TM 9-1616

WAR DEPARTMENT

U.S. Dept. of Army

TECHNICAL MANUAL

ORDNANCE MAINTENANCE

GENERATING UNITS M5 AND M6

1 AUGUST 1943

FOR ORDNANCE PERSONNEL ONLY

TECHNICAL MANUAL }
No. 9-1616

WAR DEPARTMENT
Washington, 1 August 1943

ORDNANCE MAINTENANCE

GENERATING UNITS M5 AND M6

Prepared under the direction of the
Chief of Ordnance

CONTENTS

*This manual supersedes TM 9-1616, dated 1 March 1942; TB 1616-1, dated 25 August 1942; and TB 1616-2, dated 11 November 1942.

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Section I

INTRODUCTION AND SCOPE

1. SCOPE.

a. This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, maintenance, and repair of the Generating Unit M5 (including differences between M5 and M6), supplementary to those in the Field Manuals and Technical Manuals prepared for the using arms. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the materiel.

2. DIFFERENCES IN MANUFACTURE.

a. These generating units have been assembled by different manufacturers who have used standard parts made by still other manufacturers. Working drawings have been furnished by the Ordnance Department. Similar parts will be found reasonably interchangeable regardless of where they are made. A metal plate is mounted on the instrument panel door of each unit, carrying the name of the manufacturer or prime contractor responsible for the construction of that particular unit. If required to make a record of this, be sure to copy the name exactly as it appears, because firm names are sometimes similar. For example, Units M5 have been made by the Hobart Manufacturing Company and by the Hobart Brothers Company, two entirely unrelated companies, both in Troy, Ohio.

3. DESCRIPTION AND CONSTRUCTION.

a. General. This unit is a self-contained power plant consisting of three main units: gasoline engine, power generator, and switchboard. These units are mounted on a welded steel frame, which also serves as a skid when the unit is moved. The unit is completely enclosed by a sheet metal housing. The radiator end of the unit is considered the front, and the main generator end, the rear. Right and left sides are determined from the rear, facing forward. Hinged hoods on the sides and a vertically hinged door on the rear of the housing give access to the engine, generator, and instrument panel. A sheet metal battery cover on the lower front part of the housing is easily removed for the purpose of servicing the battery (fig. 1). The canvas instruction book holder is on the inside of the instrument panel door

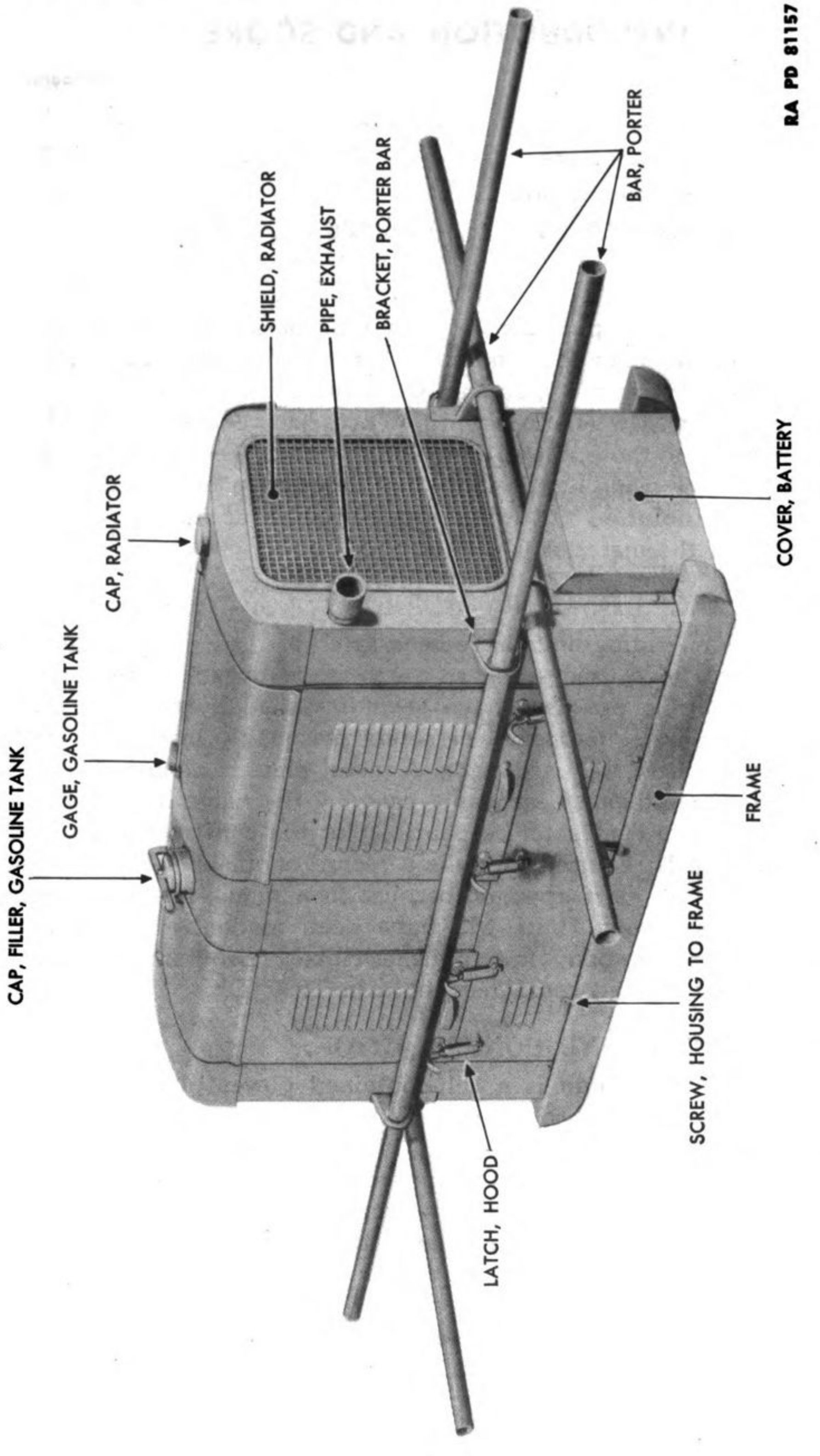

Figure 1 — Unit — Porter Bars in Place — Right Front View

INTRODUCTION AND SCOPE

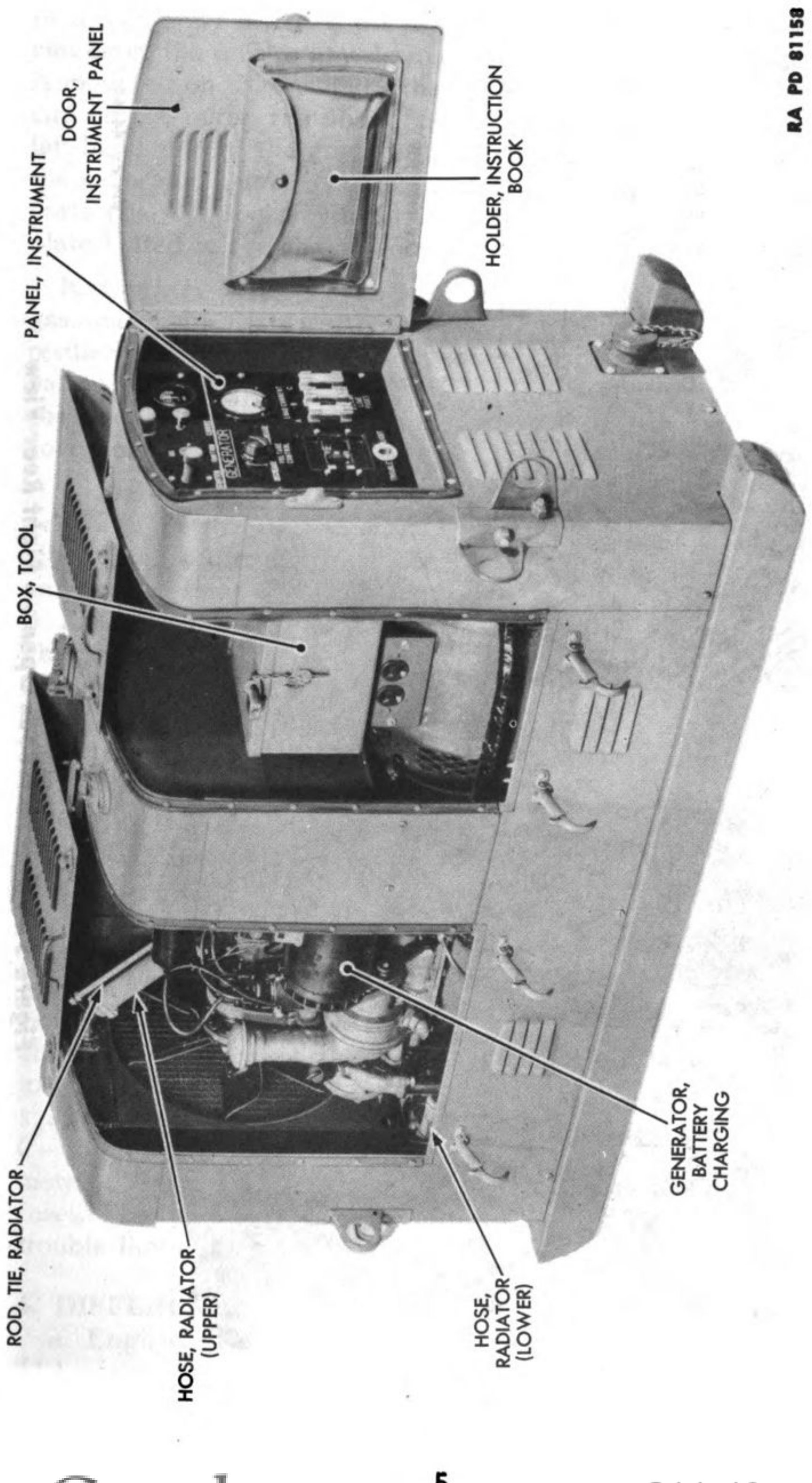

Figure 2 — Unit — Hoods Open — Left Rear View

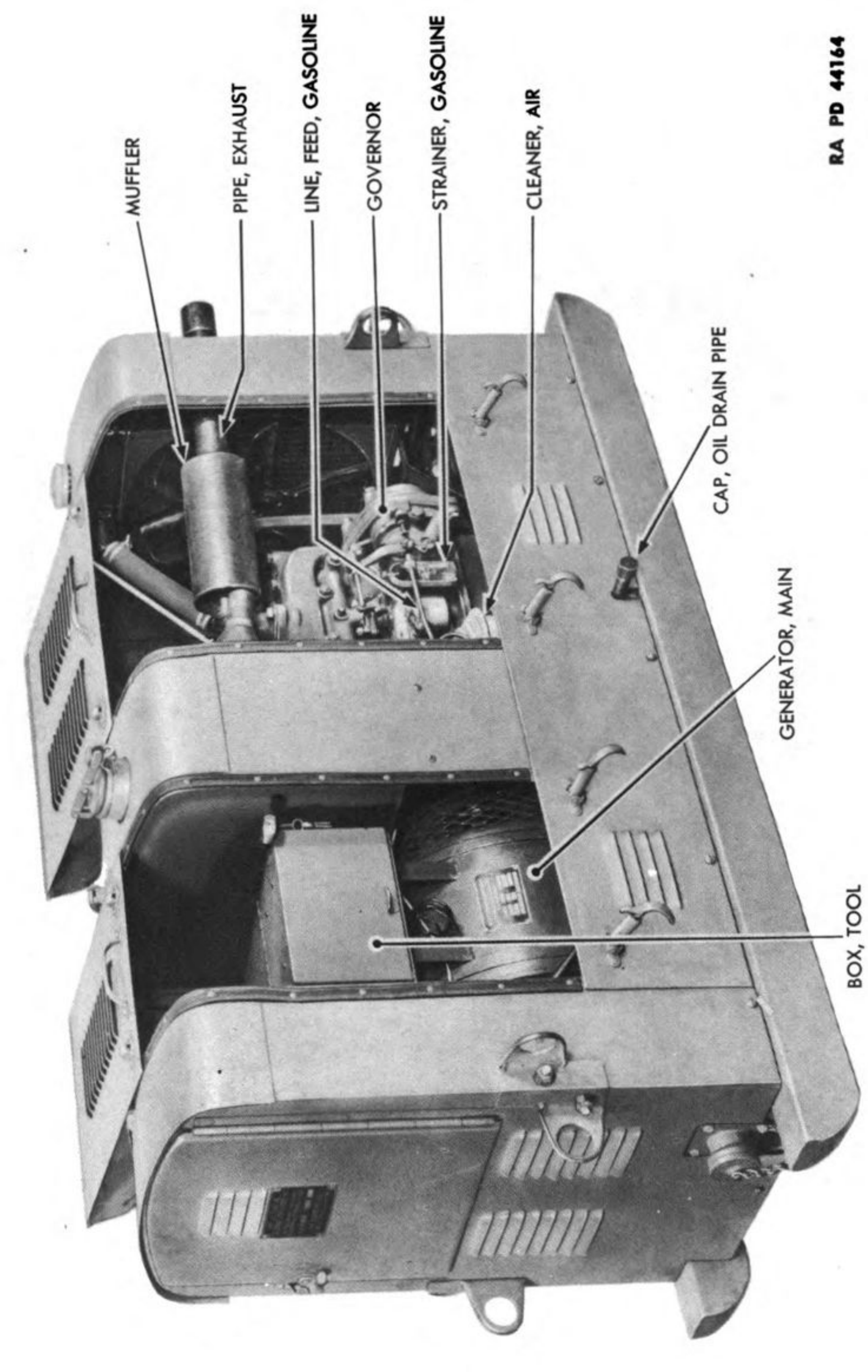

Figure 3 — Unit — Hoods Open — Right Rear View

(fig. 2). Four porter bar brackets are attached to the sides and ends of the unit. By inserting porter bars in the brackets six or eight men can carry the unit to any desired location (fig. 1). The gasoline tank is mounted on the inside of the housing, and the gasoline tank filler cap on the outer, right-hand side. The gasoline tank gage is on the left-hand side of the gasoline tank (fig. 1). A tool box, mounted on the generator, serves as a container for maintenance tools and spare parts (fig. 2). Spare cylinder head gaskets are carried under a steel plate bolted to the engine hood directly over the muffler (fig. 3).

b. Engine. The 4-cylinder, 4-cycle, 11-horsepower (N.A.C.C.) gasoline engine is directly connected to the main generator by a resilient coupling. It is equipped with an electric starting motor, battery charging generator (fig. 2), oil bath air cleaner, oil filter, and gasoline strainer. Engine speeds are controlled by a mechanical governor (fig. 3).

c. Main Generator. The main generator is an alternating-current generator of the revolving field type with separate excitation provided from a direct-current generator mounted in the same housing and on the same shaft. At 1,200 revolutions per minute, it delivers 3 KVA - 13.9 amperes at 125 volts 3-phase. Adjustments on the change-over panel governor provide either 50-cycle or 60-cycle current (fig. 2). The Unit M6, serial numbers 377 to 726 inclusive, delivers 2.5 KVA - 20 amperes at 125 volts single-phase, or 3 KVA - 13.9 amperes at 125 volts 3-phase. Units M6, serial numbers 1 to 266 and 367 to 376 inclusive, deliver 2.5 KVA - 20 amperes at 125 volts, single-phase only, but can be converted to deliver 3-phase current by making certain changes in wiring (par. 29).

d. Instrument Panel. The instrument panel (figs. 2 and 65) at the rear of the unit is reached by opening the instrument panel door. Engine controls and indicators which are on the upper part of the instrument panel, consist of an oil pressure gage, starter switch, ignition toggle switch, choke control, and battery charging generator ammeter. Generator controls and indicators, on the lower part of the instrument panel are a 0 - to 150-volt alternating-current voltmeter; a 32 -ohm field rheostat (voltage control); an alternating-current 0 - to 30-ampere ammeter; a 50-to-60-cycle frequency meter (cycle meter); a 2-pole main switch including circuit breaker, and three fuses. The dash lamp is at the top of the instrument panel and the trouble lamp socket at the bottom.

4. DIFFERENCES BETWEEN UNIT M5 AND UNIT M6.

a. Engine. The Units M5 and M6 are equipped with the same 11-horsepower engine. On the Unit M6, the engine is equipped with an auxiliary governor (fig. 7). This accessory eliminates "surge" which is especially objectionable on single-phase operation.

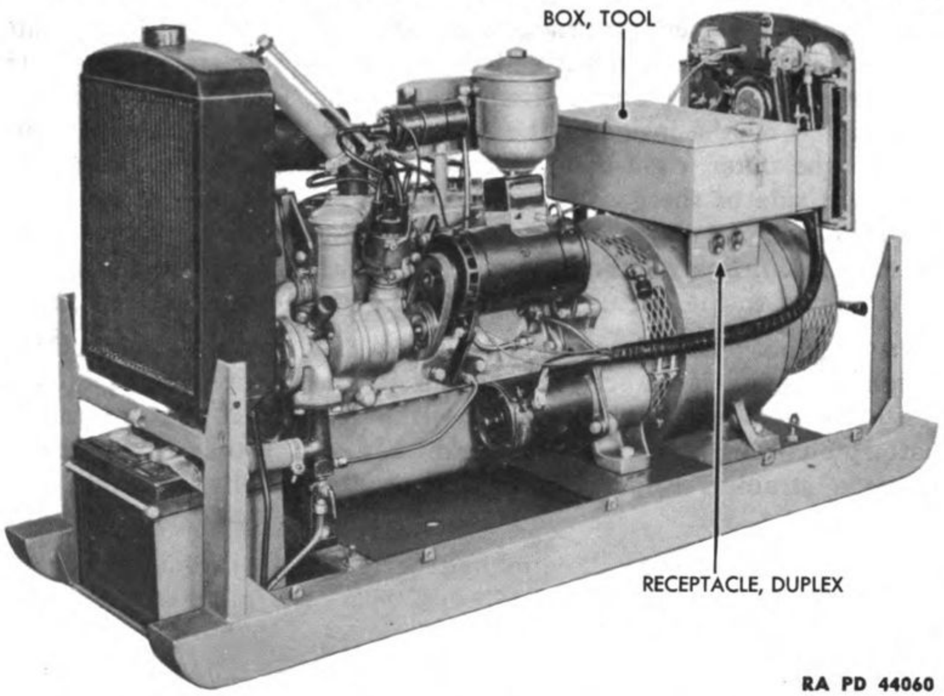

Figure 4 — Unit M5 — Housing Removed — Left Front View

b. Main Generator. Slightly larger pole pieces and laminations are provided in the main generator used on the Unit M6. Differences exist in the internal wiring of the generators (figs. 8, 9, and 10).

c. Resistors, Capacitators, and Time Delay-relay. Five resistors, four of fixed capacity and one of variable capacity, and three capacitators are located above the main generator on the Unit M6 (fig. 5). A time delay-relay is located to the right of the main generator on the Unit M6 (fig. 7). None of these assemblies appear on the Unit M5. All are needed to provide the single-phase conversion on the Unit M6.

d. Outlet Receptacle. All Units M5 have a 3-pole outlet receptacle (fig. 6). All Units M6 have a 19-pole outlet receptacle (fig. 7). Units M6, serial numbers 377 to 726, inclusive, also have a 3-pole receptacle located on the rear of the unit. The 19-pole outlet receptacles are used for single-phase current and the 3-pole outlet receptacles are used for 3-phase current.

e. Duplex Receptacle. Each generating unit is equipped with a duplex receptacle which serves as a means of securing current from the main generator to operate 110-volt lights and appliances. The receptacle is located under the tool box on the left-hand side of the Unit M5 and beneath the change-over panel on the right-hand side of the Unit M6.

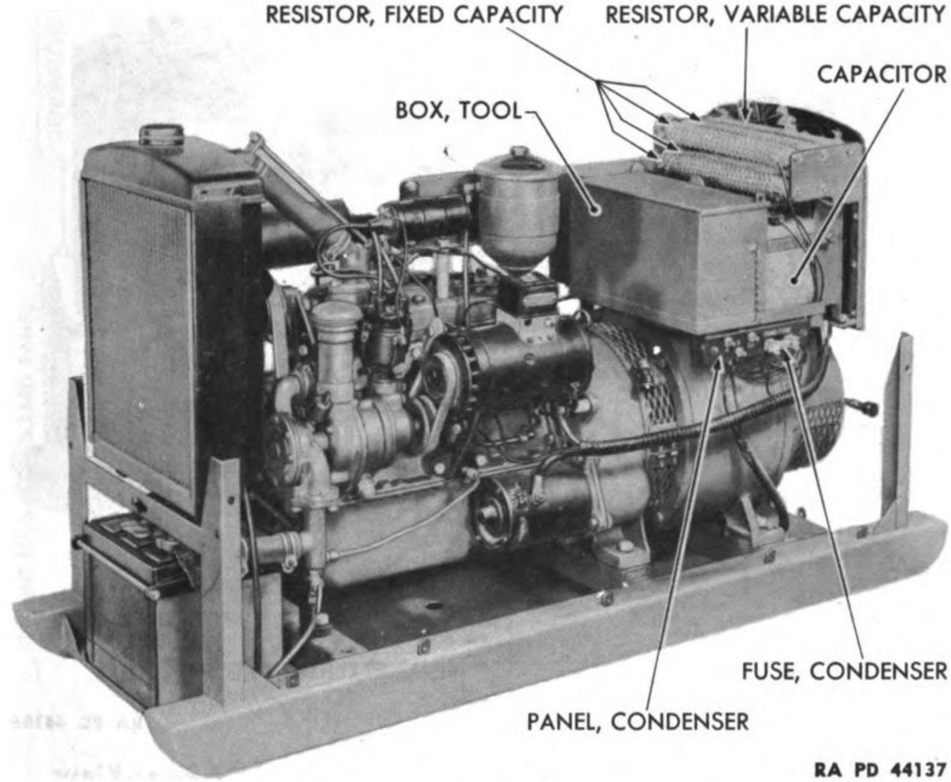

Figure 5 — Unit M6 — Housing Removed — Left Front View

f. Frequency Meter. A 10-reed frequency meter is used on the Unit M5 (fig. 6). Range of the meter is from 48 to 52, and from 58 to 62 cycles. On the Unit M6, a 5-reed frequency meter is used, having a range of from 58 to 62 cycles (fig. 7).

g. Tool Box. A rectangular, sheet metal tool box (fig. 4) is used on the Unit M5. An internal partition closes off a space for the change-over panel on the right-hand end. On the Unit M6, the tool box (fig. 5) is narrower and deeper. The compartment which houses the change-over panel is a separate box although it is welded to the same base.

h. Frame. Frames on the Units M5 and M6 are identical except that Units M6, serial numbers 377 to 726 inclusive, have an extra outlet receptacle bracket welded to the frame side member and sod pan to carry the extra 3-pole outlet receptacle (fig. 6).

i. Change-over Panel. Units M6, serial numbers 1 to 266 and 367 to 376 inclusive, have an 8- by 3¾-inch bakelite change-over panel with eight binding posts and three change-over bars. No adjustment is possible on this model. Units M6, serial numbers 377 to 726 inclusive, have an 8- by 5-inch bakelite change-over panel with

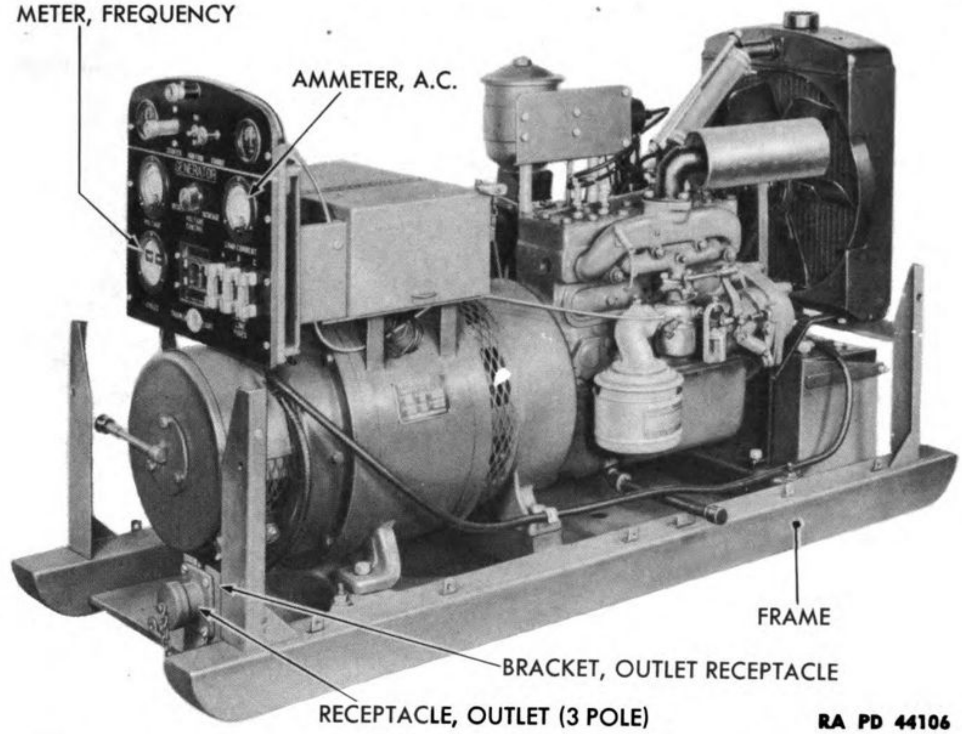

Figure 6 — Unit M5 — Housing Removed — Right Rear View

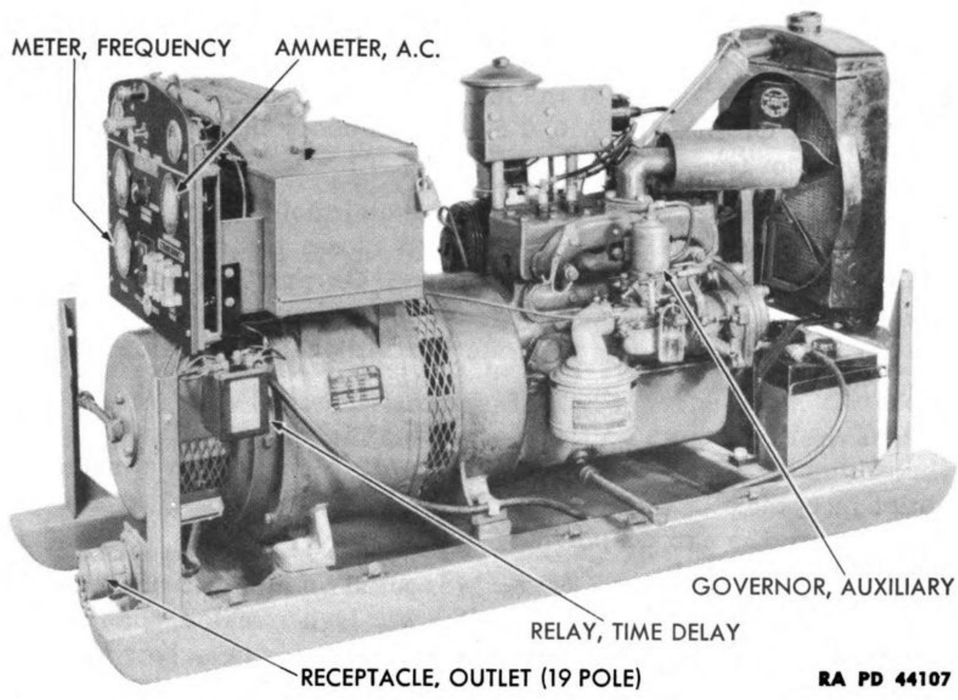

Figure 7— Unit M6 — Housing Removed — Right Rear View

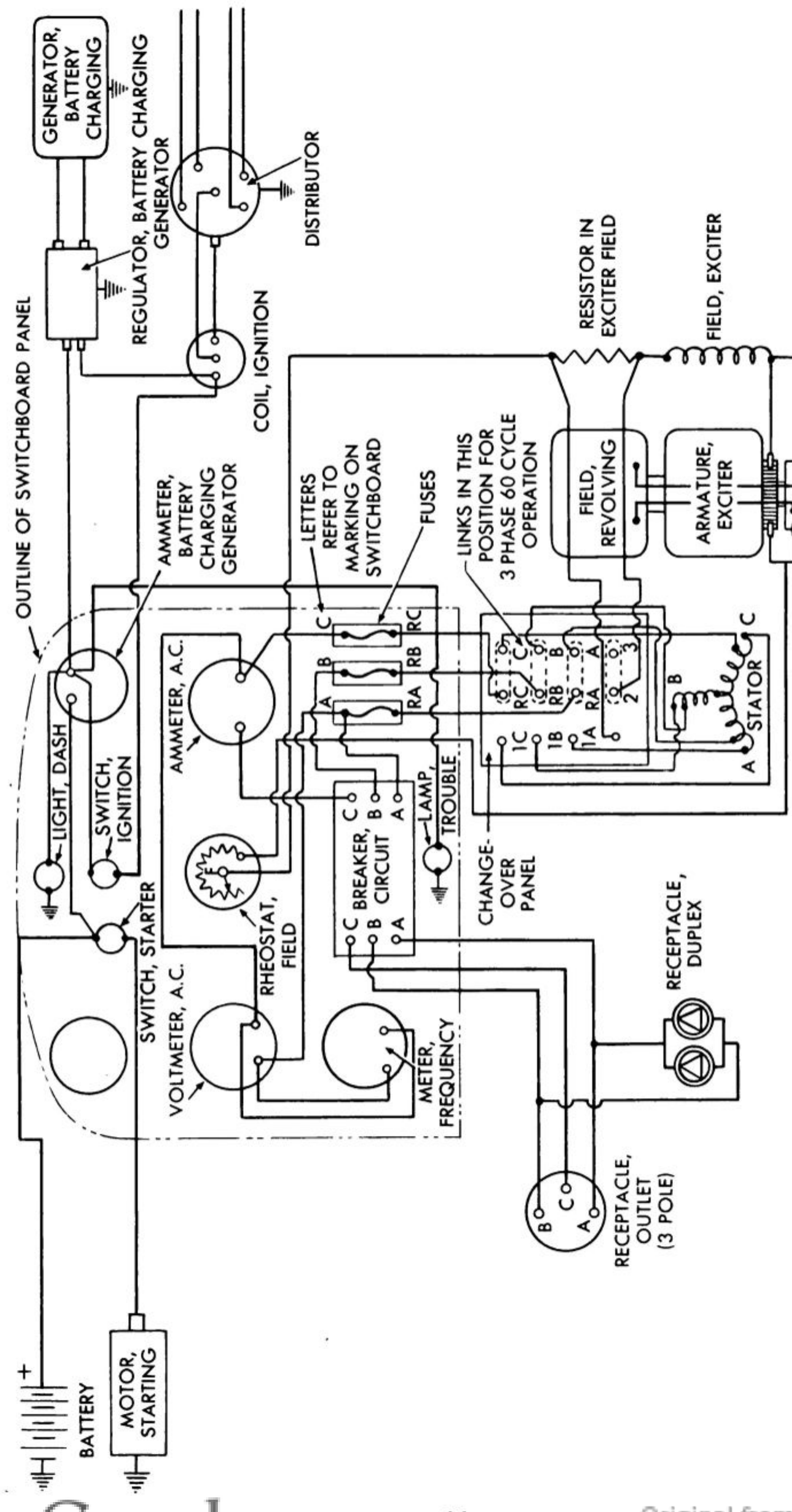

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Figure 8 — Unit M5 — Wiring Diagram

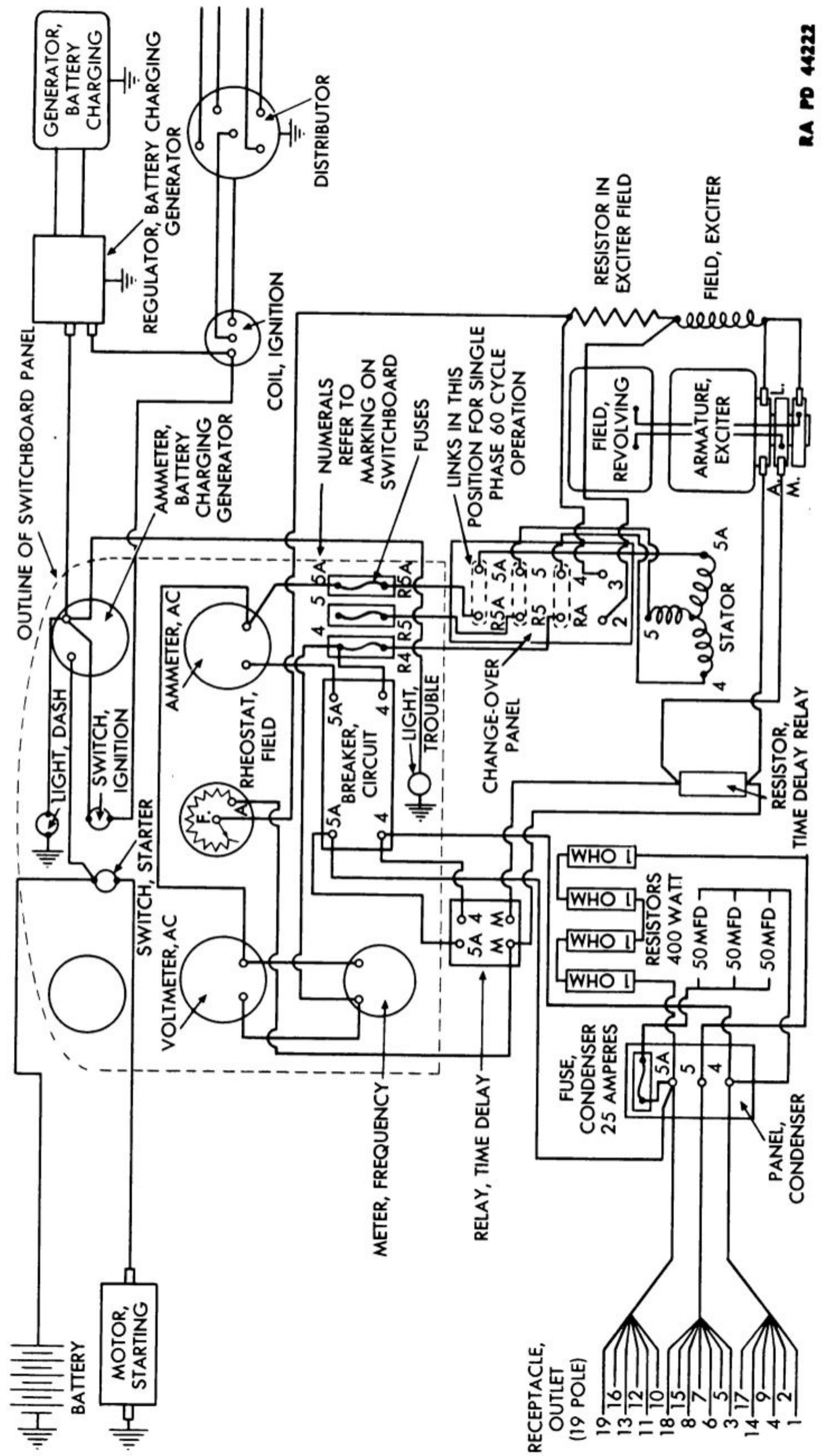


Figure 9 — Unit M6 — Wiring Diagram — Single-phase

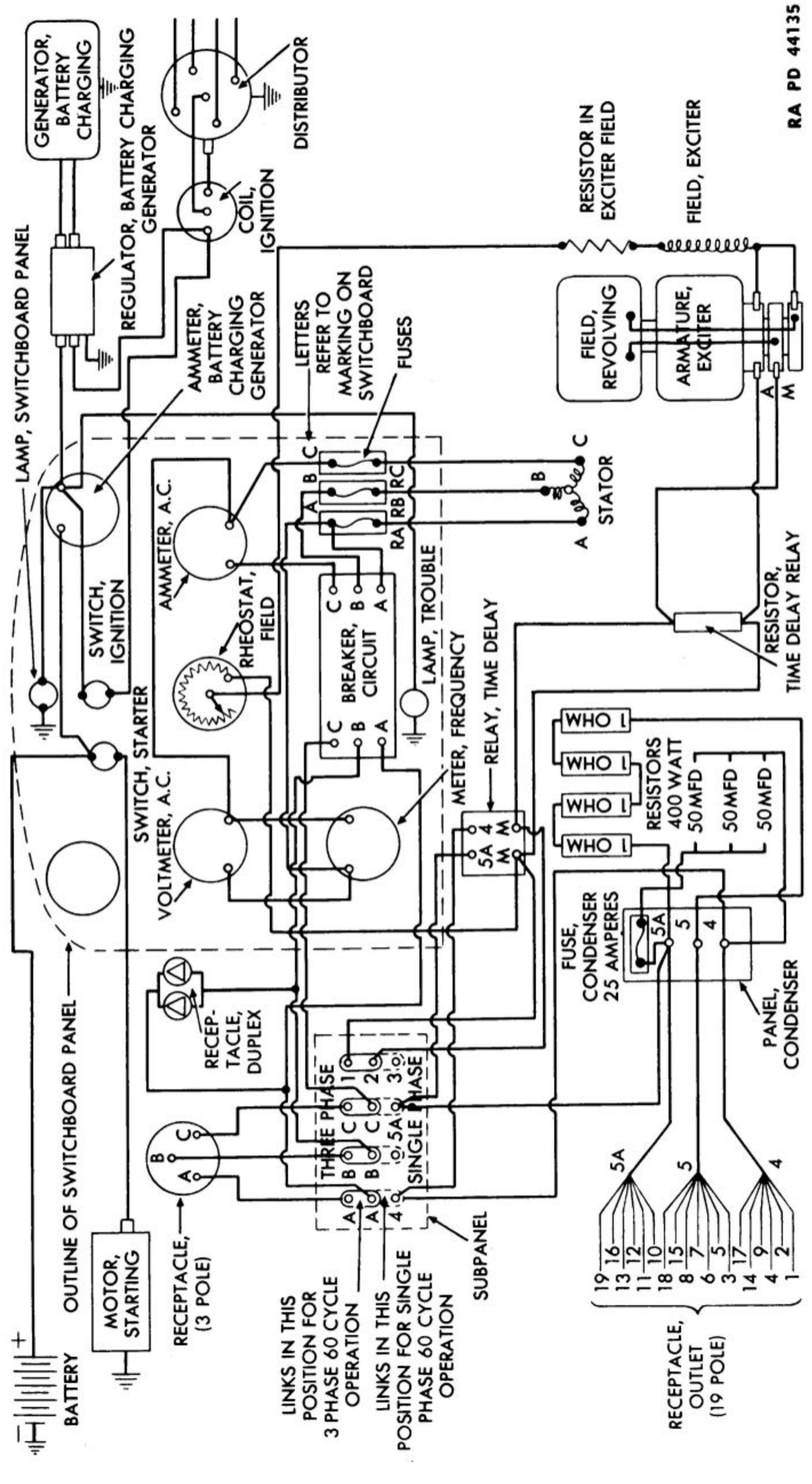


Figure 10 — Unit M6 — Wiring Diagram — Single and 3-phase

12 binding posts and four change-over bars. Its function is to enable the operator to adjust the unit for single-phase or 3-phase work. All Units M5 are equipped with an 8- by 5½-inch change-over panel equipped with 12 binding posts and 4 change-over bars. Its purpose is to enable the operator to adjust the unit for 50-cycle or 60-cycle work. On all models, the change-over panel is located within the tool box over the right-hand side of the generator.

j. **Alternating-Current Ammeter.** Although they appear the same and have the same part numbers, the alternating-current ammeters of the Unit M5 (fig. 6) and the Unit M6 (fig. 7) are not interchangeable. Slight differences in the adjustment of the internal mechanism are made during manufacture. On the Unit M5, the 20 mark on the scale is adjusted to 21.5 amperes; the 10 mark is adjusted to 10.75 amperes; and the 29 mark is adjusted to 31.20 amperes. On the Unit M6, the 20 mark on the scale is adjusted to 20.5 amperes; the 10 mark is adjusted to 10.25 amperes; and the 29 mark is adjusted to 29.75 amperes.

k. **Condenser Panel.** A condenser panel is provided on all Units M6. It is located below the left-hand end of the tool box (fig. 5). On the panel is a condenser fuse (fig. 5). These parts are needed for single-phase work. They are not used on the Unit M5.

l. **Wiring.** Differences exist in the wiring of the Unit M5, the single-phase Unit M6, and the single- and 3-phase Unit M6. Figure 8 applies to all Units M5. Figure 9 applies to Units M6 with serial numbers from 1 to 266 and 367 to 376, inclusive. Figure 10 applies to Units M6 with serial numbers 377 to 726, inclusive.

Section II

SERVICE MAINTENANCE

5. ALLOCATION OF MAINTENANCE DUTIES BY ECHELONS.

a. Definitions. Echelons and words as used in this list of maintenance allocations are defined as follows:

SECOND ECHELON:	Line organization regiments, battalions, companies, detachments, and separate companies (first and second echelons).
THIRD ECHELON:	Ordnance light maintenance companies, ordnance medium maintenance companies, ordnance divisional maintenance battalions, and post ordnance shops.
FOURTH ECHELON:	Ordnance heavy maintenance companies and service command shops.
FIFTH ECHELON:	Ordnance base regiments, ordnance bases, arsenals, and manufacturers' plants.
SERVICE: (Including preventive maintenance) (par. 23 a (1) and (2), AR 850-15 (6 Oct 42))	Consists of servicing, cleaning, lubricating, tightening bolts and nuts, and making external adjustments of subassemblies or assemblies and controls.
REPLACE: (par. 23 a (4), AR 850-15 (6 Oct 42))	Consists of removing the part, subassembly or assembly from the vehicles and replacing it with a new or reconditioned or rebuilt part, subassembly or assembly, whichever the case may be.
REPAIR: (par. 23 a (3) and (5), in part, AR 850-15 (6 Oct 42))	Consists of making repairs to, or replacement of the part, subassembly or assembly that can be accomplished without completely disassembling the subassembly or assemblies, and does not require heavy welding, or riveting, machining, fitting, and/or alining or balancing.
REBUILD: (par. 23 a (5), in part, and (6), AR 850-15 (6 Oct 42))	Consists of completely reconditioning and replacing in serviceable condition any unserviceable part, subassembly or assembly of the vehicle, including welding, riveting, machining, fitting, alining, balancing, assembling, and testing.

b. Maintenance Allocations.

	ECHELONS			
ENGINE	**2nd**	**3rd**	**4th**	**5th**
Camshaft—replace			x	
Connecting rod bearings—adjust		x		
Connecting rod bearings—replace				x
Connecting rods—replace			x	
Crankshaft—grinding, polishing, straightening				x
Crankshaft main bearings—replace			x	
Cylinder—boring, honing				x
Cylinder head—replace	x			
Engine—rebuild				x
Engine—replace		x		
Flywheel—replace		x		
Manifolds—replace	x			
Piston assembly—replace		x		
Piston pins—fitting		x		
Piston rings—fitting		x		
Pistons—fitting			x	
Timing gear cover—replace		x		
Tune-up	x			
Valve covers—replace	x			
Valve guides—replace			x	
Valve lifters and valve lifter guides—replace			x	
Valve springs—replace	x			
Valve tappets—adjustment	x			
Valves—clean carbon, light grinding		x		
Valves—replace	x			
Valves—reface and reseat		x		
COOLING SYSTEM				
Fan assembly—repair		x		
Fan assembly—replace	x			
Fan belt—adjust or replace	x			
Fan bushing or bearings—replace		x		
Hose or pipe—replace	x			
Radiator—clean and flush	x			
Radiator—repair		x		
Radiator—replace	x			
Thermostat—replace	x			
Water pump—rebuild				x
Water pump—repair		x		
Water pump—replace		x		
OILING SYSTEM				
Oil filter—replace	x			
Oil gage—replace	x			

SERVICE MAINTENANCE

	ECHELONS			
OILING SYSTEM (Cont'd)	2nd	3rd	4th	5th
Oil lines, external—clean or replace	x			
Oil lines, internal—flushing	x			
Oil lines, internal—repair or replace		x		
Oil pan—replace	x			
Oil pressure—adjustment	x			
Oil pump—repair or replace		x		
Oil strainer—clean or replace	x			
FUEL SYSTEM				
Air cleaner—clean or replace	x			
Carburetor—rebuild				x
Carburetor—repair		x		
Carburetor—replace	x			
Gasoline gage—repair		x		
Gasoline gage—replace	x			
Gasoline pipes and connections—repair or replace	x			
Gasoline tank—repair		x		
Governor—adjust	x			
Governor—rebuild				x
Governor—replace		x		
ELECTRICAL SYSTEM				
Ammeter—replace	x			
Battery—rebuild				x
Battery—repair		x		
Battery—replace, charge and service	x			
Battery cables—replace	x			
Breaker contacts—replace and adjust	x			
Distributor—repair		x		
Distributor—rebuild				x
Distributor—replace	x			
Generator—repair		x		
Generator—rebuild				x
Generator—replace	x			
Generator regulator—adjust and repair		x		
Generator regulator—rebuild				x
Generator regulator—replace	x			
Ignition coil, condenser, and spark plugs—replace	x			
Ignition harness—repair or replace wires		x		
Ignition harness assembly—replace	x			
Starting motor—rebuild				x
Starting motor—repair		x		
Starting motor—replace	x			
Starting motor spring (Bendix)—replace	x			
Switch, ignition or lighting and starting—repair		x		
Switch, ignition or lighting and starting—replace	x			

	ECHELONS			
MAIN GENERATOR	2nd	3rd	4th	5th
Bearing, ball, drive end—replace		x		
Bearing, ball, exciter end—replace		x		
Bracket assembly, exciter—repair or replace		x		
Bracket, coupling, bearing—repair or replace		x		
Brushes, commutator—replace	x			
Brushes, slip ring—replace	x			
Commutator—clean	x			
Commutator—turn and undercut		x		
Connections, electrical—tighten	x			
Fan, rotor—repair or replace		x		
Fittings, grease—repair or replace	x			
Flange, driving—repair or replace		x		
Housing, bell—replace		x		
Pole piece, exciter—repair			x	
Pole piece, exciter—replace			x	
Ring, brush—repair or replace		x		
Ring, slip—clean	x			
Ring, slip—true-up		x		
Rotor assembly—replace		x		
Springs, brush—adjust	x			
Springs, brush—replace		x		
Windings, field, exciter—repair		x		
Windings, field, exciter—replace		x		
Windings, rotor assembly—repair or replace		x		
Windings, stator assembly—repair or replace		x		

INSTRUMENT PANEL	2nd	3rd	4th	5th
Ammeter, a-c—repair			x	
Ammeter, a-c—replace	x			
Breaker, circuit, a-c—repair				x
Breaker, circuit, a-c—replace	x			
Clips, fuse, a-c—replace	x			
Control, voltage, a-c—repair			x	
Control, voltage, a-c—replace	x			
Fuses, line, a-c—replace	x			
Meter, frequency—repair			x	
Meter, frequency—replace	x			
Terminal, wire—replace or tighten	x			
Voltmeter, a-c—repair		x		
Voltmeter, a-c—replace	x			

CHANGE-OVER PANEL	2nd	3rd	4th	5th
Connections, electrical—clean and tighten	x			
Change-over bars—rearrange or replace	x			

SERVICE MAINTENANCE

	ECHELONS			
WIRING	2nd	3rd	4th	5th
Complete wiring—replace			x	
Single wire—replace	x			
MISCELLANEOUS				
Cleaning	x			
Frame assembly—repair or replace		x		
Housing assembly—repair or replace		x		
Lubrication	x			
Muffler and exhaust pipe—replace	x			
Painting	x			
Panel, instrument—repair			x	
Panel, instrument—replace		x		
Sheet metal—repair		x		

Section III

TECHNICAL INSPECTION

6. DESCRIPTION.

a. A technical inspection is a follow-up and a check on organization maintenance inspection and other maintenance functions. They determine whether the unit should be continued in service or withdrawn from operation for overhaul. These inspections are covered in paragraph 8.

7. INSPECTION RECORD.

a. A permanent record, listing any maintenance performed, should be kept of each inspection. A suitable inspection form, listing the points of inspection itemized in paragraph 8, can be prepared as a guide for maintenance personnel. Utility of the form will be increased if space is provided to record the date and remarks for each periodic inspection.

8. PRACTICAL APPLICATION.

a. Cooling System.

(1) Examine radiator and connections for signs of leakage, clogging or damage.

(2) Inspect fan for looseness, and fan belt for tension.

(3) Inspect water pump for cracks and leaks.

b. Battery Charging Generator and Regulator.

(1) Examine pulley for looseness.

(2) Check all electrical connections.

(3) Make sure all mounting and fastening screws are tight. Examine armature and brushes.

(4) Check voltage and current output of generator under full load.

(5) Inspect regulator contact points for burning and gap distance, and check tension of armature springs.

(6) Examine battery charging generator regulator case for cracks.

c. Ignition System.

(1) Inspect all wiring harness and terminals for damage, worn wiring, and loose connections.

(2) Examine and test ignition toggle switch.

(3) Check distributor for loose mounting or loose connections. Remove cap and inspect for cracks and carbon marks. Inspect breaker points and spring, high-tension rotor, and metal inserts in cap for pitting and burning. Turn cam to check for evidence of wear, looseness, and breakage of weight springs. Check distributor points for pitting and broken spring.

d. Starting Motor.

(1) Examine all connections and terminals.

(2) Inspect and test starting motor switch.

(3) Inspect commutator for carbon marks, and brushes for wear. Inspect brush springs for tension.

e. Engine.

(1) Check crankcase, block, head, and head gasket for cracks or leaks. See that all bolts are tight.

(2) Remove cover and examine valve push rods and springs. Check the valve clearance.

(3) Run engine and listen for slapping pistons, and knock in engine due to presence of carbon.

(4) Check oil pressure. Loose engine bearings are one cause of low oil pressure.

f. Fuel System.

(1) Examine gasoline tank for leaks or damage.

(2) Examine carburetor and air cleaner. Inspect connections to governor and choke rod. Check tightness of all gasoline line connections.

(3) Check gasoline gage.

g. Lubrication System.

(1) Check oil pressure at gage.

(2) Check oil line connections and brackets for tightness.

h. Main Generator.

(1) Check all connections from generator to control instruments.

(2) Start engine, put on full load, and check operation of generator.

(3) Inspect all brushes and brush holders.

