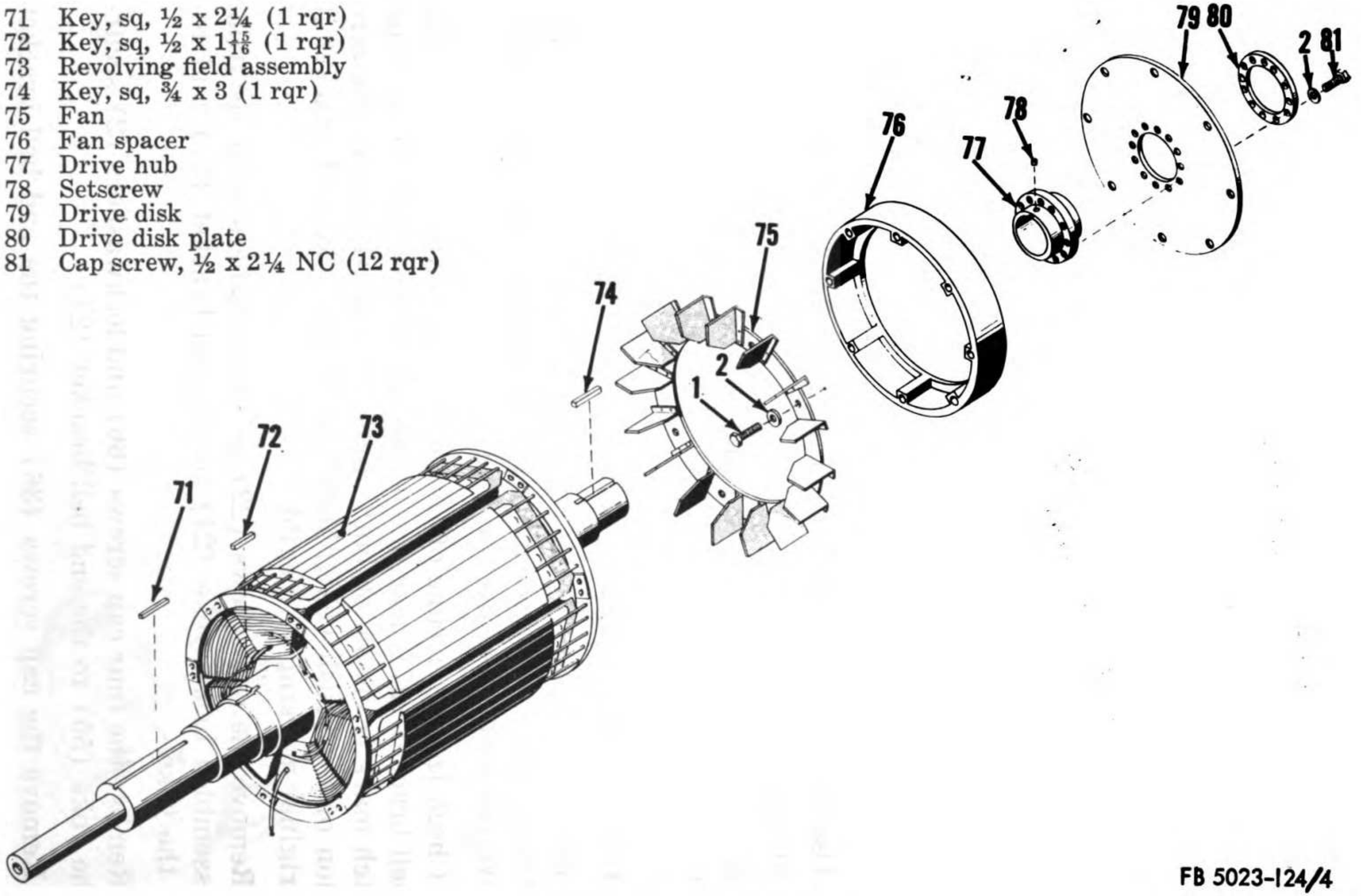

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Figure 124—Continued.

m. Attach a suitable puller and remove the bearing (50) and grease slingers (49) from the shaft. Remove the assembled brush holder yoke and bearing cap (55).

196. Main Generator Cleaning
(fig. 124)

a. Wash the all-metal parts in cleaning solvent and dry with compressed air.

b. Use compressed air to blow accumulations of dirt and dust from the assembled exciter frame (11), stator (32), and revolving field (73).

c. Use a cloth dampened with carbon tetrachloride to wipe clean the exciter frame, stator, and revolving fields.

d. Wash the bearing (50) in cleaning solvent and dry thoroughly with compressed air.

Warning: Do not allow the bearing to spin when drying with compressed air. Do not spin a dry bearing.

e. Lubricate the bearing with a small amount of OE 10.

197. Main Generator Inspection and Testing

a. Rotor Assembly and Associated Parts.

(1) Spin the bearing (50, fig. 124) and check to see that it is not rough, noisy, or badly worn. Inspect the grease slingers (49) to see that they are not broken, worn, or distorted.

(2) Inspect the drive disk (79), plate (80), hub (77), spacer (76), and fan (75) for cracks, breaks, distortion, and stripped threads.

(3) Inspect the exciter armature (6) to make sure that all windings are pressed into the core slots and are staked and soldered to the commutator risers.

(4) Test the exciter armature (6) for grounds using an ohmmeter as illustrated in figure 125.

(5) Test the armature (6, fig. 124) and revolving field (73) with a test unit (1, fig. 126) and steel strip (3). Hold the test unit and steel strip on opposite sides of the revolving field and exciter armature as shown in figure 126. Move the test unit and strip slowly around the fields and armature, keeping them opposite one another. If the steel strip vibrates, the component being tested is shorted.

Figure 125. Testing exciter armature with ohmmeter.

(6) Inspect the sliprings (63, fig. 124) and the exciter commutator to see that they are not rough, rigged, burned, or badly worn on the brush contact surfaces. If the mica is high between the commutator segments, it must be undercut.

(7) Inspect the revolving field (73) to see that they are secure and do not have any loose or bare wires. Check to see that the connecting wires from the sliprings (63) to the revolving fields (73) are tight and have good insulation.

(8) Test the revolving fields for grounds by using a dc test lamp. Test one probe to the rotor shaft and touch the other probe to one of the sliprings (63). If the lamp lights, a ground exists.

(9) Repair or replace any part found to be damaged or defective (par. 198*a*).

1 Test unit 2 Exciter armature 3 Steel strip

Figure 126. Testing exciter armature for shorts.

b. Stator Assembly.

(1) Inspect the stator (32) to see that it has no loose, bare, or frayed wires.

(2) Test the stator for shorts by using the test unit (1, fig. 126) and steel strip (3). Open the jaws on the test unit so that they fit the inside contour of the stator. Hold the unit inside the stator and hold the steel strip on the outside opposite the test unit. Move the test unit and steel strip slowly around the stator, keeping them opposite one another. If the steel strip vibrates, the stator is shorted.

(3) Test the stator for grounds and continuity by using a test lamp.

(*a*) *Ground test.* Touch one probe to the stator frame and touch the other probe to each of the stator leads. If the lamp lights, a ground exists.

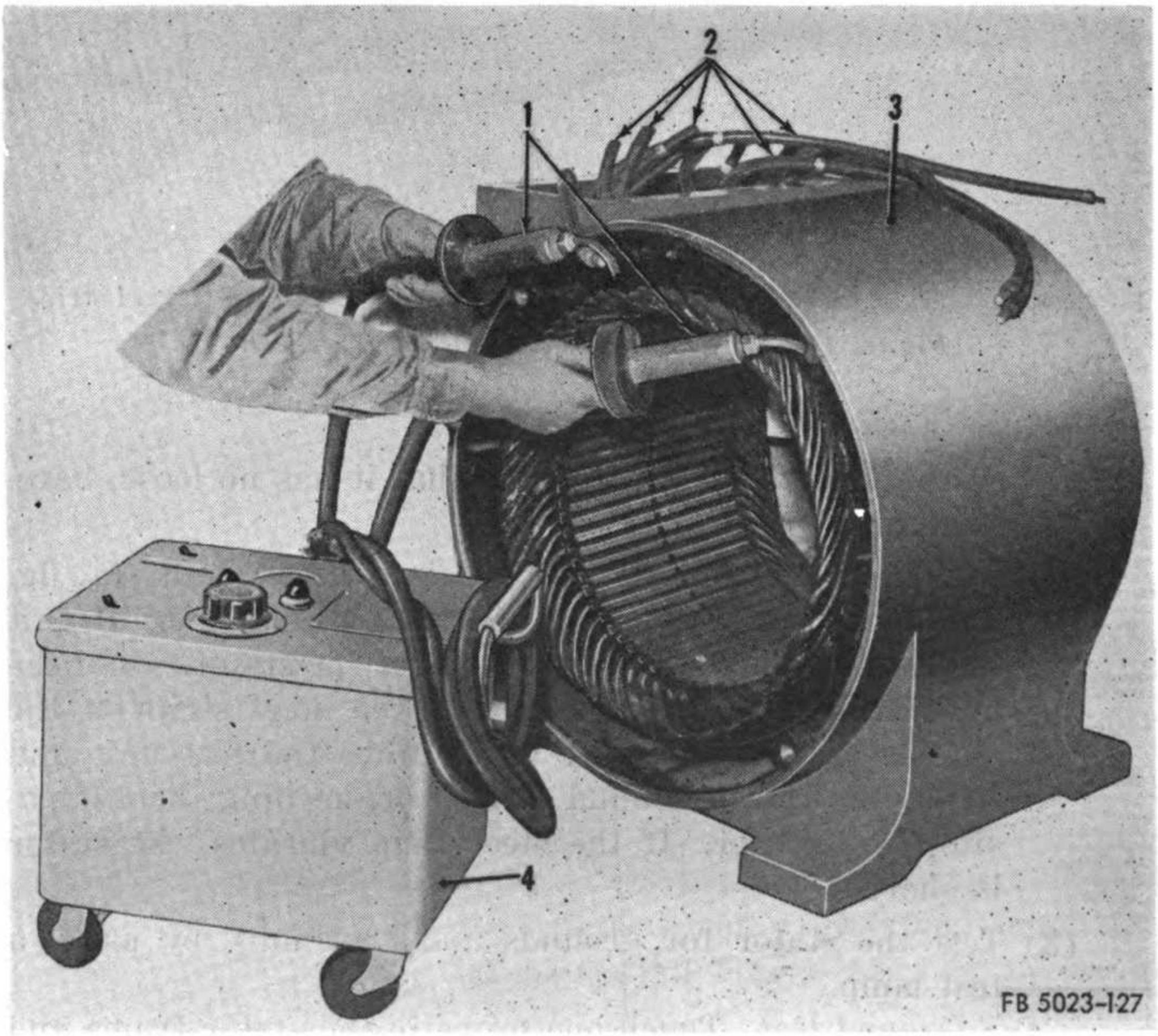
(*b*) *Continuity test.* Six different hookups are required. If the lamp fails to light any test hookup, an open circuit exists. Touch one test probe to each wire as indicated below for individual tests. The number given are the numbers appearing on the stator leads.

1. Lead number 7 to number 1 and 4.
2. Lead number 8 to number 5 and 2.
3. Lead number 9 to number 6 and 3.
4. Lead number 12 to N.
5. Lead number 11 to N.
6. Lead number 10 to N.

(4) Test the stator (3, fig. 127) with an insulating breakdown tester (4).

(*a*) Plug the tester in a 120-volt single-phase power source and turn the tester circuit breaker switch on. When the green lamp lights, it indicates that line voltage is applied to the tester.

(*b*) Adjust the tester rheostat to give a voltmeter reading of 1,800 to 1,900 volts.



1 Test probes
2 Stator leads
3 Stator
4 Insulation breakdown tester

Figure 127. Test main generator stator with insulation breakdown tester.

(*c*) Touch one test probe (1) to the stator frame.
(*d*) Touch the other test probe to a stator lead (2) and depress the test button on the probe handle or the one on the tester. When the red lamp lights, it indicates that test voltage is applied to the test probes (1). Hold the test button down approximately 30 seconds to allow sufficient time for an accurate test. If the circuit breaker trips, it indicates an insulation breakdown in the stator windings.
(*e*) Test each stator lead individually ((*c* and *d*) above).

(5) Inspect the adapter (44, fig. 124) to see that it is not cracked or broken and that it is fastened securely to the stator frame.
(6) Repair or replace any part found to be damaged or defective (par. 198*b*).

c. Exciter Frame Assembly.

(1) Inspect the exciter frame (11) to see that it is not cracked or broken.
(2) Inspect the pole shoes (9) and interpole windings (10) for signs of wear caused by the exciter armature rubbing on them. Check the pole shoe screws (12) to see that they are tight.
(3) Inspect the field coils (7) and interpole windings (10) to see that they have no loose, bare, or frayed wires (4).
(4) Test the exciter frame assembly for shorts and grounds in the same manner as for the stator (*b* (2 and 3) (*a*) above).
(5) Test for continuity by touching a test probe to each of the coil and interpole winding wires. If the lamp fails to light, an open circuit exists.
(6) Adjust the insulation breakdown tester to register 1,130 to 1,200 volts and test the exciter fields in the same manner as the stator (*b* (4) above).
(7) Repair or replace any parts found to be damaged or defective (par. 198*c*).

d. End Bell Bracket and Brush Assemblies.

(1) Inspect the end bell bracket (27) and assembled brush holder yoke (24), and brush holder yoke and bearing cap (55) to see that they are not cracked, broken, or distorted. Check to see that assembly and attaching hardware are in good condition and secure.
(2) Inspect the brush holders to see that no parts are bent, broken, or distorted. Inspect the brush springs (15 and

59) to see that they are not broken or damaged. Inspect the brushes (pars. 103 and 104).

(3) Inspect the capacitors (30 and 52) to see that there is no corrosion on the case, the case is securely attached to the end bell bracket, and the lead wires are tight and undamaged. Test the capacitors on a suitable tester. The capacitance should be 0.09 to 0.11 microfarads.

(4) Repair or replace all parts found to be damaged or defective (par. 198*d*).

e. Other Components.

(1) Inspect all other components of the main generator to see that they are not cracked, broken or distorted. Check all threaded parts to see that the threads are stripped or peened.

(2) Repair or replace all parts found to be damaged or defective.

198. Main Generator Repair

The procedures given in this paragraph are to be followed only to the extent required for making repairs or replacements of damaged or defective parts.

a. Rotor Assembly and Associated Parts.

(1) Remove the setscrew (78, fig. 124) from the drive hub (77) and use a puller to remove the hub from the rotor shaft as shown in figure 128. Remove the key (74) from the shaft.

Figure 128. Removing drive hub from rotor shaft.

(2) True the sliprings (63) and exciter commutator by placing them in a lathe. Take a light cut, or a succession of light cuts, over the entire surface until a perfectly concentric surface is obtained.

(3) Undercut the commutator mica to a depth of one thirty-second to three sixty-fourths inch with an undercutter as shown in figure 129. Center the tool carefully so as to obtain a good undercut (1, fig. 121). Be sure the mica is cut clean and square.

(4) Polish the commutator and sliprings with a commutator polishing stone.

(5) Stake and solder the wires to the commutator risers if they are loose.

Caution: Never use acid flux or acid core solder when soldering electrical connections.

(6) If the revolving fields (73, fig. 124) or exciter armature (6) is grounded or shorted, replace or rewind the defective part.

(7) If the sliprings (63) are beyond repair, replace them.