(4) Check tightness of engine to generator coupling stud nuts.

(5) Check front and rear bearings for wear or looseness.

(6) Check generator to frame bolts and nuts for tightness.

i. Instrument Panel.

(1) Operate unit under full load and observe operation of all instruments.

(2) Check all connections to instruments on back of panel.

(3) Check field rheostat (voltage control) by turning in each direction and checking rise and fall of voltage on voltmeter.

(4) Operate alternating-current generator with an overload. Circuit breaker should open.

Section IV

FRAME AND HOUSING

Paragraph

9. FRAME, DESCRIPTION AND CONSTRUCTION.

a. The frame is of welded steel construction and consists of two side members, three cross members, sod pan, and four brackets. The side members, in addition to acting as the main part of the frame, act as skids for transportation purposes. The cross members hold the side members in place and provide motor and generator mountings. The brackets, welded at the four corners of the unit, serve as supporting brackets for the radiator and the porter bar brackets. Eleven tapped brackets are welded to the sides and rear of the frame, and serve as attaching members for the sheet metal hood. A 1-piece sheet metal sod pan, securely welded to the side members, protects the unit at the bottom.

10. FRAME SPECIFICATIONS.

Make	The Hobart Brothers Co.
Type	Welded construction
Material	Steel
Over-all length	53 in.
Width	20¼ in.
Distance from front of front brackets to rear of rear brackets	47 in.
Distance between centers of engine front mounting bracket holes	7¼ in.
Distance between centers of engine rear mounting bracket holes	12⅛ in.
Distance between centers of generator mounting holes	11⅛ in.

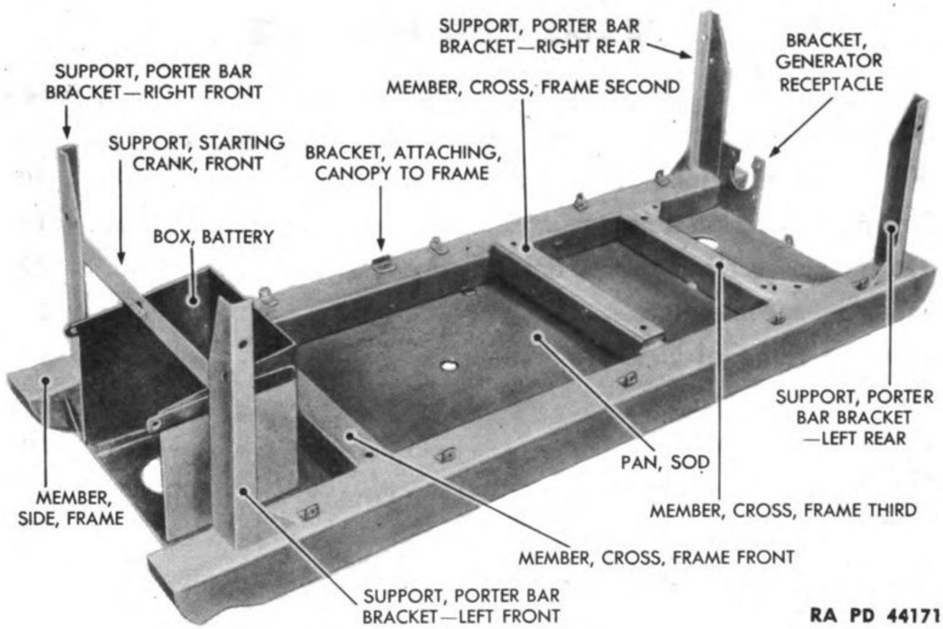


Figure 11 — Frame Assembly

Distance between centers of engine front and rear mounting holes . . . . 18⅝ in.
Distance between centers of engine rear mounting holes and main generator mounting holes . . . . 10⅞ in.

11. FRAME, INSPECTION AND REPAIR.

a. Equipment.

CHAIN (2)
JACK hydraulic (2)
TAPE, steel

b. Procedure.

(1) Visually inspect all welded joints. If any of the welded joints are broken, reweld.

(2) Check for cracked or bent cross members and supports. Weld minor cracks. Straighten bent cross members or supports (two hydraulic jacks and two chains).

12. HOUSING, DESCRIPTION AND CONSTRUCTION.

a. The entire unit is inclosed in a sheet metal housing. Two hoods provide access to the generator and to the engine. The hoods are hinged at the top and held in place by brackets at the ends of the hood hinge rod, and by latches at the bottom. A radiator shield on the front of the housing protects the radiator (fig. 1). On the rear is a

FRAME AND HOUSING

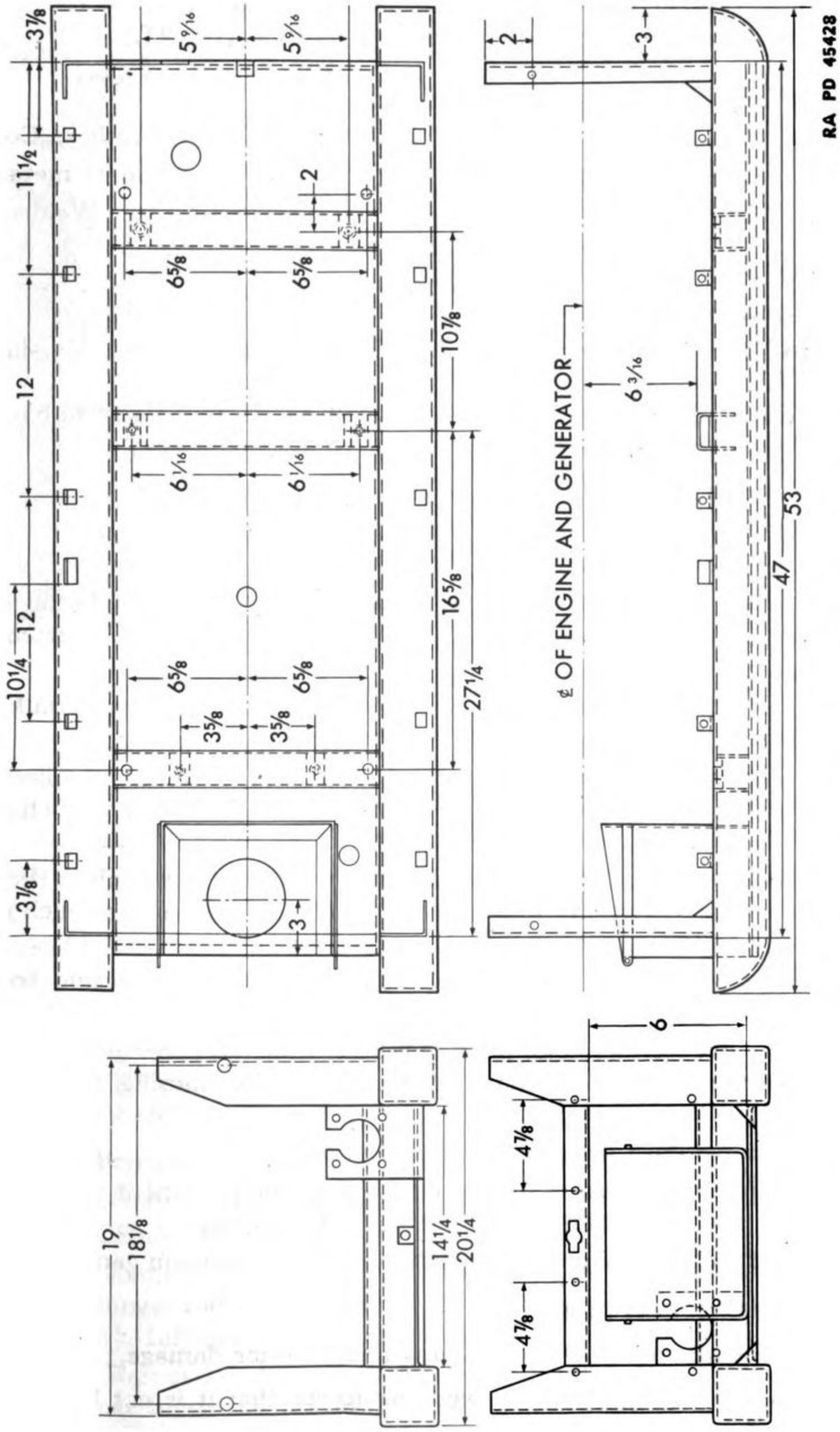


Figure 12 — Frame Checking Dimensions

hinged instrument panel door which acts as a protection for the instrument panel when the unit is not in operation (fig. 2).

13. HOUSING SPECIFICATIONS.

Make . . . . The Hobart Brothers Co.
Type . . . . Sheet metal
Construction . . . . Welded

14. HOUSING REMOVAL.

a. Equipment.

GASOLINE, container
SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{11}{16}$-in. (2)
WRENCH, pipe, adjustable, 14-in.

b. Procedure.

(1) Remove radiator cap by hand (fig. 1).

(2) Remove exhaust pipe (adjustable pipe wrench) (fig. 1).

(3) Remove six screws and lock washers which secure battery cover to housing (screwdriver) (fig. 1). Lift battery cover from housing.

(4) Lift right-hand engine hood. Lift out funnel and starting crank from inside right-hand side of engine compartment.

(5) Close shut-off cock under gasoline tank. Disconnect gasoline line from gasoline strainer on carburetor ($\frac{9}{16}$-in. open-end wrench) (fig. 3). Drain gasoline from the tank into a suitable container.

(6) Remove nuts, lock washers, and bolts which attach each of the four porter bar brackets to frame assembly ($\frac{9}{16}$-in. open-end wrench) ($\frac{11}{16}$-in. open-end wrench). Lift off porter bar brackets (fig. 1).

(7) Remove screws which secure sides and rear of housing to frame assembly (screwdriver) (fig. 1).

(8) Remove screws and plain washers which secure the sheet metal apron (under the instrument panel) to the housing (screwdriver) (fig. 2).

(9) Remove dash lamp bulb guard and bulb.

(10) Lift housing assembly vertically (two men) until it is clear of radiator and instrument panel. Set housing on floor.

(11) Lift felt pads from top of radiator and top of main generator.

15. HOUSING INSPECTION.

a. Inspect all sheet metal for dents and exterior damage.

b. Inspect all hood and door webbing to see that it is not broken or damaged.

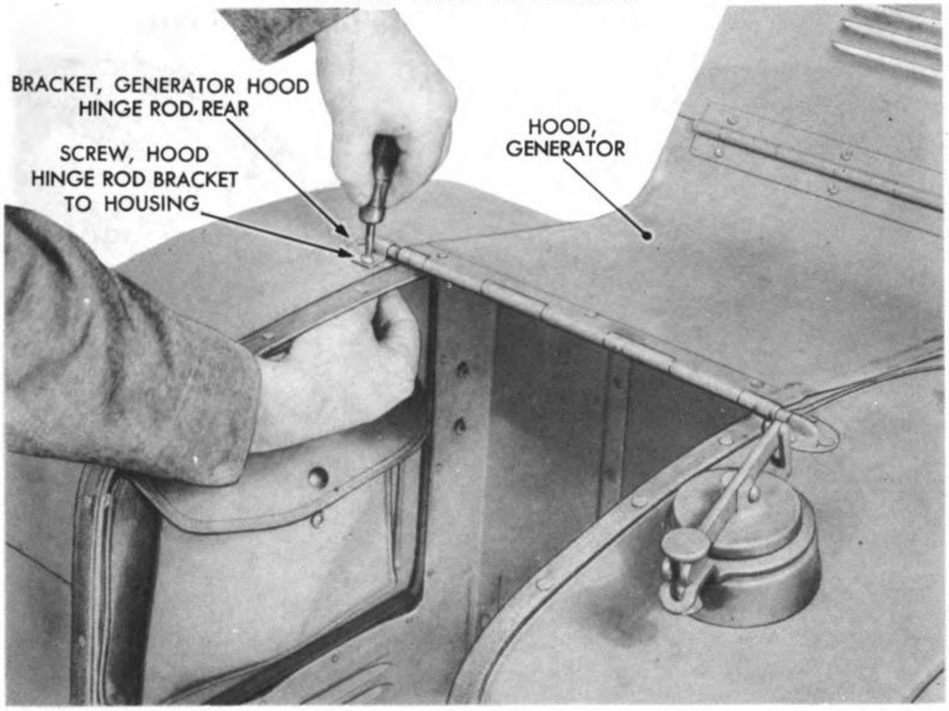


Figure 13 — Removing Canopy Generator Hood

c. Inspect hood latches for broken springs and looseness.

d. Inspect gasoline tank for leaks and rust particles.

e. Inspect all rivets which hold handles catches, webbing, hinges, and hinge rod brackets to be sure that all are tight.

f. Inspect gasoline tank shut-off cock and gasoline line for discoloration which indicates leakage.

16. HOUSING DISASSEMBLY.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, socket-head set-screw, ⅛ in.

b. Procedure.

(1) REMOVE DOORS.

SCREWDRIVER

(a) Remove nuts, lock washers, and screws which secure generator hood hinge rod rear bracket to housing assembly (screwdriver) (fig. 13). Lift generator hood from housing.

(b) Remove nuts, lock washers, and screws which hold engine hood rear hinge rod bracket to housing assembly (screwdriver). Lift engine hood from housing assembly.

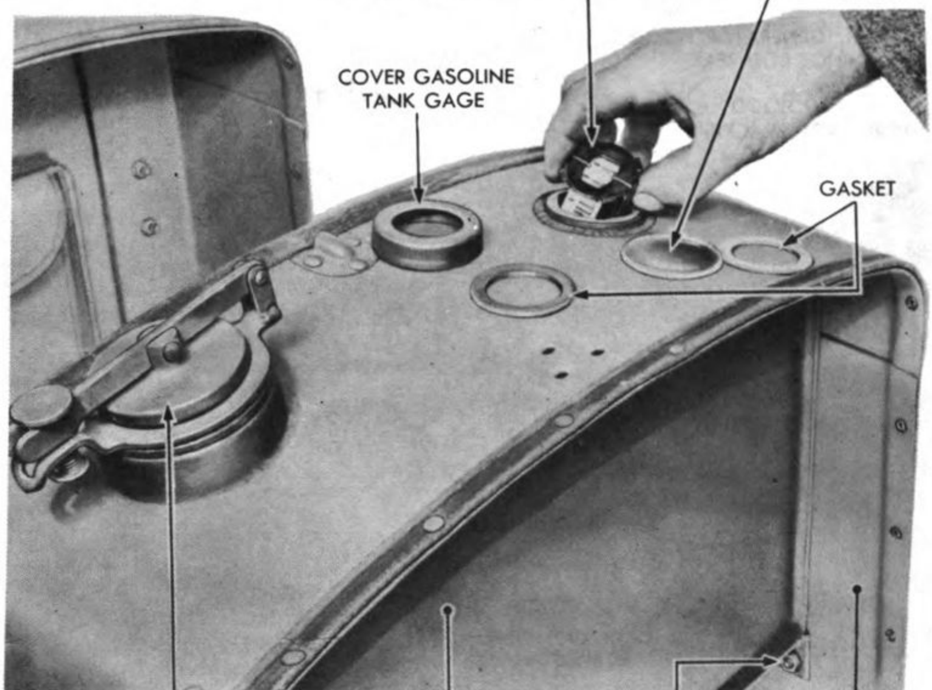


Figure 14 — Removing Gasoline Gage

(2) Remove Gasoline Gage.

(a) Unscrew gasoline tank gage cover by hand (fig. 14).

(b) Lift off the cover, two gaskets, and glass (fig. 14).

(c) Lift gasoline tank gage mechanism from gasoline tank (fig. 14).

(3) Remove Gasoline Tank Filler Cap Assembly.

WRENCH, socket-head setscrew, 1/8-in.

(a) Lift cap and loosen setscrews on inside cap (1/8-in. socket-head setscrew wrench) (fig. 15).

(b) Turn the gasoline tank filler cap assembly one-half turn and lift from tank (fig. 16).

(c) Remove the gasoline tank filler cap gasket (fig. 16).

(4) Remove Gasoline Tank.

SCREWDRIVER WRENCH, open-end, 1/2-in.

(a) Remove nuts, lock washers, and screws which attach gasoline tank to sides of housing (screwdriver) (fig. 14).

(b) Drop gasoline tank down and remove from housing assembly.

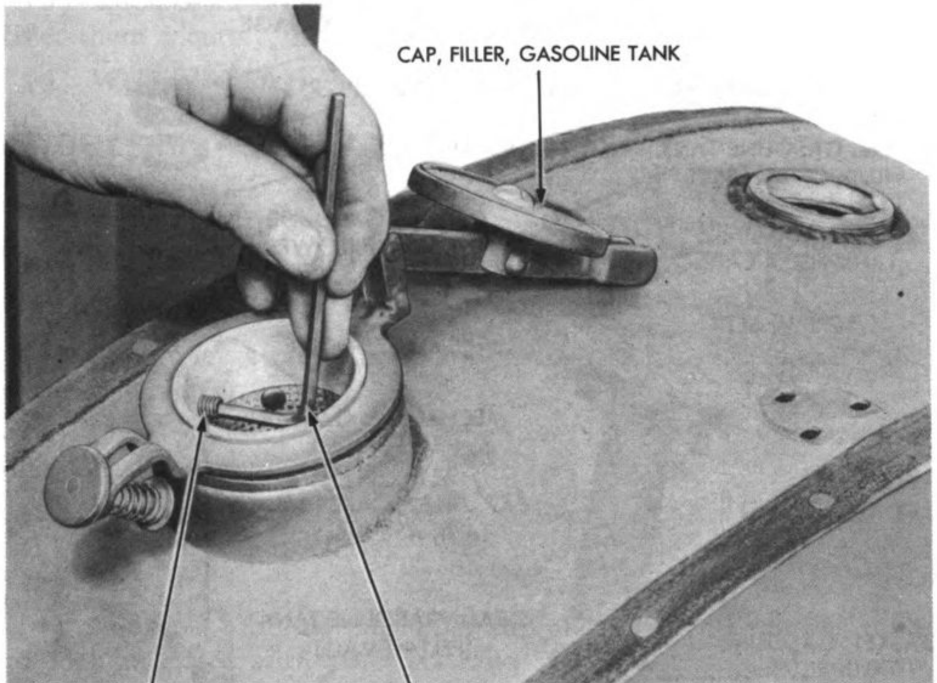


Figure 15 — Removing Gasoline Tank Filler Cap Assembly

(c) Remove the gasoline line from the gasoline shut-off cock, and the gasoline shut-off cock from gasoline tank (½-in. open-end wrench).

17. HOUSING, MAINTENANCE AND REPAIR.

a. Equipment.

FILE
HAMMER
PAINT
REMOVER, paint
SOLDERING EQUIPMENT
SOLVENT, dry-cleaning
TOOL, sheet metal bumping
WELDING EQUIPMENT

b. Procedure.

(1) If it is necessary to repaint the housing, remove all paint with REMOVER, paint and varnish and clean surfaces with SOLVENT, dry-cleaning. Bump out all dents in sheet metal (sheet metal bumping tool). In places hard to reach on the inside of sheet metal parts, fill dents with solder (soldering equipment). File solder flush with metal surface; clean and paint.

(2) Remove all worn or torn webbing, and replace with new, securely riveting it to housing (hammer).

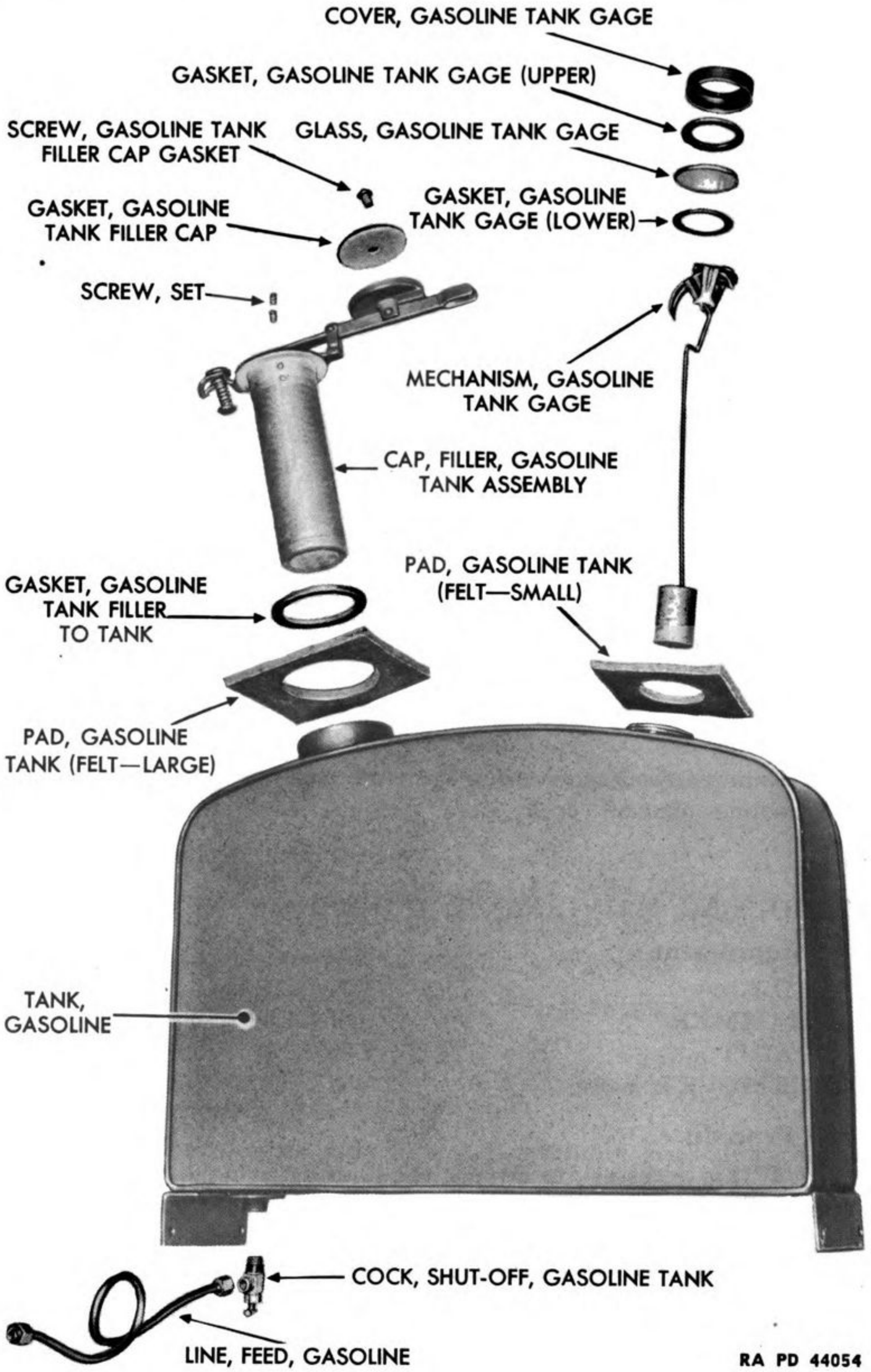


Figure 16 — Gasoline Tank Assembly — Exploded View

(3) Replace all broken hood and door catches, handles, hinges, etc. Rivet them securely in place.

(4) Weld all broken joints (welding equipment).

18. HOUSING ASSEMBLY.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 9/16-in.
WRENCH, socket-head setscrew, 1/8-in.

b. Procedure.

(1) Assemble gasoline tank shut-off cock to gasoline tank (9/16-in. open-end wrench).

(2) Place gasoline tank in position and secure in place with four bolts, lock washers, and nuts (screwdriver) (fig. 14).

(3) Place gasoline tank gage mechanism in position in tank. Install gasket, glass, and another gasket in gage cover, and screw cover to tank (fig. 16).

(4) Assemble gasoline tank filler cap and screen to gasoline tank, and lock in place with two setscrews (1/8-in. socket-head setscrew wrench) (fig. 15).

(5) Assemble the gasoline line to the shut-off cock (9/16-in. open-end wrench).

(6) Assemble generator hood to hinge rod front bracket, and secure the hinge rod rear bracket to hood with screws, lock washers, and nuts (screwdriver) (fig. 13).

(7) Assemble engine hood to hinge rod front bracket, and install hinge rod-rear bracket with screws, lock washers, and nuts (screwdriver) (fig. 13).

(8) Fasten hoods to housing by means of hood latches (fig. 1).

19. HOUSING INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 11/16-in.
WRENCH, Stillson, 14-in.

b. Procedure.

(1) Install housing assembly on unit by lowering it straight down over the radiator and instrument panel (two men) (fig. 1).

(2) Replace dash lamp bulb and guard (fig. 2).

(3) Install sheet metal apron under switchboard panel with three screws and plain washers (screwdriver) (fig. 2).

(4) Attach bottom of housing to frame (screwdriver) (fig. 1).

(5) Attach four porter bar brackets, one to each end of housing ($^9/_{16}$- and $^{11}/_{16}$-in. open-end wrenches).

(6) Connect gasoline line to gasoline strainer at the carburetor ($^9/_{16}$-in. open-end wrench) (fig. 3).

(7) Place funnel in position under engine hood and place starting crank in its position under engine.

(8) Assemble battery cover to front of housing (screwdriver) (fig. 1).

(9) Assemble exhaust pipe to muffler (Stillson wrench) (fig. 3).

Section V

MAIN GENERATOR AND EXCITER

Paragraph

20. DESCRIPTION AND CONSTRUCTION.

a. The main generator consists of two generators mounted on the same shaft in the same housing between one set of bearings. The smaller of the two generators is a direct-current stationary field type generator. Its function is to furnish excitation (direct current) for field windings of the other generator. The other generator is an alternating-current revolving field type generator. Its function is to deliver the electrical output of the unit.

b. On the Unit M5, the generator is a 3-phase, 3 KVA, alternating-current generator. It produces 60 cycles, 125 volts at 1,200 revolutions per minute or 50 cycles, 130 volts at 1,000 revolutions per minute.

c. On the Unit M6, serial numbers 377 to 726, the generator can be adjusted to deliver either a single- or 3-phase output. As a single-phase generator, it delivers 2.5 KVA, 20 amperes, 60 cycles, 125 volts at 1,200 revolutions per minute. As a 3-phase generator it delivers 3 KVA, 13.9 amperes, 60 cycles, 125 volts at 1,200 revolutions per minute. Units M6 bearing serial numbers 1 to 266, inclusive, and 367 to 376, inclusive, deliver only single-phase current.

d. The field system for the exciter is built in the exciter bearing bracket of the main generator (fig. 17).

e. Brush holders for exciter commutator and slip rings are of the radial box type. They are easily reached by removing brush cover immediately under instrument panel (fig. 17).

f. Two ball bearings support the armature shaft. Two screw type grease cups are provided for bearing lubrication.

g. A large fan is mounted on the end of the armature, toward the engine. It cools the generator by drawing air through the housing and from around all windings.

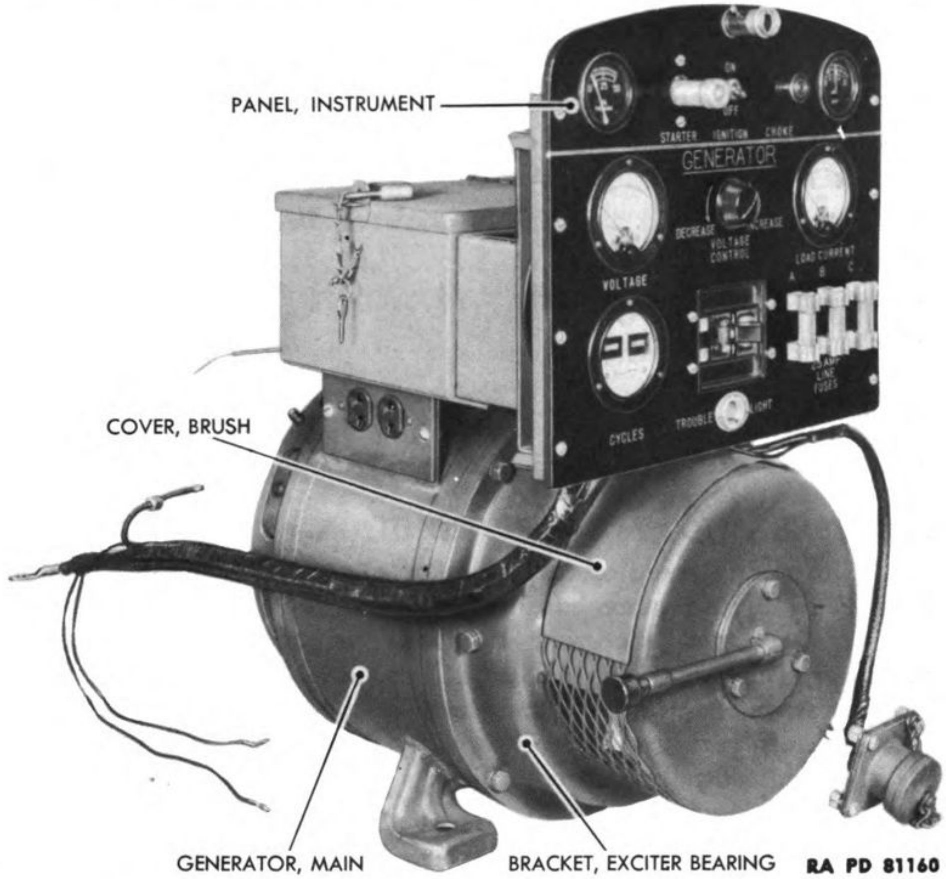


Figure 17 — Main Generator and Instrument Panel

21. SPECIFICATIONS.

a. Output (M5).

Volt	125 at 1,200 rpm
	130 at 1,000 rpm
Phase	3
Cycle	60 at 1,200 rpm
	50 at 1,000 rpm
KVA	3
Lagging power factor	0.8
Deviation limit of generator wave form	6 percent

b. Output (M6).

Volt	125 at 1,200 rpm
Phase	1 or 3
Cycle	60 at 1,200 rpm
KVA (single-phase)	2.5

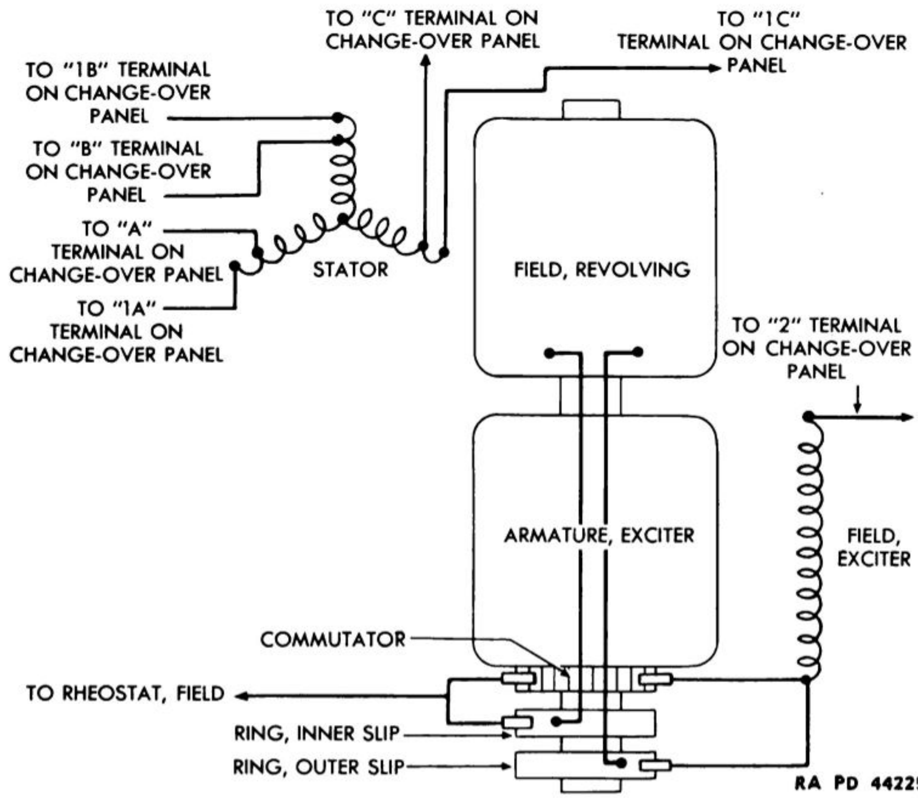


Figure 18 — Unit M5 — Diagram of Generator Wiring

KVA (three-phase) 3

c. Operation Limits.

Maximum deviation of generator wave form . . . . 6 percent
Maximum temperature rise, full load . . . . 40 C
Maximum temperature rise, 125 percent full load . . . . 55 C
Maximum voltage regulation at 0.8 lagging power factor . 16 percent

d. Construction.

Coils, type . . . . Form-wound
Coils, features . . . . Impregnated and baked
Rotor, type . . . . Balanced
Brush holders, type . . . . Adjustable spring tension
Brushes, material . . . . Carbon
Slip rings, material . . . . Copper
Commutator, material . . . . Copper
Field coils, number of (alternating-current) 6

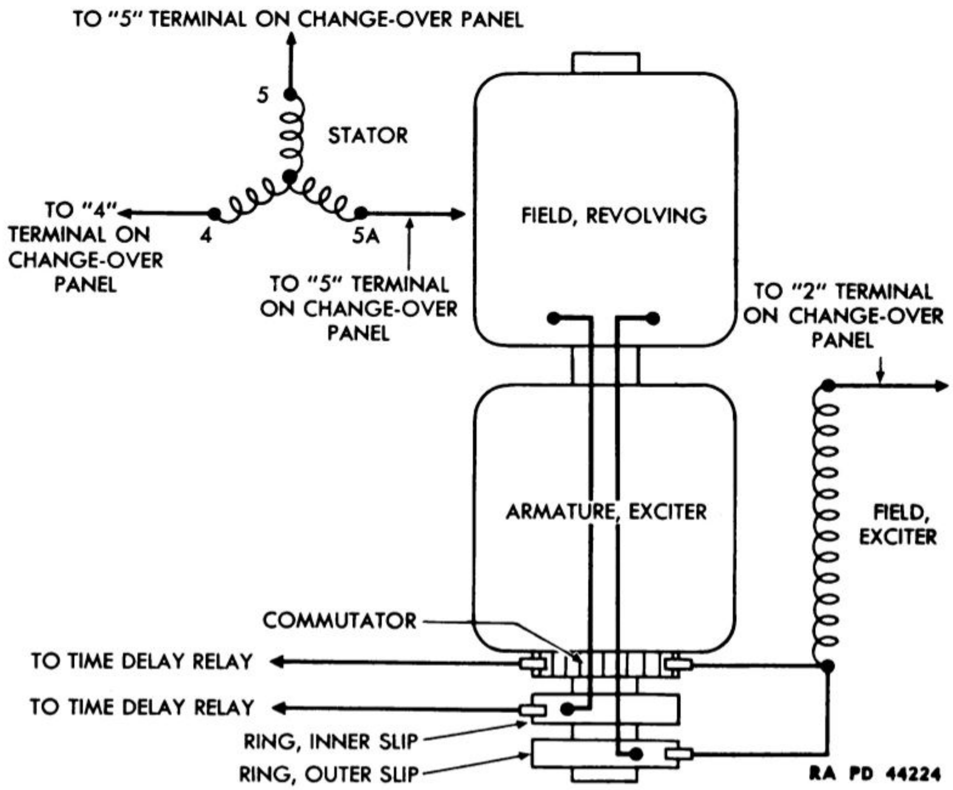


Figure 19 — Single-Phase Unit M6 — Diagram of Generator Wiring

Field coils, type (alternating current) . . . . Revolving
Field coil, features . . . . Removable and interchangeable
Bearings, number of 2
Bearings, make . . . . New Departure
Bearings, type . . . . "X"
Bearings, model WC-8507
Lubrication . . . . Screw type grease cup for each bearing

22. TROUBLE SHOOTING.

a. Equipment.

AMMETER
BATTERY
LAMP, test
LAMP, trouble, 110-volt
OHMMETERS
PROBE (2)
VOLTMETER
WIRE, electric

b. Procedure.

(1) GENERAL. Three things can go wrong with the coils and leads of a generator. These are an open circuit, short circuit, and a ground.

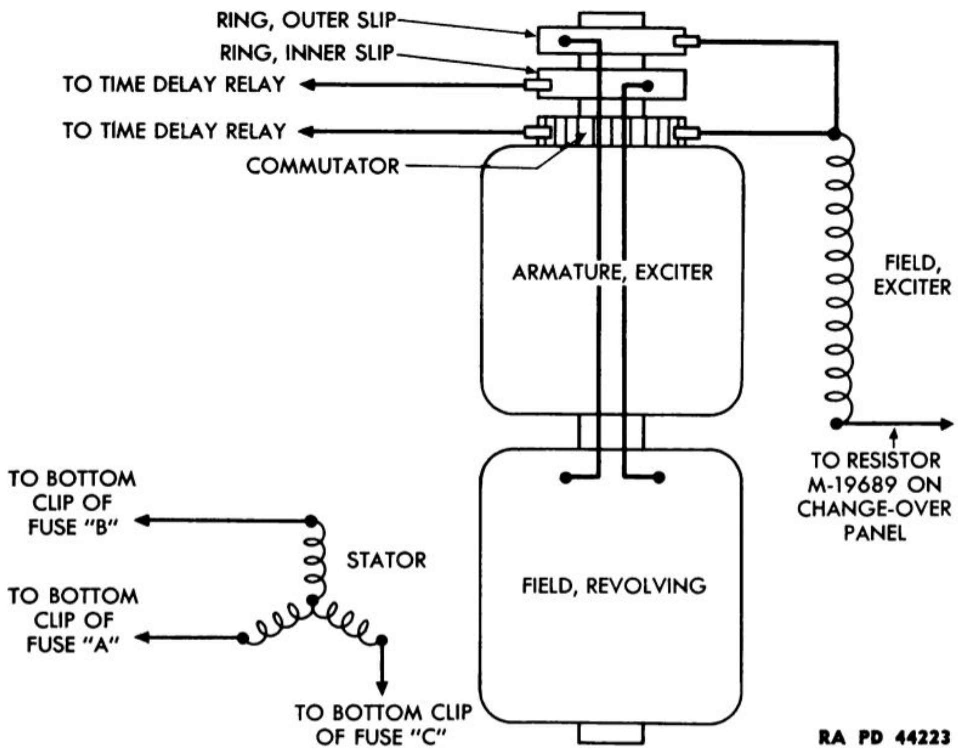


Figure 20 — Single and 3-Phase Unit M6 — Diagram of Generator Wiring

(a) Open Circuit. An open circuit is caused by a break in a wire or by an opening of a connection between two wires. This breaks the circuit because the current has no path to follow.

(b) Short Circuit. A short circuit is caused by lack of insulation on two touching wires. This enables the current to take a "short cut" instead of traversing the route it is supposed to follow.

(c) Ground. A ground is caused by lack of insulation on a wire or coil at point of contact with the framework of the generator. This allows the current to flow into the framework instead of following its proper course.

(2) CONSTRUCTION OF TEST LAMP.

BATTERY
PROBE (2)
WIRE, portable, lamp

Construct a test lamp by connecting in series a probe, a battery, a lamp bulb, and another probe. Test operation of the test lamp by touching the points of the two probes together. The bulb should light.

(3) Checking for an Open Circuit.

LAMP, test

(a) Hold the point of one probe of a test lamp against the bare wire at one end of the coil or wire being tested.

(b) Place the point of the other probe against the bare wire at the other end of the coil or wire being tested.

(c) If the test lamp lights, a continuous circuit is indicated. If the test lamp fails to light, an open circuit exists in the coil or wire being tested.

(4) Checking for a Short Circuit.

Location of short circuits is more difficult than finding open circuits. No specific directions which will apply to all cases can be given. In general, loss of generator output and presence of excessive heat indicate a short circuit.

(5) Checking for a Ground.

LAMP, test

(a) Hold one probe of a test lamp against a bare lead to the coil or wire being tested.

(b) Touch other probe of test lamp against the frame of the generator.

(c) If the test lamp lights, a ground is present. If the lamp fails to light, absence of ground is indicated.

(6) Locating the Cause of Main Generator Failure.

(a) Symptom—No Amperes at Rated Voltage Unit M5.

LAMP, test

1. Test fuses with test lamp. Replace fuse if lamp fails to light.

2. Turn on circuit breaker. Test for open circuit (test lamp) from top clip of fuse "A" on instrument panel to "A" socket of outlet receptacle (fig. 21). Repeat test from top clip of fuse "B" on instrument panel to "B" socket of receptacle. Repeat test from top clip of fuse "C" to "C" socket of receptacle. Repair or replace wiring of any circuit on which test lamp fails to light.

3. If steps *1* and *2* above reveal no open circuits, an open circuit is indicated in the wires or in the motor of the appliance receiving power from the unit.

(b) Single- and 3-phase Unit M6.

LAMP, test

If the unit is on 3-phase operation, the test is identical with step *(a)* above. If the unit is on single-phase operation, turn on the circuit breaker. Test for open circuit (test lamp) from top clip of fuse

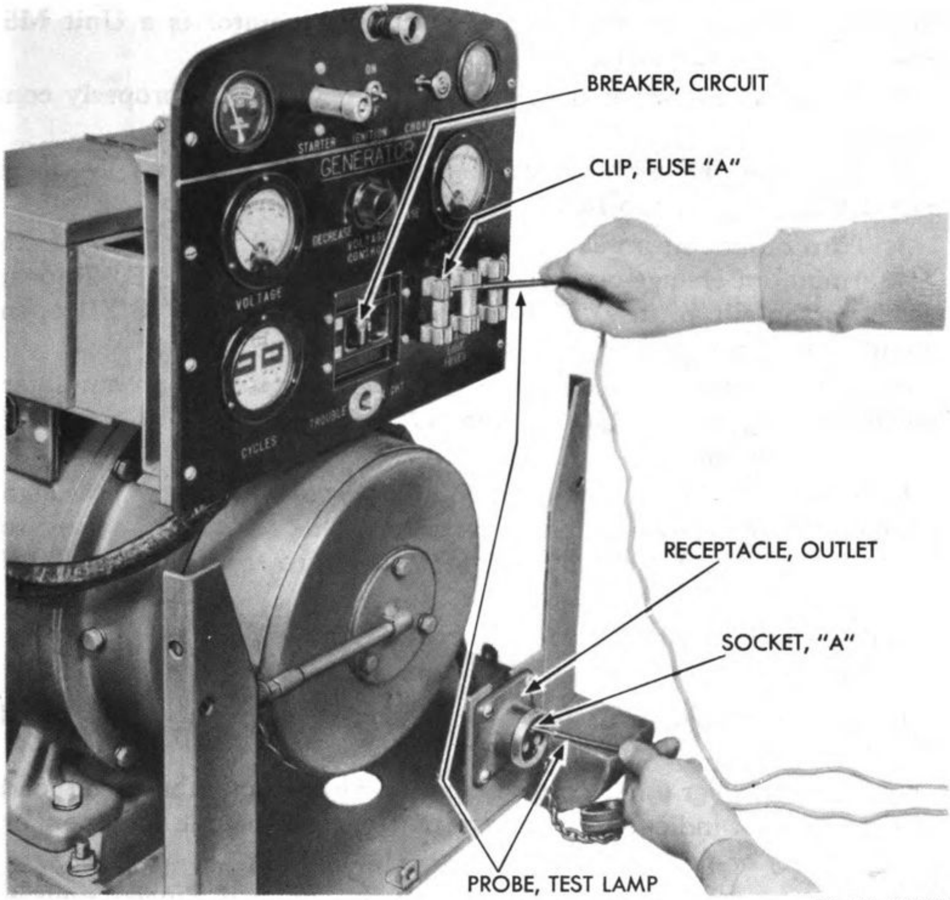


Figure 21 — Testing "A" Circuit for Open Circuit

"A" on instrument panel to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "C" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace wiring of any circuit on which test lamp fails to light.

(c) Single-phase Unit M6.

LAMP, test

Turn on the circuit breaker. Test for open circuit (test lamp) from top clip of fuse "4" to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "5A" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace wiring of any circuit on which test lamp fails to light.

(d) Symptom—Excessive Amperes at Rated Voltage.

AMMETER LAMP, test

NOTE: This condition arises only in 3-phase generators. Therefore, the following steps apply whether the generator is a Unit M5 or a Unit M6 adjusted for 3-phase operation.

1. Inspect change-over panel (fig. 8) to be sure it is properly connected.

2. Test fuse "B" with a test lamp (step b (3) above). Replace fuse if test lamp fails to light.

3. Turn on circuit breaker. Test for open circuit (test lamp) from "B" terminal of change-over panel to bottom clip of fuse "B." Repeat test from top clip of fuse "B" to outlet receptacle socket "B." If open circuit is found, repair or replace faulty wiring or switch.

4. Test ammeter by disconnecting it and substituting an ammeter known to be good. Replace equipment ammeter if it does not read same as test ammeter.

5. If the trouble is not located and corrected in steps *1* through *4* above, an unbalanced load is probable. Check external wiring to unit for open circuit or poor connection in wire from socket "B" of outlet receptacle.

(e) Symptom—Insufficient Amperes at Rated Voltage.

LAMP, test

1. Inspect change-over panel to be sure it is properly connected (fig. 8).

2. If change-over panel connections are correct, an unbalanced load on generator is indicated. Test external wiring to unit for open or short circuits or poor connections (test lamp).

(f) No Amperes and No Voltage, Unit M5, and Single- and 3-phase Unit M6.

LAMP, test — PROBE (2)
LAMP, trouble, 110-volt

1. Start engine and turn on main switch.

2. Using a standard 110-volt trouble lamp, apply the probes at terminals "RA" and "RB" of change-over panel. Repeat test from terminals "RA" and "RC." Repeat test from terminals "RB" and "RC." Stop engine. To make this test on the single-phase Unit M6, apply the probes at "R4" and "R5" terminals of the change-over panel. Repeat test from terminals "R5" and "R5A." Stop engine.

3. If trouble lamp lights on all three tests, the generator is functioning. Proceed with steps *4* through *6* below. If trouble lamp fails to light on any two of the above tests, an open circuit in the stator or leads from stator is indicated. Disassemble generator and repair or replace stator. If trouble lamp fails to light on all three tests, proceed with steps *7* through *11* below.

4. This step applies to M5 and M6, single-phase only. For Unit M5 test for open circuit (test lamp) from change-over panel terminal

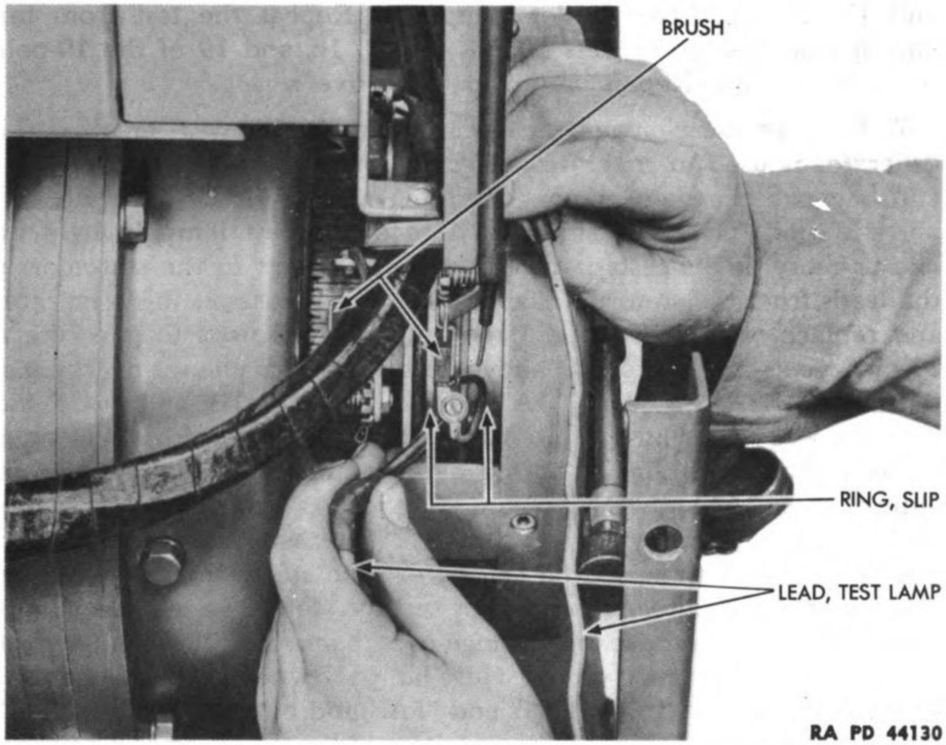


Figure 22 — Testing Revolving Field for Open Circuit

"RA" to bottom clip of fuse "A" on instrument panel. Repeat test from "RB" to bottom clip of fuse "B." Repeat test from "RC" to bottom clip of fuse "C." Repair or replace any wire having an open circuit. For Unit M6, test from terminal "RA" to bottom clip of fuse "4" on instrument panel. Repeat test from "RB" to bottom clip of fuse "5." Repeat test from "R5A" to bottom clip of fuse "5A." Repair or replace any fuse having an open circuit.

5. Test fuses with test lamp. Replace if burned out.

6. With circuit breaker on, check for open circuit from top clip of fuse "A" to socket "A" of outlet receptacle. Repeat test from "B" to "B" and from "C" to "C". Failure of test lamp to light indicates an open circuit or defective circuit breaker. Repair or replace defective parts. If the unit being tested is a single- and 3-phase Unit M6 on three-phase operation, the above steps apply. If the unit is on single-phase operation, turn on the circuit breaker. Test for an open circuit (test lamp) from top clip of fuse "A" to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "C" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace defective wiring. If the unit being tested is a single-phase Unit M6, turn on the circuit breaker. Test for open circuit (test lamp) from top clip of fuse "4" to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "5A" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace defective wiring.

7. Remove the change-over bars on the change-over panel. If the generator is used to generate a 60-cycle current test for an open circuit between change-over panel terminals "A" and "B," "A" and "C," and "B" and "C" (test lamp). Failure of the test lamp to light on one or more of the tests indicates an open circuit in the stator or in the leads from the stator to change-over panel. Disassemble generator and replace or repair stator. If the generator is used to generate a 50-cycle current, make the above tests between change-over panel terminals "1A" and "1B," "1A" and "1C," and "1B and "1C." To test single- and 3-phase Unit M6, remove the fuses from the clips on the switchboard panel. Test for an open circuit between the bottom clips of fuses "A" and "B," "A" and "C," and "B" and "C" (test lamp). Failure of the lamp to light on any of the tests indicates an open circuit in the stator or in the leads from the stator to the fuse clips. Disassemble generator and repair or replace stator. To test the single-phase Unit M6, remove the change-over bars from the change-over panel. Test for an open circuit (test lamp) between the change-over panel terminals "4" and "5," "4" and "5A," and between "5" and "5A." Failure of the lamp to light on any test indicates an open circuit in the stator or in the leads from the stator. Disassemble generator, and repair or replace stator.