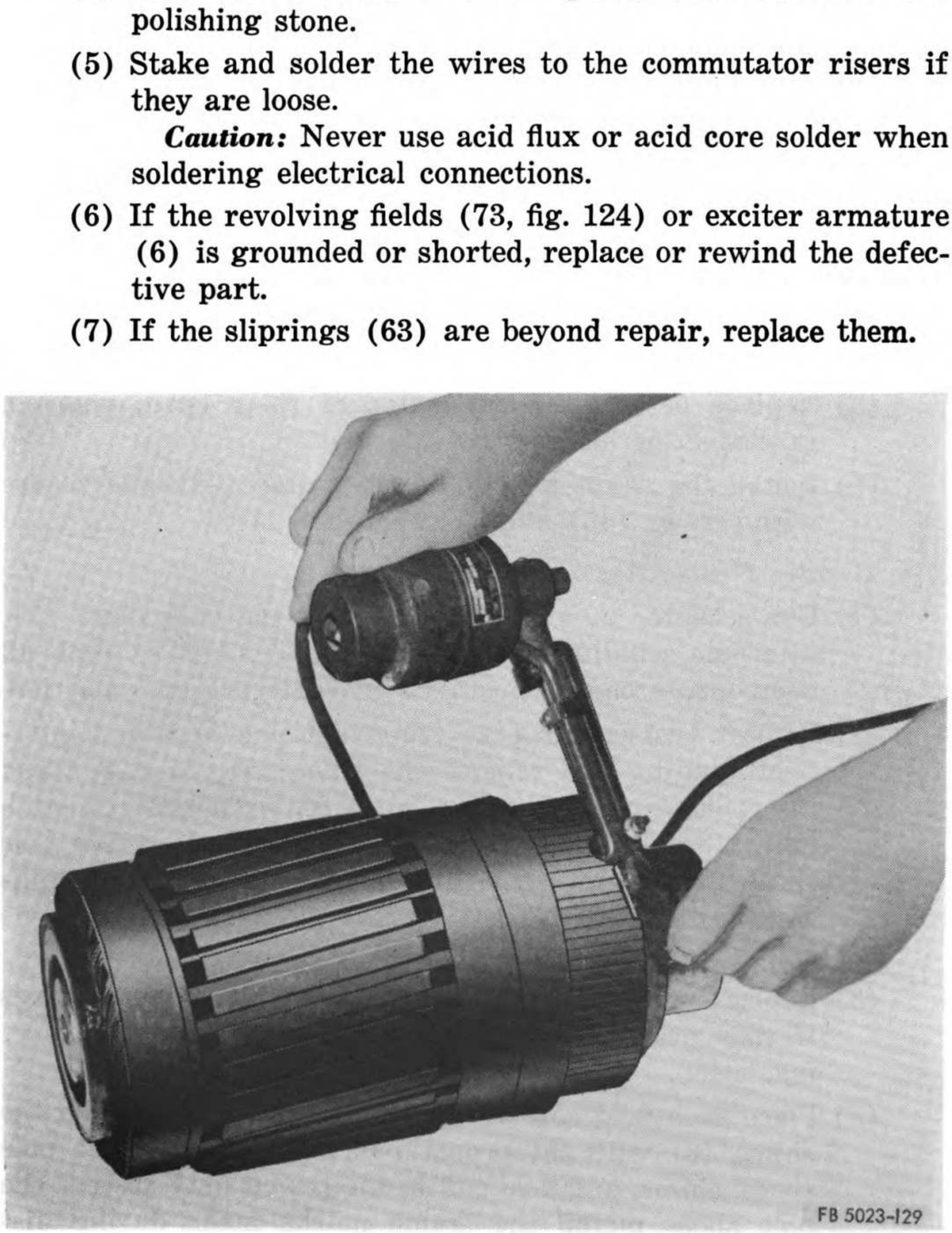


Figure 129. Undercutting commutator mica.

(*a*) Unsolder the two wires at the sliprings and use a suitable puller to pull the sliprings from the rotor shaft.

(*b*) Install new sliprings on the rotor shaft with the lugs toward the revolving fields. Press the sliprings over the key (72) and seat them firmly against the shoulder of the rotor shaft.

(*c*) Solder the leads from the revolving fields to the sliprings using rosin core solder.

(8) Pack the bearing (50) one-half full of grease. Refer to LO 5–5023.

(9) Install the key (74) in the rotor shaft keyway and press the hub (77) on the shaft until it seats against the shaft shoulder. Install and tighten the setscrews (78).

b. Stator Assembly.

(1) Remove the capscrews (45) and lockwashers (34) securing the adapter (44) to the stator (32). Remove the adapter from the stator.

(2) Use a bottom tap to recut damaged threads in the stator frame.

(3) Replace or rewind the stator if it is open, shorted, grounded, or has defective insulation.

(4) Install the adapter (44) on the stator (32) and secure with screws (45) and lockwashers (34).

c. Exciter Frame Assembly.

(1) Use a center punch to match mark the pole shoes (9), interpole windings (10), and frame (11) so that all components can be installed in their original position.

(2) Remove two screws (12) from each pole shoe and interpole winding and remove the poles (9), coils (7) and interpole windings (10). Use a center punch to match mark the shims (8 and 13) and their respective pole shoes (9) and interpole windings (10) so that the shims can be installed in their original position. Remove the shims from the frame (11).

(3) Replace or rewind the field coils and interpole windings if they are shorted, grounded, open, or have defective insulation.

(4) Place each field coil winding on a pole shoe. Match the shims (8) with the proper pole shoes. Install the pole shoes, shims, and field coil in the frame (11) so that the pole shoes match the frame marks made during disassembly. Secure each pole shoe with two screws (12).

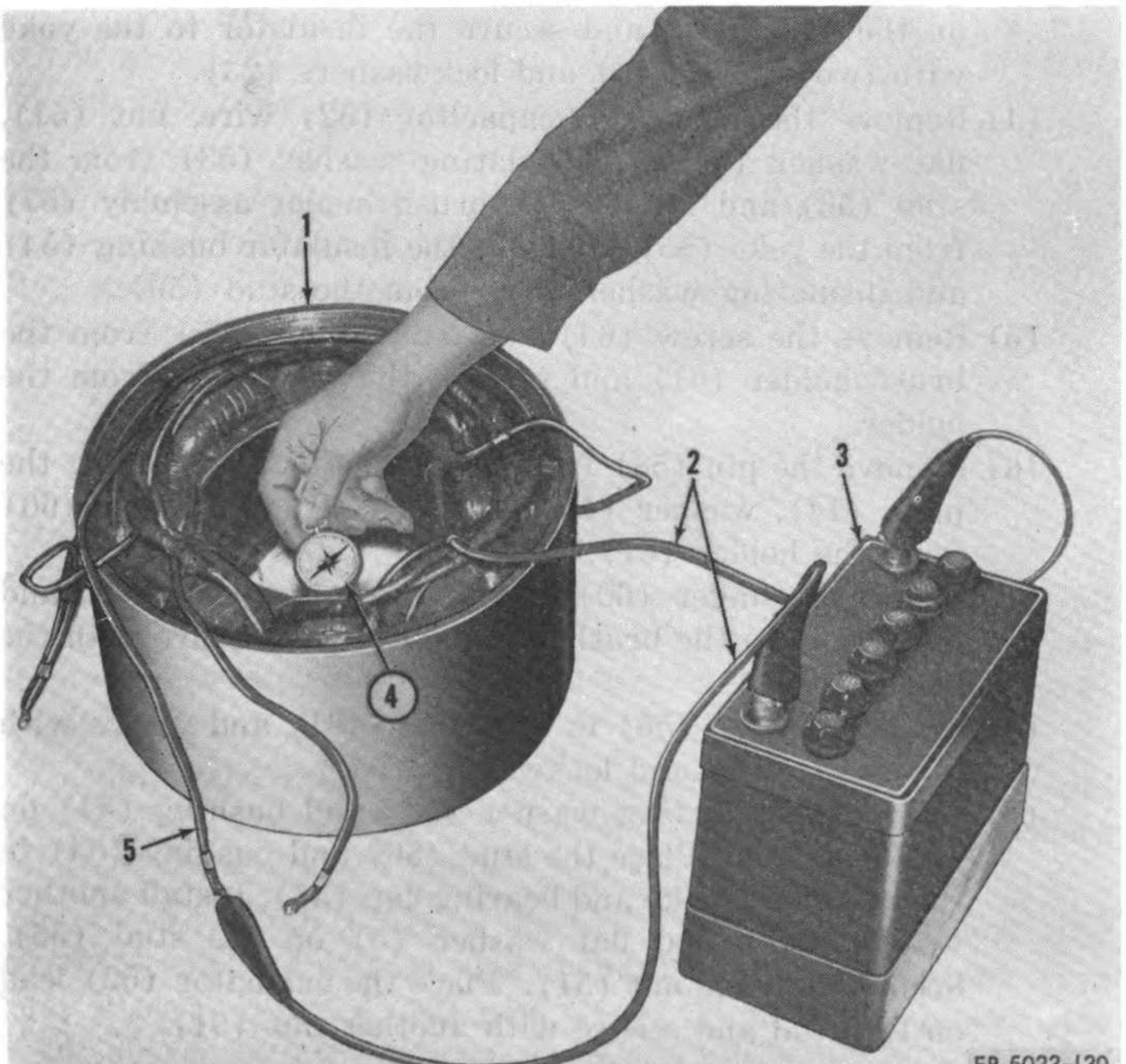
(5) Match the shims (13) with the proper interpole winding (10) and install the windings and shims in the frame (11) so that the marks made during disassembly will match. Secure each interpole winding with two screws (12).

(6) Check the polarity of the assembled exciter frame assembly (1, fig. 130).

(*a*) Attach leads (2) to the terminal posts of a fully charged battery (3).

(*b*) Attach the other end of the leads to the field coil wires (5), one lead to each wire.

(*c*) Hold a compass (4) near a pole shoe as shown in figure 130 and note the polarity of that coil. Move the compass to the opposite pole shoe and note the polarity of that coil. Both coils must have the same polarity, either north or south. If the polarity is incorrect, check all coils and mark the polarity of each.



1 Exciter frame assembly
2 Battery leads
3 Storage battery
4 Compass
5 Field coil wire

Figure 130. Checking polarity of exciter frame assembly.

(*d*) To correct the polarity, remove the field coils ((2) above) and relocate the windings (7) on the poles (9, fig. 124) so that the coils with like polarity will be opposite one another when installed ((4) above).

d. End Bell Bracket and Brush Assemblies.

(1) Remove two screws (40) and lockwashers (23) from each brush holder (41), remove pin (43) releasing the brush holders from the yoke (24).

(2) Remove two screws (42) and lockwashers (23) from each brush holder (41), remove pin (43) releasing the plate (14), frame (15), washer (16), and finger (17), from the brush holder.

(3) Place the brush plate (14), spring (15), washer (16), and finger (17), in the brush holder (41) and secure with a pin (43). Install the brush holder on the insulator (21) and secure with two screws (42) and lockwashers (23). Install the assembled brush holder and insulator on the yoke (24) and secure the insulator to the yoke with two screws (40) and lockwashers (23).

(4) Remove the nut (51), capacitor (52) wire, nut (51), flat washer (5) and insulating washer (53) from the stud (56) and remove the brush holder assembly (57) from the yoke (55). Remove the insulator bushing (54) and insulating washer (53) from the stud (56).

(5) Remove the screw (64) and lockwasher (65) from the brush holder (61) and remove the stud (56) from the holder.

(6) Remove the pin (58) from the holder (61) releasing the plate (14), washer (16), spring (59), and finger (60) from the holder (61).

(7) Install the finger (60), spring (59), washer (16), and plate (14) in the brush holder (61) and secure with the pin (58).

(8) Install the stud (56) in the holder (61) and secure with the screw (64) and lockwasher (65).

(9) Install an insulating washer (53) and bushing (54) on the stud (56). Place the stud (56) and bushing (54) in the slot of the yoke and bearing cap (55). Install another washer (53) and flat washer (5) on the stud (56). Secure with the nut (51). Place the capacitor (52) lead on the stud and secure with another nut (51).

e. Other Components.

(1) Remove the pipe plug (25) from the pipe (26). Unscrew the pipe from the elbow (28) and remove the elbow from

the nipple (29). Remove the nipple from the end bell bracket (27).

(2) Use a bottom tap to recut damaged threads in the end bell bracket (27).

(3) Use a soft mallet to straighten the cover (48) and screen (70).

(4) Replace all other damaged or defective parts.

(5) Install the nipple (29) in the end bell bracket (27). Install the elbow (28) on the nipple. Install the pipe (26) in the elbow. Install the plug (25) in the pipe.

199. Main Generator Reassembly (fig. 124)

a. Install the assembled brush holder yoke and bearing cap (55) on the rotor shaft so that the slipring brushes are towards the sliprings (63). Install a grease slinger (49) on the shaft with the cup side toward the yoke (55). Install the bearing (50) next to the grease slinger. Install another grease slinger (49) with the cup side away from the bearing (50).

b. Use a suitable hoist and install the assembled revolving field (73), brush holder yoke and bearing cap (55), and bearing (50) in the stator (32) from the adapter (44) end. During installation, support the exciter end of the revolving fields so as not to damage either the revolving fields or stator.

c. Install the end bell bracket (27) on the stator (32) and secure with cap screws (36).

d. Secure the yoke (55) to the exciter end bell bracket (27) with cap screws (66) and lockwashers (2).

e. Install the assembled brush holder yoke (24) in the end bell bracket (27). Aline the match marks for zero brush position. Secure the brush yoke to the end bracket with the screws (22) and lockwashers (23).

f. Install the exciter field frame assembly on the exciter end bracket (27) and secure with cap screws (37) and lockwashers (2) from the end bracket side.

g. Place the fan (75) on the hub (77) end of the revolving field (73) so that the blade side of the fan is toward the revolving field. Place the spacer (76) next to the fan so that the open side of the spacer is toward the fan. Install the drive disk (79) on the hub (77). Install the drive disk plate (80) on the hub (77) and disk (79) alining the holes. Secure the plate (80) and disk (79) to the hub (77) with cap screws (81) and lockwashers (2).

h. Install the key (71) in the rotor shaft. Place the exciter armature (6) on the rotor shaft so that the keyway in the armature is alined with the key (71). Place a lockwasher (2) and flat washer (5) on the screw (4). Install the screw and tighten to pull the armature (6) on to the rotor shaft. Be sure that the armature (6) seats against the shoulder of the rotor shaft.

i. Install the exciter and alternator brushes (pars. 103 and 104).

j. Install the exciter end cover (3) on the exciter frame (11) and secure with cap screws (1) and lockwashers (2).

k. Install the generator (par. 135*b*).

200. Brush Position Adjustment

a. Remove the inspection covers (48 and 70, fig. 124).

b. Connect the test leads of a dc voltmeter across the commutator brushes (3, fig. 58).

c. Start the generator set (par. 15) and increase to full speed after operating temperature is reached.

d. Turn the voltage regulator switch (8, fig. 16) off and adjust the rheostat (12) to give a dc voltmeter reading of approximately 70 volts.

e. Loosen the cap screws (22, fig. 124) and slowly rotate the brush holder yoke (24) until a peak reading is obtained on the dc voltmeter. Rotate the yoke about 2° past the peak reading position and tighten the bolts (22) securely. This is the neutral or zero brush position.

f. Stop the generator unit (par. 17) and remove the voltmeter test leads.

g. Install the inspection covers (48 and 70).