8. If step *7* above reveals no open circuit, remove the brush cover (fig. 22). Lift the four slip ring brushes (narrow) in their holders so that none make contact with either slip ring. Test for open circuit between the two slip rings (test lamp) (step **b** (3) above). If test lamp fails to light, an open circuit in the revolving field or leads is indicated. Disassemble generator, and repair or replace defective coil or lead.

9. When testing the Unit M5, if step *8* above reveals no open circuit, determine whether exciter is generating current by starting engine and applying a direct-current voltmeter between any two adjacent exciter brush holders (fig. 23). During this test, set field rheostat (voltage control) at maximum increase (i.e., turn voltage control knob clockwise as far as it will go). At least 56 volts should be indicated. If no voltage is shown, connect change-over bar on change-over panel between terminals "1" and "2." Repeat test for voltage. If this step produces voltage, replace resistor back of change-over panel between terminals "1" and "2." If correct voltage is present, check wire from commutator brush to slip ring brush for open circuit or poor connection. Check wire from top slip ring brush to field rheostat (voltage control) for open circuit or poor connection. Repair or replace defective wires. NOTE: Burned insulation on these two

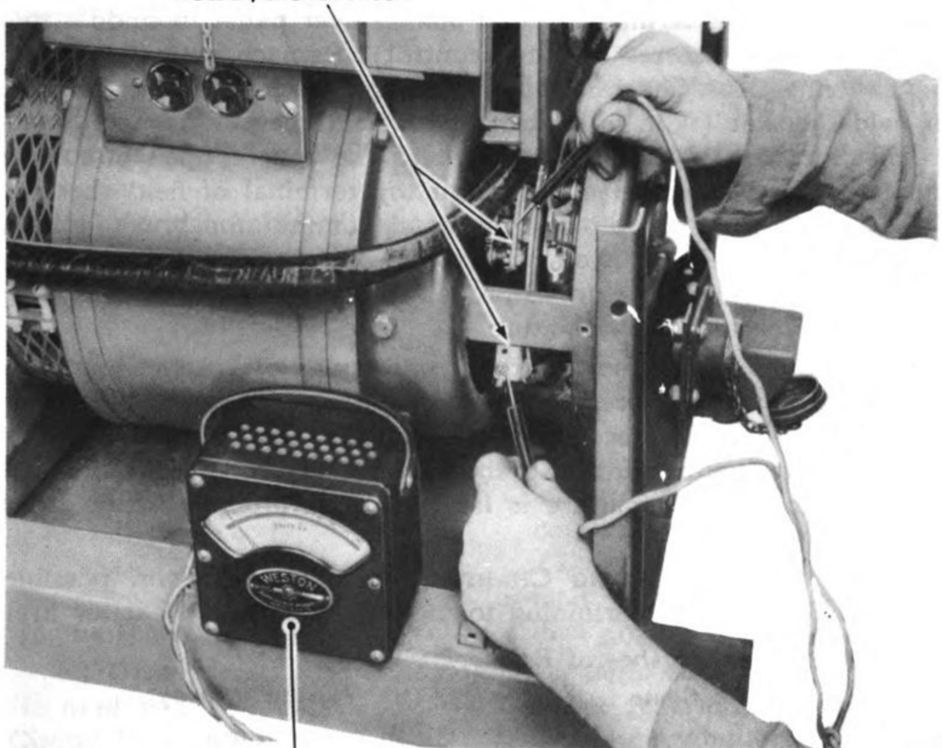


Figure 23 — Testing Exciter Voltage Output

wires indicates a short circuit in the revolving field circuit. If field is short-circuited, disassemble generator and repair or replace defective parts. This test is the same for the single-phase Unit M6, except that the change-over bar is connected between change-over panel terminals "2" and "3" instead of "1" and "2." If it is necessary to replace resistor, it is connected on rear of change-over panel between terminals "2" and "3." This test of the single- and 3-phase Unit M6 is the same as that outlined for the Unit M5, except that instead of connecting a change-over bar between change-over panel terminals "1" and "2," a wire jumper is connected across the resistor in the exciter field circuit.

10. If step *9* above shows exciter generating no voltage, examine commutator brushes to see if they are stuck in holders, broken, or worn. Replace if broken or worn. Examine brush holder springs to see that brushes are under tension and against commutator. Replace weak or broken springs. If brushes are operating satisfactorily, test for open circuit from top right-hand exciter brush to terminal "2" on change-over panel. Open circuit here indicates poor field connection on this brush holder or an open exciter field circuit. Disassemble generator and repair or replace open exciter field coils. Check for open circuit from terminal "2" on change-over panel to middle terminal on field rheostat (voltage control). Replace wire if open or repair connections. Check for open circuit from top to middle terminal of field rheostat (voltage control) with field rheostat turned to extreme clockwise position. Replace field rheostat if open circuit is indicated. Test for open circuit from top terminal of field rheostat (voltage control) to bottom right-hand commutator brush holder. Repair or replace wire if open. If above procedure reveals no fault, a defective exciter armature is probable. Disassemble generator and repair or replace exciter armature.

11. If step *9* above shows exciter generating voltage, but less than 56 volts, follow the procedure outlined in step *10* above. Look especially for a high resistance or loose connection, faulty resistor, faulty field rheostat (voltage control), short circuit in exciter field coil, or a faulty armature. If armature is faulty, it will probably show signs of heat.

(7) TROUBLE SHOOTING CHART. Possible malfunctions, possible causes, and remedies pertaining to main generator and exciter are:

(a) Arcing at Brushes of Exciter.

Possible Cause	Possible Remedy
Dirt on commutator.	Clean commutator.
Worn brushes.	Replace brushes (par. 24 **b** (10)).
Brushes stuck in holders.	Remove, clean, and install brush holder and brush (pars. 24 **b** (9) and (10) and 27 **b** (1) through (4)).
Open circuit in armature coil in exciter.	Replace armature (par. 24).
Open circuit in main generator lead to field rheostat.	Solder lead (par. 26 **b** (1) *(b) 1*).

(b) Fails to Generate Rated Amperes.

Unbalanced load on lines.	Balance load on lines.
Defective wiring in circuit.	Replace or repair wiring (par. 24).
Bars on change-over panel connected incorrectly.	Connect change-over panel bars correctly (par. 29 **b** (1) and (2)).
Field rheostat incorrectly adjusted.	Adjust field rheostat correctly.
Dirt on exciter commutator.	Clean exciter commutator.
Worn brushes on exciter.	Replace exciter brushes.
Defective rotor.	Replace rotor (par. 24 **a** through **b** (4)).

MAIN GENERATOR AND EXCITER

Possible Cause	Possible Remedy
Short circuit in revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Open circuit in revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Grounded revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Open circuit in field coil lead.	Solder field coil lead (par. 26 **b** (1) *(a) 1*).
Short circuit in field coil lead.	Replace field coil lead (par. 26 **b** (1) *(a) 3*).
Fuse burned out.	Replace burned out fuse.
No load on generator.	Put load on generator.
Defective ammeter.	Replace ammeter (par. 36).

(c) Fails to Operate at Proper Frequency.

Possible Cause	Possible Remedy
Bars on change-over panel connected incorrectly.	Connect change-over panel bars correctly (par. 29 **b** (1) and (2)).
Defective wiring in circuit.	Repair wiring (par. 26 **b** (1)).
Engine speed too low or too high.	Adjust engine speed (par. 148),

(d) Generator Delivers No Voltage or Amperage.

Possible Cause	Possible Remedy
No load on generator.	Connect generator to load.
Circuit breaker off.	Turn on circuit breaker.
Dirt on commutator of exciter.	Clean commutator.
Exciter brushes stuck in holders.	Remove, clean, and install brush holder and brush (pars. 24 **b** (9) and (10) and 27 **b** (1) through (4)).
Worn exciter brushes.	Replace exciter brushes.
Open circuit in revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Open circuit in field coil lead.	Connect and solder field coil lead par. 26 **b** (1) *(a)*).
Defective rotor.	Replace rotor (par. 24 **a** through **b** (4)).
Grounded revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Fuses blown out.	Replace fuses.
Change-over panel incorrectly connected.	Connect change-over panel correctly (pars. 27 **b** (11) *(e)* and 29 **b** (1) and (2)).
Open circuit in stator winding.	Replace body and stator (par. 24 **b** (1) through (5)).
Open circuit in wiring from change-over panel to instrument panel.	Test (par. 22 **b** (6) *(d)*) and repair or replace welding.

Possible Cause	Possible Remedy
Open circuit between stator and change-over panel.	Test (par. 22 **b** (6) *(d)*) and repair or replace wiring.
(e) Generator Delivers No Voltage.	
Defective voltmeter.	Replace voltmeter (par. 35).
Change-over panel improperly connected.	Connect change-over panel properly (par. 27 **b** (11) *(e)*).
Change-over panel bars not connected.	Connect change-over panel bars (par. 29 **b** (1) and (2)).
(f) Voltmeter Shows No Voltage.	
Fuse "A" burned out.	Replace fuse "A."
Open circuit in circuit "A."	Replace or repair wiring (par. 24).
Defective voltmeter.	Replace voltmeter (par. 35).
(g) Ammeter Registers Too High.	
Defective ammeter.	Replace ammeter (par. 36).
Fuse "B" burned out.	Replace fuse "B."
Open circuit in "B" circuit.	Repair or replace wiring (par. 24).
Change-over panel incorrectly connected.	Connect change-over panel correctly (par. 27 **b** (11) *(e)*).
Improperly balanced load.	Balance load.

23. REMOVAL.

a. Equipment.

HOIST, chain
SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 3/4-in.
WRENCH, Stillson

b. Procedure.

(1) Remove housing (par. 14).

(2) Disconnect starter switch to starting motor cable from starting motor (9/16-in. open-end wrench).

(3) Remove the wire from the ammeter to battery charging generator regulator at the regulator (screwdriver) (fig. 133).

(4) Remove ignition switch to ignition coil wire from ignition coil terminal marked "—" (3/8-in. open-end wrench) (fig. 133).

(5) Disconnect choke control from carburetor and air cleaner bracket (par. 154).

(6) Disconnect oil pressure gage line from cylinder block (1/2-in. open-end wrench) (fig. 133).

(7) Remove main generator front grease cup (1/2-in. open-end wrench). Remove main generator front grease cup elbow and nipple (Stillson wrench) (fig. 133).

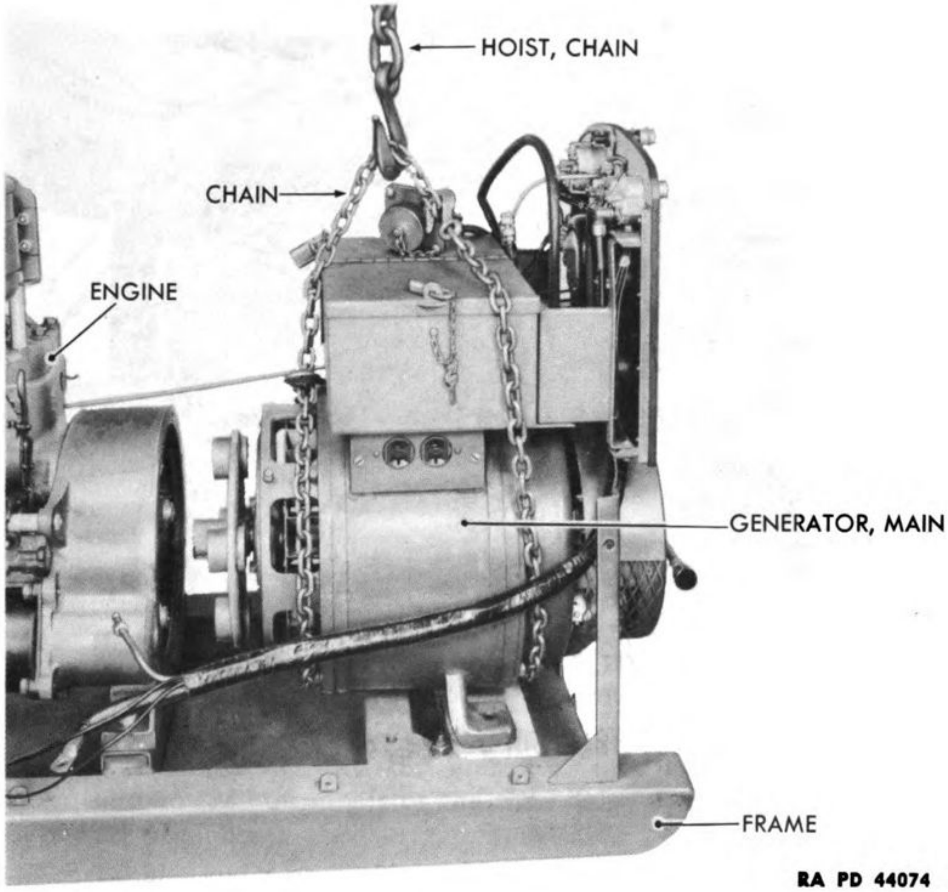


Figure 24 — Lifting Main Generator from Unit

(8) Remove main generator fan cover clamp screws and nuts (screwdriver). Lift fan cover from unit (fig. 133).

(9) Remove eight cap screws and lock washers securing main generator to bell housing (9/16-in. open-end wrench) (fig. 134).

(10) Remove outlet receptacle (pars. 62 and 63).

(11) Loosen right-hand engine rear mounting cap screw (3/4-in. open-end wrench). Pull battery to starter switch cable from cable clip (fig. 135).

(12) Remove main generator mounting cap screws and lock washers (3/4-in. open-end wrench) (fig. 134).

(13) Slide back entire main generator and instrument panel assembly until it clears engine (two men).

(14) Construct a chain or rope sling and carefully lift main generator and instrument panel assembly from unit with a chain hoist (fig. 24).

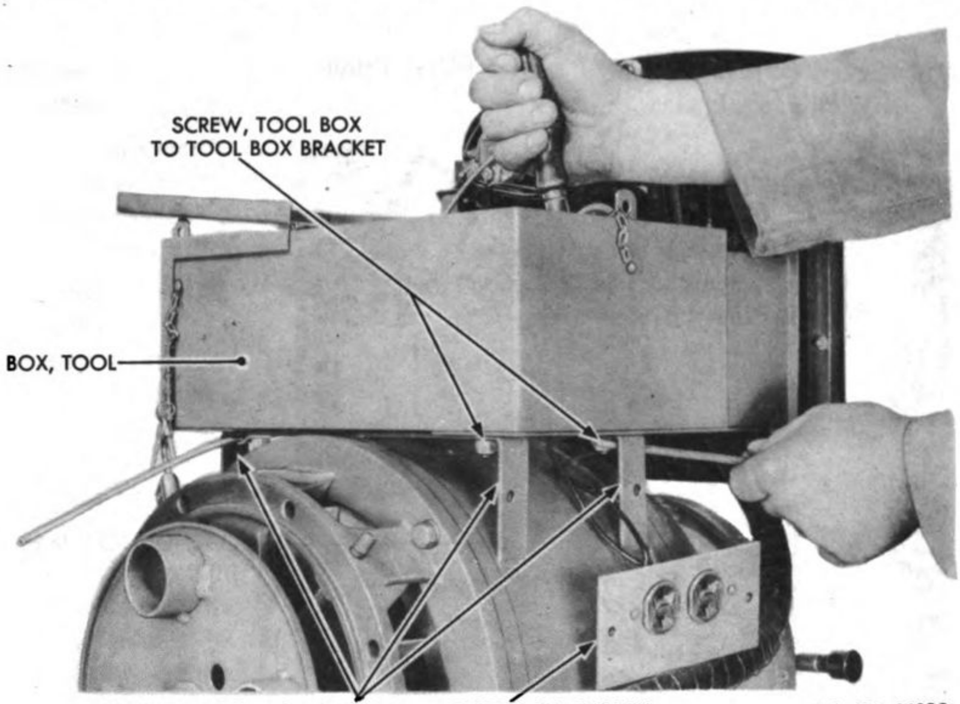


Figure 25 — Removing Tool Box to Tool Box Bracket Screws

24. DISASSEMBLY.

a. Equipment.

CUTTER, wire
HAMMER, soft
HAMMER, 2-lb
MALLET, rawhide
PULLER, bearing
PULLER, gear
SCREWDRIVER
SCREWDRIVER, large
TAG, cardboard (6)
WRENCH, open-end, $\frac{5}{16}$-in.
WRENCH, open-end, $\frac{11}{32}$-in.
WRENCH, open-end, $\frac{7}{16}$-in.
WRENCH, open-end, $\frac{1}{2}$-in.
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, socket, $\frac{1}{2}$-in.
WRENCH, socket, $\frac{9}{16}$-in.
WRENCH, socket-head set-screw, $\frac{1}{8}$-in.
WRENCH, socket-head set-screw, $\frac{5}{16}$-in.
WRENCH, Stillson

b. Procedure.

(1) REMOVE INSTRUMENT PANEL, TOOL BOX, AND CHANGE-OVER PANEL.

SCREWDRIVER
WRENCH, open-end, $\frac{5}{16}$-in.
WRENCH, open-end, $\frac{7}{16}$-in.
WRENCH, open-end, $\frac{1}{2}$-in.

(a) Unit M5. Disconnect main generator leads from back of change-over panel terminals "1," "1A," "1B," "1C," "A," "B," and "C" ($\frac{1}{2}$-in. open-end wrench) (fig. 71).

MAIN GENERATOR AND EXCITER

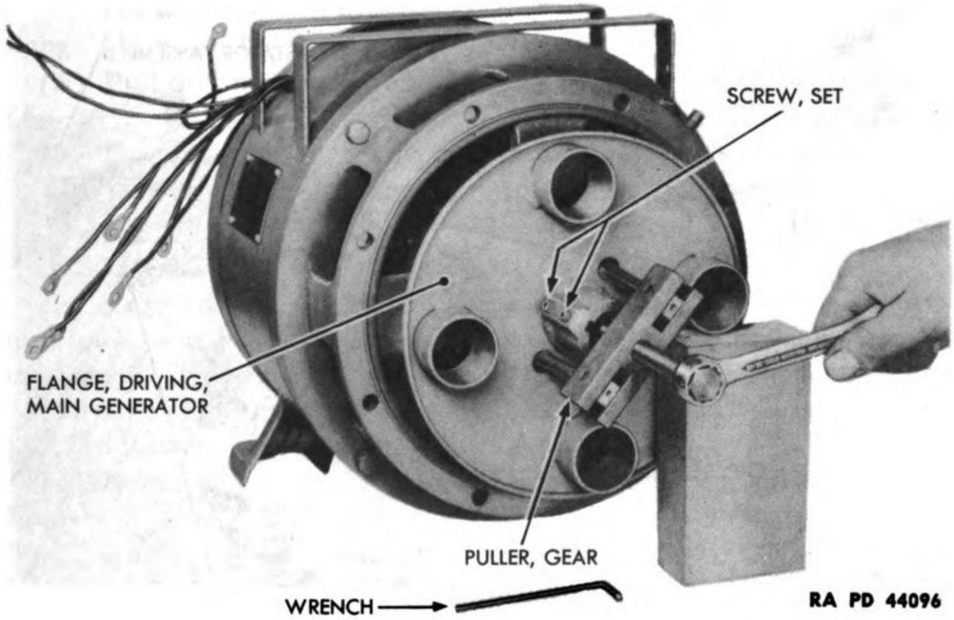


Figure 26 — Pulling Main Generator Driving Flange

(b) Single-phase Unit M6. Disconnect main generator leads from back of terminals "2," "4," "5," and "5A" of change-over panel, and from the two "M" terminals of the time delay relay (7/16- and 3/8-in. open-end wrenches).

(c) Single- and 3-phase Unit M6. Disconnect main generator leads from bottom clips of fuses "A," "B," and "C," and from the two "M" terminals of the time delay relay (7/16-in. open-end wrench).

(d) Disconnect main generator leads (5/16-in. open-end wrench) (fig. 66) from top terminal of field rheostat (voltage control).

(e) Remove screws and safety nuts (1/2-in. open-end wrench and screwdriver), securing tool box to right-hand bracket.

(f) Remove duplex receptacle to tool box bracket screws, nuts, and lock washers (screwdriver and 7/16-in. open-end wrench). Lift receptacle from bracket (fig. 74).

(g) Remove screws and safety nut which secure tool box to left-hand bracket (1/2-in. open-end wrench and screwdriver).

(h) Lift instrument panel, tool box, and change-over panel assembly from generator. CAUTION: Duplex receptacle must be pushed through tool box bracket as assembly is lifted from generator (fig. 74).

(2) REMOVE MAIN GENERATOR DRIVING FLANGE.

HAMMER, 2-lb
PULLER, gear
WRENCH, socket-head setscrew, 1/8-in.

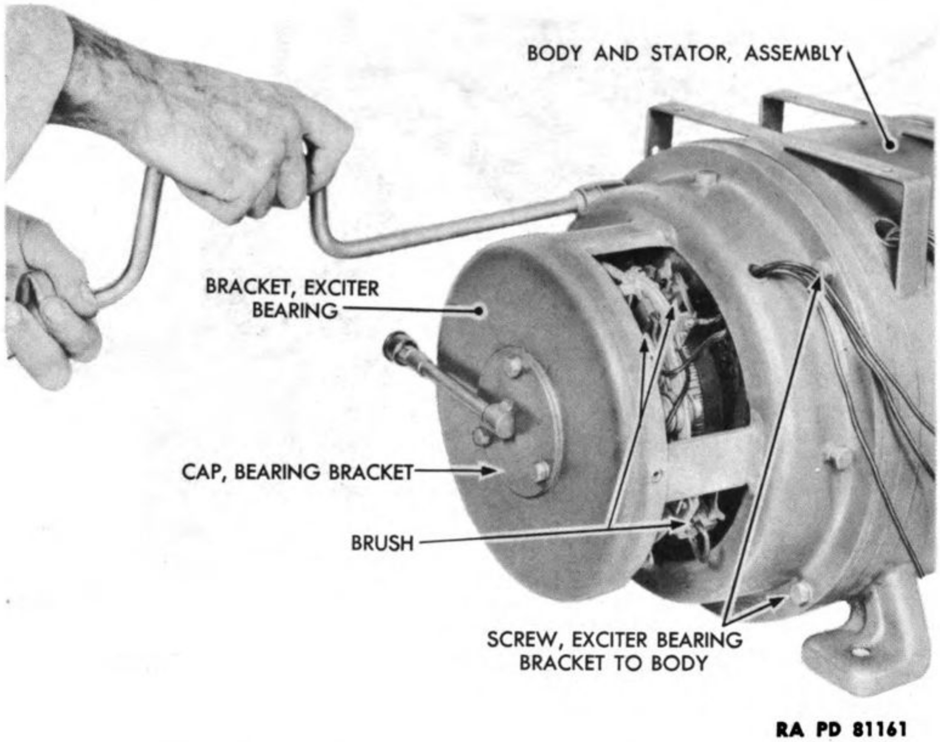


Figure 27 — Removing Exciter Bearing Bracket Assembly

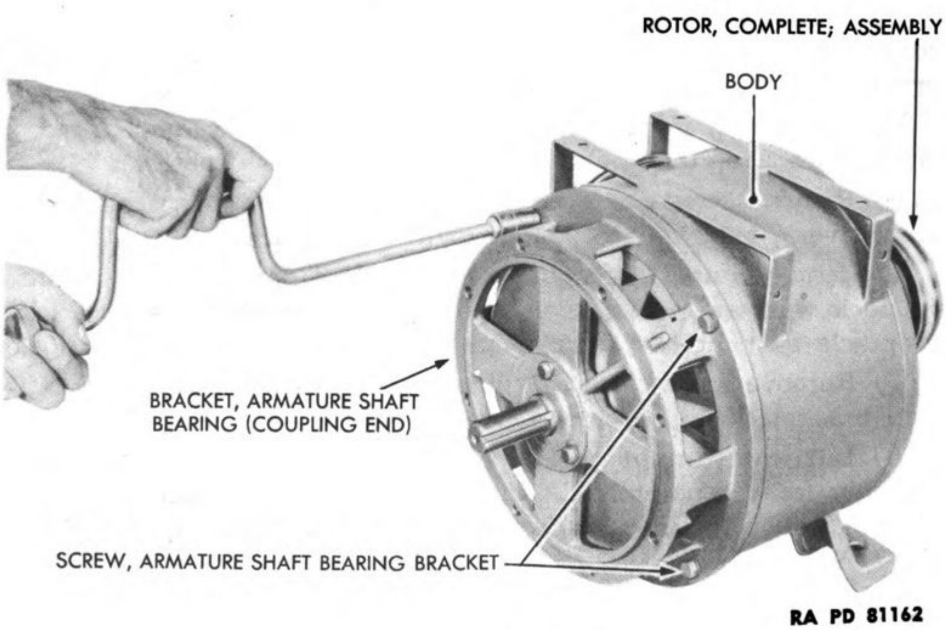


Figure 28 — Removing Armature Shaft Bearing Bracket

MAIN GENERATOR AND EXCITER

(a) Loosen socket-head setscrews in hub of main generator driving flange (1/8-in. socket-head setscrew wrench) (fig. 26).

(b) Pull driving flange from the rotor assembly shaft (gear puller) (fig. 26).

(c) Tap driving flange key from rotor assembly shaft (hammer).

(3) REMOVE EXCITER BEARING BRACKET ASSEMBLY.

HAMMER, soft	**WRENCH**, open-end, 7/16-in.
SCREWDRIVER, large	**WRENCH**, socket, 9/16-in.

(a) Unscrew two main generator brush cover machine screws and nuts, and remove cover from exciter bearing bracket (screwdriver and 7/16-in. open-end wrench).

(b) Lift all eight brushes away from rotor. **NOTE**: Brush holders are designed so that brushes will stay up (fig. 27).

(c) Remove cap screws and lock washers securing exciter bearing bracket to body and stator assembly (9/16-in. socket wrench) (fig. 27).

(d) Tap exciter bearing bracket loose from body (soft hammer). Pry exciter bearing bracket from body (large screwdriver).

(e) Lift exciter bearing bracket from generator (fig. 27). **CAUTION**: Brush holder ring is a close fit over slip ring separator. Avoid breaking separator when removing bearing bracket.

(4) REMOVE COMPLETE ROTOR ASSEMBLY.

HAMMER, soft	**WRENCH**, socket, 9/16-in.

(a) Remove cap screws and lock washers securing armature shaft bearing bracket to body (9/16-in. socket wrench) (fig. 28).

(b) Tap armature shaft bearing bracket loose from body (soft hammer) (fig. 28).

(c) Lift bracket and complete rotor assembly from body and stator assembly.

(5) REMOVE AND DISASSEMBLE ARMATURE SHAFT BEARING BRACKET.

HAMMER, soft	**WRENCH**, Stillson
WRENCH, open-end, 1/2-in.	

(a) Tap bracket loose from rotor assembly (soft hammer) (fig. 29).

(b) Lift bracket from rotor assembly.

(c) Remove cap screws and lock washers, securing grease retainer to bracket (1/2-in. open-end wrench) (fig. 29).

(d) Lift grease retainer, felt washer, and gasket from the bracket.

(e) Screw rear bearing lubrication pipe nipple from bracket (Stillson wrench) (fig. 29).

(6) DISASSEMBLE BODY AND STATOR ASSEMBLY (fig. 30).

CARDBOARD TAG (6)	**SCREWDRIVER**
CUTTER, wire	

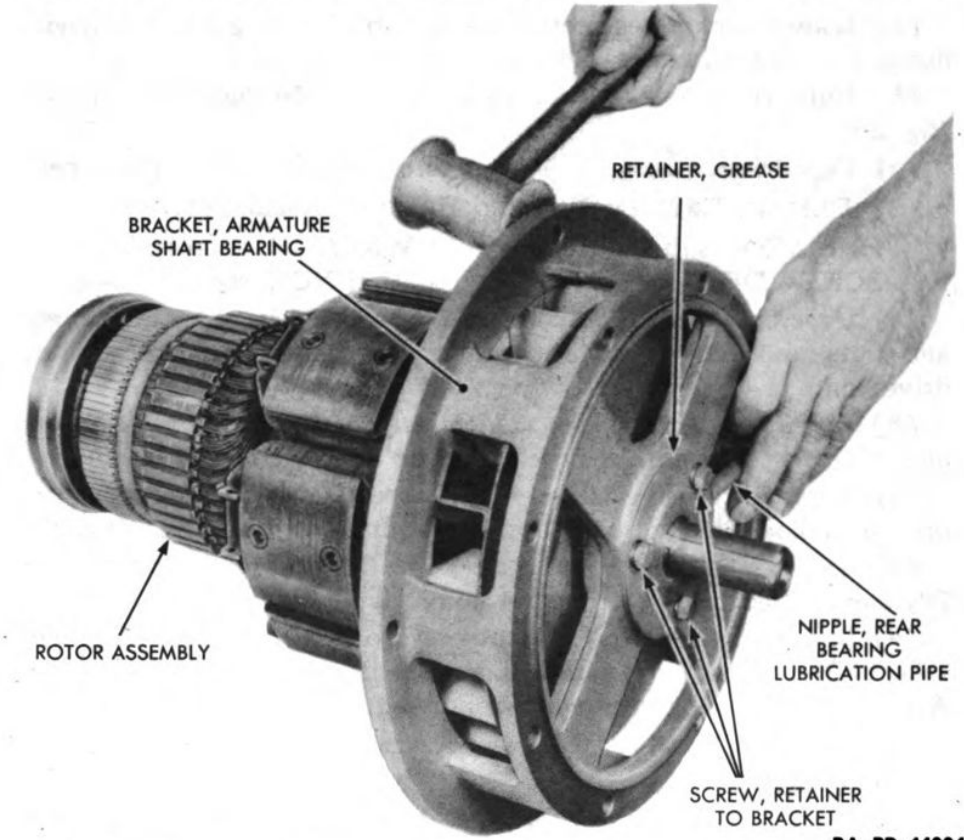


Figure 29 — Removing Armature Shaft Bearing Bracket from Rotor Assembly

(a) Very little disassembly of the body and stator assembly can be done. It is replaced as a unit when defective. Steps in disassembly are:

1. Remove tape from stator coil and main generator lead connection. Cut connection (wire cutter) and pull main generator lead from body. Repeat the step to remove each of the remaining five main generator leads. Tag wires from which leads are removed to aid in assembly (cardboard tags).

2. Pry body bushing from body (fig. 30) (screwdriver).

3. Remove name plate screws (screwdriver). Remove name plate.

(7) DISASSEMBLE COMPLETE ARMATURE ASSEMBLY (fig. 31).

CUTTER, wire	PULLER, bearing
HAMMER, hide-faced, 2-lb	WRENCH, socket-head setscrew, $\frac{5}{16}$-in.

(a) Pull armature shaft bearings from armature shaft (bearing puller). Two men are needed: one to hold the bearing puller, and one to turn the wrench on the puller.

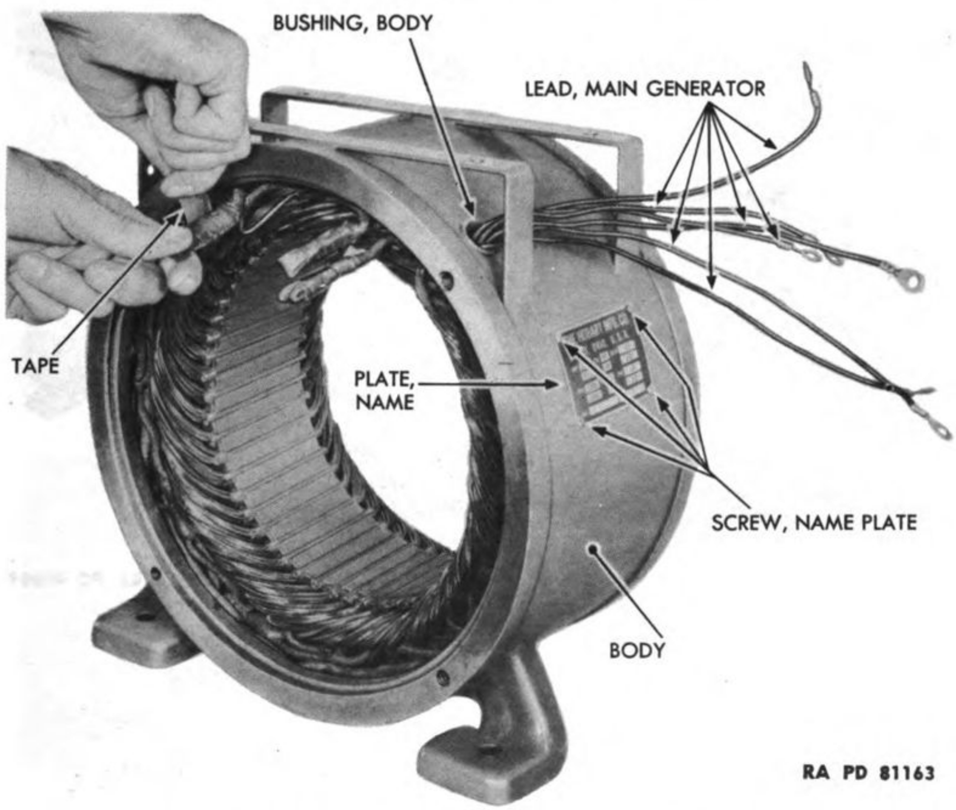


Figure 30 — Removing Main Generator Lead

(b) Remove tape from revolving field coil leads.

(c) Cut leads at point of connection (wire cutter).

(d) Remove pole piece to spider base screws from pole piece ($\frac{5}{16}$-in. socket-head setscrew wrench). Lift pole piece and revolving field coil from rotor assembly. Pick base revolving field coil insulator from under side of coil.

(e) Tap revolving field coil from pole piece (hide-faced hammer). Lift pole piece insulation and top revolving field piece insulator from coil.

(f) Repeat steps *(d)* and *(e)* above to remove remaining five revolving field coils.

(8) DISASSEMBLE EXCITER BEARING BRACKET (fig. 32).

CUTTER, wire
SCREWDRIVER
WRENCH, socket, $\frac{1}{2}$-in.
WRENCH, socket, $\frac{9}{16}$-in.
WRENCH, socket-head setscrew, $\frac{5}{16}$-in.

(a) Pull main generator leads through hole in exciter bearing bracket and into inside of bracket.

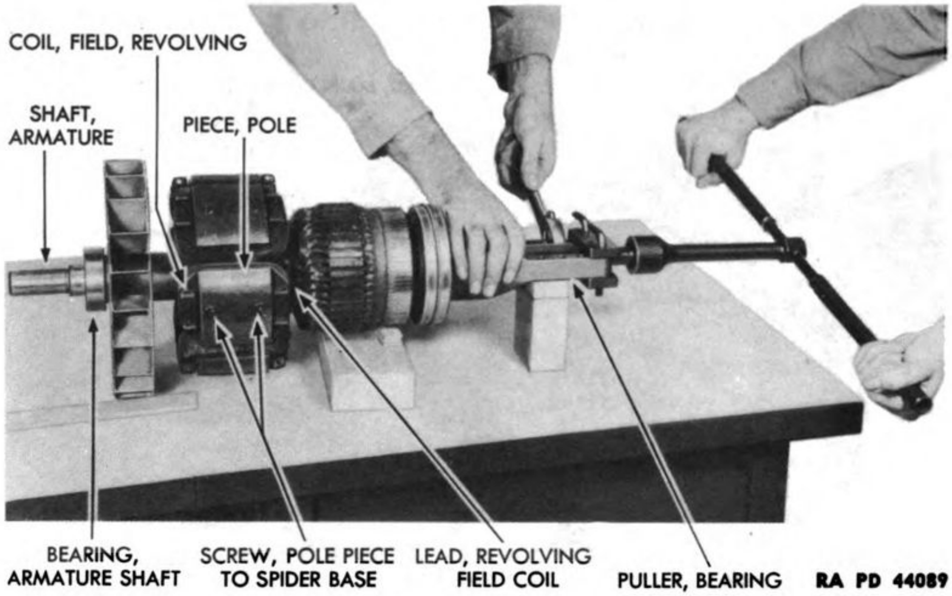


Figure 31 — Pulling Armature Shaft Bearing

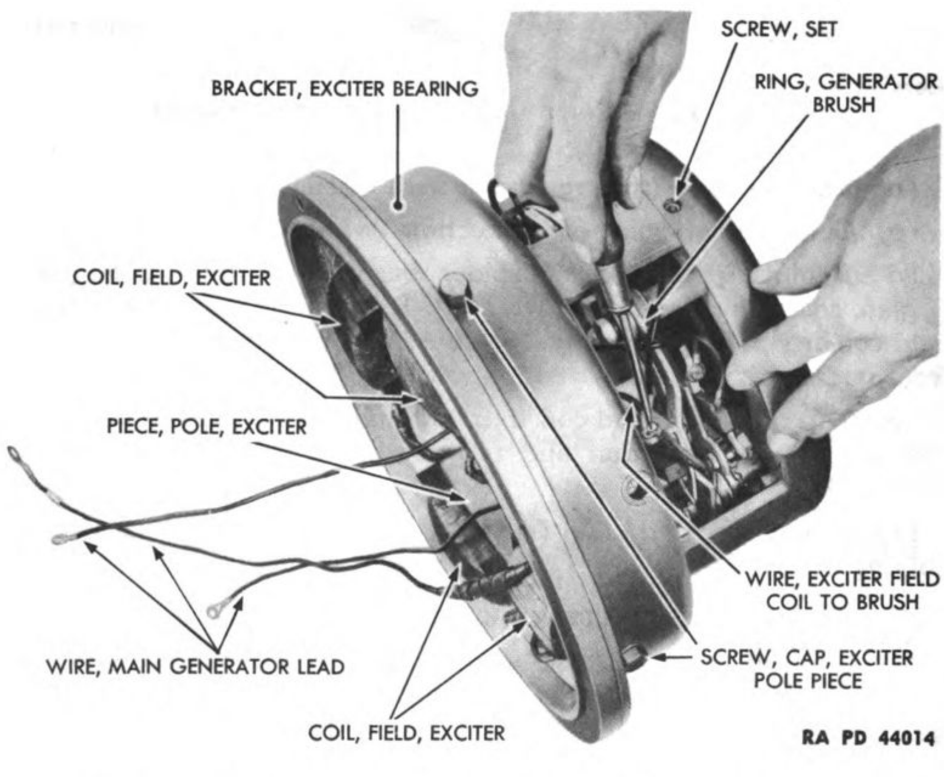


Figure 32 — Disassembling Exciter Bearing Bracket

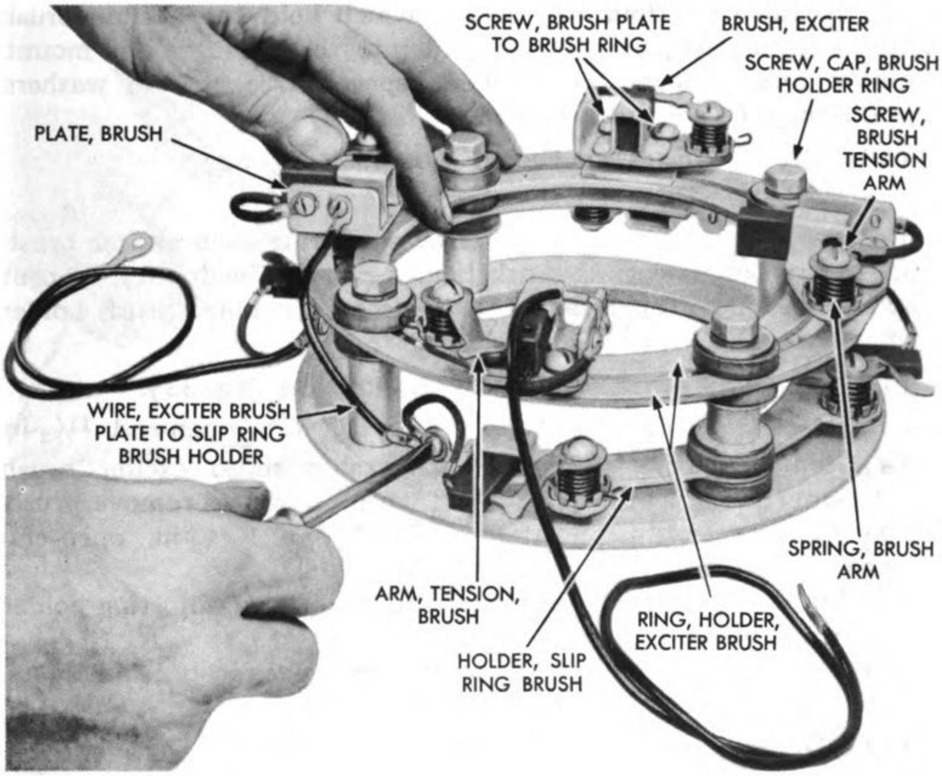


Figure 33 — Disassembling Generator Brush Ring

(b) Disconnect exciter field coil to brush wire from top right-hand exciter brush holder (screwdriver).

(c) Remove the screws which connect the exciter bearing bracket cap to the exciter bearing bracket (½-in. socket wrench) (fig. 27). Remove lock washers. Lift cap and gasket from exciter bearing bracket.

(d) Remove the four exciter pole piece cap screws and lock washers (⁹⁄₁₆-in. socket wrench). Lift all four exciter pole pieces, exciter field coils, and exciter field coil insulators from exciter bearing bracket. Pull four pole pieces and eight exciter pole insulators from exciter field coils (fig. 54). Remove insulating tape and disconnect exciter field coils from each other (wire cutter).

(e) Loosen socket-head setscrews which hold generator brush ring to exciter bearing bracket (⁵⁄₁₆-in. socket-head setscrew wrench).

(f) Lift brush ring from exciter bearing bracket.

(9) DISASSEMBLE GENERATOR BRUSH RING (figs. 33 and 52).

SCREWDRIVER WRENCH, socket, ⁹⁄₁₆-in.

(a) Remove exciter brush plate wire from slip ring brush holder (screwdriver).

(b) Remove the four cap screws which hold the exciter brush holder ring, and slip ring brush holder to the brush holder mount. Remove lock washers, flat washers, spacers, rocker arm washers, and bushings (9/16-in. socket wrench).

(10) REMOVE EXCITER BRUSH HOLDERS (fig. 53).

SCREWDRIVER

Remove two screws and lock washers securing each exciter brush holder to the inner exciter brush holder ring (screwdriver). Repeat step to remove both exciter brush holders from outer brush holder ring.

(11) DISASSEMBLE EXCITER BRUSH HOLDERS (fig. 33).

SCREWDRIVER — WRENCH, open-end, 11/32-in.

(a) Remove screw which secures brush wire to exciter brush plate (screwdriver). Lift up on brush tension arm and remove brush.

(b) Remove tension arm screw and nut (11/32-in. open-end wrench).

(c) Lift tension, screw bushing, spring and spring adjusting holder from exciter brush plate.

(d) To disassemble the remaining three exciter brush holders, repeat steps *(a)*, *(b)*, and *(c)*.

(12) DISASSEMBLE SLIP RING BRUSH HOLDERS.

SCREWDRIVER — WRENCH, open-end, 11/32-in.

(a) Remove four screws which secure the brush wires to slip ring brush holder (screwdriver). Lift up on brush tension arms, and remove the four brushes.

(b) Remove tension arm screws and nuts (11/32-in. open-end wrench and screwdriver).

(c) Lift the four tension arms, screw bushings, springs, and spring adjusting holders from slip ring brush holder.

25. INSPECTION.

a. Equipment.

AIR, compressed
BATTERY, 6-volt
CUTTER, wire ( )
GROWLER, armature
GROWLER, stator
LAMP, test
SCALE
SOLVENT, dry-cleaning
VOLTMETER, direct-current (0- to 7½-volt)

b. Procedure.

(1) CLEAN THE PARTS.

AIR, compressed — SOLVENT, dry-cleaning

(a) Clean metal parts by washing in SOLVENT, dry-cleaning, and dry with compressed air. Blow dirt from coils and windings with compressed air.

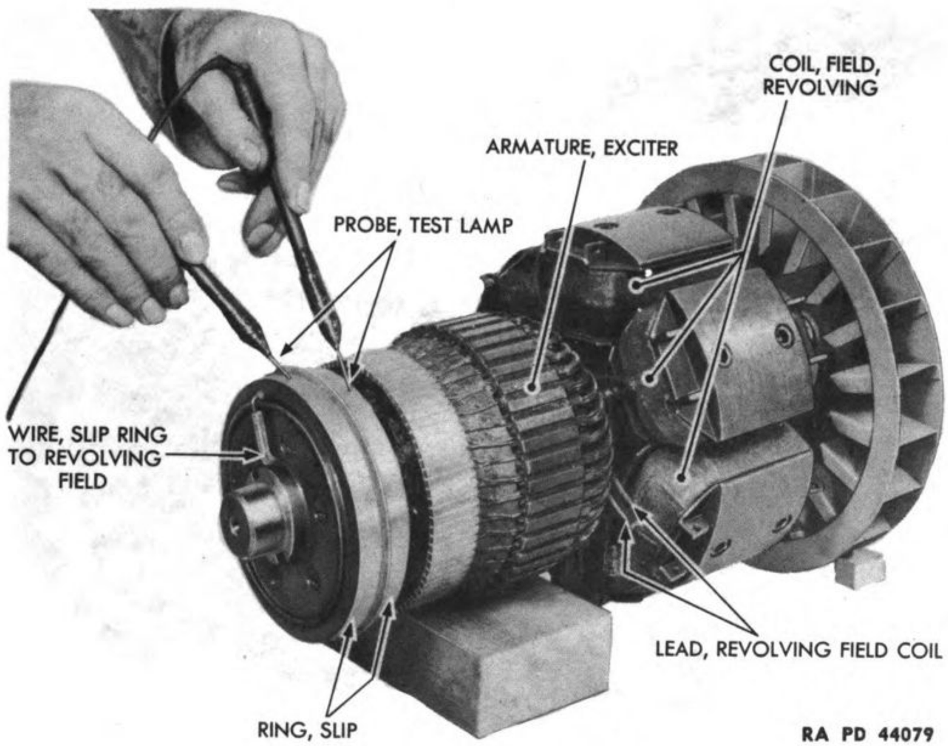


Figure 34 — Testing Revolving Field Coils for Open Circuit

(2) INSPECT ROTOR ASSEMBLY.

BATTERY, 6-volt	**LAMP**, test
GROWLER, armature	**VOLTMETER**, direct-current (0- to 7½-volt)

(a) Test revolving field coils for an open circuit by placing a probe of a test lamp on each of the two slip rings (fig. 34). If lamp lights, no open circuit is present. If lamp fails to light, trace revolving field coil wires along armature shaft keyway under exciter armature. Remove tape from connections by which the two wires are joined to field coil leads. Repeat test lamp check with probes on the two exposed connections. If lamp now lights, but did not in the first test, the open circuit is in the slip ring to revolving field coil wires or their connections. If the test lamp still fails to light, remove tape from the connections of field coil leads. Test each coil and each connection individually for an open circuit (fig. 35).

(b) Test revolving field coils for a ground by placing one probe of a test lamp on one slip ring. Place other probe on the armature shaft or paint-free portion of fan (fig. 36). If test lamp fails to light, no ground is present. If test lamp lights, disconnect both leads of each

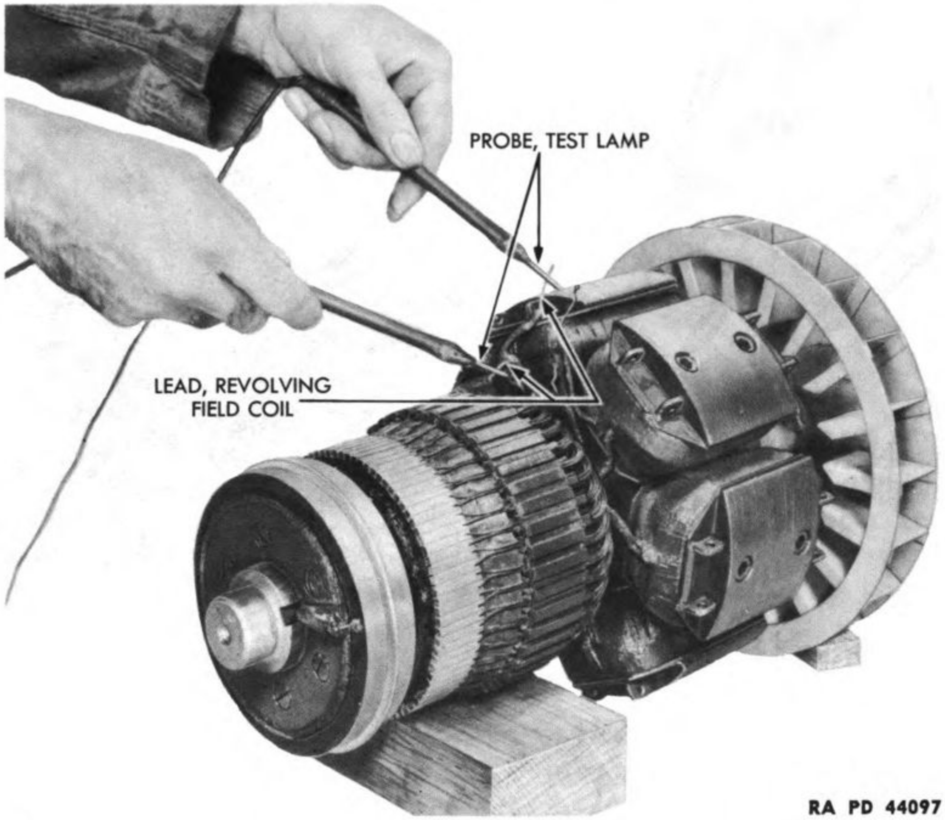


Figure 35 — Testing a Single Revolving Field Coil for Open Circuit

coil and repeat test on each. Place one probe on bare end of one of disconnected leads. Place other probe on armature shaft or fan (fig. 37). Similarly test each revolving field coil wire. Each time the test lamp lights, a grounded coil or wire is indicated.