Section XXIV. SUBBASE ASSEMBLY

201. Description

The subbase (9, fig. 5) is of welded steel construction. The design of the base permits the generator set to be towed for short distances by attaching hooks to the towing eyes (15, fig. 1). The set can be secured to a fixed foundation by bolting the base down at each corner.

202. Subbase Inspection and Repair

a. General. Inspection and repair of the subbase assembly can usually be accomplished with removal of the engine or generator.

b. Inspection.

(1) Inspect all welded joints to see that the welds are not broken or cracked.

(2) Inspect all components of the assembly to see that the paint is not cracked, chipped, blistered, or flaked off.

(3) Inspect the subbase for corrosion and dents and clean off all rust.

c. Repair.

(1) Weld all previously welded joints which show signs of breaking or cracking.

(2) Clean and paint all surfaces that have been rewelded and those surfaces where the original paint is cracked, chipped, blistered, or flaked off. Refer to TM 9–2851 for additional painting information.

Section XXV. ENGINEERING DATA

203. General

The engineering data in this section include general manufacturing tolerances, adjustment and alinement tolerances, and torque information required in maintaining the Buda generator set, model 8DCS–1125.

204. Engine

a. Torque Wrench Tension Scale for Nuts and Bolts.

Diameter		*Foot-pounds*
⅜ in.		60–70
7/16 in.		75-85
½ in.		95–105
⅝ in.		150–160
11/16 in.		195–200
¾ in.		210–230
13/16 in.		230–250
⅞ in.		245–275
1 in.		285–315
1⅛ in.		325–350
⅝ in.	(Cylinder head stud nuts)	190–200

b. Bearing Clearances.

	Desired	*Maximum*
Main bearings	0.0031 to 0.0056 in.	0.008 in.
Connecting rod bearings	0.0025 to 0.0045 in.	0.0065 in.
Camshaft bearings	0.003 to 0.007 in.	0.012 in.
Idler gear bearings	0.0015 to 0.002 in.	0.0035 in.
Rocker arm bearings	0.002 to 0.0025 in.	0.006 in.
Piston pin to rod bushing	0.001 to 0.0018 in.	0.0025 in.

c. End Thrust.

	Desired	*Maximum*
Crankshaft	0.005 to 0.013 in.	0.016 in.
Connecting rod side clearance	0.004 to 0.009 in.	0.012 in.
Camshaft	0.003 to 0.009 in.	0.015 in.
Idler gear	0.003 to 0.009 in.	0.015 in.
Accessory drive gear	0.002 to 0.005 in.	0.010 in.

d. Backlash.

	Desired	*Maximum*
Crankshaft gear	0.002 to 0.004 in.	0.010 in.
Camshaft gear	0.002 to 0.004 in.	0.010 in.
Idler gear	0.002 to 0.004 in.	0.010 in.
Water pump gear	0.003 to 0.005 in.	0.015 in.
Accessory drive gear	0.003 to 0.005 in.	0.015 in.
Oil pump gears	0.002 to 0.004 in.	0.015 in.

e. Piston Clearances.

	Desired	*Maximum*
Piston to cylinder sleeve	0.009 to 0.011 in.	0.020 in.
Compression ring gap	0.020 to 0.035 in.	
Top (firing) ring gap	0.015 to 0.030 in.	
Oil ring gap	0.015 to 0.030 in.	
Piston ring groove clearance		
Top (firing) ring	0.002 to 0.004 in.	0.012 in.
Compression ring	0.0015 to 0.0035 in.	0.010 in.
Oil ring	0.0015 to 0.0030 in.	0.010 in.
Piston pin in piston	0.0001 to 0.0003 in.	0.001 in.

f. Valves.

	Desired	*Maximum*
Valve stem to guide		
Intake	0.002 to 0.003 in.	0.005 in.
Exhaust	0.004 to 0.005 in.	0.007 in.
Valve lifter to bracket	0.0002 to 0.0005 in.	0.004 in.

g. Miscellaneous Clearances.

	Desired	*Maximum*
Oil pump gears to case	0.0017 to 0.0027 in.	0.007 in.
Oil pump gears to case flange	0.002 to 0.004 in.	0.005 in.
Cylinder sleeve above block	0.0000 in.	0.001 in.

205. Generator

a. Alternator.

(1) *Stator winding data.*

	Main	*Auxiliary*
Number of poles	6	6
Number of slots	72	72
Number of coils	72	36
Coil span, slot I to slot	10	10
Turns per coil	4½	1
Wire size	3 # 11	3 # 11
Wire insulation	Formvar cotton	Formvar cotton
Connection of phases	Star	Star
Connected	6 parallel 220 volt	
	3 parallel 400 volt	3 parallel 400 volt

	Main	*Auxiliary*
Weight of copper, lbs.	105	total
Resistance at 25° C., Ohms T–T	0.0119	220 volt 60 cycle
	0.0528	400 volt 50 cycle

Varnish treatment:

(*a*) Preheat for 2 hours

(*b*) Immerse while hot in baking varnish

(*c*) Drain well

(*d*) Bake for 15 to 16 hours at 250° F.

(*e*) Repeat the above to give 3 coats

(*f*) Add a final coat of air drying varnish

(2) *Field winding data.*

Wire size	10 sq.
Wire insulation	D. C.
Turns per coil	290
Resistance at 25° C.	4.5 (6 poles series)
Weight in lbs.	216 (6 poles)
Number of coils	6
Coils connected	Series

Varnish treatment

(*a*) Each layer of wire to be thoroughly brushed with heavy baking varnish as coil is wound.

(*b*) Bake for 10 to 12 hours at 290° F.

(*c*) Add a final coat of air drying red protective sealer.

b. Exciter.

(1) *Armature winding.*

Number of coils	89 and 1 dead
Number of coils per slot	3
Number of slots	30
Turns per coil	3⅔
Wire size and insulation	13 F. C.
Coil pitch	Slot 1 to slot 8
Number of commutator bars	89
Commutator pitch	Bar 1 to bar 45
Weight of armature winding	9.6 lbs.
Armature resistance at 25° C.	0.31 ohms
Type of winding	Wave wound
Varnish treatment	

(*a*) Preheat for 1 hour.

(*b*) Immerse while hot in baking varnish.