(c) Test revolving field coils for a short circuit by connecting a 6-volt battery to the two slip rings. Using a 0- to 7½-volt voltmeter equipped with sharp probes, measure voltage drop across each coil. This is done by inserting one probe into one lead of a coil. Insert the other probe into the other lead. Observe the reading of the voltmeter. Repeat test on each of the coils, observing voltmeter each time. If any coil has a reading appreciably less than the others, a short circuit is indicated in that coil. NOTE: If the voltmeter hand moves in the wrong direction, reverse the probes (fig. 38).

(d) Test the exciter armature for a ground with test lamp. Place one probe on a commutator bar. Place the other probe on the armature shaft or paint-free portion of the fan (fig. 39). If lamp lights, a ground is indicated. Failure of the lamp to light shows no ground to be present.

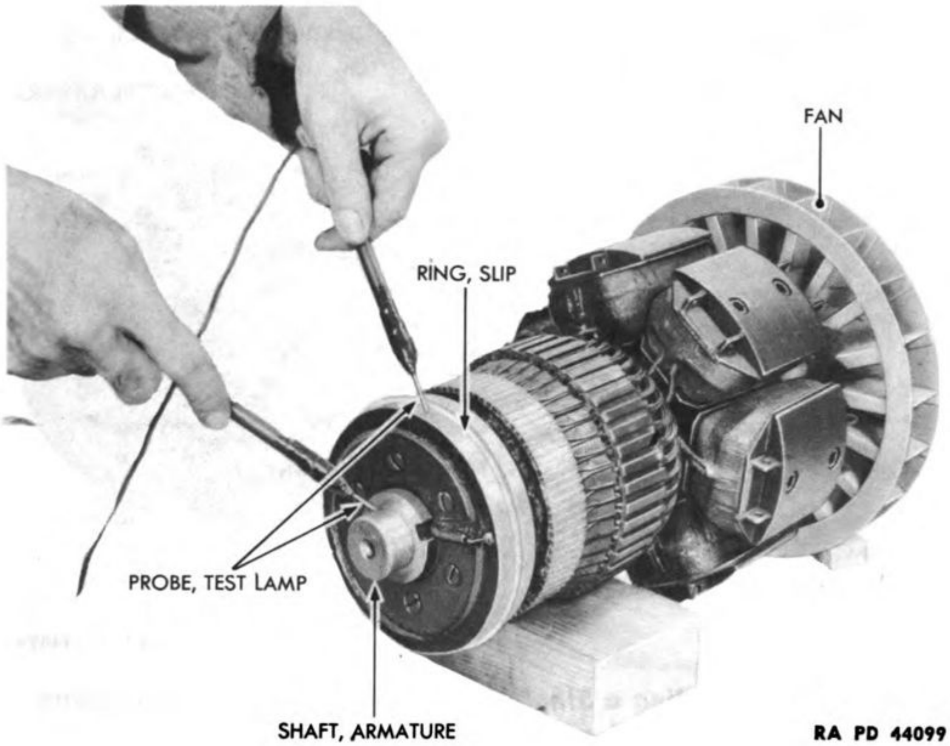


Figure 36 — Testing Revolving Field Coils for Ground

(e) Test exciter armature for a short circuit by placing it in an armature growler (fig. 40). Turn on the growler. Move the steel strip slowly around the armature coils. Keep it parallel with the shaft. Turn off the growler and revolve the armature one-half turn in the growler. Turn on the growler and test the other side of the armature. If the steel strip vibrates noticeably or is drawn to the laminations, a short circuit is indicated.

(f) Inspect the commutator bars (fig. 39). Look for burs which might short circuit two adjacent bars. Observe whether or not bars are scored.

(g) Inspect slip rings to see if they are scored (this is a rare condition). Examine slip ring separator to see if it has been broken due to improper disassembly (fig. 40).

(h) Examine generator armature shaft bearings to see if they are worn or broken. Examine balls and races to see if they are nicked or scored. Slide bearing on shaft (fig. 40). Grasp outer race and attempt to rock bearing on shaft. Presence of perceptible play indicates wear. If bearings are damaged, examine armature shaft to see if it is scored.

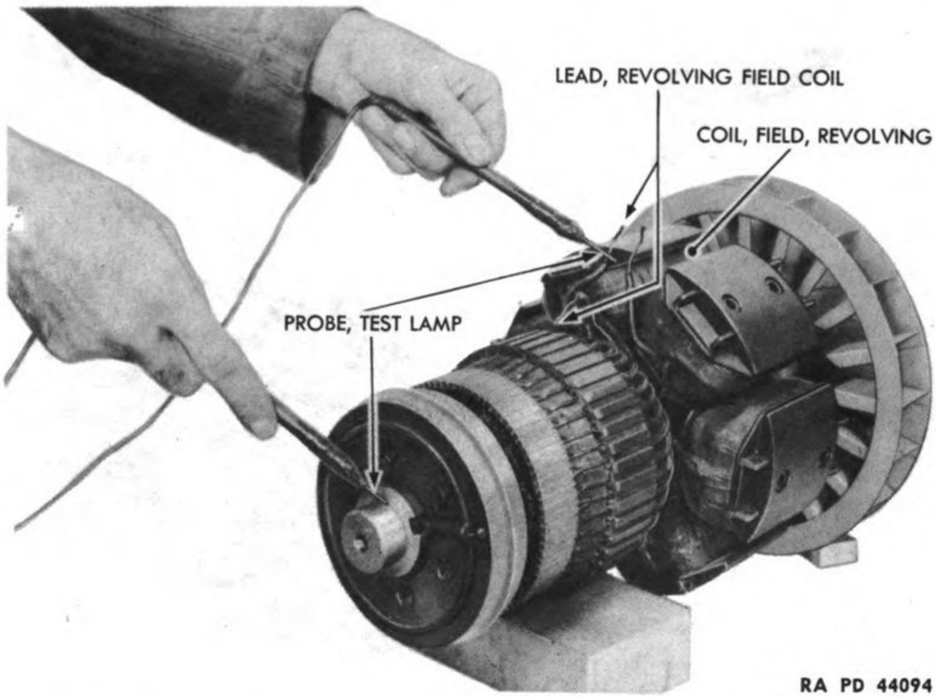


Figure 37 — Testing a Single Revolving Field Coil for Ground

(i) Inspect fan to see if it is bent, or if the weld has broken where fan is attached to armature shaft (fig. 40).

(3) INSPECT BODY AND STATOR.

GROWLER, stator LAMP, test

(a) Test stator windings for an open circuit (test lamp). Place one probe on the tip of any one of the six main generator leads from stator. Touch each of the five remaining leads, one at a time, with the other probe (fig. 41). If lamp fails to light when any one of the leads is touched, an open circuit is indicated. If the lamp lights each time, no open circuit is indicated.

(b) Test the stator windings for a ground (test lamp). Place one test lamp probe against an unpainted surface on the body. Place the other probe against tip of any one of the six main generator leads (fig. 42). If lamp lights, a ground is indicated. If lamp fails to light, no ground is present.

(c) Test stator windings for a short circuit (stator growler). Place growler within body and stator so that steel strip is parallel and next to stator laminations (fig. 43). Turn on growler. Move growler slowly around entire inner circumference of stator. If stator windings have a short circuit, growler will "growl," due to vibration of the steel switch.

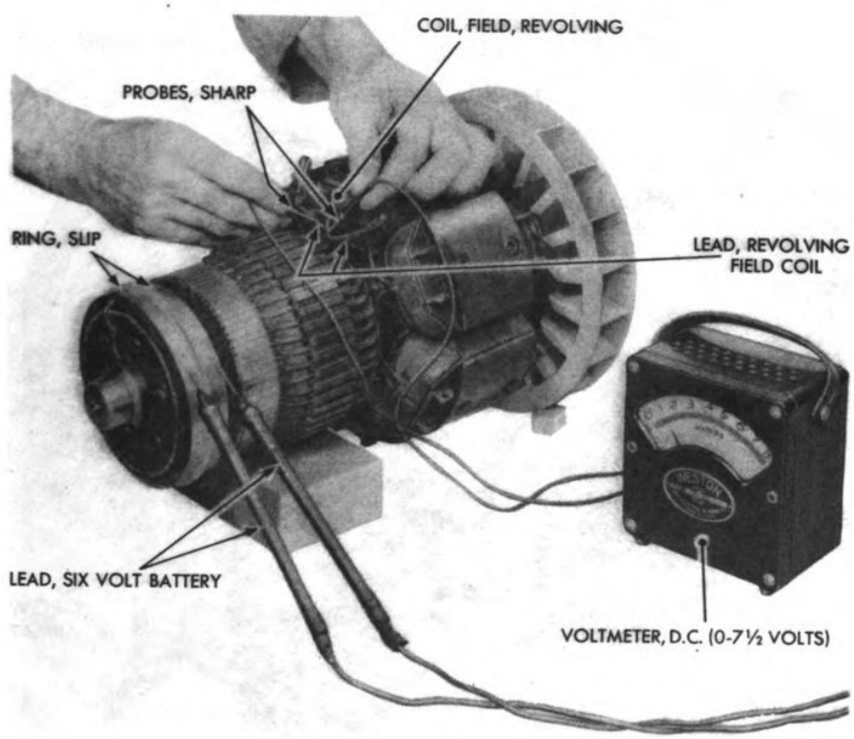


Figure 38 — Testing Revolving Field Coils for Short Circuit

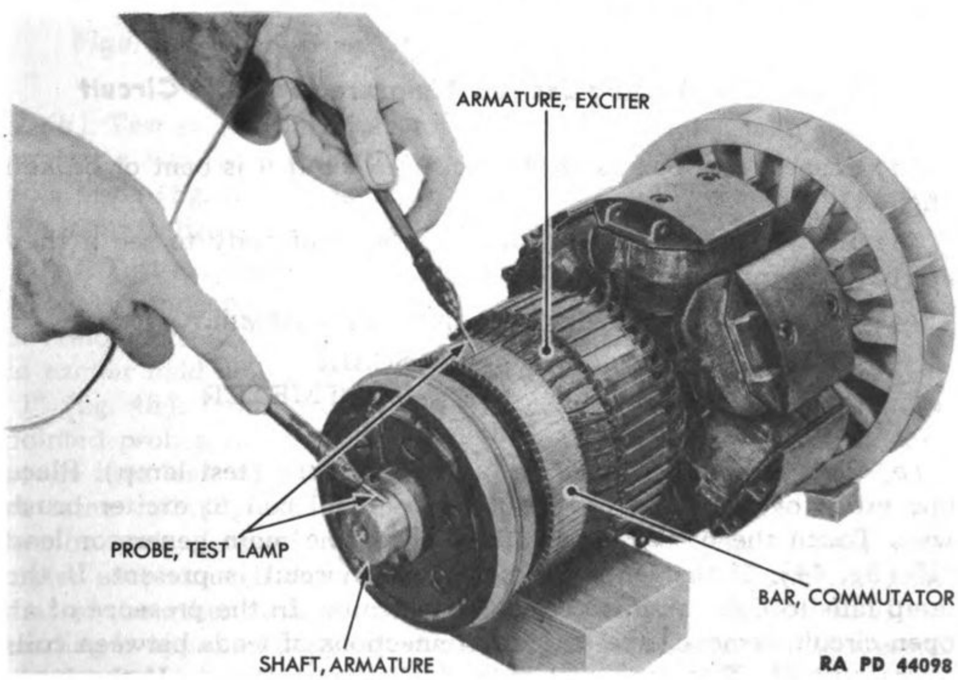


Figure 39 — Testing Exciter Armature for Ground

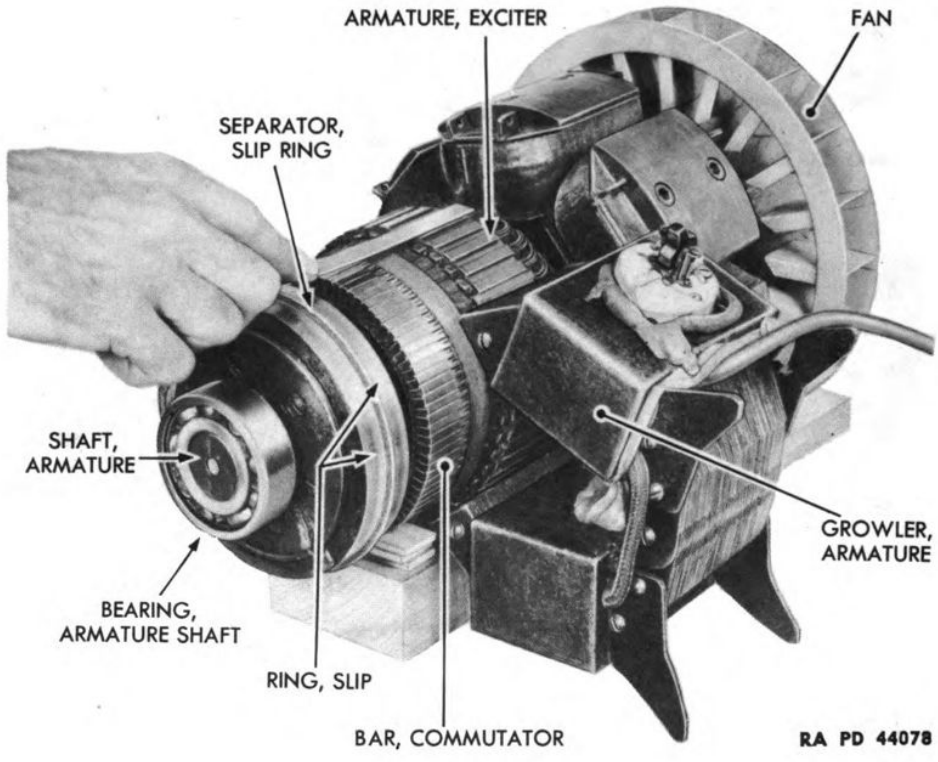


Figure 40 — Testing Exciter Armature for Short Circuit

(d) Inspect tool box support bracket to see if it is bent or broken (fig. 43).

(e) Inspect threads tapped in screw holes of body to see if they are burred or stripped (fig. 43).

(4) INSPECT EXCITER BEARING BRACKET ASSEMBLY.

BATTERY, 6-volt	SCALE
CUTTER, wire	VOLTMETER
LAMP, test	

(a) Test exciter field coils for an open circuit (test lamp). Place one probe of test lamp on tip of exciter field coil to exciter brush wire. Touch the other probe to the tip of the main generator lead "1" (fig. 44). If the lamp lights, no open circuit is present. If the lamp fails to light, an open circuit is indicated. In the presence of an open circuit, remove tape and cut connections of leads between coils (wire cutter). Test each coil individually (test lamp). If the lamp fails to light, an open circuit is indicated.

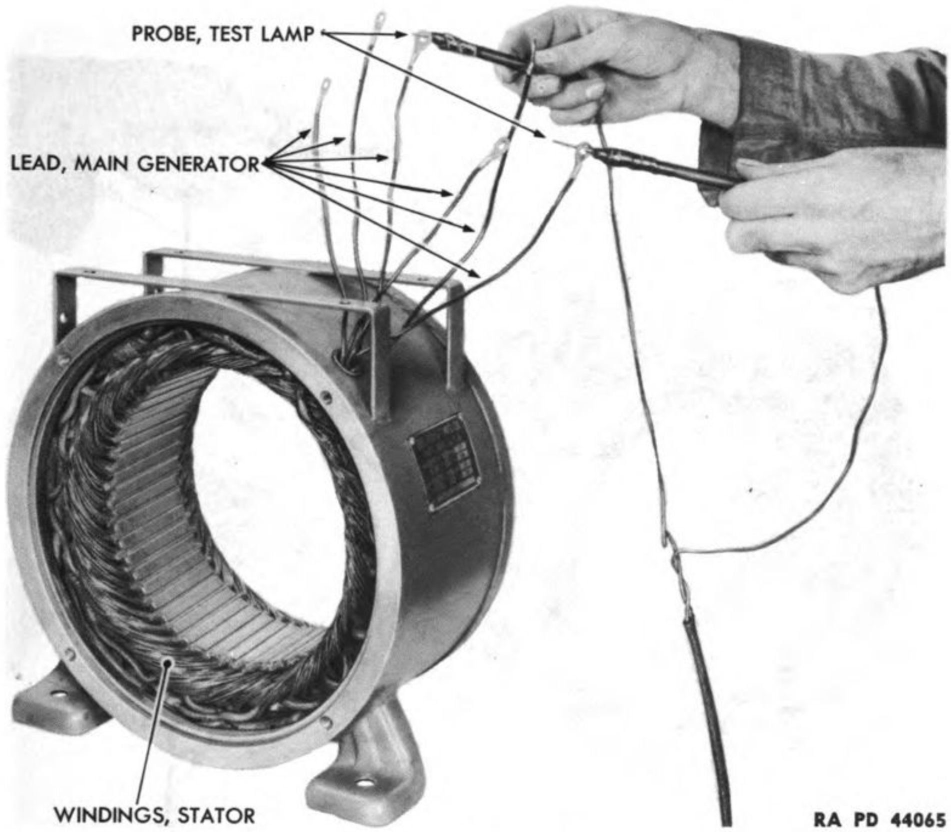


Figure 41 — Testing Stator Windings for Open Circuit

(b) Test exciter field coils for ground (test lamp). Hold one probe against a bare lead from the coil. Place the other probe against the pole piece (fig. 45). If the lamp lights, a ground is present. Failure of the lamp to light indicates coil is free of grounds.

(c) Test exciter field coils for short circuits. This test is made with all coils connected in series. It can be made with coils installed in, or removed from, the exciter bearing bracket. Connect a 6-volt battery to exciter field coil to commutator wire, and to main generator lead "1" (fig. 46). Using a 0- to 7½-volt voltmeter equipped with sharp pointed probes, measure the voltage drop across each coil. Push one probe into lead of a coil. Push the other probe into the other lead of same coil (fig. 46). Observe reading on the voltmeter. Repeat test on each of remaining three coils, observing reading on the voltmeter each time. If the reading on one coil is appreciably less than that of the other coils, a short circuit in that coil is indicated. If the reading is approximately equal on all coils, no short circuit is present. **NOTE:** If voltmeter hand moves in the wrong direction, reverse the probes.

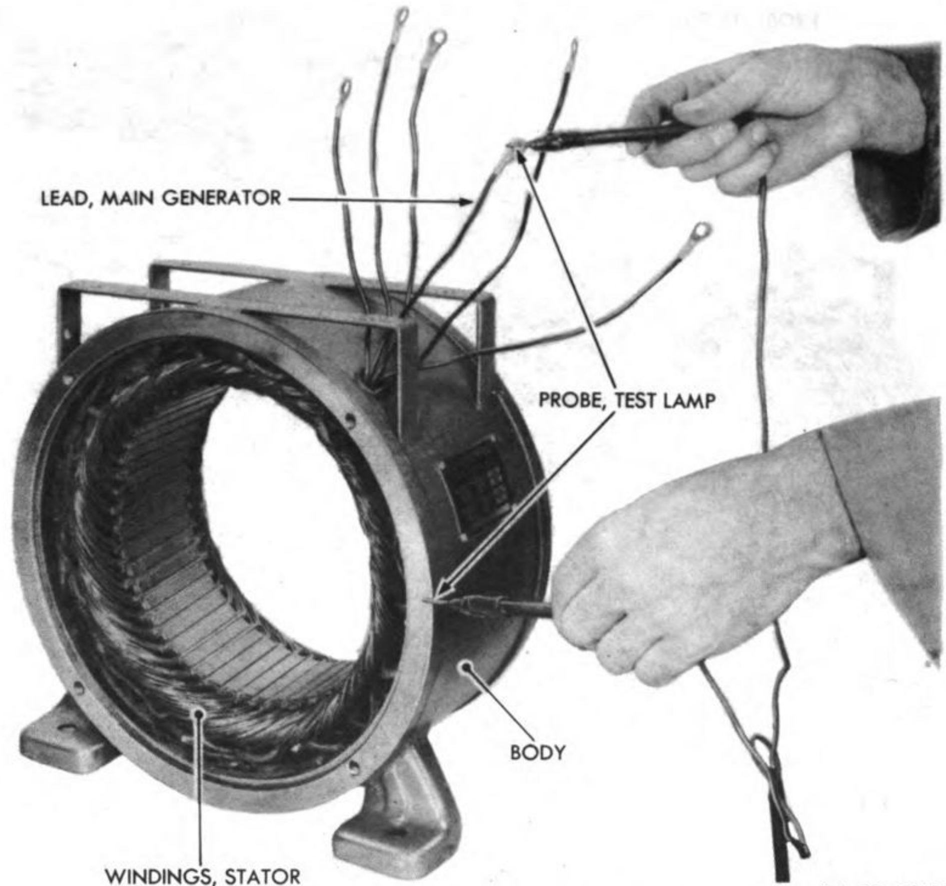


Figure 42 — Testing Stator Windings for Ground

(d) Inspect brushes to see if they are broken or worn. Measure length of each brush (scale). Any brush that is ¾ inch or less in length must be replaced.

(e) Examine threads of all screws and tapped threads in screw holes to see if they are burred or stripped.

(f) Inspect brush tension arm springs to see if they are broken or weak.

(g) Examine all insulator spacers and bushings to see if they are broken.

(h) Inspect all metal parts to see if they are bent, worn, or broken.

(5) INSPECT COUPLING END GENERATOR PARTS.

(a) Inspect driving flange to see if it is bent or broken. Observe keyway to see if it is square and free of burs. Examine threads of the sockethead setscrews and threads tapped in screw holes, to see

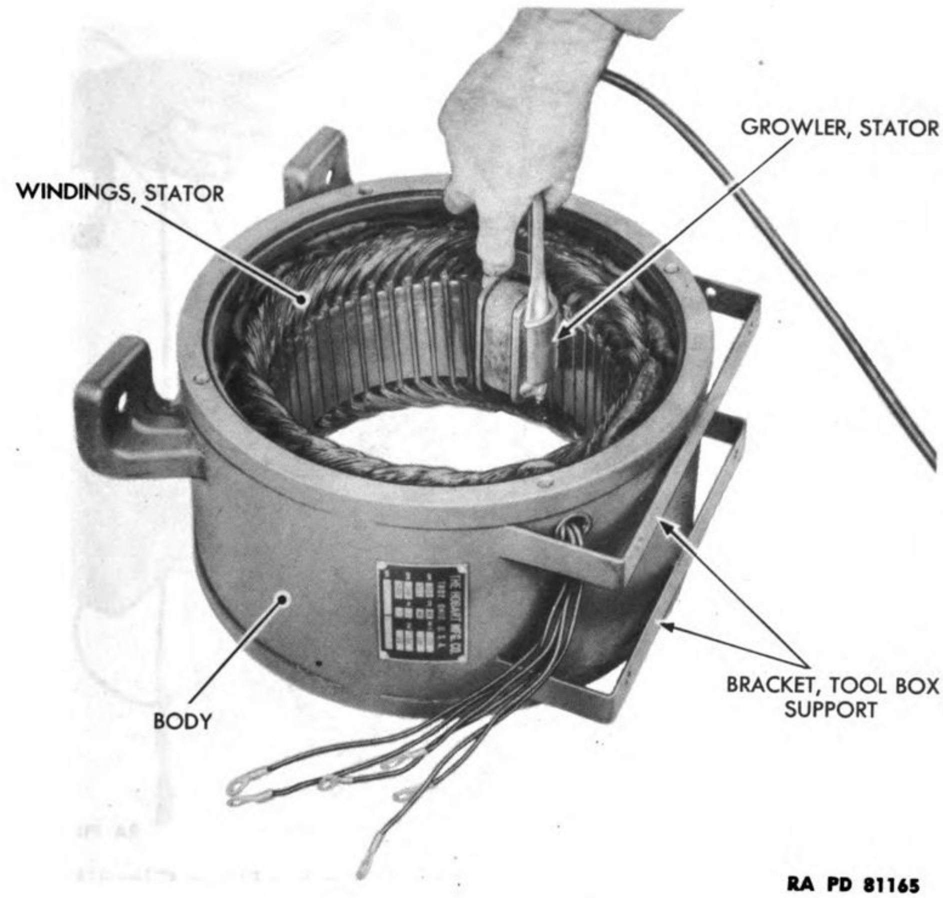


Figure 43 — Testing Stator Windings for Short Circuit

if they are burred or stripped. Examine welds to see if any have broken loose.

(b) Inspect armature shaft bearing bracket to see if it is broken. Examine threads in tapped screw holes and lubrication pipe nipple hole, to see if they are burred or stripped. Inspect lubrication pipe nipple, elbow, and grease cup to see if they are broken, bent, plugged, or have damaged threads.

(c) Inspect grease retainer to see if it is bent or if welds have broken loose. Examine felt washer to see if it is torn, worn, or grease-soaked. Inspect the gasket to see if it is torn.

(d) Examine fan cover to see if it is bent or broken.

(e) Examine all screws and lock washers to see if they are broken. Note whether or not screw threads are burred or stripped.

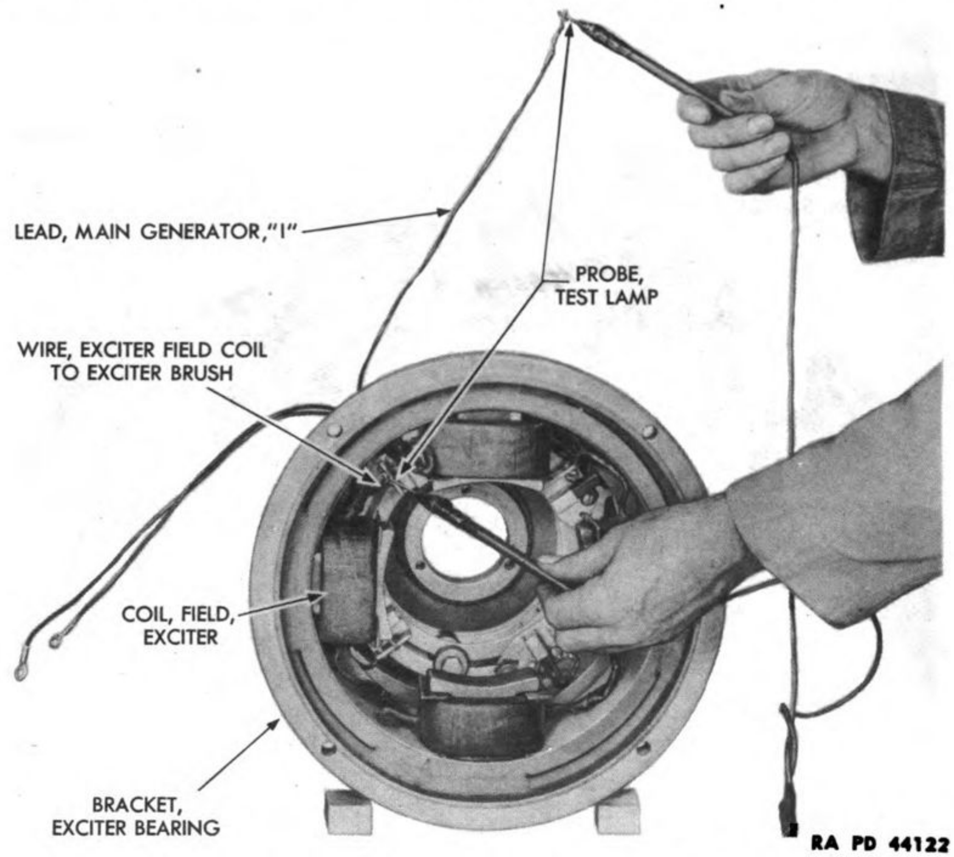


Figure 44 — Testing Exciter Field Coils for Open Circuit

26. MAINTENANCE AND REPAIRS.

a. Equipment.

DOLLY	PLIERS
EQUIPMENT, soldering	PULLER, gear
EQUIPMENT, welding	PAPER, flint, class B, No. 00
FILE, fine mill	SCALE ( )
GLYPTAL, No. 1209 black	SCREWDRIVER
HAMMER	TAP, thread, $\frac{5}{16}$-18 NC
LATHE	TAPE
LOOM	WIRE
MACHINE, undercutting	

b. Procedure.

(1) REPAIRS TO ROTOR ASSEMBLY.

(a) Revolving Field Coils.

EQUIPMENT, welding	PLIERS
GLYPTAL, No. 1209 black	SCALE, spring
LOOM	TAPE

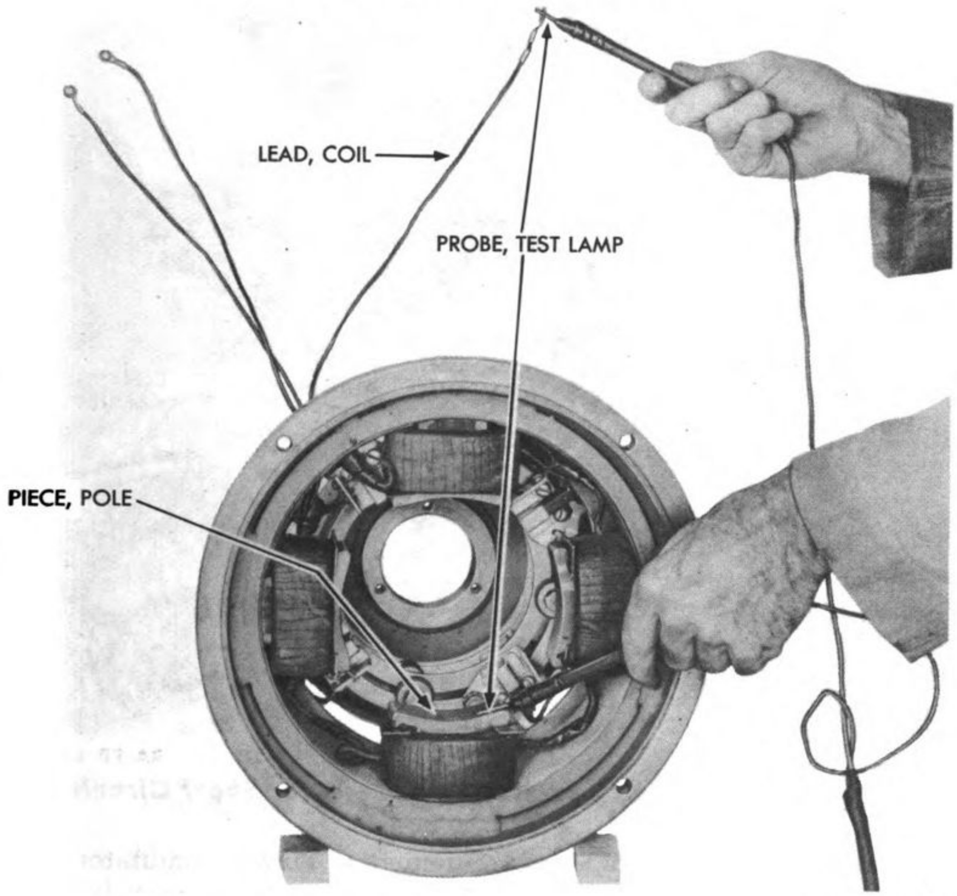


Figure 45 — Testing Exciter Field Coils for Ground

1. In case of an open circuit in a revolving field coil, replace coil. Weigh coil to be discarded and weigh the new coil (scales). Use a new coil having the same weight as the one removed to preserve rotor assembly balance. In case the open circuit is in a connection, peel back insulation on the wire. Twist wires together (pliers) and weld (welding equipment). Push loom over connection and wrap with tape. Paint tape with No. 1209 black glyptal.

2. In case a revolving field coil is grounded, replace coil and all insulators. If a connection is grounded, remove tape and loom. Install new loom and tape. Paint tape (No. 1209 black glyptal).

3. Replace short-circuited revolving field coils.

(b) Exciter Armature.

LATHE	UNDERCUTTER, armature, mica, w/saw blade
SOLDERING EQUIPMENT	

1. Examine exciter armature if it has an open circuit. If open circuit is caused by a wire pulled loose from a commutator bar, solder

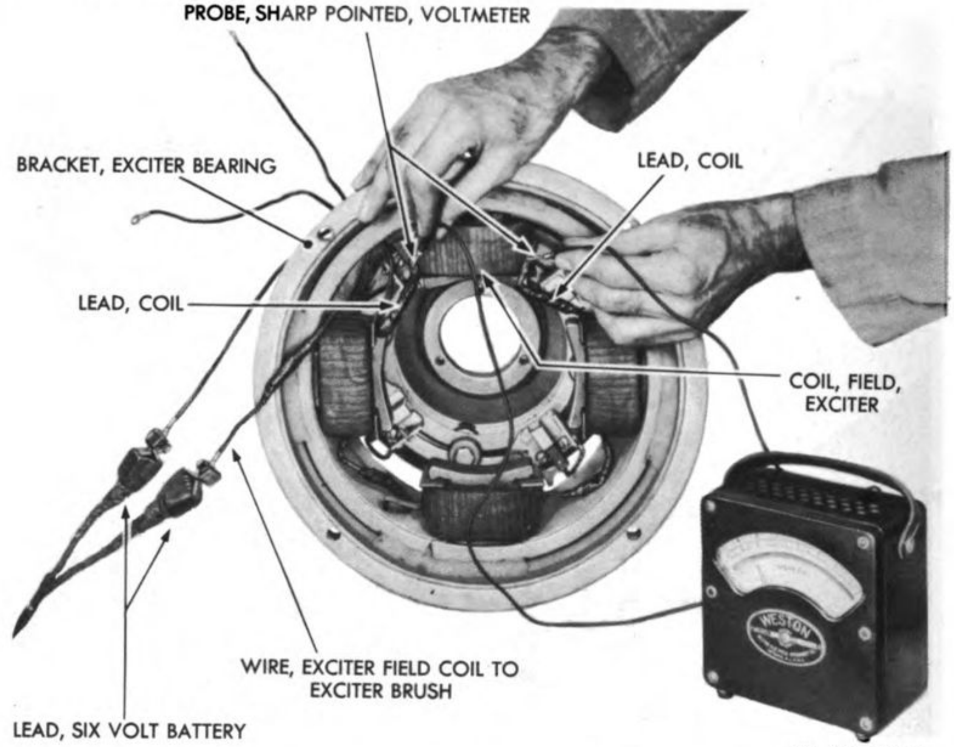


Figure 46 — Testing Exciter Field Coils for Short Circuit

wire into slot in bar (soldering equipment). Turn commutator bars down on a lathe and undercut the mica (substep (*c*) below). If break cannot be located, replace armature.

2. If exciter armature is grounded or short-circuited, replace.

(c) Commutator Bars.

LATHE	PAPER, flint, class B, No. 00
MACHINE, undercutting	

If commutator bars are scored, place armature assembly in a lathe (fig. 47). Take a cut from commutator bars. Make the cut as light as possible, but deep enough to remove all score marks. Hold a piece of No. 00 flint paper against the revolving commutator bars to remove cutting tool marks. Remove armature from lathe. Then undercut mica to a depth of 0.025 inch between commutator bars (undercutting machine) (fig. 48).

(d) Slip Rings and Slip Ring Separator.

HAMMER	SOLDERING EQUIPMENT
LATHE	TAP, thread, $\frac{5}{16}$-18 NC
PAPER, flint, class B, No. 00	UNDERCUTTER, armature, mica, w/saw blade
PULLER, gear	WELDING EQUIPMENT
SCREWDRIVER	

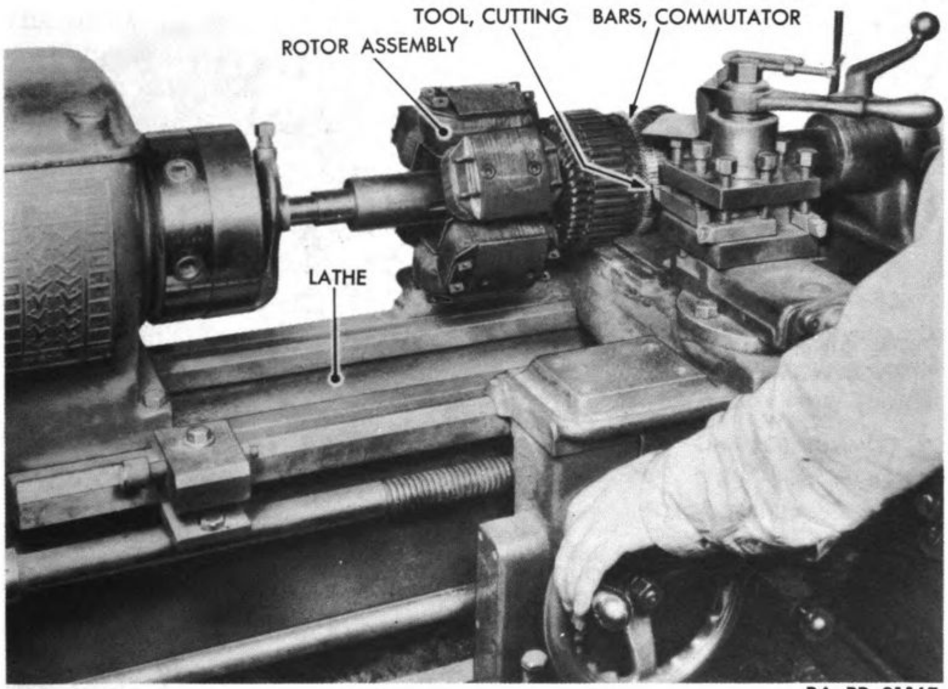


Figure 47 — Cutting Commutator Bars

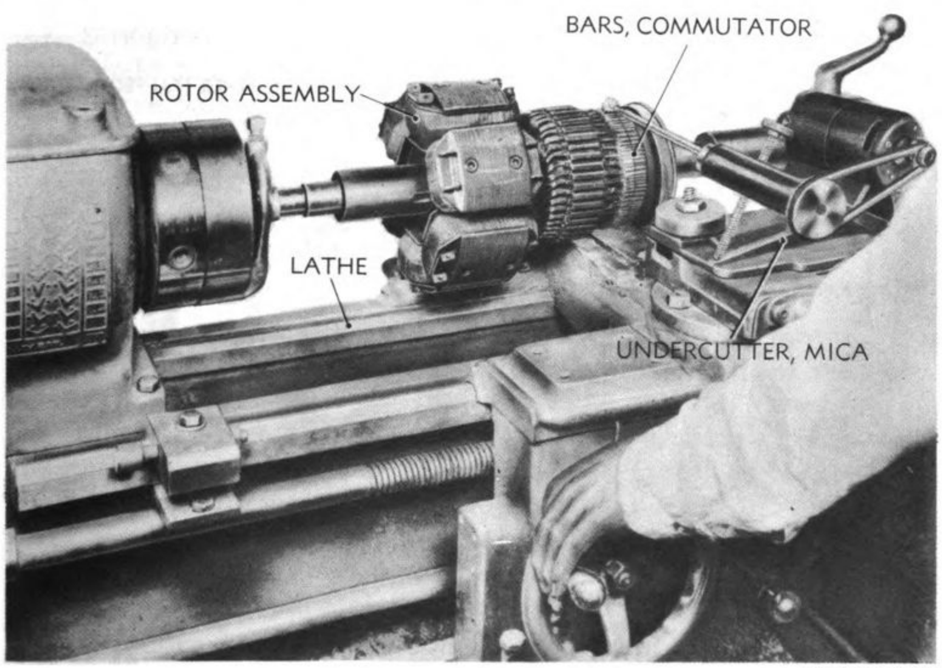


Figure 48 — Undercutting Mica Between Commutator Bars

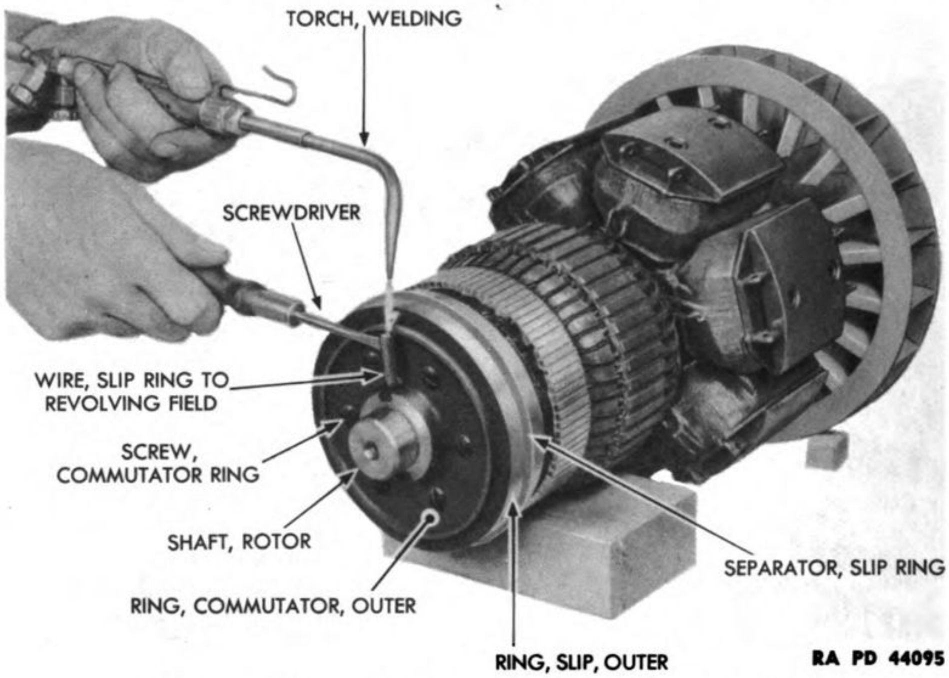


Figure 49 — Removing Slip Ring Assembly

1. If the slip rings are scored, place armature in lathe. Take a cut off each slip ring. Remove only enough metal to eliminate the score marks. Hold a piece of No. 00 flint paper against the revolving slip rings to remove cutting tool marks.

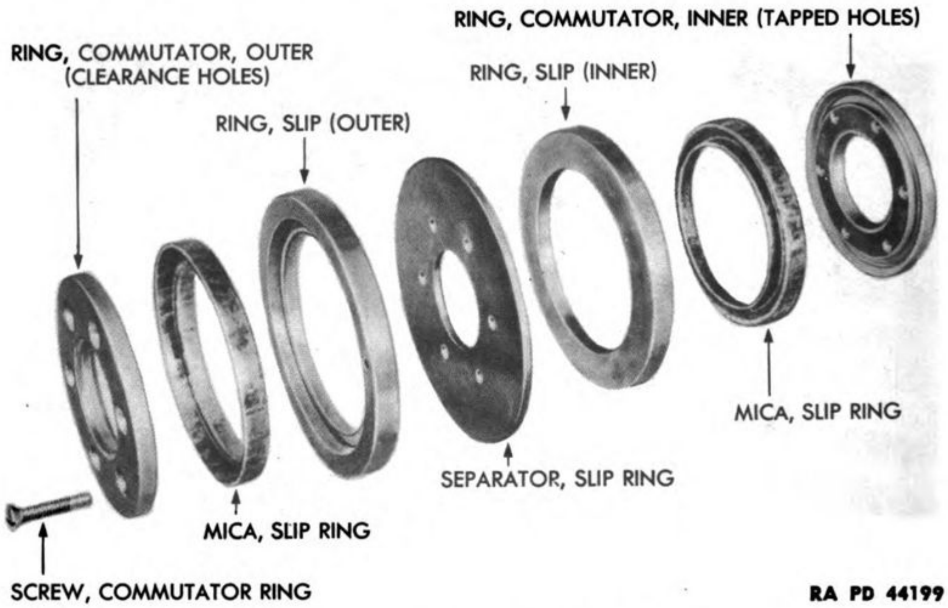


Figure 50 — Slip Ring Assembly — Exploded View

2. If the slip ring separator is broken, melt the solder which secures the revolving field wire to outer slip ring, and pry wire from slip ring (welding equipment and screwdriver) (fig. 49). Remove the six commutator ring screws (screwdriver) (fig. 49). Tap threads in two screw holes in the commutator ring on opposite sides of shaft ($^5/_{16}$-18 NC thread tap). Using a gear puller, pull the commutator outer ring from shaft (fig. 49). Lift slip ring and mica ring from shaft (fig. 50). Lift slip ring separator from shaft (fig. 50). Place a new slip ring separator in position on shaft. Place slip ring in position on the commutator ring with the mica in position between the two parts. Start assembly on shaft. Be sure screw holes line up. Tap commutator ring carefully on shaft (hammer). Install six commutator ring screws (screwdriver). Solder revolving field wire to outer slip ring (soldering equipment) (fig. 49).

(e) Generator Bearings.

FILE, fine mill

Replace armature shaft bearings if worn or broken. If shaft is scored due to bearing failure, smooth off ridges (fine mill file). Do not attempt to eliminate score marks. Smooth it just enough so bearing can be pressed on. In case shaft is damaged enough to be undersize, replace armature assembly.

(f) Fan.

DOLLY
HAMMER
WELDING EQUIPMENT

1. Straighten fan if bent (hammer and dolly). If welds have broken loose, weld fan to armature shaft (welding equipment). Be careful to preserve balance by using a very small amount of welding metal. Spot welds evenly around circumference of shaft.

(2) REPAIRS TO BODY AND STATOR ASSEMBLY (fig. 30).

(a) Stator Windings.

GLYPTAL, No. 1209 black
LOOM
TAPE
WELDING EQUIPMENT

1. If stator windings have an open circuit, it may be due to a loose connection. The coils themselves are composed of three wires connected in parallel. It is highly improbable that all three wires in one coil would break simultaneously. If an open circuit is indicated in the stator, remove tape and loom from the connection which appears at fault. Examine welds. When the faulty connection is found, weld wires together (welding equipment). Cover all exposed connections with loom and tape. Paint tape (No. 1209 black glyptal). If the open circuit is within a coil, replace stator.

2. If stator windings are grounded, inspect all connections and lead wires for faulty insulation. Remove faulty insulation. Install loom and tape on the bared wire. Paint tape (No. 1209 black glyptal).

If ground cannot be located, it is probably in a coil and it will be necessary to replace body with stator.

3. If stator windings are short-circuited, replace body with stator.

(b) Body and Tool Box Support Bracket.

DOLLY	TAP, thread
HAMMER	WELDING EQUIPMENT

1. Weld tool box support bracket if broken (welding equipment); straighten if bent (hammer and dolly).

2. Repair damaged screw hole threads in body by running a thread tap through them.

(3) REPAIRS TO EXCITER BEARING BRACKET ASSEMBLY.

(a) Exciter Field Coils.

Replace any exciter field coil having an open circuit, ground, or short circuit.

(b) Brushes.

Replace brushes if broken or worn to less than 3/4 inch in length.

(c) Brush Tension Arm Springs.

Replace brush tension arm springs if they are broken or weak. Correct tension is 8 ounces for slip ring brushes and 12 ounces for exciter brushes (par. 27 **g** (4) (**m**)).

(d) Metal Parts.

DOLLY	TAP, thread
HAMMER	

Repair burred screw holes by running a thread tap through them. Straighten bent metal parts (hammer and dolly). Replace broken metal parts.

(e) Insulator Spacers and Bushing.

Replace all broken or doubtful insulator spacers and bushings.

(4) REPAIRS TO COUPLING AND GENERATOR PARTS.

(a) Driving Flange.

FILE, fine mill	WELDING EQUIPMENT
TAP, thread	

Replace driving flange if it is bent, broken, or if the keyway is worn on edges. Reweld any welds that have broken loose (welding equipment). Remove burs from keyway (fine mill file). Remove burs from tapped screw holes by running thread tap through the threads.

(b) Armature Shaft Bearing Bracket.

TAP, thread
WIRE

Replace armature shaft bearing bracket if broken. Repair damaged threads by running a thread tap through them. Replace damaged

MAIN GENERATOR AND EXCITER

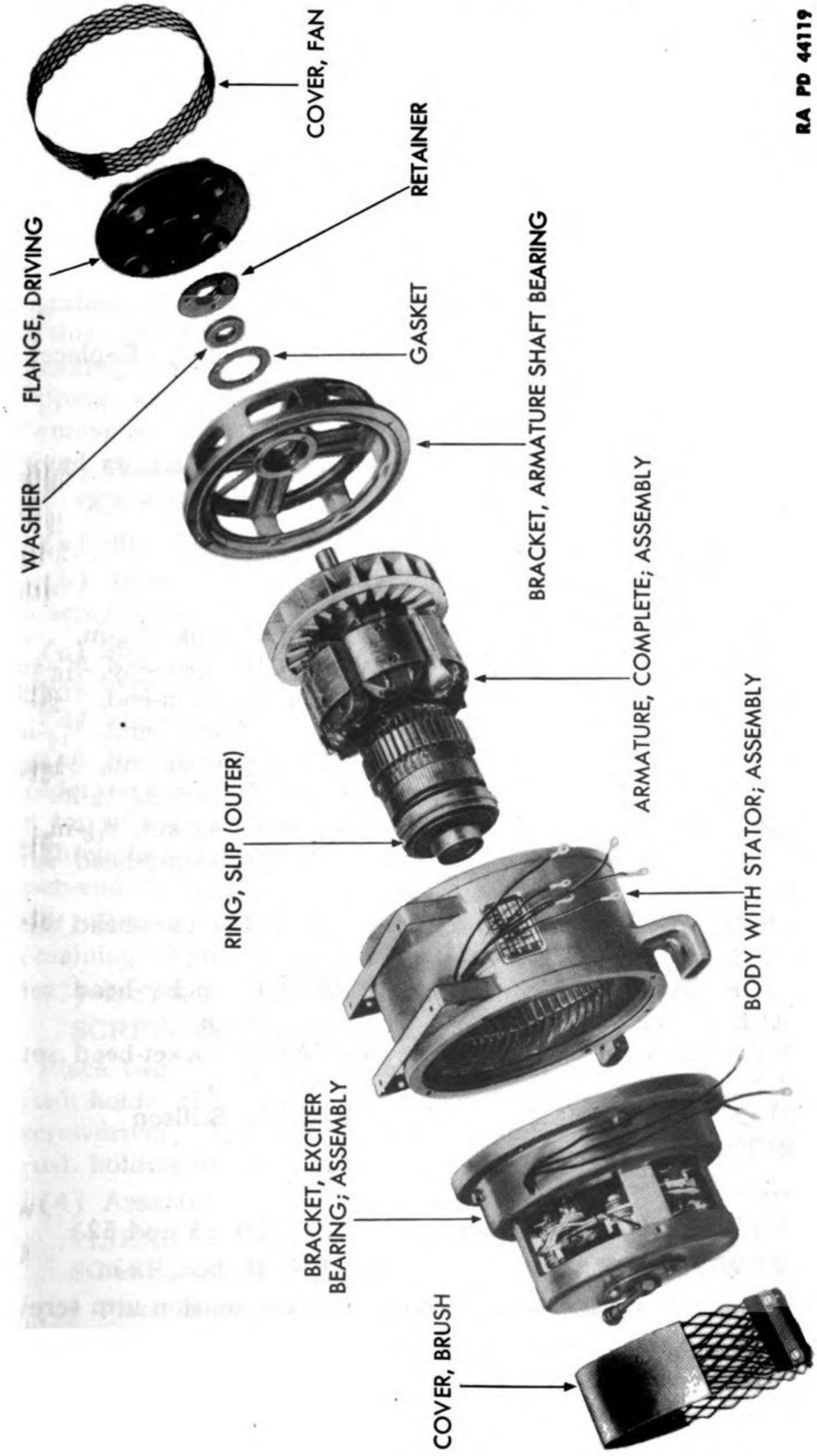


Figure 51 — Main Generator Assembly

lubrication pipe nipple, elbow, and grease cup. Clean obstructed lubrication ports by running wire through them.

(c) Grease Retainer.

WELDING EQUIPMENT

Replace grease retainer if bent. Weld if welds have broken loose (welding equipment). Replace felt washer if worn or grease-soaked. Replace gasket if torn.

(d) Fan Cover.

DOLLY
HAMMER

Straighten fan cover if bent (hammer and dolly). Replace if broken.

(e) Screws and Lock Washers.

Replace broken lock washers and screws. Replace screws having damaged threads.

27. ASSEMBLY.

a. Equipment.

BATTERY, dry cell (1½-volt)
COMPASS, magnetic
FILE
GLYPTAL, No. 1209 black
HAMMER
HAMMER, soft
LOOM
PILOT, hollow steel
PLIERS
PRESS, arbor
PUNCH, center
SCALE, spring
SCREWDRIVER
TAPE
WELDING EQUIPMENT
WRENCH, box, 3/8-in.
WRENCH, box, 9/16-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 11/32-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket-head set-screw, 9/64-in.
WRENCH, socket-head set-screw, 5/16-in.
WRENCH, socket-head set-screw, 3/8-in.
WRENCH, socket-head set-screw, 5/8-in.
WRENCH, Stillson

b. Procedure.

(1) ASSEMBLE SLIP RING BRUSH HOLDER (figs. 33 and 52).

SCREWDRIVER
WRENCH, box, 3/8-in.

(a) Slide brush tension arm bushing on brush tension arm screw.

(b) Slide slip ring brush tension arm over bushing, arm side next to screw head.

(c) Slide brush tension arm spring over arm so that end of spring hooks over tension arm from spring side.

(d) Place spring adjusting holder on end of spring.

(e) Install screw into slip ring brush holder so that spring adjusting holder tang fits into tang hole in brush holder, and brush tension arm is on top of brush holder. Tighten screw securely (screwdriver). Tighten lock nut securely on end of tension arm screw ($^{11}/_{32}$-in. open-end wrench).

(f) Repeat substeps *(a)* through *(e)* above to assemble the remaining three slip ring brush tension arms, springs, and bushings to slip ring brush holder. **NOTE**: If new brush holders are being installed, it is necessary to tap threads in brush wire screw holes at this time. Hold brush holder with pliers at screw hole to prevent breaking. Screw a No. 6-32 by $^{3}/_{16}$-inch Parker-Kalon type "2" self-tapping screw or equivalent into the screw hole (screwdriver). Remove screw.

(2) ASSEMBLE EXCITER BRUSH HOLDERS (fig. 52).

SCREWDRIVER	**WRENCH**, open-end, $^{11}/_{32}$-in.

(a) Slide brush tension arm bushing on brush tension arm screw.

(b) Slide exciter brush tension arm over bushing, arm side next to screw head.

(c) Slide brush tension arm spring over arm so that end of spring hooks over tension arm from spring side.

(d) Place spring adjusting holder on end of spring.

(e) Install screw into exciter brush plate so that spring adjusting holder tang fits into tang hole in holder and brush tension arm is on top of exciter brush plate. Tighten screw securely (screwdriver). Tighten lock nut securely on end of tension arm screw ($^{11}/_{32}$-in. open-end wrench).

(f) Repeat substeps *(a)* through *(e)* above to assemble the three remaining exciter brush holders.

(3) INSTALL EXCITER BRUSH HOLDERS (fig. 52).

SCREWDRIVER

Place two exciter brush holders in position on the inner exciter brush holder ring and secure each with two screws and lock washers (screwdriver). Repeat this step to install the two remaining exciter brush holders to the outer exciter brush holder ring.

(4) ASSEMBLE GENERATOR BRUSH RING (fig. 52).

PLIERS	**SCREWDRIVER**
SCALE, spring	**WRENCH**, box, $^{9}/_{16}$-in.

(a) Place brush holder mount flat on bench, beveled side up (fig. 52).

(b) On a brush ring screw (X), place, respectively, lock washer (W); flat steel washer (V); short fiber bushing (Q); two fiber washers (U and P); flat steel washer (N); $^{37}/_{64}$-inch steel spacer

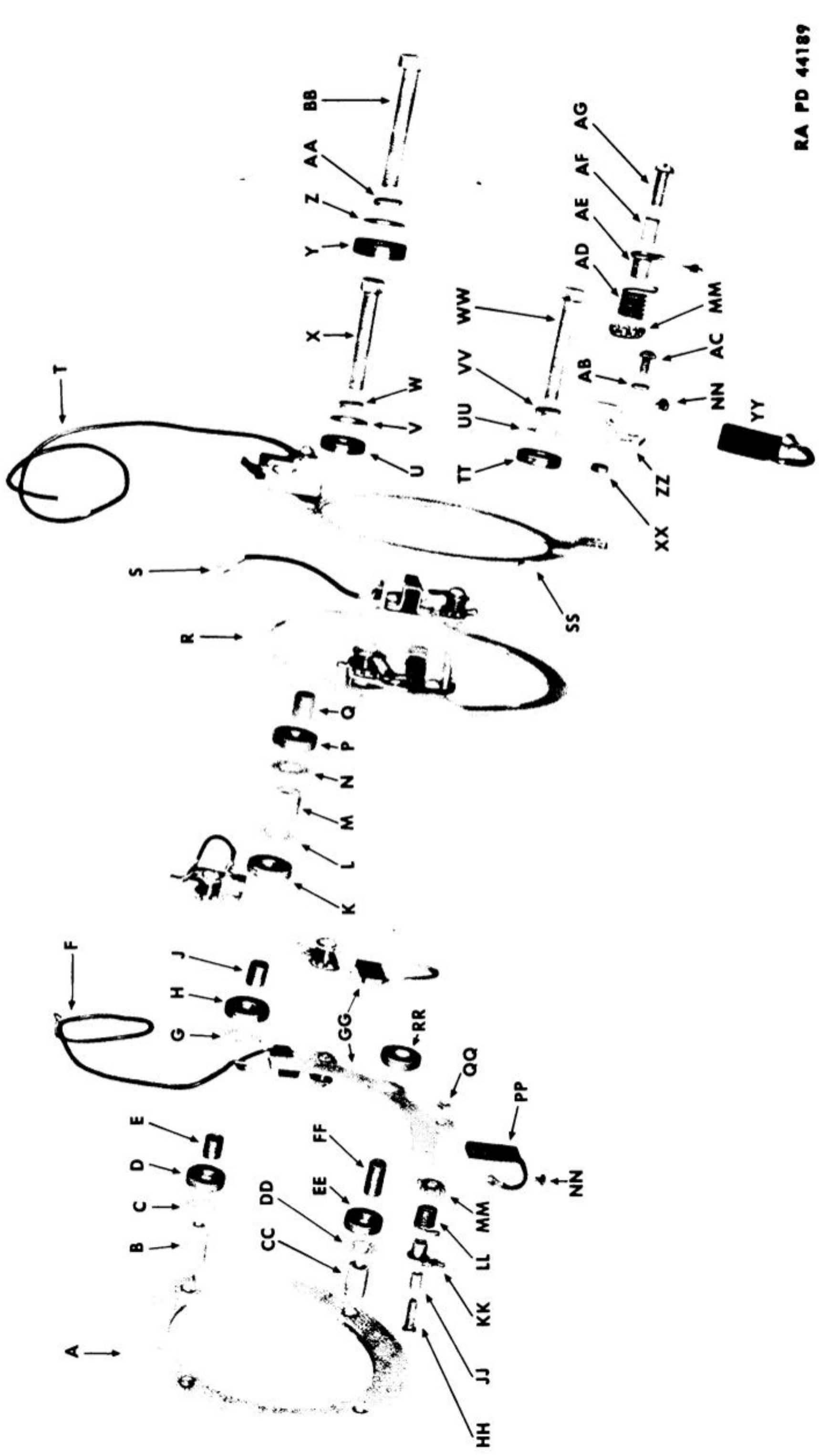


Figure 52 — Generator Brush Ring Assembly — Exploded View

A — MOUNT, BRUSH HOLDER
B — SPACER (1-23/64-IN., STEEL)
C — WASHER, STEEL, FLAT
D — WASHER, FIBER
E — BUSHING, BRUSH HOLDER
F — LEAD TO FIELD RHEOSTAT OR TIME DELAY RELAY
G — WASHER, FLAT, STEEL
H — WASHER, FIBER
J — BUSHING, BRUSH HOLDER
K — WASHER, FIBER
L — WASHER, FLAT, STEEL
M — SPACER (37/64-IN., STEEL)
N — WASHER, STEEL, FLAT
P — WASHER, FIBER
Q — BUSHING, BRUSH HOLDER
R — RING, HOLDER, EXCITER BRUSH (OUTER)
S — WIRE, EXCITER BRUSH HOLDER TO SLIP RING BRUSH HOLDER
T — LEAD, TO FIELD RHEOSTAT OR TIME DELAY RELAY
U — WASHER, FIBER
V — WASHER, FLAT, STEEL
W — WASHER, LOCK
X — SCREW, BRUSH RING
Y — WASHER, FIBER
Z — WASHER, FLAT, STEEL
AA — WASHER, LOCK
BB — SCREW, BRUSH RING
CC — SPACER (63/64-IN., STEEL)
DD — WASHER, FLAT, STEEL
EE — WASHER, FIBER
FF — BUSHING, BRUSH HOLDER
GG — HOLDER, SLIP RING BRUSH
HH — SCREW, TENSION ARM
JJ — BUSHING, BRUSH TENSION ARM
KK — ARM, BRUSH TENSION
LL — SPRING, BRUSH TENSION ARM
MM — HOLDER, SPRING ADJUSTING
NN — SCREW, BRUSH PIG TAIL
PP — BRUSH, SLIP RING
QQ — NUT, LOCK, TENSION ARM SCREW
RR — WASHER, FIBER
SS — RING, HOLDER, EXCITER BRUSH (INNER)
TT — WASHER, FIBER
UU — WASHER, FLAT, STEEL
VV — WASHER, LOCK
WW — SCREW, BRUSH RING
XX — NUT, LOCK, TENSION ARM SCREW
YY — BRUSH, EXCITER
ZZ — PLATE, EXCITER BRUSH
AB — WASHER, LOCK BRUSH, PLATE TO RING SCREW
AC — SCREW, BRUSH PLATE TO RING
AD — SPRING, BRUSH TENSION ARM
AE — ARM, BRUSH TENSION
AF — BUSHING, BRUSH TENSION ARM
AG — SCREW, BRUSH TENSION ARM

RA PD 44189B

Legend for Figure 52 — Generator Brush Ring Assembly — Exploded View

(M); flat steel washer (L); brush holder bushing (J); and fiber washer (K). Now insert screw through its hole in the slip ring brush holder (GG), plain side of brush holder away from head of screw. Then place a fiber washer (H) and flat steel washer (G) on the screw. Start screw into a screw hole in brush holder mount.

(c) On another brush ring screw (WW), place, in order given, lock washer (VV); flat steel washer (UU); long fiber bushing (FF); fiber washers (TT and RR); slip ring brush holder (GG) (plain side toward head of screw); fiber washer (EE); flat steel washer (DD); and $^{63}/_{64}$-inch steel spacer (CC). Start screw (WW) into the screw hole in brush holder mount (A) opposite the screw hole into which screw (X) was installed in step *(b)*.

(d) With the brush holder mount still flat on bench, carefully remove the screw installed in substep *(b)* above, with lock washer (W), flat steel washer (V) and top fiber washer (U) on screw. This leaves a fiber bushing (Q), fiber washer (P), steel washer (N), steel spacer (M), steel washer (L), fiber washer (K), and fiber bushing (J) in place over the brush holder.

(e) Hook outer exciter brush ring (R) over brush ring screw (WW) installed in substep *(c)* above (brush holder to left of screw). Be sure to place the ring (R) between the two top fiber washers (TT and RR) on screw (WW). Rest other side of ring on fiber washer (P) in place over screw hole on opposite side of brush holder mount (A).

(f) Insert inner exciter brush ring (SS) between two top fiber washers (TT and RR) on outer exciter brush ring (R) in place on brush holder mount (A). Place it so that brush plates on inner ring are on top, and one quarter the circumference away from the brush plates on the outer brush ring (R). Rest the other side of ring on fiber washer (P) in place over screw hole on opposite side of brush holder mount (A) (fig. 52).

(g) Insert screw (X) with lock washer (W), flat steel washer (V), and fiber washer (U) which were removed in substep *(d)* above, between the inner and outer brush rings (SS and R) through fiber bushing (Q), fiber washer (P), steel washer (N), steel spacer (M), steel washer (L), fiber bushing (J), fiber washer (K), brush holder (GG), fiber washer (H) and steel washer (G) in place on brush holder mount. Tighten screw ($^{9}/_{16}$-in. box wrench) (fig. 52).

(h) On another brush ring screw (BB), place a lock washer (AA), steel washer (Z), short fiber bushing (E), and a fiber washer (Y). Place screw (BB) between the two brush rings (R and SS). On end of the screw (BB), place a fiber washer (D), steel washer (C), and long steel spacer (B). Tighten screw into brush holder mount (A) ($^{9}/_{16}$-in. box wrench) (fig. 52).

(i) Repeat step *(h)* above to install remaining brush ring screw.

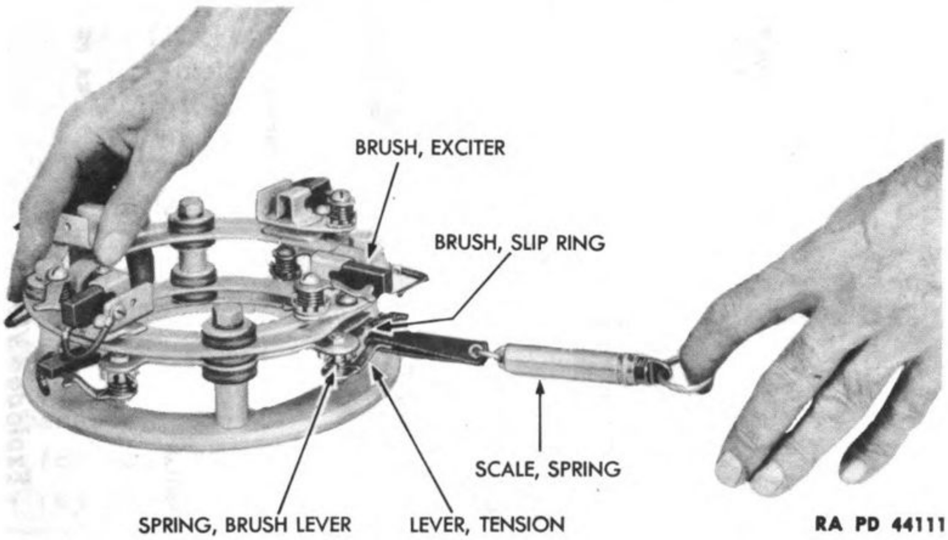


Figure 53 — Measuring Brush Spring Tension

(j) Tighten brush ring screw (WW) installed in step *(c)* above ($\frac{9}{16}$-in. box wrench).

(k) Place an exciter brush (YY) in each of the four brush plates (ZZ), with wires next to brush ring (R). Place tension arm (AE) against side of each brush (YY) near top of brush, so that the brush is held up in the plate (ZZ). Connect wires to screw (AC) in outer hole on brush holder plates (ZZ) (screwdriver) (fig. 33).

(l) Place a slip ring brush (PP) in each slip ring brush plate, with wires next to screw holes. Place brush tension arm (KK) against side of brush (PP) near top so that brush is held up in plate. Attach wires to screw in brush plate (screwdriver).

(m) Measure tension of brushes with a spring scale. Hook scale to end of brush tension arm. Pull scale and observe reading (fig. 53). Move end of brush tension arm spring to right or left to decrease or increase tension. Correct tension is 8 ounces for slip ring brushes, and 12 ounces for exciter brushes.

(n) Looking at the brush ring assembly from the side assembled in step *(c)* above, connect wire from exciter brush plate to the slip ring brush holder which is closest to mount (screwdriver) (fig. 33).

(o) Connect an 18-inch, unmarked main generator lead to slip ring brush holder assembled in step *(c)* above (screwdriver) (fig. 33).

(p) Connect a 22-inch, unmarked main generator lead to the exciter brush plate to the right of the one referred to in step *(n)* above (screwdriver).

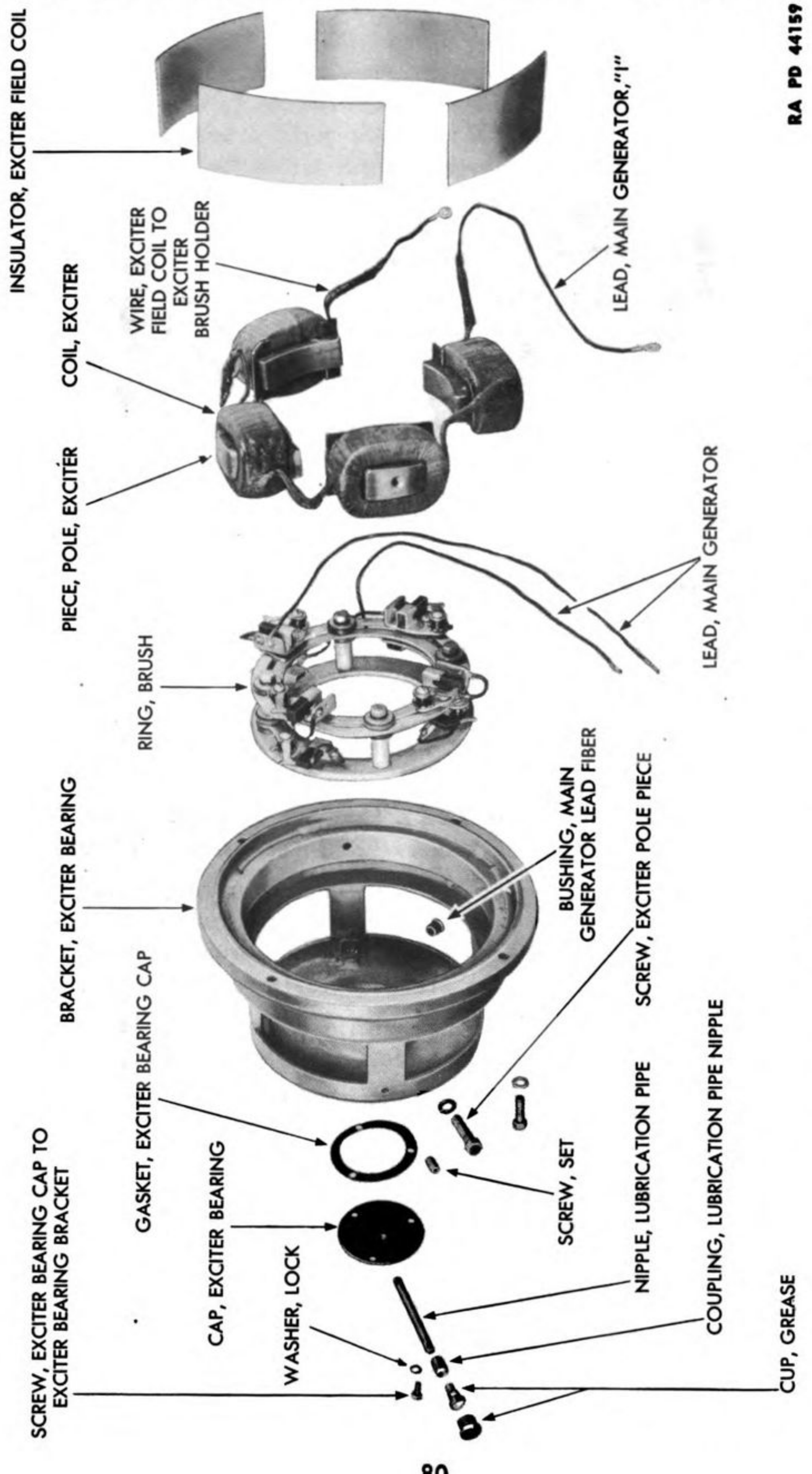


Figure 54 — Exciter Bearing Bracket Assembly — Exploded View

(5) ASSEMBLE EXCITER BEARING BRACKET (fig. 54).

BATTERY, dry cell (1½-volt)	PLIERS
COMPASS, magnetic	SCREWDRIVER
FILE	TAPE
GLYPTAL, No. 1209, black	WELDING EQUIPMENT
HAMMER	WRENCH, socket, $\frac{9}{16}$-in.
LOOM	WRENCH, socket-head setscrew, ⅜-in.

(a) Place exciter bearing bracket on bench, open end up. Examine inside of bracket for burs where brush ring seats. Remove burs if present (file).

(b) Tap main generator lead fiber bushing into place in bracket (hammer).

(c) Start setscrews in brush ring.

(d) Place brush ring in position in bracket so exciter brush referred to in step (4) *(n)* is next to main generator lead fiber bushing installed in step *(b)*. Pull two main generator leads through bushing. Tighten socket-head setscrews which clamp brush ring in bracket (⅜-in. socket-head setscrew wrench) (fig. 32).

(e) Turn exciter bearing bracket so main generator lead bushing is to the front.

(f) Place exciter pole insulators in position on an exciter field coil, and secure to coil with tape. Slide an exciter pole piece through the coil, so insulators are between coil and pole piece. Turn coil and pole piece so leads point down, and hold assembly in position in bracket to right of main generator lead bushing. Start exciter pole piece screw and lock washer into pole piece through screw hole in bracket.

(g) Assemble another exciter field coil, two insulators and pole piece (as in step *(f)* above), and secure in place in bracket to right of coil already installed with pole piece screw. The leads on this coil must point up.

(h) Continue on around the bracket and install remaining exciter field coils. Alternate the directions of the coil leads. Leads from the last installed coil must point up.

(i) Place exciter field coil insulators in position between the exciter field coils and bracket. Care must be exercised to keep insulators from between pole pieces and bracket. Tighten exciter pole piece cap screws ($\frac{9}{16}$-in. socket wrench).

(j) Clean insulation from ends of coil leads for a distance of about 1 inch. Slide loom (1½ in. long) down over every other lead. Connect coils in series by twisting bare ends of adjacent coil leads together (pliers). Do not connect left-hand lead of first coil installed and right-hand lead of last coil installed. Connect 16-inch main

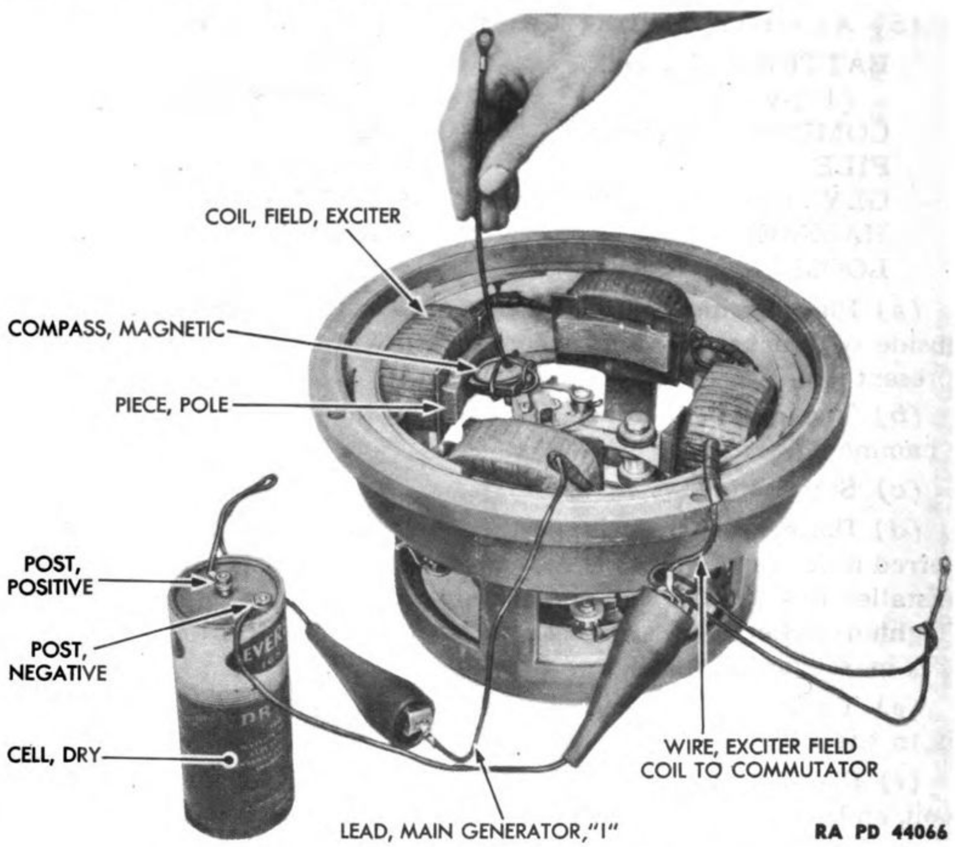


Figure 55 — Exciter Field Coil Polarity Test

generator lead marked "I" to right-hand lead of last coil installed. Connect 5-inch exciter field coil to exciter brush holder wire, to left-hand lead of first coil installed. Weld wires together on all five connections (welding equipment). Pull loom up over each connection and wrap with tape. Paint tape (No. 1209 black glyptal).

(k) Push all connected coil leads down between exciter field coils.

(l) Test and correct polarity of coils as follows:

1. Connect positive post of a 1½-volt dry cell battery to main generator lead "1." Connect negative post to exciter field coil to exciter wire (fig. 55).

2. Hold a magnetic compass edgewise against pole piece of the first coil installed so that the needle points "south."

3. Move compass to the same position on coil to the right. The needle should now point "north."

4. Move compass to the next coil to the right. Needle should point "south."

5. Move compass to remaining coil to the right. Needle should point "north."

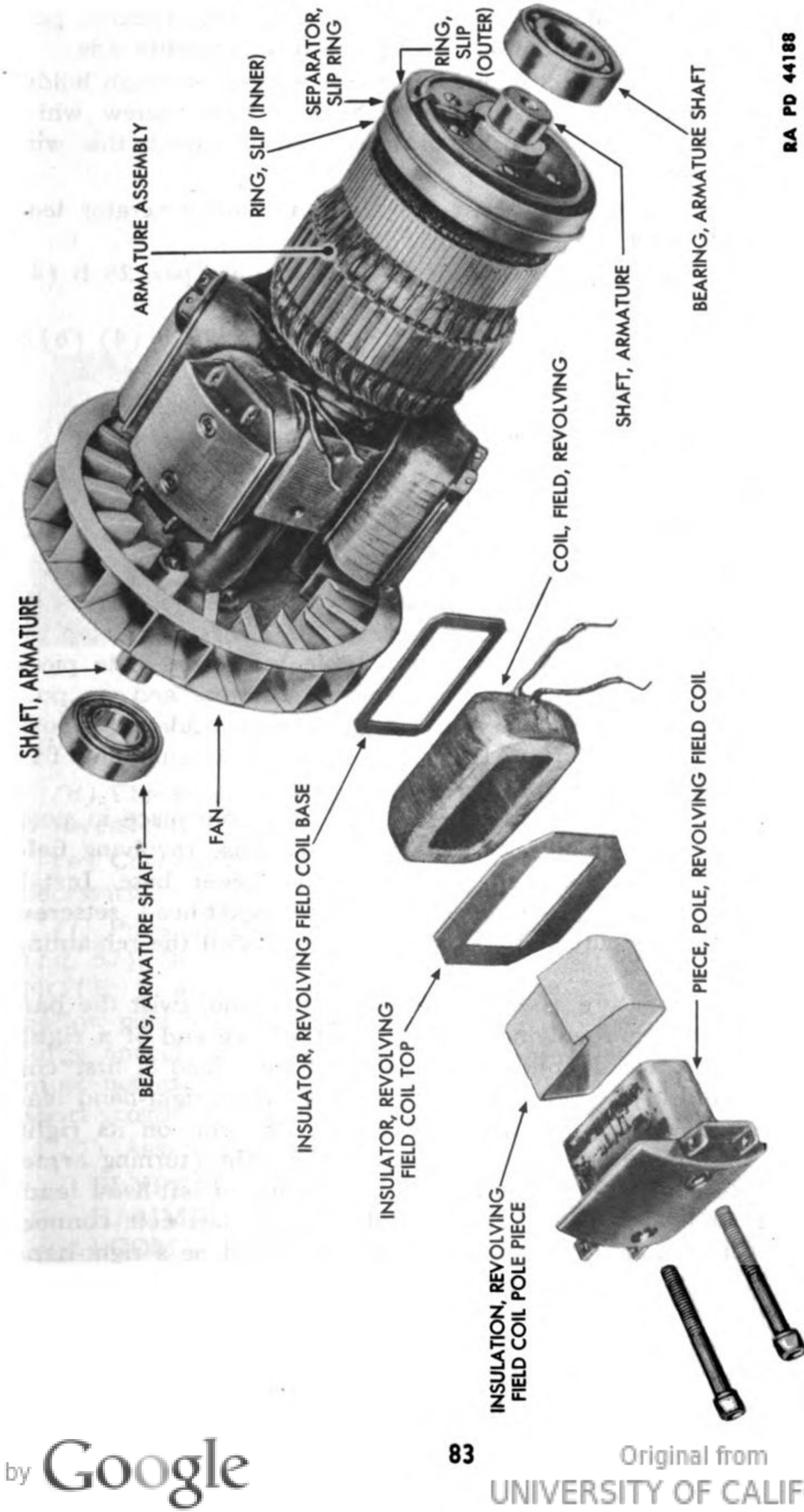


Figure 56 — Complete Armature Assembly

6. If compass points the wrong way on any coil, remove pole piece. Turn coil over and insert pole piece from opposite side.

(m) Attach 5-inch exciter field coil wire to exciter brush holder immediately below it (screwdriver). NOTE: Same screw which secures brush pigtail to brush holder is used to attach this wire (fig. 54).

(n) Pull main generator lead "1" through main generator lead bushing with other two leads (fig. 54).

(o) Check exciter field coils for an open circuit (par. 25 **b** (4) *(a)*). Repair if open.

(p) Check exciter field coils for a ground (par. 25 **b** (4) *(b)*). Repair if grounded.

(6) ASSEMBLE COMPLETE ARMATURE ASSEMBLY (fig. 56).

GLYPTAL, No. 1209, black
HAMMER
LOOM
PILOT, hollow
PLIERS
PRESS, arbor
TAPE
WELDING EQUIPMENT
WRENCH, socket-head setscrew, $\frac{5}{16}$-in.

(a) Place a revolving field coil pole piece on bench, large side down. Wrap pole piece insulation around pole piece. Push top revolving field coil insulator down over pole piece and pole piece insulation. Place revolving field coil over insulators and on pole piece, flat side down. Lay base revolving field coil insulator in position on top of coil. Repeat the step to assemble remaining five revolving field coils and pole pieces.

(b) Place assembled revolving field coil and pole piece in position on spider base of armature shaft. Be sure base revolving field coil insulator is not between pole piece and spider base. Install pole piece to spider base screws ($\frac{5}{16}$-in. socket-head setscrew wrench). Tighten securely. Repeat the step to install the remaining revolving field coils.

(c) Facing armature assembly from slip ring end, twist the bare end of a slip-ring-to-revolving-field wire to the bare end of a right-hand lead from a coil (pliers). Connect left-hand lead of first coil to the left-hand lead of the coil on its right. Connect right-hand lead of this second coil to the right-hand lead of the coil on its right. Continue on around armature assembly to the right (turning armature assembly to left) connecting left-hand leads to left-hand leads and right-hand leads to right-hand leads. On the last coil, connect the only lead remaining disconnected, which should be a right-hand lead, to the other slip-ring-to-revolving-field wire. Weld connections (welding equipment), and cover with loom and tape. Paint tape (No. 1209 black glyptal). Push connections down under end of exciter armature. Wrap connections with linen tape to hold them in place. Paint tape (No. 1209 black glyptal).

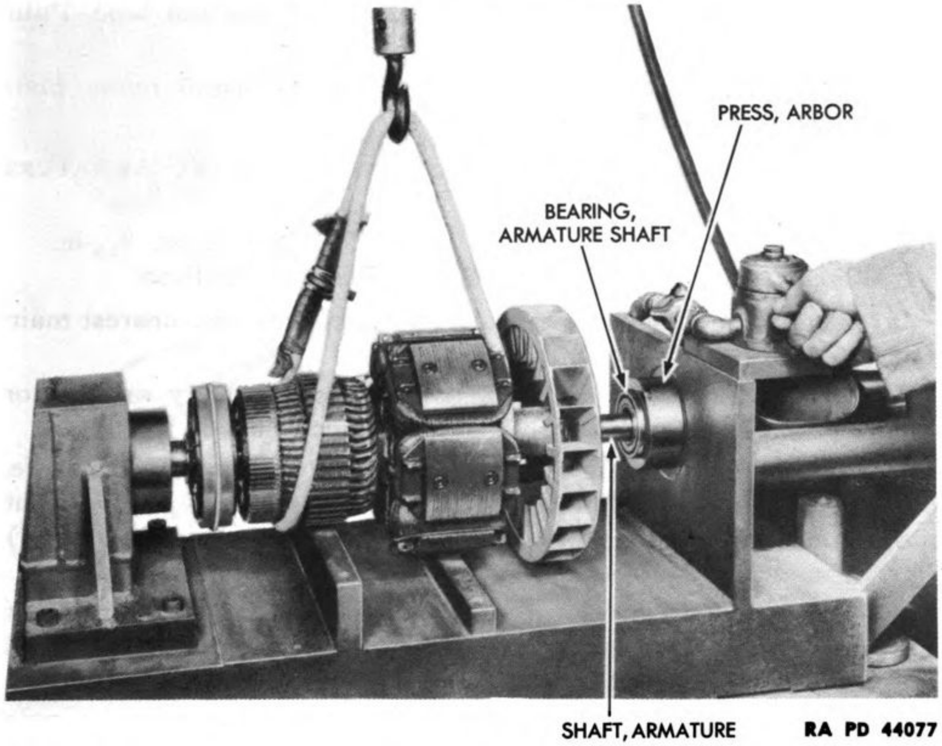


Figure 57 — Pressing Armature Shaft Bearing on Shaft

(d) Check revolving field for open circuit (par. 25 **b** (2)). Repair if necessary.

(e) Check revolving field for ground (par. 25 **b** (2)). Repair if necessary.

(f) Press armature shaft bearings on armature shaft (arbor press) (fig. 57). Be sure open face of bearings is toward ends of shaft. NOTE: In an emergency, bearings can be driven onto shaft with a hollow pilot and hammer. The inside diameter of the pilot must be large enough to fit over end of rotor shaft, and outside diameter must not exceed the diameter of the inner race of the bearing. A short length of 1½-inch iron pipe can be used as a pilot.

(7) ASSEMBLE STATOR.

GLYPTAL, red	SCREWDRIVER
HAMMER	TAPE
LOOM	WELDING EQUIPMENT
PLIERS	

(a) Tap insulator bushing into place in body (hammer). Insert ends of six main generator leads through bushing.

(b) Connect main generator leads "A," "B," "C," "1A,", "1B," and "1C" to wires as tagged at disassembly (pliers). Weld connections

(welding equipment). Cover connections with loom and tape. Paint tape (No. 1209 black glyptal).

(c) Place name plate in position on body. Install name plate screws (screwdriver).

(8) INSTALL COMPLETE ARMATURE ASSEMBLY AND ARMATURE SHAFT BRACKET.

WRENCH, open-end, ½-in.	WRENCH, socket, $\frac{9}{16}$-in.
WRENCH, socket, ½-in.	WRENCH, Stillson

(a) Set body and stator assembly on bench, with end nearest main generator leads toward back of bench (fig. 51).

(b) Insert armature assembly into position in body and stator assembly, slip ring end first, from front of bench (fig. 51).

(c) Slip armature shaft bearing bracket on fan end of armature. Revolve bracket so that lubrication pipe nipple hole is on top right side. Install four cap screws and lock washers ($\frac{9}{16}$-in. socket wrench) (figs. 29 and 51).

(d) Insert felt washer into grease retainer. Place grease retainer and gasket in position over armature shaft on bearing bracket. Install three cap screws and lock washers (½-in. socket wrench) (fig. 51).

(e) Screw elbow onto lubrication pipe nipple. Screw the nipple into armature shaft bearing bracket (Stillson wrench). Tighten grease cup in elbow (½-in. open-end wrench) (fig. 51).

(9) INSTALL EXCITER BEARING BRACKET ASSEMBLY.

SCREWDRIVER	WRENCH, socket, ½-in.
WRENCH, open-end, ½-in.	WRENCH, socket, $\frac{9}{16}$-in.

(a) Turn generator assembly on bench so slip ring end is to front of bench. Slide stator body as near edge of bench as possible. CAUTION: Be sure bench is bolted to floor.

(b) Inspect bare end of slip-ring-to-revolving-field wire, where it is attached to outer slip ring. Bend bare end (screwdriver) if necessary so that it makes no contact with mica. This is a precaution against possible grounding.

(c) Inspect brushes in exciter bearing bracket to be sure all are lifted up in their plates. Slide bracket on end of armature, with bracket turned so that the main generator leads protrude from top right side of bracket.

(d) Install four cap screws and lock washers ($\frac{9}{16}$-in. socket wrench).

(e) Using a new gasket, place exciter bearing cap in position on end of exciter bearing bracket (fig. 54). Be sure lubrication pipe nipple hole points to left (fig. 54). Install three screws and lock washers (½-in. socket wrench) (fig. 54).

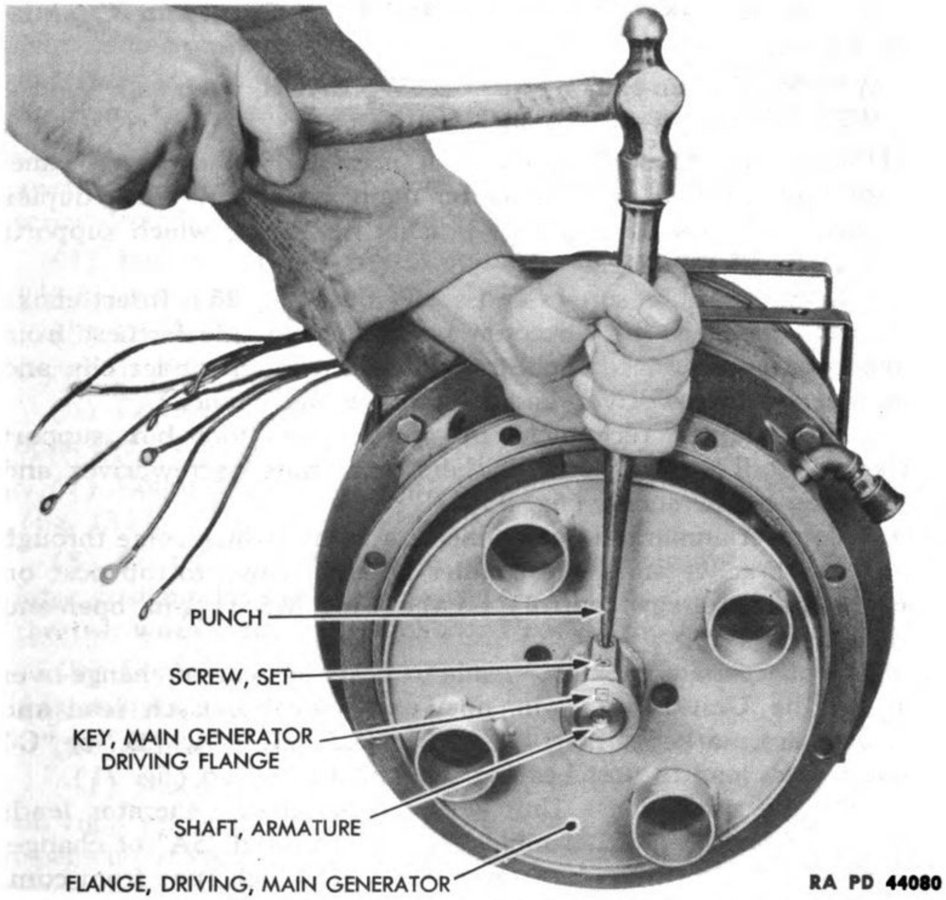


Figure 58 — Installing Main Generator Driving Flange

(f) Install lubrication pipe nipple, coupling and grease cup into exciter bearing cap ($\frac{1}{2}$-in. open-end wrench) (fig. 54).

(g) Lift tension arm on each of the brushes and let brushes drop against exciter commutator or slip ring.

(10) INSTALL MAIN GENERATOR DRIVING FLANGE.

HAMMER	PUNCH, center
HAMMER, soft	WRENCH, socket-head setscrew, $\frac{9}{64}$-in.

(a) Tap main generator driving flange key into position in keyway in armature shaft (hammer) (fig. 58).

(b) Drive main generator driving flange on armature shaft (soft hammer) (fig. 58).

(c) Tighten setscrews in hub of driving flange ($\frac{9}{64}$-in. socket-head setscrew wrench). Center punch hub next to screws, to lock screws in position (punch and hammer) (fig. 58).

(11) INSTALL INSTRUMENT PANEL, TOOL BOX, AND CHANGE-OVER PANEL.

WRENCH, open-end, 5/16-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

(a) Place switchboard panel, tool box, and change-over panel assembly in position on bracket on main generator. Work duplex receptacle into position through bracket on stator, which supports tool box (fig. 25).

(b) Install tool box screws and safety nuts (fig. 25). Insert choke control clip beneath nut on screw on right-hand side farthest from switchboard panel. Place choke control wire conduit under clip and tighten screw (screwdriver and 1/2-in. open-end wrench).

(c) Hold duplex receptacle in position on tool box support bracket. Install screws, lock washers, and nuts (screwdriver and 7/16-in. open-end wrench) (fig. 25).

(d) Connect unmarked main generator leads (which come through the exciter bracket and have smaller holes in tips) to top post on field rheostat (voltage control) on the Unit M5 (5/16-in. open-end wrench).

(e) Connect main generator leads to posts on rear of change-over panel of the Unit M5 (7/16-in. open-end wrench). Each lead and each post are marked either "1," "1A," "1B," "1C," "A," "B," or "C". Connect each lead to post bearing same mark as lead (fig. 71).

(f) On the single-phase Unit M6, connect main generator leads "2," "4," "5," and "5A" to terminals "2," "4," "5," and "5A" of change-over panel. Connect main generator lead "M" which runs from commutator to rear post of time delay relay marked "M." Connect main generator lead "M" which runs from slip ring to front post of time delay relay marked "M" (7/16-in. open-end wrench).

(g) On the single- and 3-phase Unit M6, connect main generator leads "A," "B," and "C" to bottom clips of fuses "A," "B," and "C." Connect main generator lead "M" which runs from commutator to rear post of time delay relay marked "M." Connect main generator lead "M" which runs from slip ring to front post of time delay relay marked "M" (7/16-in. open-end wrench).

28. INSTALLATION.

a. Equipment.

CHAIN (or rope)
HOIST, chain
SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 3/4-in.

b. Procedure.

(1) Using a chain or rope sling, lower main generator and instrument panel assembly into position in frame (chain hoist) (fig. 24).

(2) Turn engine flywheel so that one of coupling studs is in top dead center position. Turn generator driving flange so that a coupling socket is at top dead center. Slide main generator forward into position (two men).

(3) Install main generator to bell housing cap screws and lock washers (9/16-in. open-end wrench). Be sure to install the one short screw directly behind the starting motor (fig. 134).

(4) Install main generator mounting cap screws and lock washers (3/4-in. open-end wrench) (fig. 134).

(5) Place main generator fan cover in position on generator, and secure in place by tightening clamp screws (screwdriver) (fig. 133).

(6) Connect oil pressure gage line to "T" on cylinder block (1/2-in. open-end wrench) (fig. 137).

(7) Connect cable to starting motor (9/16-in. open-end wrench) (fig. 133).

(8) Connect ammeter wire to battery charging generator regulator post marked "B" (screwdriver). NOTE: This is the shorter of the two wires from the switchboard panel (fig. 133).

(9) Connect switch wire to ignition coil terminal marked "—" (3/8-in. open-end wrench).

(10) Connect choke control (par. 154).

(11) Place battery to starter switch cable in position under clip on right rear engine mounting cap screw. Tighten cap screw (3/4-in. open-end wrench). Connect cable to positive post of battery (9/16-in. open-end wrench).

(12) Place outlet receptacle in position on frame, with socket marked "A" up. Install mounting screws and safety nuts (screwdriver and 1/2-in. open-end wrench) (pars. 62 and 63).

(13) Test and adjust main generator (par. 29).

(14) Check all brushes to be sure they are down against commutator or slip ring. Slide brush cover over exciter bearing bracket, with screws on right side of generator, and with mesh across bottom of bracket. Install brush cover screws and nuts (screwdriver and 1/2-in. open-end wrench). CAUTION: Do not draw screws too tight because of danger of creating a ground. Tighten only until ends of guard are about 1/2 inch apart.

(15) Install housing (par. 19).

29. ADJUSTMENTS.

a. Equipment.

WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH socket-head set-screw, 3/8-in.

b. Procedure.

(1) ADJUST UNIT M5 TO DELIVER 60 CYCLES.

WRENCH, open-end, 3/8-in. WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

(a) Connect change-over bars on change-over panel between binding posts "2" and "3," "RA" and "A," "RB" and "B," "RC" and "C" (1/2-in. open-end wrench) (fig. 72).

(b) Start engine and adjust governor adjusting screw (figs. 186 and 206) until frequency meter shows 61 or 62 cycles with no load on generator (7/16- and 3/8-in. open-end wrenches) (par. 148).

(c) Put load on generator and observe frequency meter. It should register 60 cycles. Adjust governor adjusting screw if necessary to get proper reading (7/16- and 3/8-in. open-end wrenches) (figs. 186 and 206).

(2) ADJUST UNIT M5 TO DELIVER 50 CYCLES.

WRENCH, open-end, 3/8-in. WRENCH, open-end, 7/16-in.

(a) Connect change-over bars on change-over panel between binding posts "1" and "2," "1A" and "RA," "1B" and "RB," "1C" and "RC" (7/16-in. open-end wrench) (fig. 72).

(b) Start engine and adjust governor adjusting screw (figs. 186 and 206) until frequency meter shows 51 or 52 cycles with no load on main generator (7/16- and 3/8-in. open-end wrenches) (par. 148).

(c) Put load on generator and observe frequency meter. It should register 50 cycles. Adjust governor adjusting screw if necessary to get proper reading (7/16- and 3/8-in. open-end wrenches) (par. 148).

(3) ADJUST SINGLE- AND 3-PHASE UNIT M6 TO DELIVER 3-PHASE CURRENT.

WRENCH, open-end, 7/16-in.

(a) Some Units M6 can be adjusted to deliver 3-phase current. Those bearing serial numbers 377 to 726, inclusive, have a change-over panel similar to the change-over panel on the M5, and can be adjusted to function as 3-phase units. Connect change-over bars on change-over between binding posts "A" and "A," "B" and "B," "C" and "C," "1" and "2."

(4) ADJUST SINGLE- AND 3-PHASE UNIT M6 TO DELIVER SINGLE-PHASE CURRENT.

WRENCH, open-end, 7/16-in.

(a) Units M6 bearing serial numbers 1 to 266, inclusive, and numbers 367 to 376, inclusive, are exclusively single-phase generators but can be converted to deliver 3-phase current by making certain changes in wiring (step (5) below).

(b) Units M6 bearing serial numbers 377 to 726, inclusive, can be adjusted to deliver single-phase current from the 19-pole outlet

receptacle. Connect change-over bars on change-over panel between binding posts "A" and "4," "B" and the unmarked post immediately below it, "C" and "5A," "2" and "3" (7/16-in. open-end wrench).

(5) CONVERT SINGLE-PHASE UNIT M6 TO DELIVER 3-PHASE OUTPUT.

WRENCH, open-end, 5/16-in. WRENCH, open-end, 3/8-in.

(a) Remove the 19-pole outlet receptacle (par. 63) and install 3-pole outlet receptacle in its place (par. 62).

(b) Connect wire from "C" socket of outlet receptacle to terminal "5A" on circuit breaker (5/16-in. open-end wrench) (fig. 9).

(c) Connect wire from "B" socket of outlet receptacle to top clip of fuse "5" (3/8-in. open-end wrench) (fig. 9).

(d) Remove both wires from lower left-hand terminal "4" (next to frequency meter) of circuit breaker (5/16-in. open-end wrench) (fig. 9).

(e) Connect wire from "A" socket of outlet receptacle to lower left-hand terminal "4" (next to frequency meter) of circuit breaker (5/16-in. open-end wrench) (fig. 9).

(6) LOWER VOLTAGE OUTPUT.

WRENCH, socket-head setscrew, 3/8-in.

(a) Under no-load conditions, the voltmeter will often show several volts more than are delivered under load. As this is a normal condition, no adjustment is necessary. However, if for any reason the voltage must be lowered, the procedure is as follows:

1. Loosen socket-head setscrews which lock the generator brush ring to the exciter bearing bracket (3/8-in. socket-head setscrew wrench) (fig. 32).