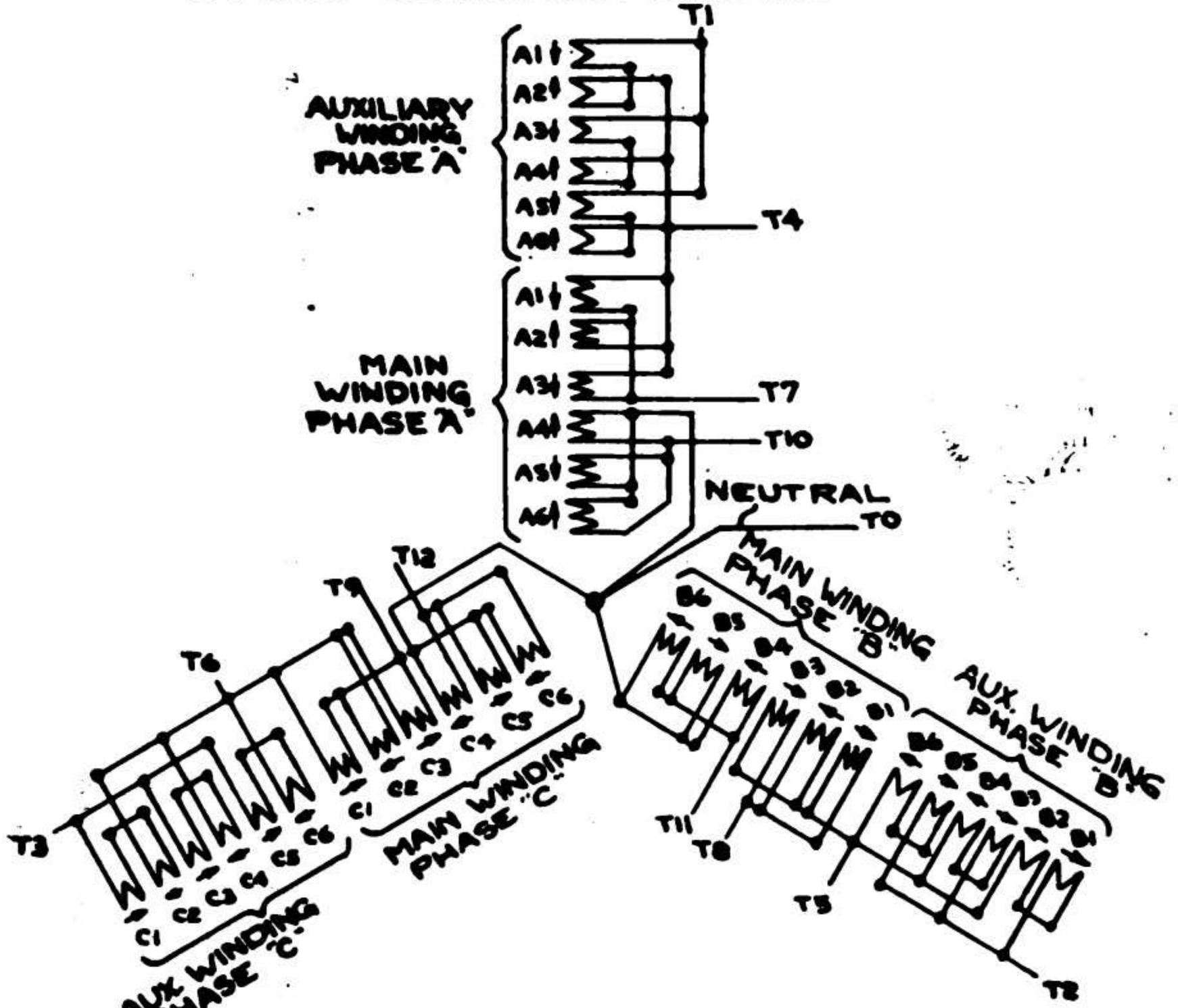
(*c*) Drain well.

(*d*) Bake for 7 to 8 hours at 250° F.

(*e*) Repeat the above to give 3 coats.

(*f*) Add a final coat of air drying varnish.

STATOR CONNECTION DIAGRAM



ROTOR WIRING DIAGRAM

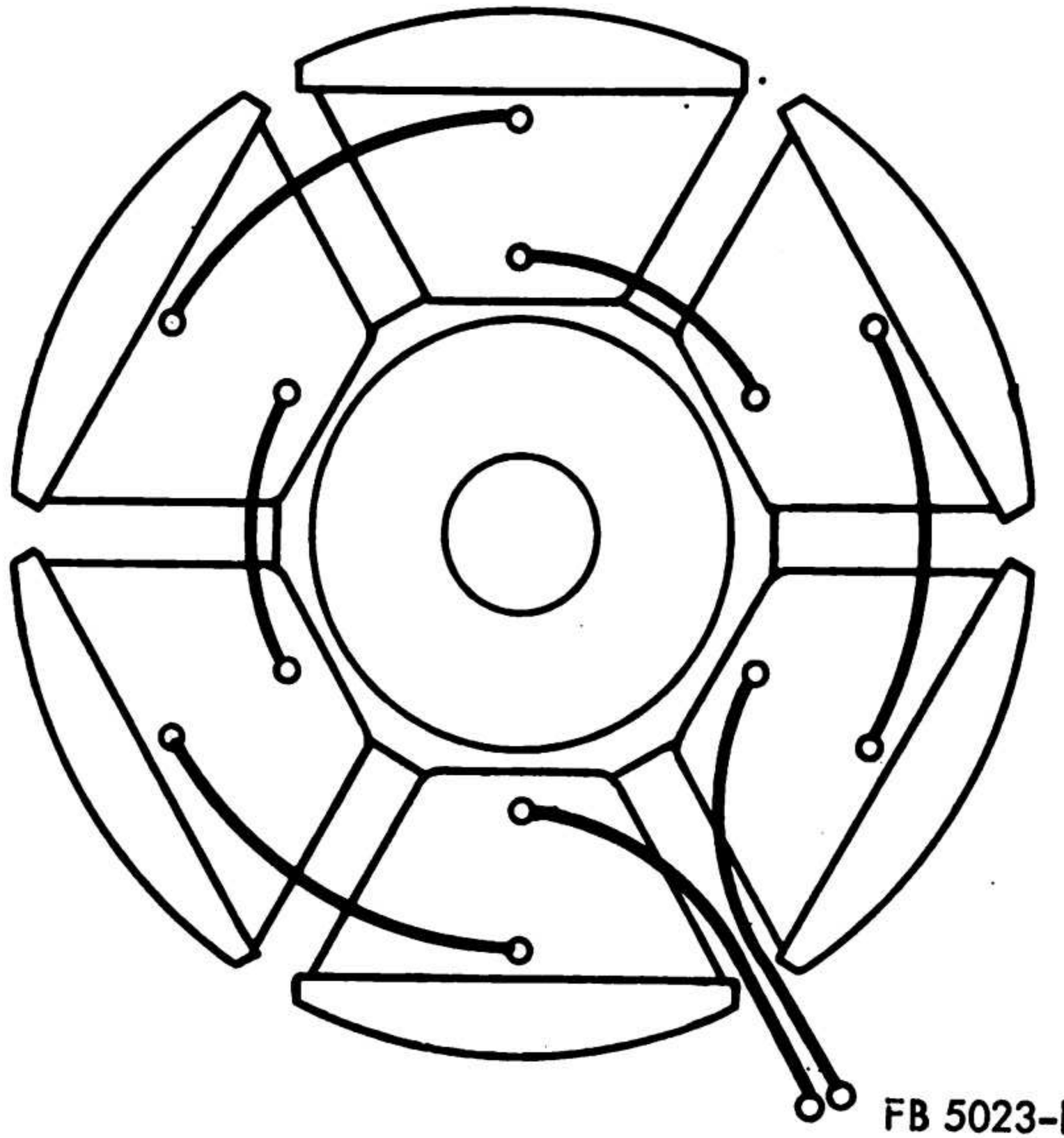


Figure 131. Rotor and stator wiring diagram.

(2) *Field winding:*

	Shunt	Interpole
Wire size	21 and 20	9 sq.
Wire insulation	E	D. C.
Turns per coil	500 and 700	51
Resistance at 25° C.	4 series 76.5	0.117
Weight in lbs.	6.4 and 13	9
Number of coils	4	4
Coils connected	Series	Series
Varnish treatment		

(*a*) Preheat for 1 hour.
(*b*) Immerse while hot in baking varnish.
(*c*) Drain well.
(*d*) Bake for 7 or 8 hours at 250° F.
(*e*) Repeat the above to give 3 coats.
(*f*) Add a final coat of air drying varnish.