2. Turn brush ring (counterclockwise from rear of unit) until desired voltage is obtained.

3. Tighten setscrews (3/8-in. socket-head setscrew wrench) (fig. 32).

Section VI

INSTRUMENTS AND GAGES

30. DESCRIPTION AND CONSTRUCTION.

a. Oil Pressure Gage. The oil pressure gage is an indicating instrument only. It indicates whether or not the oil pump is working. As the pump builds up pressure, oil is forced through the oil pressure gage line to the gage. As the oil is forced into the mechanism (which consists of a crescent-shaped tube), the tube straightens out. This moves the hand from zero toward 50 on the dial.

b. Battery Charging Generator Ammeter.

(1) Of standard automotive design, the battery charging generator ammeter registers up to 30 amperes of current flow in either direction through it. Current passing through a coil sets up a magnetic field which attracts or repels a piece of iron. The iron is linked to a hand which indicates the direction of the current (i.e., charge or discharge) and the amount of current (i.e., number of amperes).

(2) The function of the ammeter is to register rate of charge or discharge in engine battery circuit.

c. Alternating-current Voltmeter. A standard alternating-current voltmeter is provided to register voltage of main generator output. Range of voltmeter is from zero to 150 volts.

d. Alternating-current Ammeter. An alternating-current ammeter is provided to register amount of current in main generator output. Range of the ammeter is from zero to 30 amperes.

e. Frequency Meter.

(1) A frequency meter is provided to measure the number of cycles per second.

(2) On the Unit M5, the frequency meter is a 10-reed instrument. A 5-reed unit is used on the M6.

INSTRUMENTS AND GAGES

31. SPECIFICATIONS.

a. Oil Pressure Gage.

Make	Stewart-Warner
Model	444029
Range	0 to 50 lb

b. Direct-current Ammeter.

Make	Stewart-Warner
Model	440021
Range	—30 to +30 amp

c. Alternating-current Voltmeter.

Make	Triplett
Model	332 J.P.
Range	0 to 150 volts

d. Alternating-current Ammeter.

Make	Triplett
Model	332 J.P.
Range	0 to 30 amp

e. Frequency Meter.

Make	Triplett
Model	372
Range (M5)	48 to 52 and 58 to 62 cycles
Reeds (M5)	10
Reeds (M6)	5

32. TROUBLE SHOOTING.

a. Fails to Register.

Possible Cause	Possible Remedy
Defective connection to instrument.	Repair connection.
Defective mechanism.	Replace mechanism or instrument.

b. Registers Incorrectly.

Possible Cause	Possible Remedy
Out of adjustment.	Adjust or replace instrument.
Defective connection to instrument.	Repair connection.
Defective mechanism.	Replace mechanism or instrument.

33. OIL PRESSURE GAGE.

a. Removal of Oil Pressure Gage (fig. 59).

WRENCH, open-end, 3/8-in. WRENCH, open-end, 1/2-in.

(1) Disconnect oil pressure gage line from oil gage (1/2-in. open-end wrench).

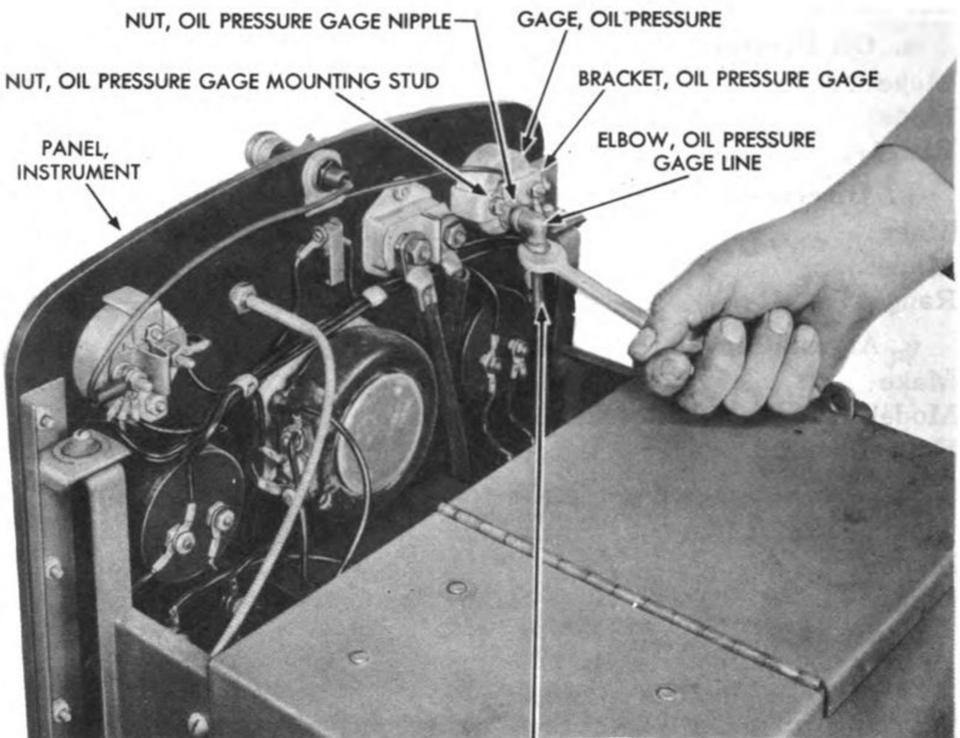


Figure 59 — Removing Oil Pressure Gage

(2) Remove oil pressure gage mounting stud nuts and lock washers (3/8-in. open-end wrench).

(3) Lift oil pressure gage bracket from engine side of instrument panel, and remove oil pressure gage from face of switchboard.

b. Inspection and Test of Oil Pressure Gage.

COMPRESSED AIR

(1) Check functioning of oil pressure gage by attaching compressed air hose to nipple. Introduce low air pressure (10 to 20 lb) to gage. If hand moves from zero toward 50 on dial, and no air leak can be detected, gage is in satisfactory condition.

(2) Inspect bezel and glass assembly; if broken, replace.

(3) Examine elbow, washers, and nuts to see if any are broken or have damaged threads.

c. Installation of Oil Pressure Gage (fig. 59).

WRENCH, open-end, 3/8-in. WRENCH, open-end, 1/2-in.

(1) Place oil pressure gage in position from the front of switchboard. Place oil pressure gage bracket in position on back of oil gage

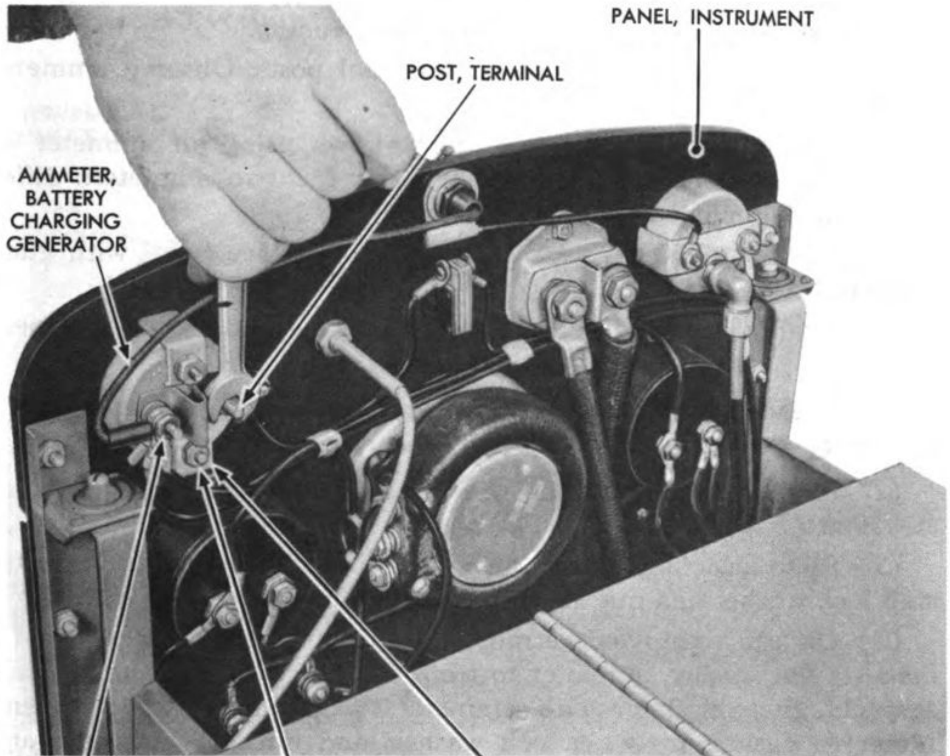


Figure 60 — Removing Battery Charging Generator Ammeter

on engine side of switchboard. Install oil pressure gage mounting flat washers, lock washers, and nuts (3/8-in. open-end wrench).

(2) Connect oil pressure gage line to elbow (1/2-in. open-end wrench).

34. BATTERY CHARGING GENERATOR AMMETER.

a. Removal of Battery Charging Generator Ammeter (fig. 60).

AMMETER	**WRENCH**, open-end, 11/32-in.
BATTERY, 6-volt, dry-cell	**WRENCH**, open-end, 3/8-in.

(1) Remove two ammeter terminal post nuts, lock washers; four washers, and five wires (11/32-in. open-end wrench).

(2) Remove ammeter attaching clamp nuts, lock washers, and clamps (3/8-in. open-end wrench).

(3) Lift ammeter from instrument panel.

b. Inspection and Test of Battery Charging Generator Ammeter.

(1) Compare functioning of ammeter with an ammeter of known good quality as follows:

(a) Connect leads from posts of a 6-volt dry-cell battery to terminal posts of ammeter. Observe ammeter reading.

(b) Reverse leads on ammeter terminal posts. Observe ammeter reading.

(c) Repeat substeps *(a)* and *(b)* above, using an ammeter of known good quality. If readings between the two ammeters differ appreciably, replace ammeter.

(2) Inspect glass to see if it is broken. Replace bezel with glass assembly if broken.

(3) Examine nuts and washers to see if they are broken. Inspect threads of nuts. Replace damaged parts.

c. Installation of Battery Charging Generator Ammeter.

WRENCH, open-end, 11/32-in. WRENCH, open-end, 3/8-in.

(1) Place battery charging generator ammeter in position on instrument panel.

(2) Slide attaching clamps into position over attaching studs. Install lock washer and nut on each stud (3/8-in. open-end wrench).

(3) On the right-hand terminal of the ammeter (marked "+"), install a flat washer, ammeter to trouble lamp wire, ammeter to battery charging regulator wire, ammeter to ignition switch wire, ammeter to dash lamp wire, lock washer, and nut (11/32-in. open-end wrench) (fig. 60). On right-hand terminal (marked "—"), install a flat washer, starter switch to ammeter wire, lock washer, and nut (11/32-in. open-end wrench) (fig. 60).

35. ALTERNATING-CURRENT VOLTMETER.

a. Removal of Alternating-current Voltmeter (fig. 61).

SCREWDRIVER WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Remove nut and lock washer from each terminal (3/8-in. open-end wrench). Remove four wires from terminals.

(2) Remove attaching screws, nuts, and lock washers (screwdriver and 1/4-in. open-end wrench).

(3) Lift voltmeter from face of instrument panel.

b. Inspection and Test of Alternating-current Voltmeter.

VOLTMETER, alternating-current

(1) Test functioning of voltmeter as follows:

(a) From an unvarying source of approximately 110-volt, 50- or 60-cycle alternating current, attach lead to each voltmeter terminal. Observe voltmeter reading.

(b) Connect another voltmeter known to be accurate across the voltmeter terminals. Observe voltmeter reading.

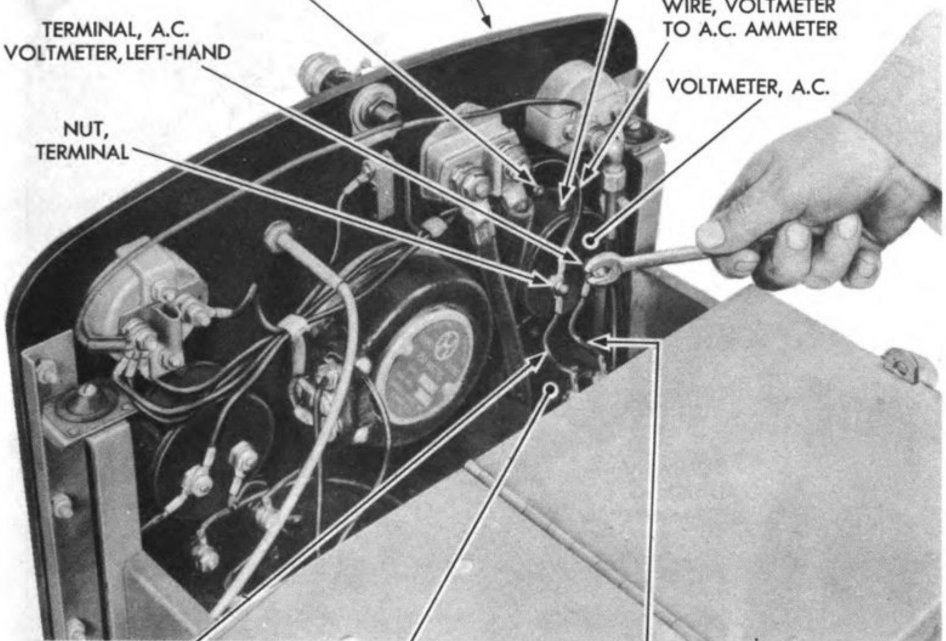


Figure 61 — Removing Alternating-current Voltmeter

(c) If voltmeter being tested registers differently than the one known to be accurate, replace the voltmeter.

(2) Inspect rear cap; replace if broken.

(3) Examine screws, nuts, and lock washers to see if they are broken or have damaged threads. Replace defective parts.

c. Installation of Alternating-current Voltmeter (fig. 61).

SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Place alternating-current voltmeter in position on instrument panel.

(2) Install screws, lock washers, and nuts (screwdriver and 1/4-in. open-end wrench).

(3) On voltmeter right-hand terminal, next to voltage control, install frequency meter to voltmeter right-hand wire, voltmeter to alternating-current ammeter wire, lock washer, and nut (3/8-in. open-end wrench).

(4) On left-hand voltmeter terminal, next to edge of instrument panel, install frequency meter to voltmeter left-hand wire, voltmeter

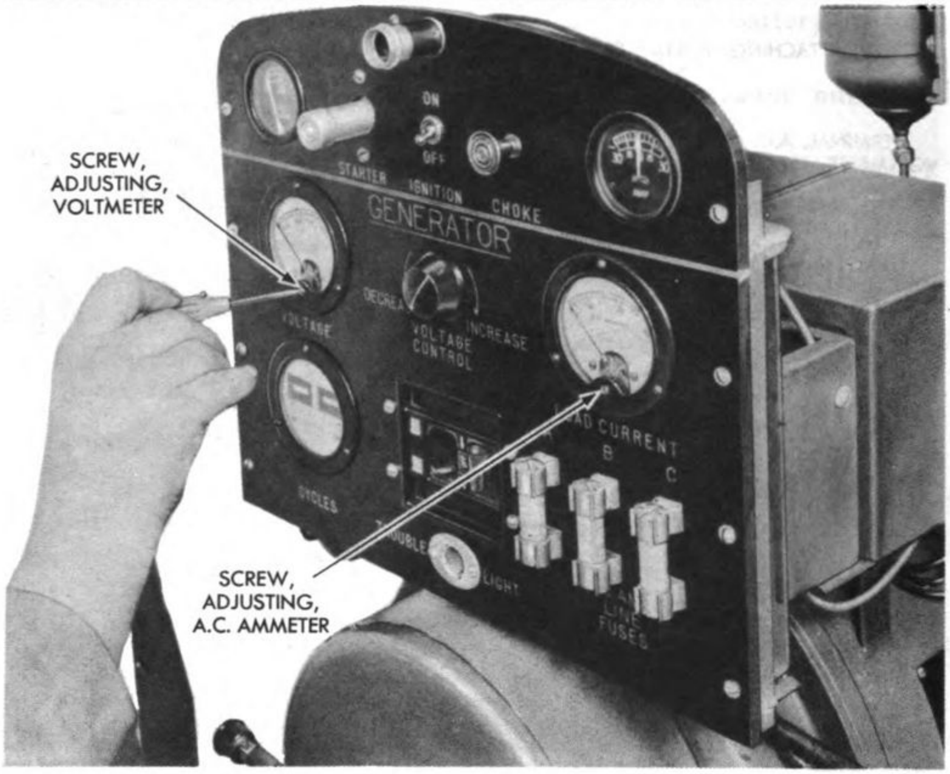


Figure 62 — Adjusting Alternating-current Voltmeter

to fuse "A" ("4" on single-phase Unit M6) wire, lock washer, and nut (3/8-in. open-end wrench).

d. Adjustment of Alternating-current Voltmeter (fig. 62).
SCREWDRIVER

With engine of unit not running, turn voltmeter adjusting screw to right or left until hand points to zero (screwdriver).

36. ALTERNATING-CURRENT AMMETER.

a. Removal of Alternating-current Ammeter (fig. 63).
SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Remove nuts, lock washers, and three wires from ammeter terminals (3/8-in. open-end wrench).

(2) Remove screws, lock washers, and nuts (screwdriver and 1/4-in. open-end wrench).

(3) Lift alternating-current ammeter from face of instrument panel.

b. Inspection and Test of Alternating-current Ammeter.
AMMETER

(1) Test alternating-current ammeter as follows:

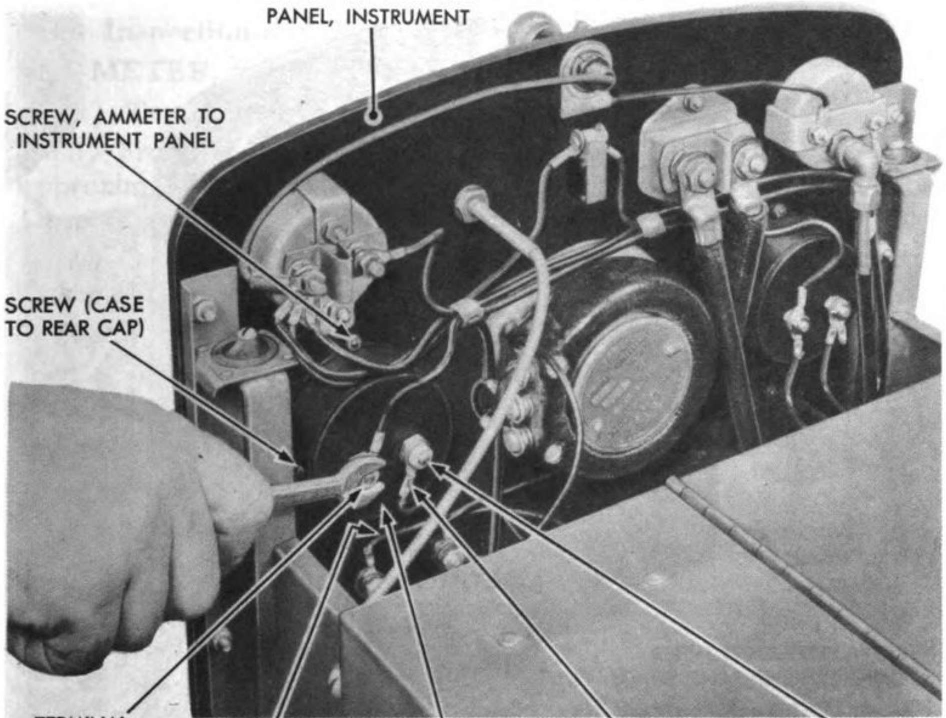


Figure 63 — Removing Alternating-current Ammeter

(a) Connect leads from a source of approximately 30 amperes, 50- to 60-cycle alternating-current to terminals of ammeter. CAUTION: Do not connect the ammeter directly across a power line. Observe reading. Disconnect leads from ammeter.

(b) Connect same leads to terminals of an ammeter known to be accurate. Observe reading.

(c) If the two readings vary, replace ammeter.

(2) Inspect rear cap; replace if broken.

(3) Examine all screws, nuts, and washers to see if any are broken or if threads are damaged. Replace defective parts.

c. Installation of Alternating-current Ammeter (fig. 63).

SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Place ammeter in position on instrument panel and install ammeter-to-instrument panel, screws, lock washers, and nuts (screwdriver and 1/4-in. open-end wrench).

(2) On left-hand alternating-current ammeter terminal, next to field rheostat, install ammeter to circuit breaker wire, lock washer, and nut (3/8-in. open-end wrench).

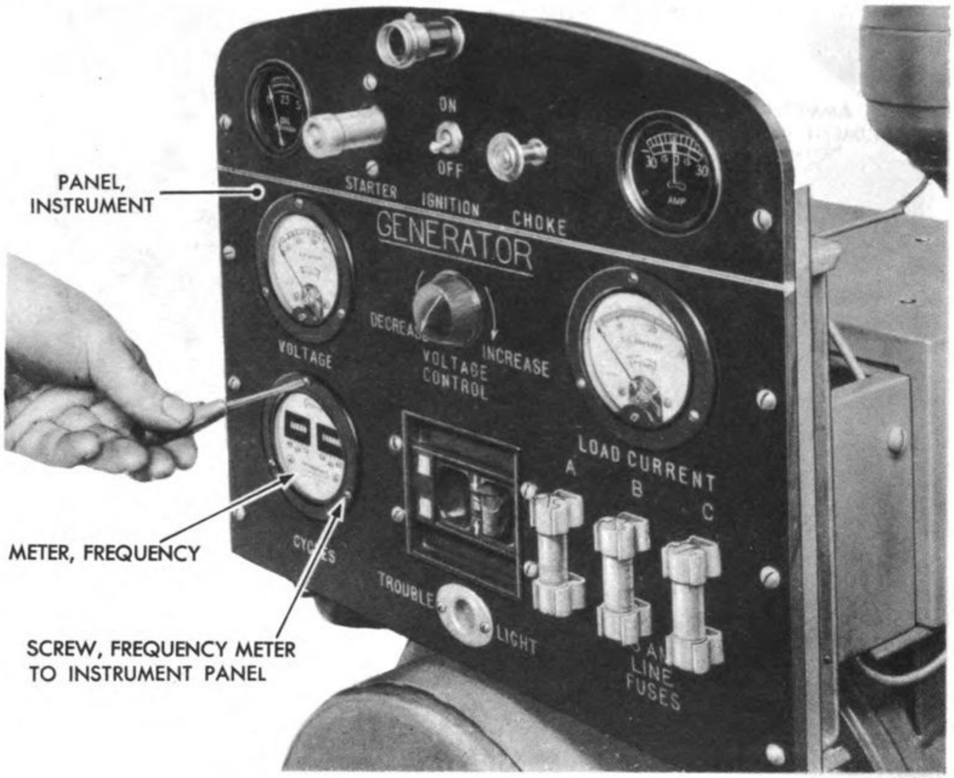


Figure 64 — Removing Frequency Meter

(3) On right-hand ammeter terminal, toward edge of panel, install ammeter to fuse "C" ("5A" on single-phase Unit M6) wire, ammeter to voltmeter wire, lock washer, and nut (3/8-in. open-end wrench).

d. Adjustment of Alternating-current Ammeter (fig. 62).

SCREWDRIVER

With engine not running, turn alternating-current ammeter adjusting screw to right or left until ammeter hand points to zero (screwdriver).

37. FREQUENCY METER.

a. Removal of Frequency Meter.

SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Disconnect wires from frequency meter terminals on rear of instrument panel (3/8-in. open-end wrench) (fig. 61).

(2) Remove nuts, screws, and lock washers from meter on front of instrument panel (screwdriver and 1/4-in. open-end wrench) (fig. 64).

(3) Lift frequency meter from face of instrument panel.

b. Inspection and Test of Frequency Meter.

METER, frequency

(1) Test frequency meter as follows:

(a) From an unvarying source of 50-cycle alternating-current, and approximately 110 volts, connect leads to frequency meter terminals. Observe reading. Disconnect leads.

(b) Connect same leads to a frequency meter of known accuracy. Observe reading.

(c) If readings differ, replace frequency meter.

(2) Inspect rear cap; replace if cracked.

(3) Examine all screws, nuts, and washers to see if they are broken or have damaged threads. Replace defective parts.

c. Installation of Frequency Meter.

SCREWDRIVER
WRENCH, open-end, ¼-in.
WRENCH, open-end, ⅜-in.

(1) Place frequency meter in position on instrument panel (fig. 61).

(2) Install frequency meter to panel screws, lock washers, and nuts (screwdriver and ¼-in. open-end wrench) (fig. 64).

(3) On left-hand terminal, next to edge of instrument panel, install left-hand voltmeter-to-frequency-meter wire (also frequency meter to fuse "A" if single- and 3-phase Unit M6; frequency meter to fuse "4" on single-phase Unit M6), lock washer, and nut (⅜-in. open-end wrench) (fig. 61).

(4) On right-hand terminal, next to field rheostat, install right-hand voltmeter-to-frequency-meter wire, lock washer, and nut (⅜-in. open-end wrench) (fig. 61).

Section VII

INSTRUMENT PANEL

38. DESCRIPTION AND CONSTRUCTION.

a. Instrument Panel.

(1) Located at the rear of the unit, the instrument panel furnishes a consolidated location for the switches, fuses, and instruments of the unit (fig. 65). Grouped at the top are the engine instruments and controls. Included in this group are the oil pressure gage, starter switch, ignition switch, choke control, and battery charging generator ammeter. Grouped beneath the engine controls are the main generator instruments and controls. This group consists of an alternating-current voltmeter, field rheostat (voltage control), alternating-current ammeter, frequency meter, circuit breaker, and three fuses. At the extreme top center of the panel is a dash lamp. At the extreme bottom center is a trouble light socket.

(2) Constructed of Bakelite, the instrument panel is cut and drilled to receive all instruments and screws. Directive lettering to explain and identify the instruments is cut on the face of the panel. The lettering indentations are painted white to make the lettering more legible.

INSTRUMENT PANEL

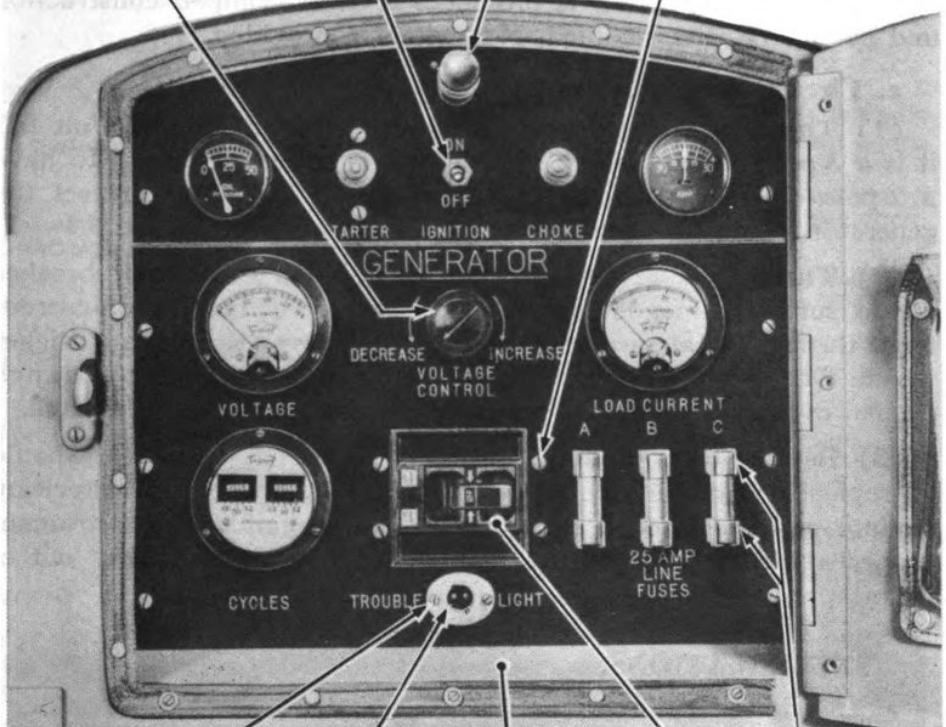


Figure 65 — Instrument Panel

b. Field Rheostat (Voltage Control).

(1) The field rheostat, labeled "voltage control" on the instrument panel, is an adjustable resistance unit. Its function is to allow manual adjustment of the voltage output of the main generator.

(2) A high-resistance wire is wound around a doughnut-shaped piece of porcelain. The knob controls a contact which slides around the inside of the coil. In this way, up to several feet of resistant wire can be introduced into the circuit to lower the voltage. When the field rheostat knob is turned clockwise as far as it will go, the rheostat wire is entirely eliminated from the circuit. This permits the maximum voltage output of the generator to flow through the lines from the unit. As the knob is turned counterclockwise, more and more resistant wire comes into the circuit. Consequently, the voltage falls.

c. Dash Lamp. Of standard automotive design, the dash lamp illuminates the instrument panel. It is turned on and off by built-in switch.

d. Trouble Light Socket. A simple, double contact, automotive-type trouble light socket is provided. It is of crimped construction and cannot be disassembled. No switch is provided.

e. Circuit Breaker.

(1) The circuit breaker serves a dual function. On the Unit M5 it is a 3-pole service switch for the main generator. Units M6 have a 2-pole circuit breaker. It is also a "safety valve" to protect the generator in case of an overload in the lines from the unit.

(2) Three coils (two on Units M6) within the circuit breaker create sufficient magnetism when an excessive amount of current flows through, to attract an iron lever. The lever serves as a trigger which, when drawn to the coil, allows springs to snap the switch off. An overload in any one of the three lines will trip the switch.

(3) Because of its extreme sensitiveness, the circuit breaker should be replaced as a unit if it fails to work properly. Special precision equipment is needed to disassemble and assemble the instrument properly. Improper tension on springs would throw the unit out of balance, and might result in considerable damage to the unit.

39. SPECIFICATIONS.

a. Instrument Panel.

Make .... Spaulding Fiber
Material .... Bakelite Corp.

b. Dash Lamp.

Make .... Cole-Hersee Co.
Model DL-5
Type .... d-c
Bulb .... 6 to 8 volts, 21 cp

c. Ignition Switch.

Make .... Arrow-Hart and Hegeman Electric Co.
Model 8963
Type .... Toggle

d. Circuit Breaker.

Make .... Heinemann Electric Co.
Model 0142
Type .... 2- or 3-pole
Voltage 125
Amperage 25

e. Trouble Light Socket.

Make .... Cole-Hersee Co.
Model 2036
Type .... d-c

INSTRUMENT PANEL

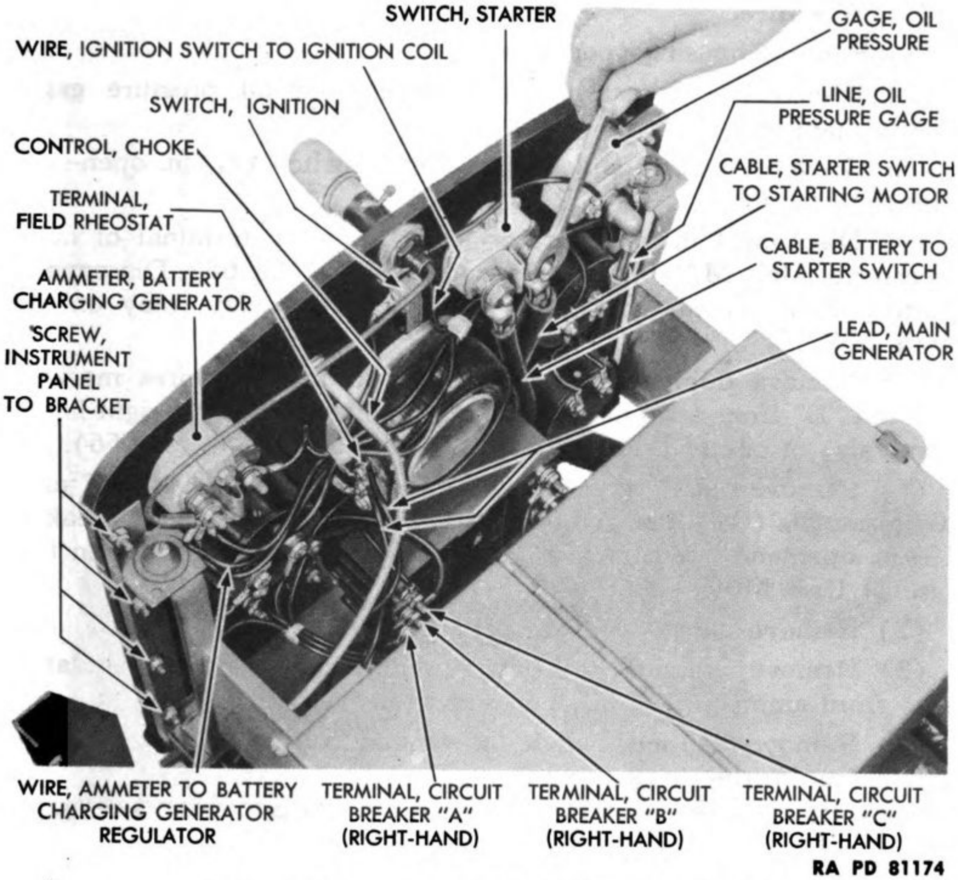


Figure 66 — Removing Instrument Panel

f. Field Rheostat.

Make	Hardwick-Hingle, Inc.
Model	D
Watt	150
Ohm	32

g. Fuses.

Make	Buss
Model	1014
Amperes	25
Volts	250

40. REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, box, 3/8-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.

b. **Procedure.**

(1) Remove housing (par. 14).

(2) Disconnect oil pressure gage line from oil pressure gage (½-in. open-end wrench) (fig. 59).

(3) Disconnect both cables from starter switch (9/16-in. open-end wrench) (fig. 66).

(4) Disconnect main generator leads from top terminal of field rheostat of Unit M5 (5/16-in. open-end wrench) (fig. 66). Disconnect main generator leads from "M" posts on time delay relay on all Units M6.

(5) Remove duplex receptacle to circuit breaker wires marked "A" and "B" from terminals "A" and "B" (the two lower right-hand terminals) of circuit breaker (⅜-in. open-end wrench) (fig. 66).

(6) Remove outlet receptacle wires from terminals "A," "B," and "C" terminals (the three right-hand terminals) of the circuit breaker (⅜-in. open-end wrench) (fig. 70). This step does not apply in the case of Unit M6.

(7) Remove choke control (par. 154).

(8) Remove ammeter to battery charging generator regulator wire from ammeter (⅜-in. open-end wrench) (fig. 66).

(9) Remove ignition switch to ignition coil wire from ignition switch (screwdriver) (fig. 66).

(10) Disconnect wires from terminals "2," "RA," "RB," and "RC" (the center row) of change-over panel on Unit M5 (½-in. open-end wrench). On single and 3-phase Unit M6 disconnect wires from terminals "A," "B," and "C" of the middle row terminals on change-over panel. On single-phase Unit M6, disconnect wires from terminals "RA," "R5," and "R5A" on change-over panel.

(11) Remove instrument panel-to-bracket screws and safety nuts (⅜-in. box wrench and screwdriver) (fig. 66).

(12) Lift instrument panel from unit.

41. DISASSEMBLY.

a. **Equipment.**

PLIERS	WRENCH, open-end, 9/16-in.
SCREWDRIVER	WRENCH, open-end, 19/32-in.
WRENCH, open-end, ⅜-in.	WRENCH, open-end, 11/16-in.

b. **Procedure.**

(1) Remove oil pressure gage (par. 33).

(2) Remove battery charging generator ammeter (par. 34).

(3) Remove alternating-current voltmeter (par. 35).

(4) Remove alternating-current ammeter (par. 36).

(5) Remove frequency meter (par. 37).

INSTRUMENT PANEL

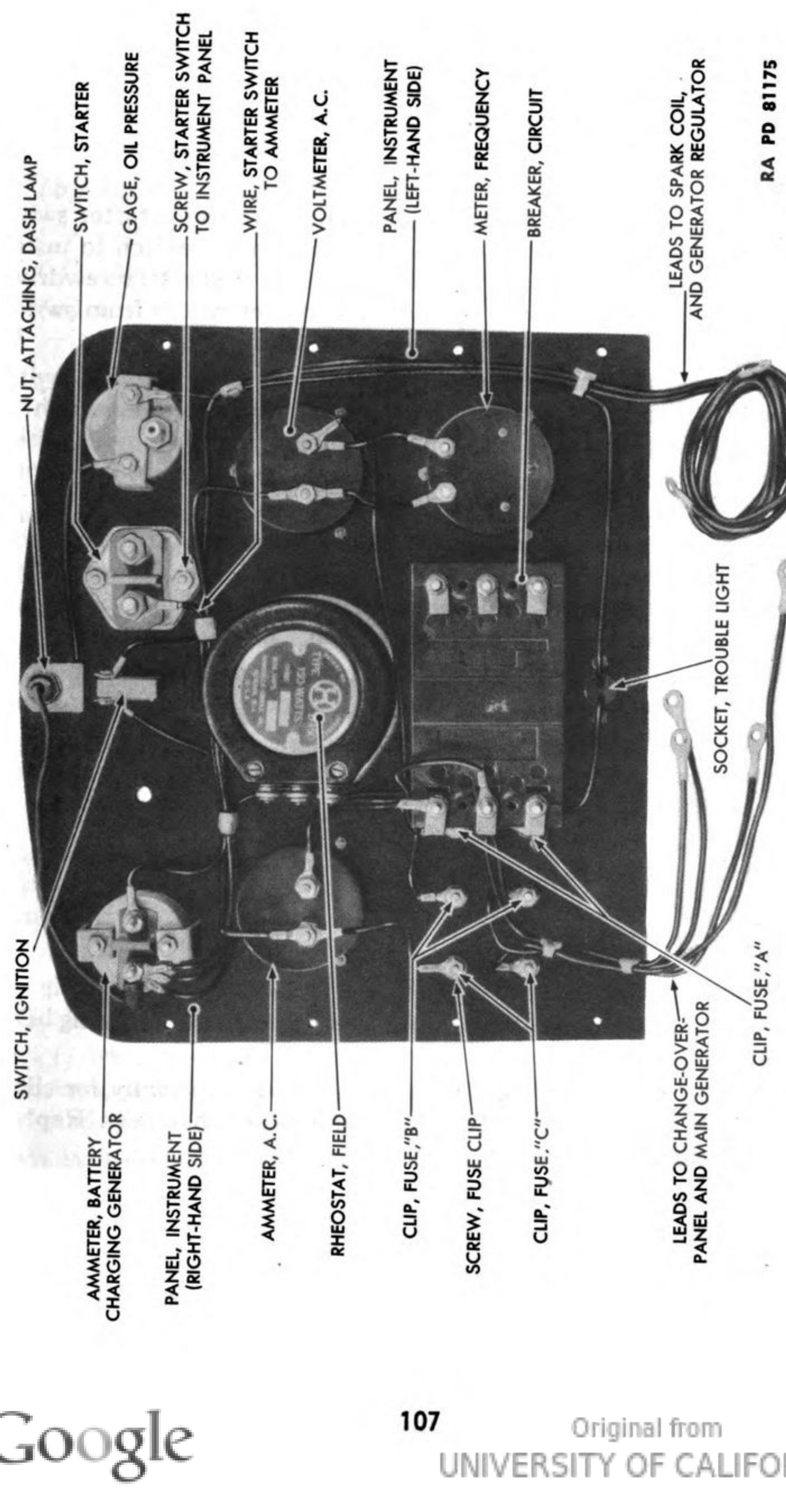


Figure 67 — Instrument Panel — Reverse Side

(6) Pull fuses from fuse clips. Remove fuse clip screws, nuts, flat washers, and lock washers (3/8-in. open-end wrench) (figs. 65 and 67). Lift fuse clips from switchboard panel.

(7) Remove dash lamp attaching nut lock washer, flat washer, ground wire terminal, and flat washer from rear of dash lamp. Lift dash lamp from instrument panel (19/32-in. open-end wrench) (figs. 65 and 67).

(8) Disconnect starter switch to ammeter wire from starter switch (9/16-in. open-end wrench) (fig. 67). Remove starter switch to instrument panel screws, nuts, lock washers, and flat washers (screwdriver and 3/8-in. open-end wrench) (fig. 67). Lift starter switch from switchboard panel.

(9) Remove ammeter to ignition switch wire from ignition switch (screwdriver) (fig. 67). Screw ferrule ring from ignition switch on face side of instrument panel (pliers) (fig. 65). Remove ignition switch mounting nut (11/16-in. open-end wrench) (fig. 65). Lift switch from instrument panel.

(10) Loosen setscrew in knob of field rheostat (voltage control) and pull knob from shaft (screwdriver) (fig. 65). Remove field rheostat attaching nut (9/16-in. open-end wrench) and pull field rheostat from reverse side of instrument panel.

(11) Remove circuit breaker mounting screws and washers from face of panel (screwdriver) (fig. 65). Lift circuit breaker from panel.

(12) Remove trouble light socket attaching screws (screwdriver) (fig. 65), nuts, and lock washers, and lift trouble light from instrument panel.

42. INSPECTION AND REPAIR.

a. Equipment.

COMPRESSED AIR
SOLVENT, dry-cleaning

b. Procedure.

(1) Wash instrument panel with SOLVENT, dry-cleaning. Dry with compressed air.

(2) Visually inspect panel for breakage. Look especially for slight cracks which collect dirt and act as conductors when wet. Replace instrument panel if broken.

43. ASSEMBLY.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 19/32-in.
WRENCH, open-end, 11/16-in.

b. Procedure.

(1) INSTALL INSTRUMENTS.

PLIERS	WRENCH, open-end, 9/16-in.
SCREWDRIVER	WRENCH, open-end, 19/32-in.
WRENCH, open-end, 3/8-in.	WRENCH, open-end, 11/16-in.

(a) Install oil pressure gage (par. 33).

(b) Install battery charging generator ammeter (par. 34).

(c) Install alternating-current voltmeter (par. 35).

(d) Install alternating-current ammeter (par. 36).

(e) Install frequency meter (par. 37).

(f) Place a fuse clip in position on panel (fig. 64). Insert a fuse clip screw through clip and panel. Install lock washer and nut (screwdriver and 3/8-in. open-end wrench) (fig. 67). Repeat this step to install remaining five fuse clips.

(g) Place a flat washer on threaded end of dash lamp. Insert a lamp into its opening on top of panel. On base of lamp, install flat washer, ground wire terminal, flat washer, and dash lamp attaching nut (19/32-in. open-end wrench) (fig. 67).

(h) Place starter switch in position on panel and install screws, lock washers, and nuts (screwdriver and 3/8-in. open-end wrench) (fig. 67).

(i) Place ignition switch in position from reverse side of panel. Install, on face side of panel, ignition switch mounting nut (11/16-in. open-end wrench) and ferrule ring (pliers) (fig. 65).

(j) Place field rheostat (voltage control) in position from reverse side of instrument panel (fig. 67). From face side, install field rheostat attaching nut (9/16-in. open-end wrench). Install field rheostat knob (screwdriver) (fig. 65).

(k) Place circuit breaker in position on reverse side of panel (fig. 67). From face of panel, install circuit breaker mounting screws and lock washers (screwdriver) (fig. 65).

(l) Place trouble light socket in position. Install screws, lock washers, and nuts (screwdriver and 3/8-in. open-end wrench) (figs. 65 and 67).

(2) INSTALL WIRING.

SCREWDRIVER	WRENCH, open-end, 3/8-in.
WRENCH, open-end, 5/16-in.	WRENCH, open-end, 9/16-in.

(a) On right-hand terminal (next to edge of instrument panel) of battery charging generator ammeter, install ammeter-to-trouble-lamp-socket wire, ammeter-to-battery-charging-generator-regulator wire, ammeter-to-ignition-switch wire, ammeter-to-dash-lamp wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(b) On left-hand terminal (next to ignition switch) of battery charging generator ammeter, install the starter-switch-to-ammeter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(c) On right-hand terminal (next to ammeter) of ignition switch, install ammeter-to-ignition-switch wire, lock washer, and screw (screwdriver) (fig. 67).

(d) On left-hand terminal (next to starter switch) of ignition switch, install ignition-switch-to-coil wire, lock washer, and screw (screwdriver) (fig. 67).

(e) On oil pressure gage right-hand mounting stud, install dash lamp ground wire under the lock washer (3/8-in. open-end wrench) (fig. 67).

(f) On right-hand terminal (next to ignition switch) of starter switch, install starter-switch-to-ammeter wire beneath the washer (9/16-in. open-end wrench) (fig. 67).

(g) On oil pressure gage left-hand mounting stud, install trouble lamp socket ground wire under lock washer (3/8-in. open-end wrench) (fig. 67).

(h) On right-hand terminal (next to edge of instrument panel) of alternating-current ammeter, install alternating-current ammeter to voltmeter wire, alternating-current ammeter to fuse "C" ("5A" on single-phase Unit M6) wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(i) On left-hand terminal (next to field rheostat) of alternating-current ammeter, install alternating-current ammeter to circuit breaker wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(j) Connect Field Rheostat.

1. Unit M5. To the two lower terminals of field rheostat (voltage control), connect the two terminals on one end of change-over panel "1" wire (5/16-in. open-end wrench) (figs. 67 and 72).

2. Single- and 3-phase Unit M6. Connect the wire from the resistor in the exciter field to the two lower terminals of the field rheostat.

3. Single-phase Unit M6. Connect the wire from terminal "4" on change-over panel to the two lower terminals of the field rheostat.

(k) On right-hand terminal (next to field rheostat) of alternating-current voltmeter, install alternating-current ammeter-to-voltmeter wire, right-hand frequency-meter-to-voltmeter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(l) On left-hand terminal (next to edge of instrument panel) of alternating-current voltmeter, install left-hand frequency-meter-to-voltmeter wire, voltmeter-to-"A" ("4" on single-phase Unit M6) fuse wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

INSTRUMENT PANEL

(m) On left-hand terminal (next to edge of instrument panel) of frequency meter, install left-hand frequency-meter-to-voltmeter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67). On Units M6 the voltmeter-to-fuse-"A" or "4" (as the case may be) wire must also be installed on this terminal.

(n) On right-hand terminal (next to circuit breaker) of frequency meter, install right-hand frequency-meter-to-voltmeter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(o) On top right terminal (next to fuses) of circuit breaker, install alternating-current ammeter-to-circuit-breaker wire, flat washer, tag marked "C," lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(p) On middle right-hand terminal (next to fuses) of circuit breaker, install circuit-breaker-to-fuse-"B" wire, flat washer, tag marked "B," lock washer, and nut (3/8-in. open-end wrench) (fig. 67). Omit this step when repairing the single-phase Unit M6.

(q) On lower right-hand terminal (next to fuses) of circuit breaker, install circuit-breaker-to-fuse-"A" ("4" on single-phase Unit M6) wire, flat washer, clip marked "A," lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(r) On terminal of top clip of fuse "A" ("4" on single-phase Unit M6), install flat washer, voltmeter-to-fuse-"A" wire, circuit-breaker-to-fuse-"A" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(s) On terminal of top clip of fuse "B," install flat washer, circuit-breaker-to-fuse-"B" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67). Omit this step on single-phase Unit M6.

(t) On terminal of top clip of fuse "C" ("5A" on single-phase Unit M6), install flat washer, alternating-current ammeter-to-fuse-"C" ("5A" on single-phase Unit M6) wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(u) Connect Fuses.

1. Unit M5. On terminal of bottom clip of fuse "A," install flat washer, fuse-"A"-to-change-over-panel-"RA" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67). On terminal of bottom clip of fuse "B," install flat washer, fuse-"B"-to-change-over-panel-"RB" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67). On terminal of bottom clip of fuse "C," install flat washer, fuse-"C"-to-change-over-panel-"RC" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

2. Single- and 3-phase Unit M6. On terminal of bottom clip of fuse "A," install flat washer, main generator lead "A" wire, flat washer, lock washer, and nut. On terminal of bottom clip of fuse "B," install flat washer, main generator lead "B," flat washer, lock washer, and nut. On bottom clip of fuse "C," install flat washer, main generator lead "C," flat washer, lock washer, and nut.

3. *Single-phase Unit M6.* On terminal of bottom clip of fuse "4," install flat washer, fuse "4"-to-change-over-panel-"RA" wire, flat washer, lock washer, and nut. On terminal of bottom clip of fuse "5," install flat washer, fuse "5" to change-over panel "R5" wire, flat washer, lock washer, and nut. On terminal of bottom clip of fuse "5A," install flat washer, fuse-"5A"-to-change-over-panel-"R5A" wire, flat washer, lock washer, and nut.

(v) Connect trouble light socket ground wire and ammeter-to-trouble-light-socket wire, to trouble light socket (screwdriver) (fig. 67).

44. INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, box, 3/8-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Place instrument panel in position on brackets. Install attaching screws and safety nuts (3/8-in. box wrench and screwdriver) (fig. 66).

(2) CONNECT FIELD RHEOSTAT WIRES.

(a) Unit M5. Connect field rheostat-to-change-over-panel "1" wire to terminal marked "1" on change-over panel. Install lock washer and nut (7/16-in. open-end wrench) (fig. 72).

(b) Single- and 3-phase Unit M6. Connect field rheostat-to-resistor wire to resistor in field circuit.

(c) Single-phase Unit M6. Connect field rheostat-to-change-over-panel-"3" wire to change-over panel terminal "3."

(3) CONNECT FUSE WIRES.

(a) Unit M5. Connect fuse-"A"-to-change-over-panel-"RA" wire, to change-over panel terminal "RA." Install lock washer and nut (7/16-in. open-end wrench) (fig. 72). Connect fuse-"B"-to-change-over-panel-"RB" wire, to change-over panel terminal "RB." Install lock washer and nut (7/16-in. open-end wrench) (fig. 72). Connect fuse-"C"-to-change-over-panel-"RC" wire, to change-over panel terminal "RC." Install lock washer and nut (7/16-in. open-end wrench) (fig. 72).

(b) Single- and 3-phase Unit M6. Connect circuit breaker-to-change-over-panel wire, marked "A," "B," and "C," to corresponding terminals in middle row on change-over panel.

(c) Single-phase Unit M6. Connect fuse-"4"-to-change-over-panel-"RA" wire, to terminal "RA" of change-over panel. Connect fuse "5" to change-over panel "R5" on change-over panel. Connect fuse-"5A"-to-change-over-panel-"R5A" wire, to change-over panel terminal "R5A."

(4) Connect ammeter-to-battery-charging-generator-regulator wire, to right-hand terminal (next to edge of instrument panel) of battery charging generator ammeter (3/8-in. open-end wrench) (fig. 66).

(5) Connect ignition switch to ignition coil wire, to left-hand terminal (next to starter switch) of ignition switch (screwdriver) (fig. 66).

(6) Install choke control (par. 154).

(7) CONNECT DUPLEX RECEPTACLE.

(a) Unit M5. Connect the two duplex receptacle to circuit breaker wires marked "A" and "B," to the terminals marked "A" and "B" (the two lower right-hand terminals of circuit breaker, respectively) (3/8-in. open-end wrench) (fig. 66).

(b) Single- and 3-phase Unit M6. Connect the two duplex receptacles to circuit breaker wires marked "A" and "B" to the terminals marked "A" and "B."

(8) Connect unmarked main generator leads which come from exciter bearing bracket, to top terminal of field rheostat (5/16-in. open-end wrench).

(9) Connect battery starter switch cable to right-hand terminal (next to ignition switch) of starter switch (9/16-in. open-end wrench) (fig. 66).

(10) Connect starter-switch-to-starting-motor-cable, to left-hand terminal (next to oil pressure gage) of starter switch (9/16-in. open-end wrench) (fig. 66).

(11) Connect oil pressure gage line to gage (1/2-in. open-end wrench) (fig. 66).

(12) Install housing (par. 19).

45. FIELD RHEOSTAT REMOVAL.

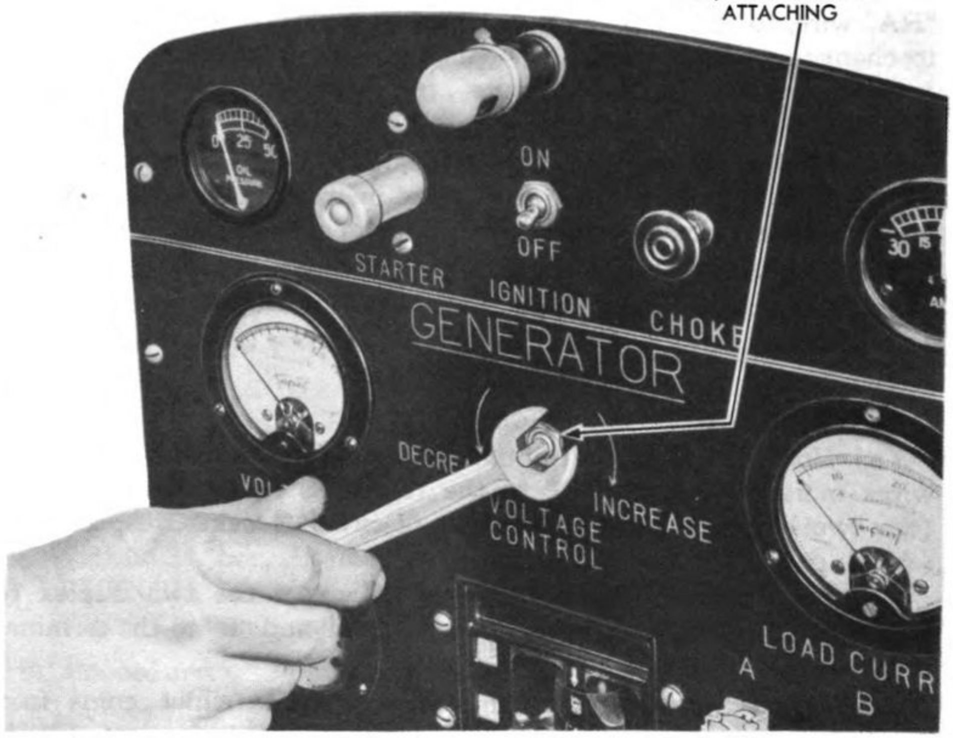
a. Equipment.

SCREWDRIVER	WRENCH, open-end, 3/8-in.
WRENCH, open-end, 5/16-in.	WRENCH, open-end, 9/16-in.

b. Procedure.

(1) From top terminal of field rheostat, remove nut, two main generator leads, and shakeproof terminal lug (5/16-in. open-end wrench) (fig. 67).

(2) From each lower terminal of field rheostat, remove nut, field rheostat-to-change-over-panel-"2" wire, and shakeproof terminal lug (3/8-in. open-end wrench) (fig. 67).



RA PD 44126

Figure 68 — Removing Field Rheostat

(3) Loosen setscrew in field rheostat knob and remove knob (screwdriver) (fig. 65).

(4) Remove field rheostat attaching nut (9/16-in. open-end wrench) (fig. 68).

(5) Lift field rheostat from reverse side of instrument panel.

46. FIELD RHEOSTAT INSPECTION AND REPAIR.

a. Equipment.

LAMP, test PLIERS

b. Procedure.

(1) Visually inspect the porcelain of winding form assembly for fractures. Replace assembly if broken.

(2) Test winding of the winding form for an open circuit with a test lamp. Place probes of test lamp about an inch apart on windings on the part kept shiny by contact. Make several tests around winding so that all parts of winding are tested. If lamp fails to glow on any of the trials, an open circuit is indicated. Replace assembly if it has an open circuit.

(3) Examine all screws, nuts, and lock washers. Replace any that are broken or have damaged threads.

47. FIELD RHEOSTAT INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 5⁄16-in.
WRENCH, open-end, 3⁄8-in.
WRENCH, open-end, 9⁄16-in.

b. Procedure.

(1) Place field rheostat in position on reverse side of instrument panel, with shaft through hole in panel (fig. 67).

(2) Install field rheostat attaching nut (9⁄16-in. open-end wrench) (fig. 68).

(3) Slide knob on shaft and tighten setscrew (screwdriver) (fig. 65).

(4) On each lower terminal of the field rheostat, install a shakeproof terminal lug, field rheostat-to-change-over-panel-"2" wire, and nut (3⁄8-in. open-end wrench) (fig. 67).

(5) On top terminal of field rheostat, place a shakeproof terminal lug and the unmarked main generator leads coming from exciter bearing bracket. Install the nut (5⁄16-in. open-end wrench) (fig. 67).

48. DASH LAMP AND TROUBLE LIGHT SOCKET REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 3⁄8-in.
WRENCH, open-end, 5⁄8-in.

b. Procedure.

(1) REMOVE DASH LAMP.

WRENCH, open-end, 3⁄8-in.
WRENCH, open-end, 5⁄8-in.

(a) Disconnect wire from right-hand terminal of battery charging generator ammeter (3⁄8-in. open-end wrench) (fig. 67).

(b) Remove dash lamp mounting nut from base of dash lamp (5⁄8-in. open-end wrench) (fig. 67), and remove flat washer, ground wire terminal, and flat washer (fig. 67).

(c) Pull dash lamp from face of instrument panel, and remove spacer and flat washer from base of lamp (fig. 65).

(2) REMOVE TROUBLE LIGHT SOCKET.

SCREWDRIVER
WRENCH, open-end, 3⁄8-in.

(a) Disconnect trouble light socket wire from right-hand terminal of battery charging generator ammeter (3⁄8-in. open-end wrench) (fig. 67).

(b) Disconnect trouble light socket ground wire from left-hand oil pressure gage mounting screw (3⁄8-in. open-end wrench) (fig. 67).

(c) Remove socket screws and nuts (screwdriver and 3⁄8-in. open-end wrench) (fig. 67).

(d) Pull trouble light socket from instrument panel.

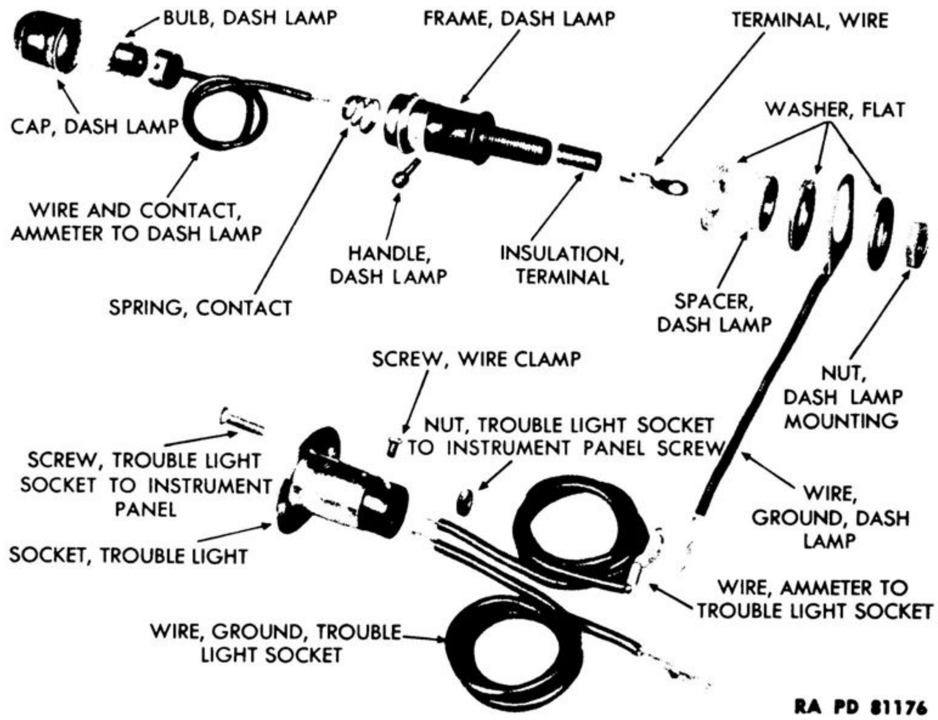


Figure 69 — Dash Lamp and Trouble Light Socket Assemblies — Exploded View

49. DASH LAMP AND TROUBLE LIGHT SOCKET DISASSEMBLY.

a. Equipment.

IRON, soldering　　SCREWDRIVER
PLIERS

b. Procedure.

(1) DISASSEMBLE DASH LAMP.

IRON, soldering　　PLIERS

(a) Pull dash lamp cap from frame of lamp (fig. 69).

(b) Turn bulb one-eighth turn counterclockwise and pull from socket (fig. 69).

(c) Screw dash lamp handle from contact (pliers) (fig. 69).

(d) Push wire and contact from frame (fig. 69).

(e) Push terminal insulation up on wire, and disconnect terminal from wire (soldering iron) (fig. 69).

(f) Pull wire and contact, and contact spring, from frame (fig. 69).

(2) DISASSEMBLE TROUBLE LIGHT SOCKET.

SCREWDRIVER

(a) Loosen the wire clamp screws (screwdriver) (fig. 69).

(b) Pull wires from socket.

50. DASH LAMP AND TROUBLE LIGHT SOCKET INSPECTION AND REPAIR.

a. Equipment.

CLOTH, abrasive, aluminum-oxide
COMPRESSED AIR
FILE, fine mill
SOLDERING EQUIPMENT
SOLVENT, dry-cleaning

b. Procedure.

(1) Clean all metal parts in an approved SOLVENT, dry-cleaning, and dry with compressed air.

(2) Clean terminals and contact points with CLOTH, abrasive, aluminum-oxide.

(3) Examine insulation of wires. Replace if worn, broken, or badly weathered.

(4) Examine all metal parts. Replace if bent or broken.

(5) Examine all threads on frame, screws, and nuts. Replace parts having badly damaged threads. Remove burs from threads with a fine mill file.

(6) Examine contact points. Build up with solder if worn (soldering equipment).

(7) Examine fiber blocks containing contact points. Replace if broken.

51. DASH LAMP AND TROUBLE LIGHT SOCKET ASSEMBLY.

a. Equipment.

PLIERS
SCREWDRIVER
SOLDERING EQUIPMENT

b. Procedure.

(1) ASSEMBLE DASH LAMP.

PLIERS SOLDERING EQUIPMENT

(a) Slide contact spring, small end first, on ammeter to dash lamp wire. Thread wire through large end of frame (fig. 69).

(b) Screw dash lamp handle into the contact through its opening in frame (pliers) (fig. 69).

(c) Slide terminal insulation on end of ammeter to dash lamp wire. Solder terminal to tip of wire (soldering equipment) (fig. 69). Pull insulation down over connection.

(d) Insert bulb in socket and turn one-eighth turn clockwise.

(e) Push cap on end of frame.

(2) ASSEMBLE TROUBLE LIGHT.

SCREWDRIVER

(a) Insert bare ends of wires into their openings on trouble light socket. Install wire clamp screws (screwdriver) (fig. 69).

52. DASH LAMP AND TROUBLE LIGHT SOCKET INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/8-in.

b. Procedure.

(1) INSTALL DASH LAMP.

WRENCH, open-end, 3/8-in.
WRENCH, open-end, 5/8-in.

(a) Place a flat washer and spacer on threaded end of frame (fig. 69).

(b) Insert dash lamp through its opening in instrument panel (fig. 65).

(c) On the threaded end of dash lamp install a flat washer, dash lamp ground wire terminal, flat washer, and dash lamp mounting nut (5/8-in. open-end wrench) (fig. 67).

(d) Connect ammeter-to-dash-lamp wire to right-hand terminal (next to edge of instrument panel) of battery charging generator ammeter (3/8-in. open-end wrench) (fig. 67).

(2) INSTALL TROUBLE LIGHT SOCKET.

SCREWDRIVER
WRENCH, open-end, 3/8-in.

(a) Place trouble light socket in position on instrument panel (fig. 65).

(b) Install two screws and nuts (screwdriver and 3/8-in. open-end wrench) (fig. 65).

(c) Connect ammeter-to-trouble-light-socket wire, to right-hand terminal (next to edge of panel) of battery charging generator ammeter (3/8-in. open-end wrench) (fig. 67).

(d) Connect trouble light socket ground wire to left-hand oil pressure gage mounting screw (screwdriver) (fig. 67).

53. IGNITION SWITCH.

a. Removal.

PLIERS
WRENCH, open-end, 9/16-in.
SCREWDRIVER

(1) Disconnect ammeter wire from ignition switch (screwdriver) (fig. 67).

(2) Disconnect coil wire from ignition switch (screwdriver) (fig. 67).

(3) Remove ignition switch lock nut (pliers) (fig. 65) and ignition switch mounting nut (9/16-in. open-end wrench) (fig. 65) from face of instrument panel.

(4) Lift ignition switch from reverse side of panel (fig. 67).

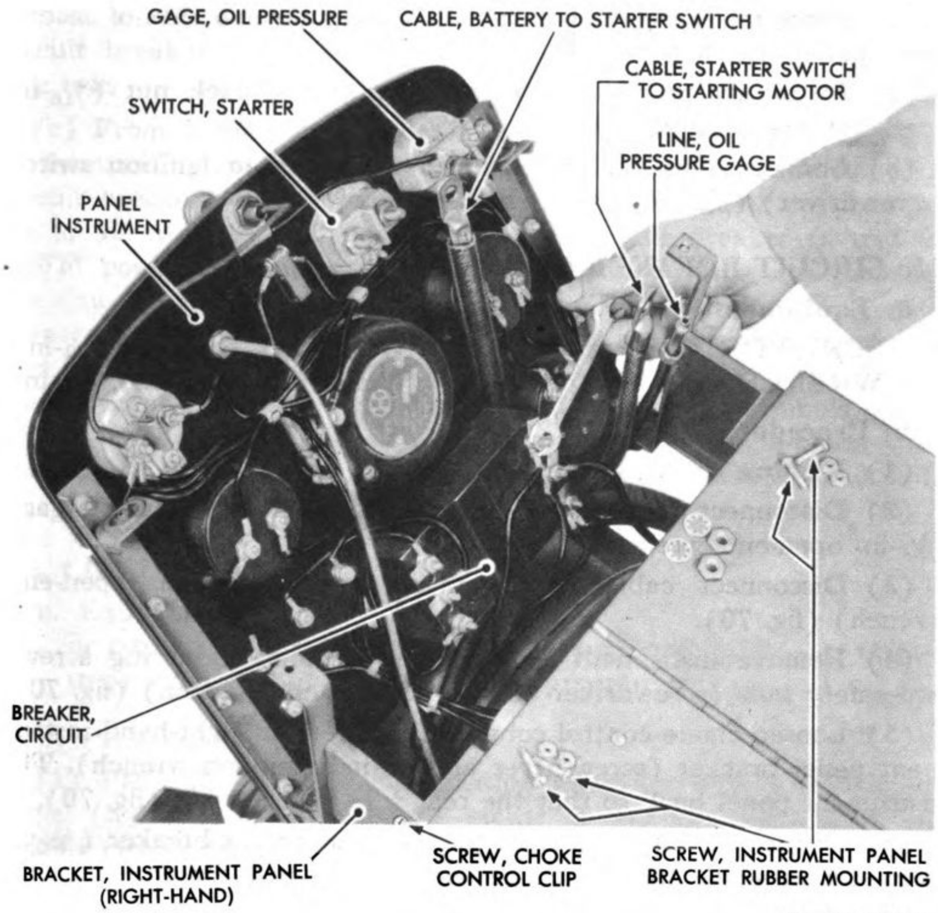


Figure 70 — Removing Circuit Breaker

b. Inspection and Repair.

CLOTH, abrasive, aluminum-oxide	FILE, fine mill
	LAMP, test

(1) Clean terminals with CLOTH, abrasive, aluminum-oxide.

(2) Turn switch on and test for continuity of circuit with a test lamp. Place test lamp probes on two terminals of switch. If lamp fails to light, replace switch.

(3) Repeat step (1) above with switch turned off. If lamp lights, replace switch.

(4) Examine threads on switch. Remove burs with a fine mill file. Replace switch if threads are stripped.

c. Installation.

PLIERS	WRENCH, open-end, $^9\!/_{16}$-in.
SCREWDRIVER	

(1) Place ignition switch in position from reverse side of instrument panel (fig. 67).

(2) Install ignition switch mounting nut and lock nut (9/16-in. open-end wrench and pliers) (fig. 65).

(3) Connect ammeter and ignition coil wires to ignition switch (screwdriver) (fig. 67).

54. CIRCUIT BREAKER REMOVAL.

a. **Equipment.**

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.

b. **Procedure.**

(1) Remove housing (par. 14).

(2) Disconnect oil pressure gage line, from oil pressure gage (1/2-in. open-end wrench) (fig. 70).

(3) Disconnect cables from starter switch (9/16-in. open-end wrench) (fig. 70).

(4) Remove instrument panel bracket rubber mounting screws and safety nuts (screwdriver and 3/8-in. open-end wrench) (fig. 70).

(5) Loosen choke control conduit clip screw on right-hand instrument panel bracket (screwdriver and 1/2-in. open-end wrench). Tip instrument panel back so that the rear side is accessible (fig. 70).

(6) Disconnect all wires from terminals of circuit breaker (3/8-in. open-end wrench) (fig. 70). Tag wires to aid installation.

(7) Remove circuit breaker mounting screws and lock washers from face of instrument panel (screwdriver) (fig. 65).

(8) Lift circuit breaker from panel (fig. 70).

55. CIRCUIT BREAKER INSPECTION.

a. **Equipment.**

LAMP, test

b. **Procedure.**

(1) No attempt should be made to disassemble and repair circuit breaker. Special equipment is needed for the job. Replace assembly if it fails to function properly.

(2) STEPS IN TESTING THE CIRCUIT BREAKER.

LAMP, test

(a) Examine case and handle. Replace circuit breaker if these parts are broken.

(b) With circuit breaker turned on, test for continuity of circuit (test lamp) between the top terminals (one on each side). Repeat test on the middle terminals and then on the lower terminals. Omit

test on middle terminals on single-phase Unit M6 having 2-pole circuit breaker. Replace circuit breaker if lamp fails to light on any test.

(c) From a measured variable source of alternating 50- or 60-cycle current, attach leads to top terminals (one on each side) of circuit breaker. With circuit breaker in "ON" position, step current up to 50 amperes, 125 volts, and allow circuit breaker to trip to "OFF" position. Reset circuit breaker to "ON" position, and measure the time interval required for it to trip to "OFF" position. With a 50-ampere load at 125 volts, it should trip in no less than 6 seconds and no more than 25 seconds, after it has been reset to "ON" position. Repeat this test on the middle and the lower terminals of the circuit breaker. Omit test on middle terminals on single-phase Unit M6 having 2-pole circuit breaker. Replace circuit breaker if it fails to function properly.

56. CIRCUIT BREAKER INSTALLATION.

a. Equipment.

SCREWDRIVER	WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.	WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Place circuit breaker in position on reverse side of instrument panel (fig. 70). Be sure handle points toward the fuses when off. Install circuit breaker mounting screws and lock washers (screwdriver) (fig. 65).

(2) UNIT M5.

(a) On top left-hand terminal (next to frequency meter) of circuit breaker, install flat washer, tag marked "C," circuit breaker to outlet receptacle wire marked "C," flat washer, lock washer, and nut (⅜-in. open-end wrench) (fig. 70).

(b) On middle left-hand terminal (next to frequency meter) of circuit breaker, install flat washer, tag marked "B," circuit breaker to outlet receptacle wire marked "B," circuit breaker to duplex receptacle wire marked "B," flat washer, lock washer, and nut (⅜-in. open-end wrench) (fig. 70).

(c) On lower left-hand terminal (next to frequency meter) of circuit breaker, install flat washer, tag marked "A," circuit breaker to duplex receptacle wire marked "A," flat washer, lock washer, and nut (⅜-in. open-end wrench)(fig. 70).

(d) On top right-hand terminal (next to fuses) of circuit breaker, install flat washer, tag marked "C," alternating-current ammeter to circuit breaker wire, flat washer, and nut (⅜-in. open-end wrench) (fig. 70).

(e) On middle top right-hand terminal (next to fuses) of circuit breaker, install flat washer, tag marked "B," circuit breaker to fuse "B" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 70).

(f) On lower right-hand terminal (next to fuses) of circuit breaker, install flat washer, tag marked "A," circuit breaker to fuse "A" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 70).

(3) SINGLE-PHASE UNIT M6.

(a) On top left-hand terminal of circuit breaker install flat washer, tag marked "5A," circuit breaker to time delay relay wire "5A," circuit breaker to panel condenser wire marked "5A".

(b) On lower left-hand terminal, install tag marked "4," circuit breaker to time delay relay "4" wire, tag marked "4," circuit breaker to panel condenser wire marked "4".

(c) On lower left-hand terminal, install tag marked "5A," and alternating-current ammeter to circuit breaker wire.

(d) On lower right-hand terminal, install tag marked "4," circuit breaker to fuse "4" wire.

(4) SINGLE- AND 3-PHASE M6 UNIT.

(a) On top left-hand terminal of circuit breaker tag marked "C," install circuit breaker to change-over panel wire marked "O".

(b) On middle left-hand terminal of circuit breaker, install tag marked "B," circuit breaker to change-over panel wire marked "B".

(c) On lower left-hand terminal, install tag marked "A," circuit breaker to change-over panel wire marked "1".

(d) Follow steps *(d)*, *(e)*, and *(f)* in (2) above.

(5) Lift instrument panel into position on bracket, and install mounting screws (screwdriver and 3/8-in. open-end wrench) (fig. 70).

(6) Connect cables to starter switch (9/16-in. open-end wrench) (fig. 70).

(7) Connect oil pressure gage line to oil pressure gage (1/2-in. open-end wrench) (fig. 70).

(8) Insert choke control under clip on right-hand instrument panel bracket. Tighten choke control clip screw (screwdriver) (fig. 70).

(9) Install housing (par. 19).

Section VIII

CHANGE-OVER PANEL, TOOL BOX, AND RECEPTACLES

57. DESCRIPTION AND CONSTRUCTION.

a. Change-over Panel.

(1) Located in a compartment in the right-hand end of the tool box, the change-over panel provides the means of changing the Unit M5 from 60-cycle to 50-cycle. In the Unit M6, the change-over panel enables unit to be converted from 3-phase to single-phase, except on units bearing serial numbers 1 to 266 and 367 to 376, inclusive.

(2) The change-over panel consists of a Bakelite plate with binding posts mounted on it, to receive the change-over bars. The manner in which the change-over bars are connected determines the frequency, or the phase, of the current output of the generator.

b. Tool Box. Constructed of sheet steel, the tool box is located on top of the main generator. It is equipped with two doors. The left-hand door gives access to the tool compartment. The right-hand door gives access to the change-over panel.

c. Duplex Receptacle.

(1) On the M5 model, a duplex outlet receptacle is provided. It is located on the left side of the unit beneath the tool box and is similar to standard outlet receptacles used in homes. It provides a convenient method of taking power from the generator to operate standard 110-volt, alternating-current lights or appliances. Two plugs can be inserted at the same time.

(2) Because of its riveted and molded construction, disassembly of the duplex receptacle is impractical. Replace the assembly in case of failure.

d. The 3-pole Outlet Receptacle.

(1) All Units M5 and some Units M6 are equipped with a 3-pole outlet receptacle located on the rear of the unit below the instrument panel. The body of the outlet receptacle is brass, and is threaded

to receive a brass cover. A Bakelite insulator held inside the body by a split ring holds the contacts in position.

(2) This receptacle provides the means of connecting power lines to take off the current generated by the unit.

e. The 19-pole Outlet Receptacle.

(1) The 19-pole outlet receptacle used on all Units M6 is similar in construction and function to the 3-pole unit described above. The difference is that one has 19 contacts and 19 wires while the other has three.

58. SPECIFICATIONS.

a. Change-over Panel.

Make	Spaulding Fiber
Material	Bakelite Corp.
Size (M5)	5½ x 8 in.
Size (M6)	8 x 5 in.
Number of binding posts (M5)	12
Number of binding posts (M6)	8
Number of change-over bars (M5)	4
Number of change-over bars (M6)	3

b. Tool Box.

Make	The Hobart Bros. Co.
Material	Sheet steel
Construction	Welded

c. Duplex Receptacle.

Make	Hobart Mfg. Co.
Model	M19951
Type	Double contact
Number of sockets	2

d. 3-pole Outlet Receptacle.

Make	Hobart Mfg. Co.
Model	P19416

e. 19-pole Outlet Receptacle.

Make	The Pyle-National Company
Model	C56703

59. CHANGE-OVER PANEL.

a. Removal (fig. 71).

SCREWDRIVER — WRENCH, open-end, ½-in.
WRENCH, open-end, 7/16-in.

(1) Disconnect all wires from binding posts on rear of change-over panel (7/16-in. open-end wrench) (fig. 71). Lift resistor from rear of binding posts "1" and "2."

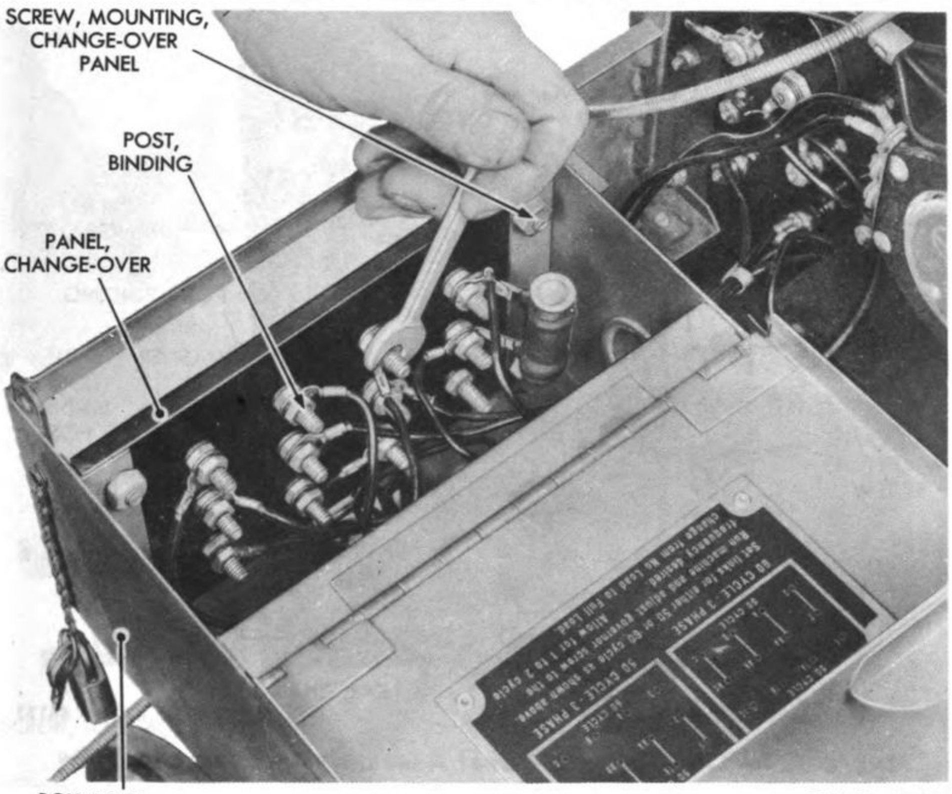


Figure 71 — Removing Change-over Panel

(2) Remove change-over panel mounting screws, nuts, and lock washers (screwdriver and ½-in. open-end wrench) (fig. 71).

(3) Lift change-over panel from tool box (fig. 71).

b. Disassembly.

WRENCH, open-end, ½-in. (2)

(1) Remove nuts, change-over bars, and lock washers from binding posts (two ½-in. open-end wrenches) (fig. 72). Lift binding posts from change-over panel.

c. Inspection and Repair.

CLOTH, abrasive, aluminum-oxide
COMPRESSED AIR
FILE, fine mill
SOLVENT, dry-cleaning

(1) Wash change-over panel, binding posts, change-over bars, lock washers, and nuts (SOLVENT dry-cleaning) and dry (COMPRESSED AIR). Clean corrosion from metal parts (CLOTH, abrasive, aluminum-oxide).

(2) Carefully inspect change-over panel to detect any cracks which might harbor dirt. Dirt acts as a conductor when damp. Replace change-over panel if fractured.

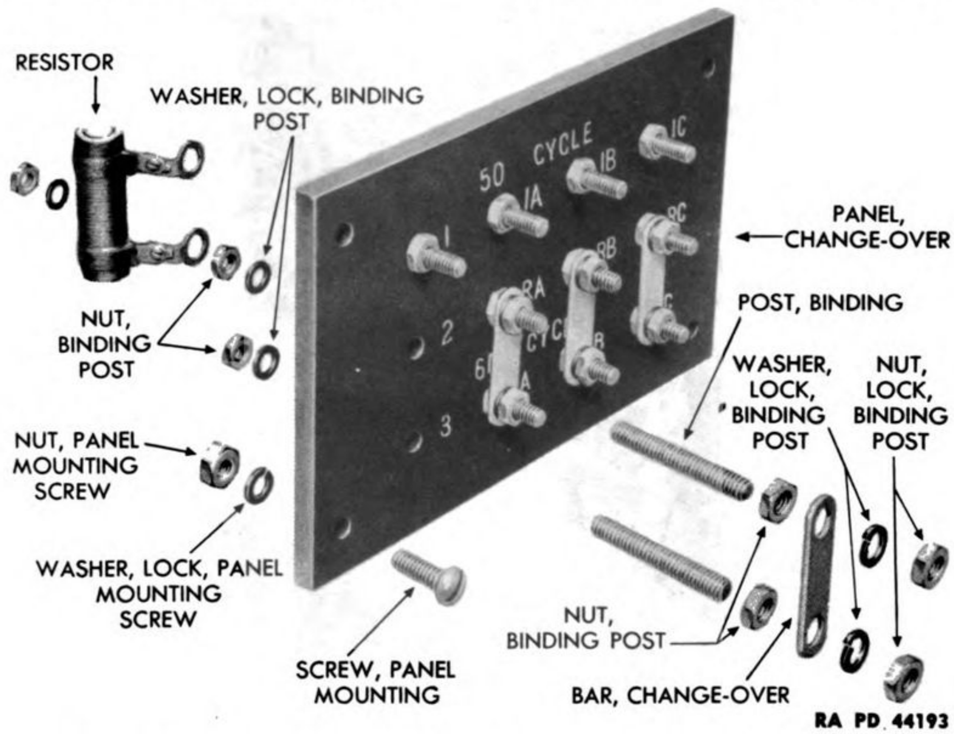


Figure 72 — Change-over Panel Assembly — Exploded View

(3) Inspect all metal parts to see if any are bent or broken. Replace unserviceable parts.

(4) Inspect threads of binding posts and nuts. Remove burs (fine mill file).

d. Assembly.

WRENCH, open-end, ½-in. (2)

(1) Insert binding post about half its length through a binding post hole in change-over panel (fig. 72).

(2) Screw a nut up to face of change-over panel. On the reverse side, install a lock washer and nut (two ½-in. open-end wrenches).

(3) Repeat steps (1) and (2) above to install remaining binding posts. NOTE: There are 12 binding posts on the Unit M5; eight on the Units M6 with serial numbers 1 to 266 and 367 to 376, inclusive. Other Units M6 have 12 binding posts on the change-over panel.

e. Installation.

SCREWDRIVER WRENCH, open-end, ½-in.
WRENCH, open-end, 7/16-in.

(1) Place change-over panel in position in right-hand end of tool box. Install mounting screws, lock washers, and nuts (screwdriver and ½-in. open-end wrench).

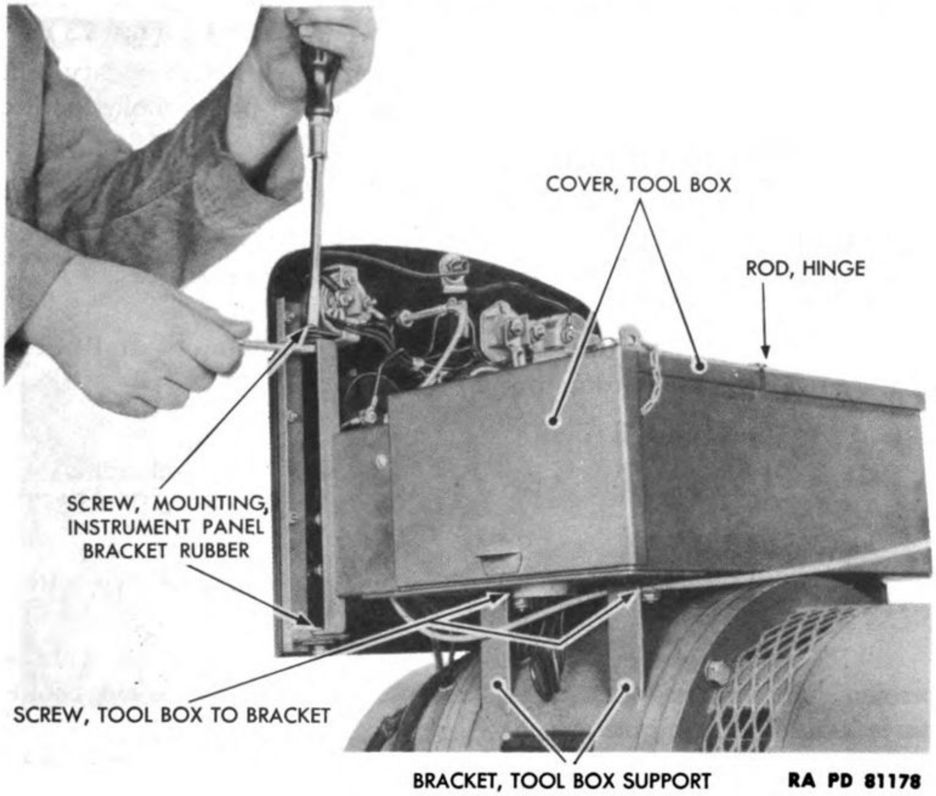


Figure 73 — Removing Tool Box

(2) Place resistor in position on reverse side of change-over panel, between binding posts "1" and "2" (fig. 71).

(3) Connect each of the 11 wires to rear of binding post bearing same mark as stamped on terminal of wire. Install lock washer and nut on each binding post except "3," to which no wire is connected (fig. 71).

(4) Install change-over bars on binding posts. If the unit is to be used on 60 cycles, put bars between posts "2" and "3," "RA" and "A," "RB" and "B," "RC" and "C." If unit is to be used on 50 cycles, put bars between binding posts "1" and "2," "1A" and "RA," "1B" and "RB," "1C" and "RC." Over bar on each post install lock washer and nut (½-in. open-end wrench) (fig. 72).

60. TOOL BOX.

a. Removal (fig. 73).

SCREWDRIVER	**WRENCH,** open-end, ½-in.
WRENCH, open-end, ⅜-in.	

(1) Remove housing (par. 14).

(2) Remove change-over panel (par. 59).

(3) Remove switchboard bracket rubber mounting screws and safety nuts (screwdriver and 3/8-in. open-end wrench) (fig. 73).

(4) Remove tool box support bracket screws and safety nuts (screwdriver and 1/2-in. open-end wrench). Remove choke control clip from under right front screw nut.

(5) Lift tool box from tool box support bracket.

b. Disassembly.

HAMMER
PLIERS
PUNCH

Remove hinge rod from cover hinge (punch, hammer and pliers) (fig. 73). Lift covers from tool box.

c. Inspection and Repair.

CLOTH
DOLLY
HAMMER
SOLVENT, dry-cleaning
WELDING EQUIPMENT

(1) Clean tool box (SOLVENT, dry-cleaning) and dry with a clean cloth.

(2) Visually inspect box and covers to see if they are bent or broken. Straighten bent parts (hammer and dolly). Weld broken parts (welding equipment).

(3) Inspect cover hinge rod to see if it is worn or bent. Straighten rod if bent (hammer and dolly). Replace rod if worn.

d. Assembly.

HAMMER

Set covers in closed position on tool box. Drive hinge rod through the hinge (hammer) (fig. 73).

e. Installation.

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.

(1) Place tool box in position on tool box support bracket (fig. 74).

(2) Install tool box support bracket screws and safety nuts (screwdriver and 1/2-in. open-end wrench) (fig. 73). Be sure to install choke control clip under right front screw nut (fig. 73).

(3) Install instrument panel bracket rubber mounting screws (screwdriver and 3/8-in. open-end wrench) (fig. 73).

(4) Install change-over panel (par. 59).

(5) Install housing (par. 19).

61. DUPLEX RECEPTACLE.

a. Removal (fig. 74).

SCREWDRIVER
WRENCH, open-end, 1/2-in.

CHANGE-OVER PANEL, TOOL BOX, AND RECEPTACLES

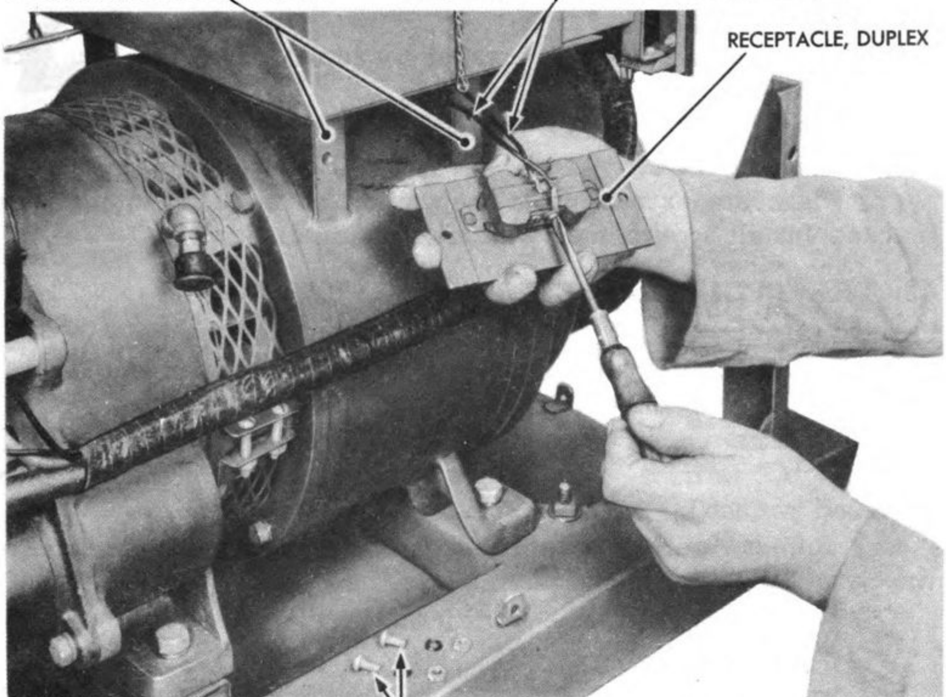


Figure 74 — Removing Duplex Receptacle

(1) REMOVE RECEPTACLE FROM BRACKET.

SCREWDRIVER　　　WRENCH, open-end, ½-in.

(a) Remove duplex receptacle-to-tool box bracket screws, nuts, and lock washers.

(2) DISCONNECT RECEPTACLE.

SCREWDRIVER

(a) Pull duplex receptacle away from tool box bracket, and disconnect circuit breaker to duplex receptacle wires from duplex receptacle.

b. Inspection and Repair.

BRUSH, wire (power driven)　　　COMPRESSED AIR
CLOTH, abrasive, aluminum-oxide

(1) Clean exterior of duplex receptacle by buffing it on a power driven wire brush. Clean dust from the assembly with compressed air. Clean terminals with CLOTH, abrasive, aluminum-oxide.

(2) Inspect Bakelite body of receptacle; replace if broken.

c. Installation.

SCREWDRIVER　　　WRENCH, open-end, ½-in.

(1) CONNECT RECEPTACLE.

SCREWDRIVER

(a) Connect wire (circuit breaker to duplex receptacle) to each of the terminals of duplex receptacle.

(2) INSTALL RECEPTACLE ON BRACKET.

SCREWDRIVER — WRENCH, open-end, ½-in.

(a) Place duplex receptacle in position on left side of tool box bracket. Install screws, lock washers, and nuts (fig. 74).

62. THE 3-POLE OUTLET RECEPTACLE.

a. Removal.

SCREWDRIVER — WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

(1) Remove circuit breaker to outlet receptacle wires from "A," "B," and "C" terminals on left-hand side of circuit breaker (⅜-in. open-end wrench).

(2) Remove outlet receptacle-to-frame screws and nuts (screwdriver and ½-in. open-end wrench) (fig. 6).

(3) Lift outlet receptacle from frame.

b. Disassembly (fig. 75).

SCREWDRIVER

(1) Unscrew cover from body and remove split ring (screwdriver).

(2) Lift insulator, retainer, and wires from body.

(3) Remove gasket from receptacle cover.

c. Inspection and Repair.

SOLDERING EQUIPMENT

(1) Inspect all soldered connections and solder all broken connections (soldering equipment).

(2) Inspect condition of all gaskets and replace those broken or worn.

(3) Check all insulation, replacing broken and worn parts.

d. Assembly.

SCREWDRIVER

(1) Pass wires through receptacle body, and position retainer and insulator in body.

(2) Insert split ring in body to secure insulator and retainer in position (screwdriver).

(3) Assemble the cover gasket to receptacle cover, and screw cover onto body.

e. Installation.

SCREWDRIVER — WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

CHANGE-OVER PANEL, TOOL BOX, AND RECEPTACLES

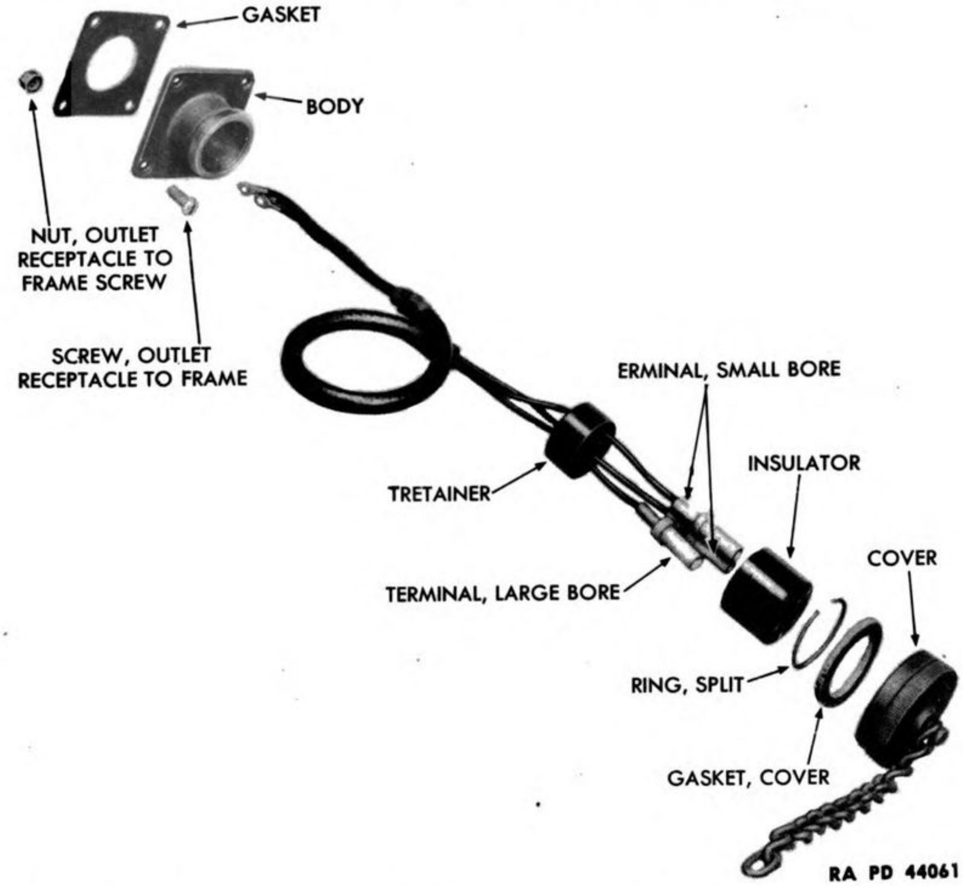


Figure 75 — 3-pole Outlet Receptacle Assembly — Exploded View

(1) Place receptacle in position, with gasket between frame and receptacle.

(2) Secure to frame with four screws and nuts (screwdriver and ½-in. open-end wrench).

(3) Attach "A," "B," and "C" wires to their proper terminals on back of circuit breaker (⅜-in. open-end wrench).

63. THE 19-POLE OUTLET RECEPTACLE (UNIT M6).

a. Removal.

SCREWDRIVER — WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

(1) Remove wires from "A," "B," and "C" terminals on left-hand side of circuit breaker (⅜-in. open-end wrench).

(2) Remove outlet receptacle-to-frame screws and nuts (screwdriver and ½-in. open-end wrench) (fig. 7).

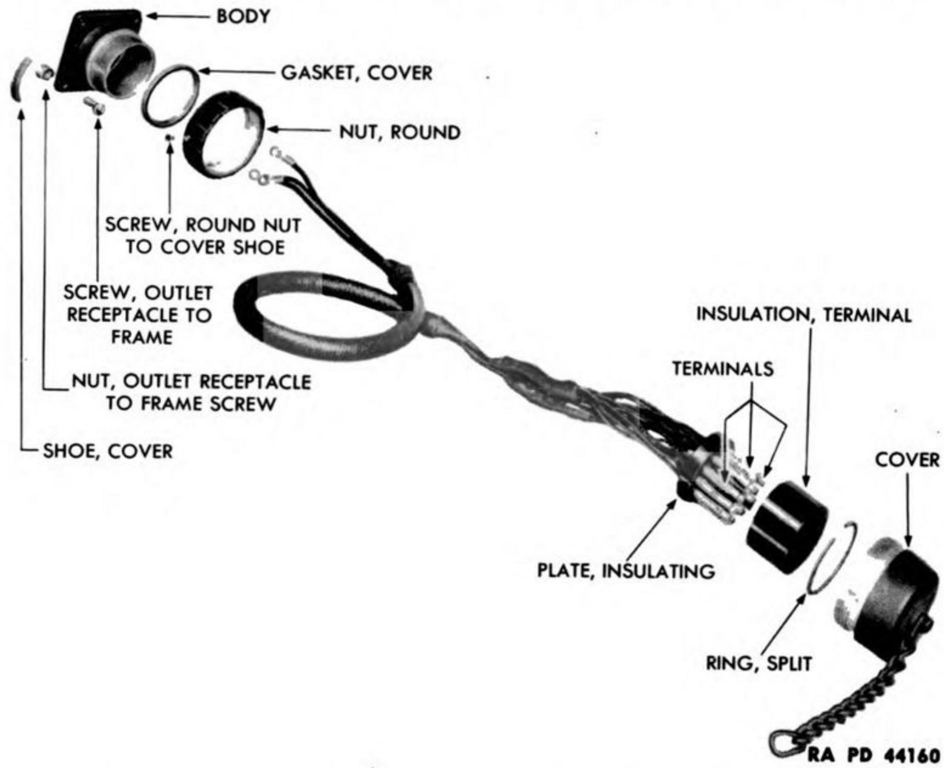


Figure 76 — 19-pole Outlet Receptacle Assembly — Exploded View

(3) Lift outlet receptacle from frame (fig. 7).

b. Disassembly (fig. 76).

SCREWDRIVER

(1) Screw round nut from cover. Lift cover from body.

(2) Remove split ring from body.

(3) Lift terminal insulation from body and slide body back off the wires.

(4) Remove cover shoe screws. Lift cover shoes from round nut, and round nut from body.

(5) Lift cover gasket from body.

c. Inspection and Repair.

COMPRESSED AIR — SOLVENT, dry-cleaning
SOLDERING EQUIPMENT

(1) Clean all metal parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect all soldered connections; solder broken connections (soldering equipment).

(3) Inspect all gaskets and insulators. Replace broken or worn parts.

(4) Inspect all metal parts. Replace broken or bent parts.

d. Assembly (fig. 76).

SCREWDRIVER

(1) Push cover gasket on body.

(2) Place round nut on body, collar end first. Insert cover shoe under collar, and install round nut to cover shoe screws. Repeat operation to install remaining cover shoes and screws.

(3) Slide body on wires but not on insulating plate.

(4) Fit terminal insulation over terminals, up against insulating plate. Be sure groove in terminal insulation lines up with groove in insulating plate.

(5) Insert insulating plate and terminal insulation into body. NOTE: Groove will allow it to fit together in but one position.

(6) Insert split ring in end of body (fig. 76).

e. Installation.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

(1) Place outlet receptacle in position on frame. Install screws (screwdriver and ½-in. open-end wrench) (fig. 7).

(2) Connect wires "A", "B", and "C" to terminals; "A", "B", and "C" on left side of circuit breaker (⅜-in. open-end wrench) (fig. 70).

Section IX

ENGINE (GENERAL)

64. DESCRIPTION.

a. The engine is a 4-cylinder Hercules, model ZXB, 4-cycle, L-head gasoline engine. It produces 11 horsepower.

b. Cylinder Block and Main Bearings. Constituting the main frame of the engine, the cylinder block and crankcase are cast integrally. The cylinders are water-jacketed the full length of the bore. Three main bearings support the crankshaft. These bearings consist of babbitt-lined shells for the top half of the bearing and babbitt-lined drop forged caps for the lower half. Two large alloy-steel cap screws secure the bearing caps to the cylinder block. Bearing adjustment is made by adding or removing shims.

c. Cylinder Head. Conventional in design, the cylinder head is a 1-piece casting. It is secured to the cylinder block with 13 cap screws and 2 stud nuts. It is designed so that the major part of the combustion chamber is over the valves. To ensure adequate cooling, the cylinder head is completely water-jacketed.

d. Connecting Rods and Pistons.