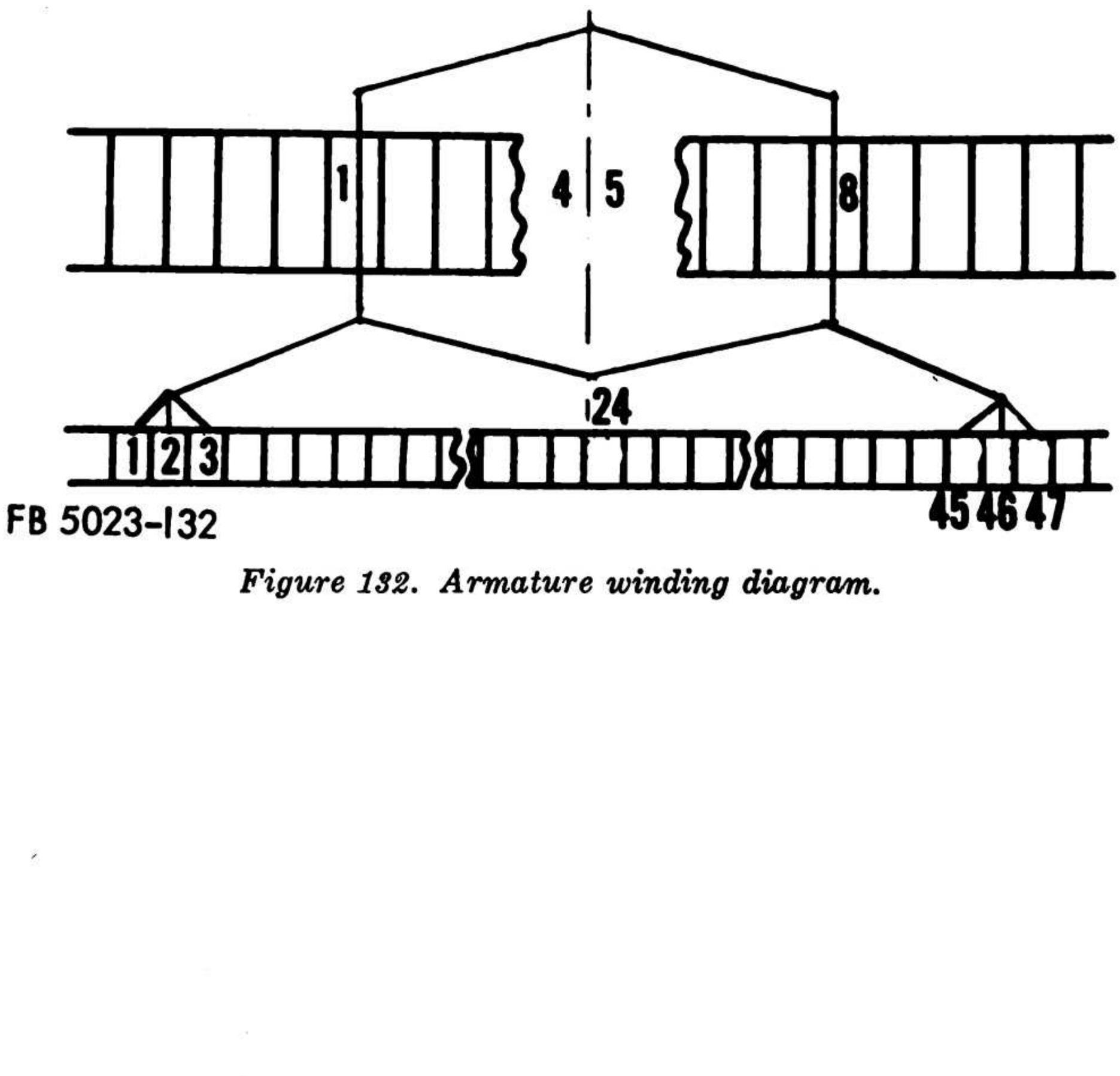


Figure 132. Armature winding diagram.

CHAPTER 5

SHIPMENT, LIMITED STORAGE, AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

206. Limited Storage

a. Inspection. Inspect the generator set as directed in paragraph 36.

b. Cleaning and Painting. Clean and paint the generator set as directed in paragraph 32.

c. Complete Lubrication. Lubricate the generator set as directed in LO 5–5023.

d. Protection in Storage.

(1) Flush the cooling system (par. 77*b*). If freezing temperatures are anticipated, add antifreeze in accordance with table I. Protect the cooling system to 15° below the lowest expected temperature.

(2) Coat all unpainted metal surfaces and parts with approved preservative oil.

(3) Check the condition of the batteries with a hydrometer. Charge the batteries if necessary and add sufficient electrolyte to bring each cell up to the proper level. If the batteries do not come up to the full-charged state, replace them (par. 90*d*).

(4) If the generator set is to be stored outside or otherwise subjected to rain, dust, and so on, protect it with a tarpaulin or other suitable covering.

e. Inspection and Exercising.

(1) Operate the generator set at least once every 10 days. Start the generator set (par. 15) and run it long enough to bring it up to operating temperature to assure complete lubrication of all moving parts.

(2) During this exercise period, inspect the generator set for damage, rusting, pilferage, and leakage of lubricant, fuel, and coolant.

(3) Batteries must be restored to full charge during each

exercise period. Using a hydrometer, check the specific gravity of the electrolyte in each cell. A battery which will not take or hold a full charge in each cell must be replaced.

(4) Perform a monthly inspection (par. 36*c*) on the generator set every 30 days.

207. Domestic Shipment

a. General. Prepare the generator set for shipment by following the instructions given in paragraph 18.

b. Hoisting and Handling.

Warning: Be sure that the lifting device and lifting slings are capable of handling 12,000 pounds before attempting to lift the generator set.

(1) Lift uncrated units by means of a sling through the lifting eye (3, fig. 3).

(2) Lift crated units as instructed in paragraph 7*b*.

c. Blocking. Use wire rope, steel straps, or wooden blocks to prevent end and side movement of the generator set on the carrier. Specific tiedown procedures are determined by the type and size of the carrier being used.

Section II. DEMOLITION OF THE GENERATOR SET TO PREVENT ENEMY USE

208. General

When capture or abandonment of the generator set to an enemy is imminent, the responsible unit commander makes the decision to destroy the unit or 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.

209. 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. Demolition by Explosives (fig. 133). Place as many of the following charges as the situation permits and detonate them simultaneously with detonating cord and a suitable detonator.

(1) A 2-pound charge between the fuel injection pumps and the engine block and a ½-pound charge at each fuel injector.

(2) A 4-pound charge on the alternator shaft. Insert the charge through the inspection openings.

Note. The above charges are the minimum requirements for this method.

(3) A 1-pound charge behind the control panel.

(4) A 1-pound charge on the starting motor, water pump, and supercharger.

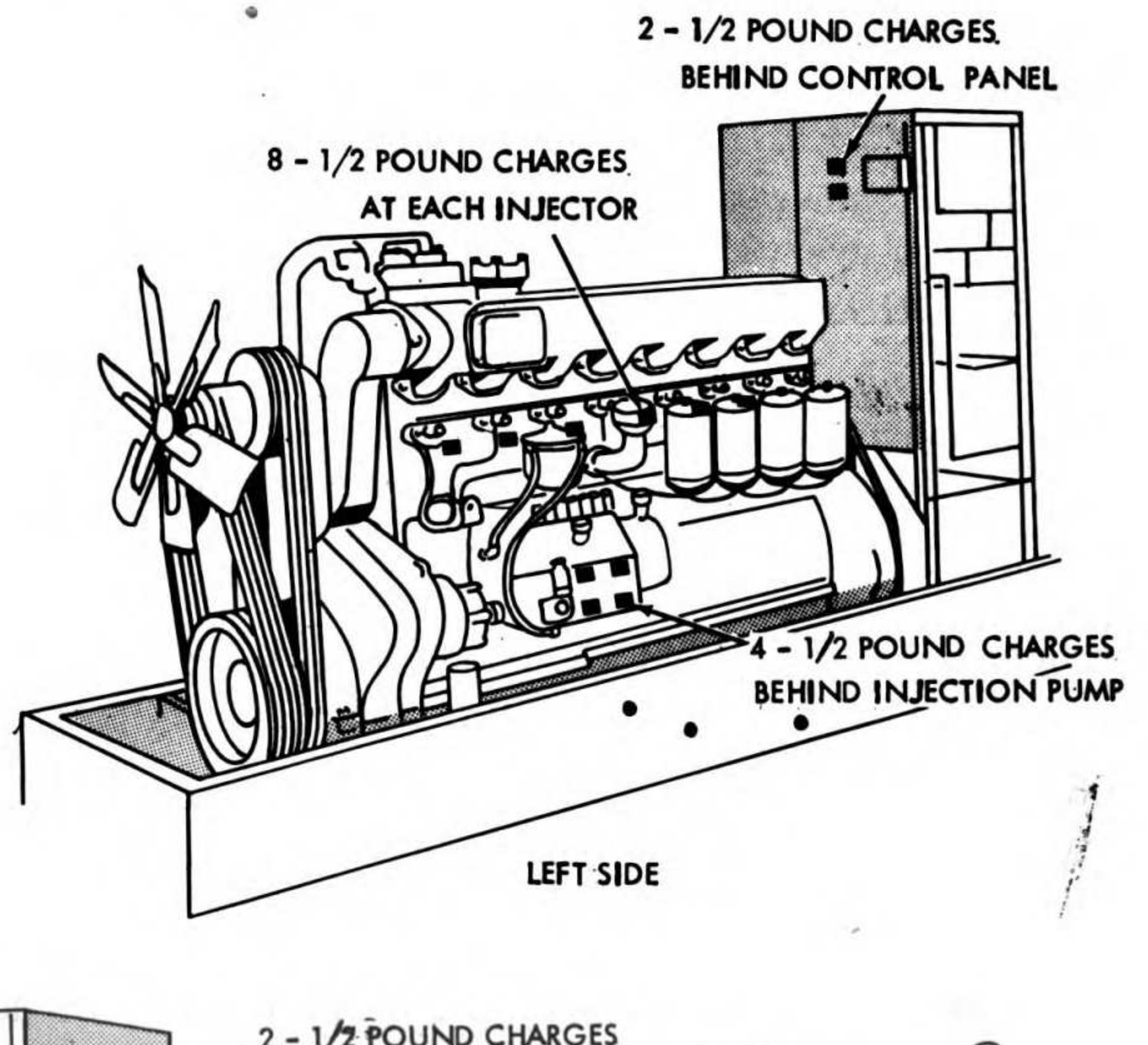


Figure 133. Placement of demolition charges.

b. Demolition by Mechanical Means. Use sledge hammers, crowbars, picks, axes, or any other heavy tools which may be available, together with the tools normally included with the generator set to destroy the following:

(1) The fuel injection pump, engine speed governor, fuel injectors, and injection lines.

(2) The sliprings, brush holders, and generator windings.

Note. The steps are the minimum requirements for this method.

(3) All switches and instruments on the control panel and wiring.

(4) The radiator coil, batteries, engine block, and oil pans.

210. Other Demolition Methods

If the situation prohibits employing either of the preferred methods, use the following, either singly or in combination.

a. Demolition by Weapons Fire. Fire on the generator set with the heaviest weapons available. Direct fire at both engine and generator.

b. Demolition by Scattering and Concealment. Remove all easily accessible parts such as the injection pump. injectors, alternator and exciter brushes, starting motor 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. Demolition by 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 insulation material used on windings and wiring, this method will not seriously damage the generator unless high temperatures are sustained for some time.

d. Demolition by Submersion. Totally submerge the unit in a body of water to provide some water damage and concealment. Salt water will do the greatest damage to metal parts.

e. Demolition by Misuse. Perform the steps listed below to make the unit inoperative.

directly to the injection pump.

(1) Remove the fuel cutoff valve and connect the fuel line

(2) Drain the radiator and oil pan.

(3) Expose the inspection openings of the generator.

(4) Start the engine and drop small tools, bolts, nuts, or metal scraps into the generator.

(5) Set the throttle so that the engine will run at maximum speed until failure occurs and abandon the unit.

211. Training

All operators should receive thorough training in the destruction of the generator set. Simulated destruction, using all the methods above, should be included in the operator training program. It must be emphasized in training that demolition operations usually are 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 9–850	Abrasive, Cleaning, Preserving, Sealing, Adhesive, and Related Materials Issued for Ordnance Materiel.
TM 9–1799	Fire Extinguishers.
TM 11–483	Radio Suppression.

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 5–5023	Generator Set, Electric, Portable, Diesel Driven, Skid Mounted, 100 KW, 127–220 Volt, 3 Phase, 60 Cycle, or 230–400 Volt, 3 Phase, 50 Cycle, Buda Model 8DCS–1125.
TM 9–2851	Painting Instructions for Field Use.

4. Preventive Maintenance Services

TB 5–5023–1	Generator Set, Electric, Portable, Diesel Driven, Skid Mounted, 100 KW, 127–220 Volt, 3 Phase, 60 Cycle, or 230–400 Volt, 3 Phase, 50 Cycle, Buda Model 8DCS–1125.
TM 5–505	Maintenance of Engineer Equipment.

5. Publication Indexes

DA Pam 108–1	Index of Army Motion Pictures, Television, Recordings, and Film Strips.
DA Pam 310–1	Index of Administrative Publications.
DA Pam 310–2	Index of Blank Forms.
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 310–5	Index of Graphic Training Aids and Devices.
DA Pam 310–25	Index of Supply Manuals—Corps of Engineers.
SM ENG 1	Introduction.

6. Supply Manuals

SM ENG 3–41	List of Current Issue Items, Federal Class 41 Handtools.
SM ENG 5–41	List of All Items, Stock List, Federal Class 41, Handtools.
SM ENG 7, 8, & 9–5023	Generator Set, Portable; Diesel-Driven; Skid-Mounted 100-Kilowatt; 127–220-Volt, 3-Phase 60-Cycle or 230–400-Volt, 3-Phase, 50-Cycle; Buda Model 8 DCS–1125.

APPENDIX II
TOOL AND PUBLICATIONS SET

Engineer stock No.		Description	Quantity
Code No.	Part No.		
GE	95–3844.110.500	Tool and publications set, consists of the following indented items: DEPARTMENT OF THE ARMY Supply manual ENG 7, 8, & 9–5023.	1
GE	99–1999.000.010	Modification kit, MWO ENG 1991–1, for lubrication guides, check cards and manuals; MIL–P–11743.	1
GE	13–5496.005.090	OILER, steel, rd; force feed; 1 pint capacity; 9 in. Flexible spout; FS RR–O–376 Type 2.	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
GE	41–7165.120.040	SCREWDRIVER; common; plastic handle; 12 in. long x ⅜ in. wide blade; Vaco Products Co.; No. A–616–12 or equal.	1
GE	41–9587.500.400	WRENCH, adjustable, cresent type; single hd; open end; heavy duty; FS GGG–W–631; Type 1; 1 15/16 in. opening x 12 in. long.	1

INDEX

[AG 412.41 (3 Oct 56)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

Official:

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

Distribution:

Active Army:

DCSLOG (1)
CNGB (1)
ASA (2)
Tec Svc, DA (1) except
COFENGRS (15)
Engr Bd (2)
Hq CONARC (3)
CONARC Bd (2)
Army AA Comd (2)
OS Maj Comd (5)
OS Base Comd (5)
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Armies (2)
Corps (2)
Ft & Cp (1)
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CGSC (2)
Engr Sch (50)
Gen Depots (2) except
Atlanta Gen Depot
(None)
Engr Sec, Gen Depots (10)
Engr Depots (10)
POE (OS) (2)
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OS Sup Agencies (2)
Fld Maint Shops (1)
Div Engr (2)
Engr Dist (2) except
Savannah Engr Dist (1)
Mil Dist (1) except
Ariz Mil Dist (2)
MAAG (1)
JBUSMC (3)
Units org under fol TOE:
5–48R, Engr Sup Point
Co (2)
5–157R, Engr Fld Maint
Co (5)
5–262R, Hq & Hq Co,
Engr Maint and Sup
Gp (1)
5–267R, Engr Depot Co
(1)
5–278R, Engr Depot
Maint Co (5)
5–279R, 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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