(1) Babbitt for connecting rod bearings is poured directly into the steel of the connecting rod and cap. Two alloy-steel connecting rod bolts secure the cap to the rod. The piston pin is clamped into the top of the rod by the connecting rod piston pin clamp screw. This device prevents the piston pin from working loose and scoring the cylinder walls.

(2) Cast-iron pistons are used. Bronze bearings are provided in the piston pin bosses. Each piston has two compression rings and one oil ring.

e. Exhaust and Intake Manifold. This engine is equipped with an exhaust and intake manifold cast in one piece.

f. Accessory Drive. An accessory drive assembly on left front corner of the engine is the means of driving the water pump, distributor, and battery charging generator.

65. SPECIFICATIONS.

Make .... Hercules
Model .... ZXB

Rating:

Bore .... 2⅝ in.
Stroke .... 3 in.
Horsepower (N.A.C.C.) 11
Piston displacement 64.9
Firing order 1-2-4-3
Lubrication.... Forced feed to all connecting rods and main bearings

Cylinder Head:

Type .... Detachable
Valve arrangement .... L-head
Exhaust valve diameter clearance .... ⅞ in.
Intake valve diameter clearance .... 1⅛ in.

Pistons:

Material .... Cast iron
Rings above pin 3
Rings below pin 0
Number of oil rings 1
Number of compression rings 2
Oil ring width .... 3/16 in.
Compression ring width .... ⅛ in.

Piston Pin:

Diameter .... 11/16 in.
Bearing length .... 1½ in.
Bearing location .... In piston
Number of bearings per piston 2

Crankshaft:

Number of bearings 3
Bearing diameter .... 2 in.
Bearing length (front) .... 1 5/16 in.
Bearing length (center) .... 1⅜ in.
Bearing length (rear) .... 1⅜ in.

Camshaft:

Drive .... Helical gear
Number of bearings 4
Diameter (front, center, and rear) .... 1¼ in.
Length (front) .... 1⅛ in.
Length (center, Nos. 2 and 3) .... 19/32 in.
Length (rear) .... 19/32 in.
Location .... Right-hand side of cylinder block

Connecting Rods:

Bearing diameter .... 1½ in.

Bearing length .... 1 in.
Connecting rod length (center to center) .... 5 1/8 in.

Carburetor:

Size .... 5/8 in. SAE
Adjustment .... Idling speed only
Cooling .... Water pump

Generator:

Mounting .... Steel bracket on left side of cylinder block
Drive .... V-belt off accessory drive
Starting motor mounting ...... Standard SAE mount on bell housing
Spark plug size .... 14 mm.
Exhaust manifold bore .... 1 17/32 in.
Method of suspension .... 4 point

66. TROUBLE SHOOTING.

a. Engine Fails to Start.

Possible Cause	Possible Remedy
No gasoline in tank.	Fill gasoline tank.
Gasoline tank shut-off cock closed.	Open shut-off cock.
Water in gasoline tank, line, strainer, or carburetor.	Drain gasoline. Clean parts. Fill tank with gasoline.
Faulty carburetion.	Clean carburetor (pars. 138 and 139).
Gasoline line plugged.	Remove and clean gasoline line.
Dirt in fuel system.	Disassemble and clean components.
Throttle valve loose, stuck, or out of adjustment.	Free, connect, or adjust throttle valve.
Carburetor loose on manifold.	Tighten carburetor.
Manifold loose on cylinder block.	Tighten manifold.
Air cleaner improperly assembled.	Assemble air cleaner correctly (par. 136).
Distributor condenser short-circuited.	Replace distributor condenser (par. 99).
Broken or disconnected ignition wire.	Repair, replace, or connect ignition wire.
Ignition toggle switch off or broken.	Turn on or replace ignition toggle switch (par. 53).
Ignition coil to distributor high-tension cable disconnected.	Connect ignition coil to distributor high-tension cable.
Battery run down.	Recharge battery (par. 113).
Ignition coil defective.	Replace ignition coil (par. 97).
Distributor out of time.	Time distributor (par. 103).
Distributor point spring or rotor spring broken.	Replace distributor points or rotor (par. 99).

Possible Cause	Possible Remedy
Sheared distributor drive gear pin.	Overhaul distributor and replace distributor drive gear pin (pars. 99 and 100).
Distributor points pitted.	Replace distributor points (par. 99).
Ignition cables, coil, and distributor wet.	Wash with SOLVENT, dry-cleaning, and wipe with dry cloth.
Valves fail to close (after storage of unit).	Clean rust or deposits from valve stems and valve guides (par. 116).

b. Popping, Spitting, and Spark Knock.

Carbon deposits.	Clean carbon from engine.
Hot spot in cylinder head due to carbon formation or clogged water jacket.	Clean carbon deposits from engine (par. 117). Clean water jacket (par. 117).
Valve sticking.	See subparagraph **i** below.
Improper valve timing.	Time valves (par. 129).
Improper distributor timing.	Time distributor (par. 103).
Improper carburetion.	Clean carburetor (pars. 138 and 139).
Improper spark plugs.	Replace spark plugs (par. 104).
Improper spark plug gaps.	Adjust spark plugs (par. 104).
Spark plugs dirty.	Clean and adjust spark plugs (par. 104).
Exhaust valve heads too thin, causing hot spots.	Replace exhaust valve (pars. 116 and 129).
Weak valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve spring.	Replace valve spring (pars. 116 and 129).
Broken valve.	Replace valve (pars. 116 and 129).
Broken valve spring seat.	Replace valve spring seat (pars. 116 and 129).
Broken valve spring pin.	Replace valve spring pin (pars. 116 and 129).
Valves not properly seated.	Grind valves (par. 125) or reface valves and valve seats (pars. 124 and 125).
Crossed spark plug wires.	Put spark plug wires in proper firing order (par. 104).
Distributor out of time.	Time distributor to engine (par. 103).
Ignition cables, coil, and distributor wet.	Wash with SOLVENT, dry-cleaning, and wipe with dry cloth.

c. Engine Missing or Sluggish.

Possible Cause	Possible Remedy
Ignition cables disconnected.	Connect ignition cables.
Ignition cables short-circuited.	Repair or replace ignition cables.
Spark plugs fouled or broken.	Clean or replace spark plugs (par. 104).
Spark plugs out of adjustment.	Clean and adjust spark plugs (par. 104).
Distributor points burned or pitted.	Replace distributor points (par. 99).
Distributor out of time.	Time distributor (par. 103).
Weak ignition coil.	Replace ignition coil (par. 97).
Governor loose.	Tighten governor.
Generator not functioning and battery weak.	Repair generator and recharge battery (par. 85).
Ignition coil, distributor, and cables wet.	Wash with SOLVENT, dry-cleaning, and wipe with dry cloth.
Faulty compression.	See subparagraph **f** below.
Faulty carburetion.	Clean carburetor (pars. 138 and 139).
Air cleaner dirty.	Clean air cleaner (par. 136).
Overheating.	See cooling system trouble shooting (par. 70).

d. Excessive Bearing Wear.

Crankshaft journal scored.	Grind or replace crankshaft (par. 127).
Crankshaft journal out-of-round.	Grind or replace crankshaft (par. 127).
Crankshaft or cylinder block oil passages obstructed.	Clean oil passages (par. 117).
Bearings sprung.	Replace bearings.
Bearings loose.	Adjust bearings (par. 129).
Bearings tight.	Adjust bearings (par. 129).
Crankshaft misalined.	Straighten or replace crankshaft (par. 127).
Bearings misalined.	Aline bearings with shims (par. 129).
Lack of engine oil.	Maintain proper engine oil level.
Low oil pressure.	Adjust oil pressure regulator (par. 161). Fit bearings properly (par. 129).
Connecting rod bent.	Straighten or replace connecting rod (par. 126).
Improper oil.	Use correct oil (par. 164).

e. Burned Valves and Seats.

Possible Cause	Possible Remedy
Weak valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve spring seat.	Replace valve spring seat (pars. 116 and 129).
Improper engine oil.	Change to correct engine oil.

f. Faulty Compression.

Worn valves.	Grind valves (par. 125).
Valve seats pitted or worn.	Reface valve seats (par. 124).
Piston rings stuck.	Clean carbon from ring and piston, or replace one or both (par. 126).
Piston ring worn or broken.	Replace piston ring (par. 126).
Loose spark plugs.	Tighten spark plugs.
Cylinder head loose.	Tighten cylinder head cap screws and stud nuts.
Cylinder head gasket damaged or defective.	Replace cylinder head gasket (par. 116).
Pistons worn.	Fit new pistons (par. 126).
Cylinders worn.	Rebore cylinders (par. 124).
Worn valve stems.	Replace valves (par. 116).
Valve guides worn.	Replace valve guides (par. 116).
Valve spring broken or weakened.	Replace valve spring (pars. 116 and 129).
Valve spring seat broken.	Replace valve spring seat (pars. 116 and 129).
Valve spring seat pin broken.	Replace valve spring seat pin (pars. 116 and 129).
Valve timing incorrect.	Time valves (par. 129).

g. Excessive Engine Oil Consumption.

Worn piston rings.	Replace piston rings (par. 126).
Broken piston rings.	Replace piston rings (par. 126).
Gear cover loose.	Tighten gear cover.
Oil pan loose.	Tighten oil pan.
Defective oil seal.	Replace oil seal (par. 116).
Accessory drive loose.	Tighten accessory drive.
Bell housing loose.	Tighten bell housing.
Torn gasket.	Replace gasket.
Poor grade engine oil.	Use good engine oil.
Cylinder walls worn.	Rebore cylinders (par. 124).
Cylinder walls out-of-round.	Rebore cylinders (par. 124).

Possible Cause	Possible Remedy
Cylinder walls tapered excessively.	Rebore cylinders (par. 124).
Cylinder main bearings loose.	Adjust or replace cylinder main bearings (par. 129).
Connecting rod bearings loose.	Adjust connecting rod bearings or replace connecting rods (par. 129).
Piston ring gaps too large.	Replace piston rings (par. 126).
Piston rings improperly seated.	Replace piston rings (par. 126).
Engine overheating.	See cooling system trouble shooting (par. 70).
Piston oil ring slots filled with carbon.	Clean or replace piston rings (pars. 117 and 126).
Excessive oil pressure.	Adjust oil pressure regulator (par. 161).
Too much engine oil in engine.	Maintain proper engine oil level.
High or low engine oil pressure.	See lubrication system trouble shooting (par. 158).

h. Excessive Cylinder and Piston Wear.

Improper engine oil.	Change to correct engine oil.
Lack of engine oil.	Maintain proper oil level in engine.
Dirty engine oil.	Change engine oil.
Overheating.	See cooling system trouble shooting (par. 70).
Improper piston installation and fitting.	Fit new pistons (par. 126).
Piston rings improperly fitted.	Fit new piston rings (par. 126).
Piston ring broken.	Replace piston ring (par. 126).
Piston ring stuck.	Clean piston and ring, or replace either or both (par. 126).
Air cleaner loose.	Tighten air cleaner.
Air cleaner dirty.	Clean air cleaner (par. 136).
Carburetor delivering too rich mixture.	Clean carburetor (pars. 138 and 139).
Broken valve spring seat pin.	Replace valve spring seat pin (pars. 116 and 129).
Improper valve timing.	Time valves (par. 129).
Carbon deposits on valve seat and valve head.	Clean carbon from parts (par. 117).
Valves sticking.	See subparagraph **i** below.
Improper type of valve.	Use proper valve.
Valve head too thin, causing hot sections.	Replace valve (pars. 116 and 129).

Possible Cause	Possible Remedy
Valve seats too narrow.	Reface valve seats (par. 124).
Carburetor mixture too lean.	Clean carburetor.
Overheating.	See cooling system trouble shooting (par. 70).
Low grade fuel.	Use specified fuel.

i. Valves Sticking.

Valve stems lack proper clearance in valve guides.	Ream valve guides to obtain proper clearance.
Weak valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve spring seat.	Replace valve spring seat (pars. 116 and 129).
Broken valve spring seat pin.	Replace valve spring seat pin (pars. 116 and 129).
Valve stems scored.	Replace valves (par. 125).
Valve stems dirty.	Clean valves.
Gum deposits from inferior gasoline or engine oil.	Clean parts. Use specified gasoline and engine oil.

j. Overheating.

Cooling system ineffective.	See cooling system trouble shooting (par. 70).
Insufficient amount of engine oil.	Maintain proper level of engine oil.
Carburetor choke valve partly closed.	Adjust choke control (par. 154).
Valves improperly timed.	Time valves (par. 129).
Clogged exhaust system.	Clean manifold, exhaust pipe adapter, muffler, and exhaust pipe.
Carburetor out of adjustment.	Clean and adjust carburetor (pars. 138 and 139).

67. TUNE-UP.

a. Equipment.

BRUSH, wire	SCREWDRIVER
GAGE, compression	VOLTMETER
HOT WATER	WRENCH, open-end, $^{9}/_{16}$-in.
OIL, engine, SAE 10	WRENCH, open-end, $^{11}/_{16}$-in.

b. Procedure. Importance of periodic engine tune-up cannot be overstressed. Efficient engine operation cannot be maintained if tune-ups are forgotten or poorly done. Complete engine tune-up, as outlined below, must be done after each 200 hours of engine operation. Under adverse climatic conditions, tune-ups must be performed oftener. To avoid hit-and-miss methods, perform the steps in the following order.

(1) TEST COMPRESSION.

GAGE, compression	OIL, engine, SAE 10

(a) Remove all four spark plugs (par. 104).

(b) Hold a compression gage tightly in a spark plug opening. Push the starter button. Observe the gage reading. Repeat the operation on the three remaining cylinders. If all four cylinders have within 5 pounds of the same compression, the compression is satisfactory. If one or more cylinders have low compression, determine the cause as follows:

1. If compression on two adjacent cylinders is low, a faulty head gasket permitting compression leakage between the two cylinders, is indicated.

2. Pour about one-eighth pint of OIL, engine, SAE 10, into each cylinder having low compression. Repeat the test. If compression remains unchanged, sticking or poorly seating valves are indicated. If compression improves, worn cylinders, pistons, and piston rings are indicated.

(c) Correct the cause of low or uneven compression before attempting to tune up engine.

(2) CLEAN AND TEST SPARK PLUGS.

(a) Before installing spark plugs removed in step (1) above, clean, adjust, and test them (par. 104). Replace defective spark plugs. Install spark plugs.

(3) INSPECT AND TEST BATTERY AND CABLES.

BRUSH, wire	WRENCH, open-end, $^9/_{16}$-in.
HOT WATER	WRENCH, open-end, $^{11}/_{16}$-in.
VOLTMETER	

(a) Connect the positive lead of a voltmeter to the starting motor terminal. Connect the negative lead to an oil line or other good ground. Press the starter switch for 15 seconds with the ignition switch off. If the engine cranks rapidly with the voltmeter reading 5 or more volts, a satisfactory starting circuit is indicated. If the engine cranks slowly, or if the voltmeter reads under 5 volts, perform the following steps:

1. Check condition of battery (par. 113). Recharge or replace if necessary.

2. Remove the battery ground cable ($^9/_{16}$-in. open-end wrench and $^{11}/_{16}$-in. open-end wrench), the battery to starter switch cable, and the starter switch to starting motor cable. Clean cable terminals, switch and motor terminals, and battery parts with hot water and a wire brush. Install the cables.

(4) DISTRIBUTOR.

(a) Inspect the distributor breaker points. Replace (par. 99) if pitted or burned.

(b) Time the distributor (par. 103).

(5) COIL AND CONDENSER.

(a) Test operation of ignition coil (par. 97).

(b) Test operation of distributor condenser (par. 100).

(6) AIR CLEANER.

Service the air cleaner (par. 136).

(7) CARBURETOR.

Remove, disassemble, and clean the carburetor (pars. 137 and 138). Assemble and install the carburetor (par. 141).

(8) VALVE TAPPETS.

Adjust valve tappets with the engine warmed up and running (par. 129). NOTE: Paragraph reference is to adjustment of valve tappets with engine cold. Procedure is similar here except that proper clearance is 0.006 inch.

(9) COOLING SYSTEM.

SCREWDRIVER

(a) Inspect for leakage. Repair if found.

(b) Tighten all hose connection clamp screws (screwdriver).

(c) Check fan belt tension (par. 79).

(d) Check thermostat.

Section X

COOLING SYSTEM

68. DESCRIPTION AND CONSTRUCTION.

a. General. The cooling system consists of a radiator, radiator cooling fan, water pump, water passages in the cylinder block and head, thermostat, and connections between these units. It has a capacity of 5 quarts. The function of the cooling system is to maintain the engine at an efficient operating temperature. To perform this function properly, the cooling system must be kept free of any foreign matter that might tend to clog the water passages. The water pump must be leakproof, and must keep the water circulating in the system. The water passages in the cylinder block and head must be kept free from rust and corrosion so that heat may be properly dissipated. The hose connections must be in good condition, and all connections must be kept tight so that they will not leak. The cylinder head bolts must be kept tight to eliminate the possibility of exhaust gases entering the cooling system. Water is drawn from the bottom of the radiator by the water pump, and is forced under pressure through the water passages in the cylinder block and head, and back into the top of the radiator. The thermostat, mounted in the cylinder head, assists in maintaining proper water temperature under operating conditions.

b. Water Pump. The water pump is of the centrifugal type, and is mounted on the front of the engine. It is gear-driven from the accessory drive gear train. A vane type impeller is pressed on, and pinned to, the water pump drive shaft. The water pump drive shaft is flattened at the end, and fits into an opening in the accessory drive gear which drives the pump. The water pump is sealed against leaks by the use of a composition water pump rotary seal. This seal

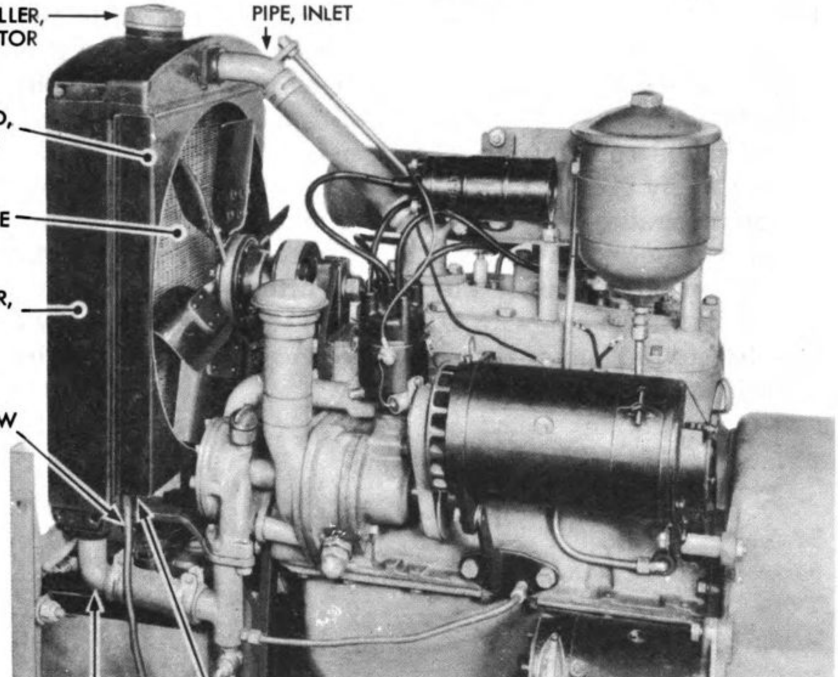


Figure 77 — Radiator Assembly and Connections

is retained in place by a water pump rotary seal spring, two water pump rotary seal washers, and a water pump shaft snap ring. The water pump shaft operates in a bronze bushing pressed into the water pump body. A large grease cup is provided for lubricating the pump shaft. The water bypass tube allows water circulation through the engine while the thermostat is closed.

c. Radiator. The radiator is of the copper fin and tube type, with brass upper and lower tanks. The tubes and fins are designed to give maximum heat radiation. Water from the cylinder head of the engine enters the upper tank of the radiator and passes through the radiator core (where it is cooled) to the lower tank. From the bottom tank, water is pumped back into the engine and cylinder head water jackets, to maintain proper engine temperatures. The upper water tank is provided with a radiator filler hole, radiator cap, overflow tube, and radiator water inlet pipe (fig. 77). The bottom tank is fitted with a radiator outlet pipe (fig. 77). The radiator core is made up of a series of brass tubes and fins, properly spaced and soldered to both the upper and lower tanks. The fan shield is a 1-piece sheet metal stamping, and is soldered or welded to the upper and lower tanks and side members. The two side members are soldered to the upper and lower tanks.

d. Fan and Belt. The radiator cooling fan is of the 6-blade steel pusher type, mounted on the shaft at the front of the engine. It is driven by means of a rubber belt directly connected to the fan drive pulley on the front end of the crankshaft. The 6-blade fan is attached to the fan bearing by means of eight cap screws and four double nuts. The fan bearing is cast iron, with a highly finished inner surface in which the spindle operates. The spindle is steel, with its bearing surface finely ground to insure a free running fit in the bearing. The fan-driven pulley is a 2-piece sheet metal stamping, securely welded to the fan hub. The fan hub is a 1-piece sheet metal stamping, and acts as an oil reservoir. The hub is fitted with a plug, which is removed to fill the hub with OIL, engine (seasonal grade). An impeller, attached to the end of the spindle, forces oil into the bearing surfaces, assuring proper lubrication.

69. SPECIFICATIONS.

a. Water Pump.

Make	Hercules
Model	ZXB
Type	Centrifugal
Weight	4½ lb

b. Radiator

Make	McCord
Model	J-41
Type	Fin and tube
Weight	16 lb

c. Fan.

Make	Switzer-Cummings
Type	6-blade pusher
Lubrication	Oil plug in hub

d. Fan Belt.

Make	Gates Vulco
Model	790
Type	V
Outside circumference	32 7/16 in.
Outside width	15/16 in.
Inside width	¾ in.

e. Radiator Hose.

Material	Reinforced rubber
Outside diameter	1¼ in.
Upper radiator hose length	7½ in.
Lower radiator hose length	3¾ in.
Water pump outlet hose length	1½ in.

f. Cooling System.

Capacity	5 quarts

70. TROUBLE SHOOTING.

a. The following chart is provided as a guide to common troubles and their causes, and is a recommended procedure for inspection to locate the cause:

(1) OVERHEATING.

Possible Cause	Possible Remedy
Lack of water or antifreeze.	Fill cooling system.
Fan belt loose.	Adjust or replace fan belt (par. 79).
Thermostat sticking shut.	Replace thermostat (par. 130).
Water pump not operating.	Rebuild water pump (pars. 73, 74, 75, and 76).
Cooling system clogged.	Clean cooling system (par. 71).
Ignition timing incorrect.	Time engine (par. 103).
Radiator core passages clogged.	Clean radiator core (par. 71).
Leaks at connections, hoses, radiator core, or cylinder head gasket.	Tighten all connections, repair radiator core, and tighten or replace all hoses.
Water pump leaking.	Replace water pump seal (par. 73, 74, and 75).

(2) OVERCOOLING.

Thermostat not closing.	Replace thermostat (par. 130).

71. MAINTENANCE.

a. Equipment.

BUCKET, radiator filler	PLIERS
COMPRESSED AIR	SCREWDRIVER
GUN, reverse-flushing	SOLUTION, radiator cleaning
HOSE (2)	THERMOMETER
HYDROMETER	WRENCH, socket, $\frac{9}{16}$-in.
OIL, engine (seasonal grade)	

b. Procedure.

(1) GENERAL. Externally inspect cooling system components daily. After each 150 hours of operation, a detailed inspection of the components must be made.

(2) DAILY INSPECTION.

BUCKET, radiator filler	OIL, engine, SAE 30
HYDROMETER	SCREWDRIVER

(a) See that radiator is full of water. Add water if necessary (radiator filler bucket).

(b) When antifreeze is used, test strength with a hydrometer. Refer to chart (step (5) below). Add antifreeze if necessary.

(c) Inspect all hose connections for water leaks. Tighten clamps if necessary (screwdriver).

(d) Turn down grease cup on water pump. Fill if necessary.

(e) Remove oil plug from fan (screwdriver), and fill fan hub with approved OIL, engine (seasonal grade).

(f) Check fan belt tension. Adjust if necessary (par. 79).

(g) Visually inspect radiator for leaks. Repair if leaking.

(3) PERIODIC INSPECTION.

PLIERS	SOLUTION, radiator cleaning
SCREWDRIVER	THERMOMETER

(a) Remove thermostat. Test its operation by placing it in a pan of water. Heat the water and check the temperature at which the thermostat is fully opened (thermometer). Allow water to cool, and check temperature at which the thermostat is fully closed. The thermostat should be fully opened by the time the water temperature reaches 165 F, and fully closed by the time the water temperature reaches 140 F on cooling. Replace thermostat if found faulty.

(b) Remove all radiator hose connections (screwdriver). Visually inspect exterior and interior. Replace if cracked, rotted, or if inside has become spongy or jelly-like.

(c) Clean cooling system. Add an approved radiator cleaning solution, containing no acid or caustic, to radiator contents. Add enough water to fill the cooling system completely. Run engine 20 to 30 minutes with the radiator covered. Drain the cooling system; then close the drain cock (pliers). Fill system with water.

(d) If water drained from cooling system shows an unusual amount of scale and rust, the system must be reverse-flushed.

(4) REVERSE-FLUSH COOLING SYSTEM.

COMPRESSED AIR	HOSE (2)
GUN, reverse-flushing	SCREWDRIVER

(a) Radiator. Remove upper and lower radiator hose from radiator (screwdriver). Attach a hose (long enough to conduct water to a drain) to the upper radiator inlet pipe. Secure a length of hose to the lower radiator outlet pipe with a radiator hose clamp. Hold a reverse-flushing gun (connected to water and air hose) to the other end of this hose. Turn on the water. When the radiator is full, turn on a short blast of air. Repeat the operation until water discharged from the hose attached to the upper radiator inlet pipe, is clean.

(b) Engine Water Jacket. Remove the thermostat from the cylinder head, as cold water would cause it to close and as a result, build up a pressure in the system and cause damage. Remove the radiator outlet hose from the cylinder head water outlet, and the inlet hose from the water pump (screwdriver). Attach drain hose

to water pump inlet with a radiator hose clamp. Hold reverse-flushing gun to the cylinder head water outlet. Allow water jacket to fill with water. Turn on air in short blast. Repeat process until water hose attached to water pump discharges clean water.

(5) ANTIFREEZE IN COOLING SYSTEM.

BUCKET, radiator filler
PLIERS
SCREWDRIVER
WRENCH, socket, 9/16-in.

(a) Inspect all cooling system components for leaks. If leaks are found, repair. Tighten all radiator hose connections (screwdriver). Tighten cylinder head cap screws and nuts (9/16-in. socket wrench). Clean and reverse-flush cooling system.

(b) Close the drain cock (pliers) and remove radiator cap.

(c) Determine the amount of antifreeze needed from chart below. Mix with water to make 5 quarts of solution.

ANTIFREEZE CHART

Anti-freeze	Water	COMPOUND antifreeze, (Ethylene Glycol type)	
Qt	Qt	°F	Gravity
0	5	32	1.000
½	4½	26	1.016
1	4	16	1.031
1½	3½	3	1.045
2	3	—11	1.058
2½	2½	—31	1.070

(d) Pour solution into radiator until it appears to be full. Start and run engine until thermostat opens. Pour remainder of solution into radiator.

(e) Run engine 20 to 30 minutes to insure thorough mixing of water and antifreeze.

72. WATER PUMP REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Remove housing (par. 14).

(2) Remove battery (par. 113).

(3) Remove radiator (par. 78).

(4) Loosen hose clamp screws (screwdriver) on water pump discharge hose (fig. 78).

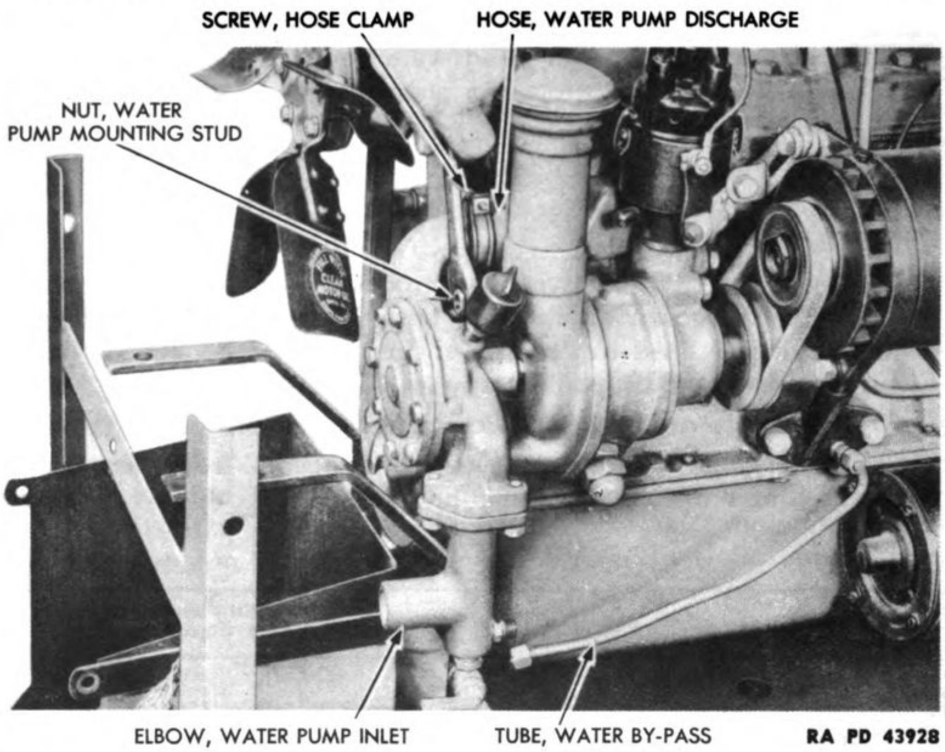


Figure 78 — Removing Water Pump

(5) Disconnect water bypass tube from water pump inlet elbow ($\frac{1}{2}$-in. open-end wrench) (fig. 78).

(6) Remove the two water pump mounting stud nuts and lock washers ($\frac{9}{16}$-in. open-end wrench) (fig. 78). To prevent breaking water pump discharge bracket, the bottom should be removed first and replaced last.

(7) Lift water pump and attached water pump inlet elbow, drain cock, and drain tube from engine.

73. WATER PUMP DISASSEMBLY (fig. 79).

a. Equipment.

DRIFT	VISE
DRIVER, bushing	WRENCH, open-end, $\frac{7}{16}$-in.
HAMMER	WRENCH, open-end, $\frac{1}{2}$-in.
PRESS, arbor	WRENCH, open-end, $\frac{9}{16}$-in.
PUNCH, small	WRENCH, open-end, $\frac{11}{16}$-in.
SCREWDRIVER (2)	

b. Procedure.

(1) Remove water drain tube from drain cock ($\frac{9}{16}$-in. open-end wrench).

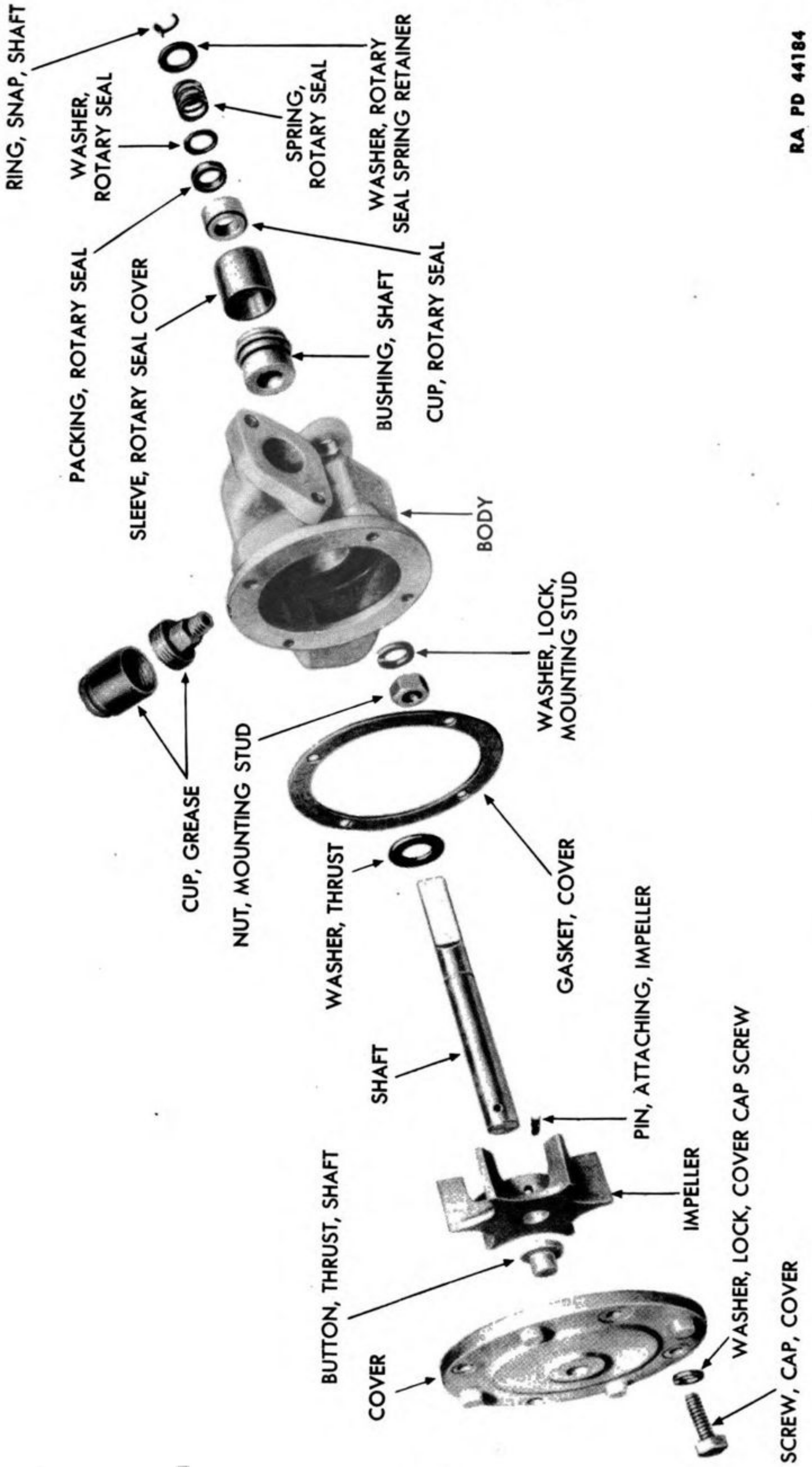


Figure 79 — Water Pump — Exploded View

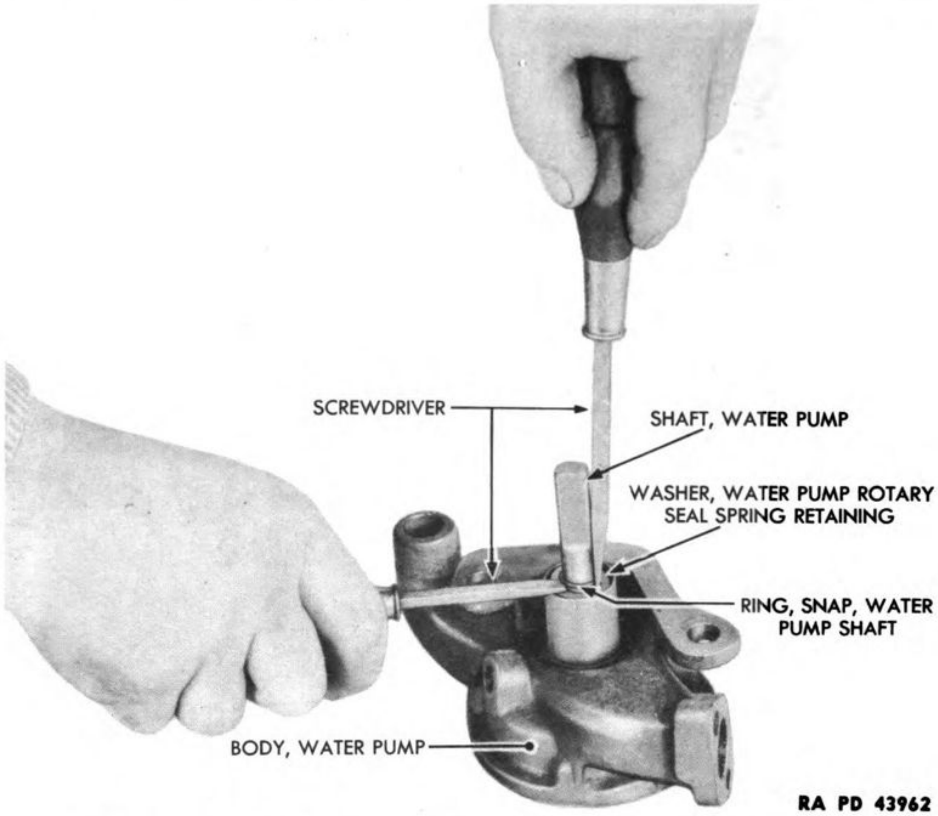


Figure 80 — Removing Water Pump Shaft Snap Ring

(2) Remove water drain cock from water inlet elbow ($1\frac{1}{16}$-in. open-end wrench).

(3) Remove cap screws and lock washers which hold water pump inlet elbow to water pump body, and remove elbow and gasket ($\frac{1}{2}$-in. open-end wrench) (fig. 78).

(4) Remove grease cup from water pump body ($\frac{9}{16}$-in. open-end wrench).

(5) Remove four cap screws and lock washers which hold water pump cover to water pump body, and remove cover and gasket ($\frac{7}{16}$-in. open-end wrench) (fig. 79).

(6) Drive water pump shaft thrust button from water pump cover (hammer and small punch) (fig. 79).

(7) Press down water pump rotary seal spring retainer washer with one screwdriver, and remove water pump shaft snap ring with another screwdriver (fig. 80).

(8) Disassemble water pump rotary seal spring retainer washer, water pump rotary seal spring, water pump rotary seal washer, water

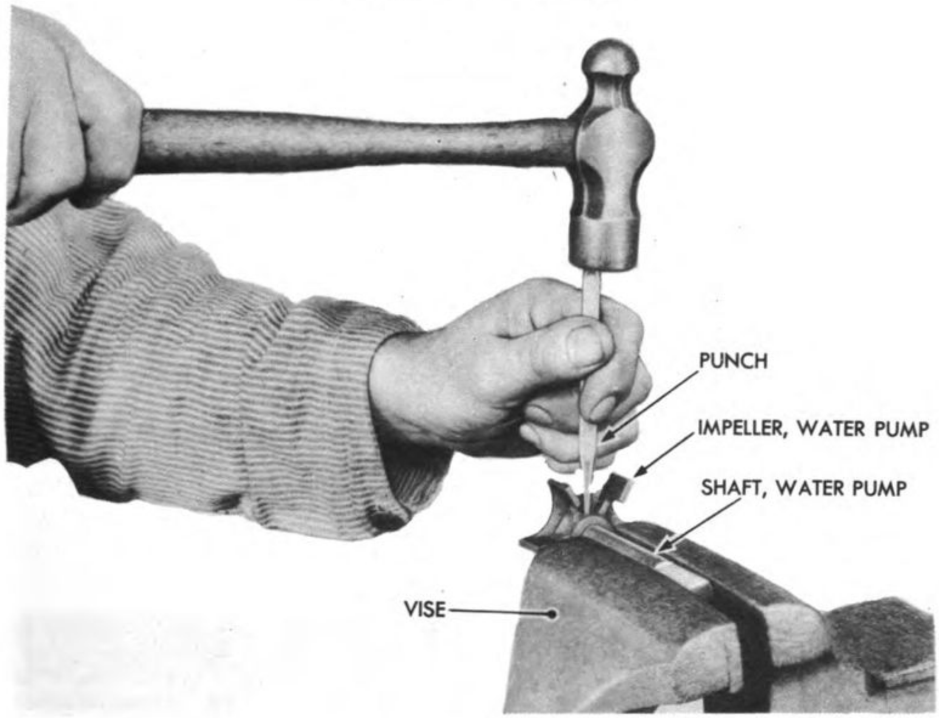


Figure 81 — Removing Pin from Water Pump Impeller and Shaft

pump rotary seal packing, and water pump rotary seal cup from the water pump shaft (two screwdrivers) (fig. 79).

(9) Lift water pump impeller, shaft, and thrust washer from water pump body (fig. 79).

(10) Holding water pump shaft securely in a vise, drive out pin attaching water pump impeller to water pump shaft (punch and hammer) (fig. 81).

(11) Support water pump impeller on the sides of an open vise, and drive water pump shaft from impeller (drift and hammer).

(12) Support water pump body in arbor press; press water pump shaft bushing from water pump body with a suitable bushing driver or pilot (fig. 82). CAUTION: Do not support water pump body on the attaching lugs, as they may break.

(13) Drive the water pump rotary seal cover sleeve from water pump shaft bushing (punch and hammer).

74. WATER PUMP INSPECTION.

a. Equipment.

COMPRESSED AIR
SOLVENT, dry-cleaning
WELDING EQUIPMENT

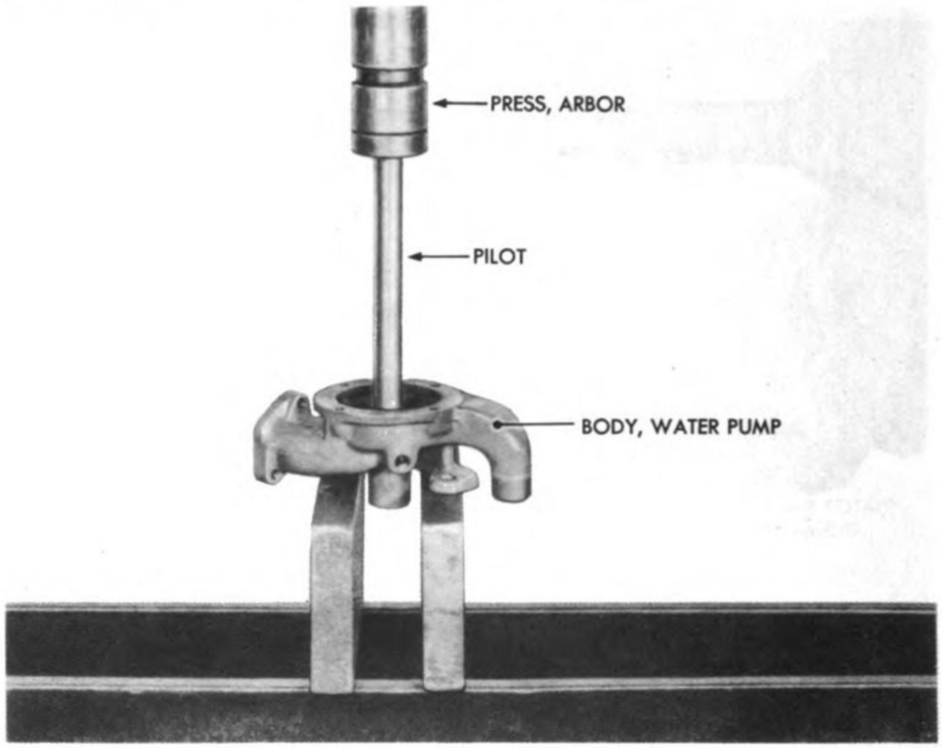


Figure 82 — Removing Water Pump Shaft Bushing from Body

b. Procedure.

(1) Clean all parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect water pump body and cover for cracks. Replace or weld, if broken (welding equipment).

(3) Inspect water pump shaft thrust button in cover, and replace if worn.

(4) Inspect fit of water pump shaft in impeller, and replace shaft or impeller, or both, if shaft is not a press fit in impeller.

(5) Inspect fit of water pump shaft in water pump shaft bushing, and replace bushing if worn enough to permit noticeable side play.

(6) Inspect water pump shaft for wear and damage. Replace if necessary.

75. WATER PUMP MAINTENANCE AND REPAIR.

a. Because of its construction, the water pump requires very little care, except that the grease cup must be kept filled with the specified lubricant, and turned down every day to insure proper lubrication of water pump shaft bushing.

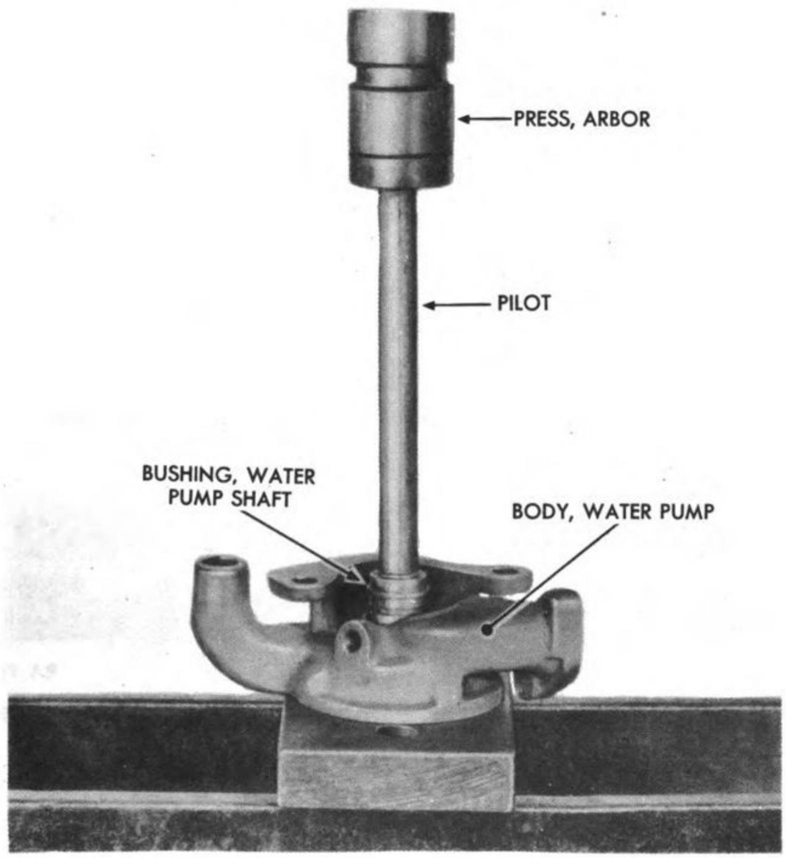


Figure 83 — Pressing Water Pump Shaft Bushing Into Body

b. In case of overhaul and repair, always use new gaskets, new water pump impeller pin, new water pump rotary seal cup, new water pump shaft thrust washer, new water pump shaft thrust button, and new water pump shaft snap ring. Replace other parts if worn or broken.

76. WATER PUMP ASSEMBLY.

a. Equipment.

HAMMER
PRESS, arbor
SCREWDRIVER
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 11/16-in.

b. Procedure.

(1) Supporting water pump body in an arbor press, press water pump shaft bushing into body until shoulder of bushing is flush with outside of water pump body (fig. 83).

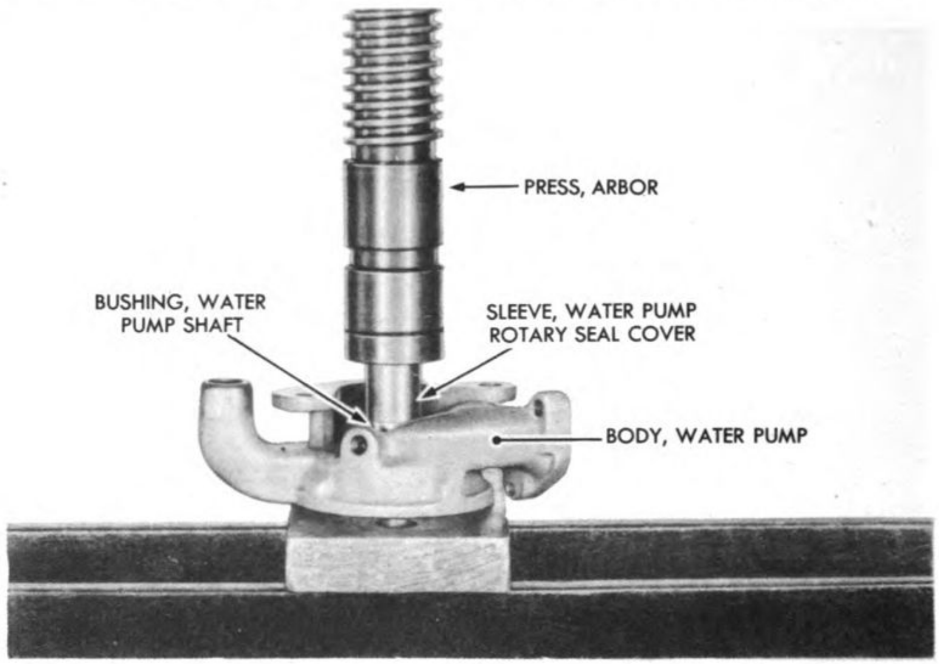


Figure 84 — Pressing Water Pump Rotary Seal Cover Sleeve Onto Water Pump Shaft Bushing

(2) Press water pump rotary seal cover sleeve over water pump shaft bushing, until sleeve is flush with flange on the water pump shaft bushing (arbor press) (fig. 84).

(3) Press shaft into impeller (fig. 85) making sure that pinhole in impeller lines up with pinhole in shaft. Drive pin in place (hammer).

(4) Assemble water pump shaft thrust washer over shaft, and assemble shaft and impeller to body with bushing (fig. 79).

(5) Assemble rotary seal cup, packing, washer, spring, and retaining washer over shaft and into rotary seal cover sleeve (fig. 79).

(6) Press down on rotary seal spring retainer washer to compress spring and assemble snap ring (screwdriver).

(7) Press a new thrust button into cover (arbor press) (fig. 79).

(8) Place cover on water pump body, and install cap screws and lock washers (7/16-in. open-end wrench).

(9) Assemble grease cup to body (9/16-in. open-end wrench) and fill with GREASE, water pump.

(10) Assemble water pump inlet elbow to body, using a new gasket (1/2-in. open-end wrench).

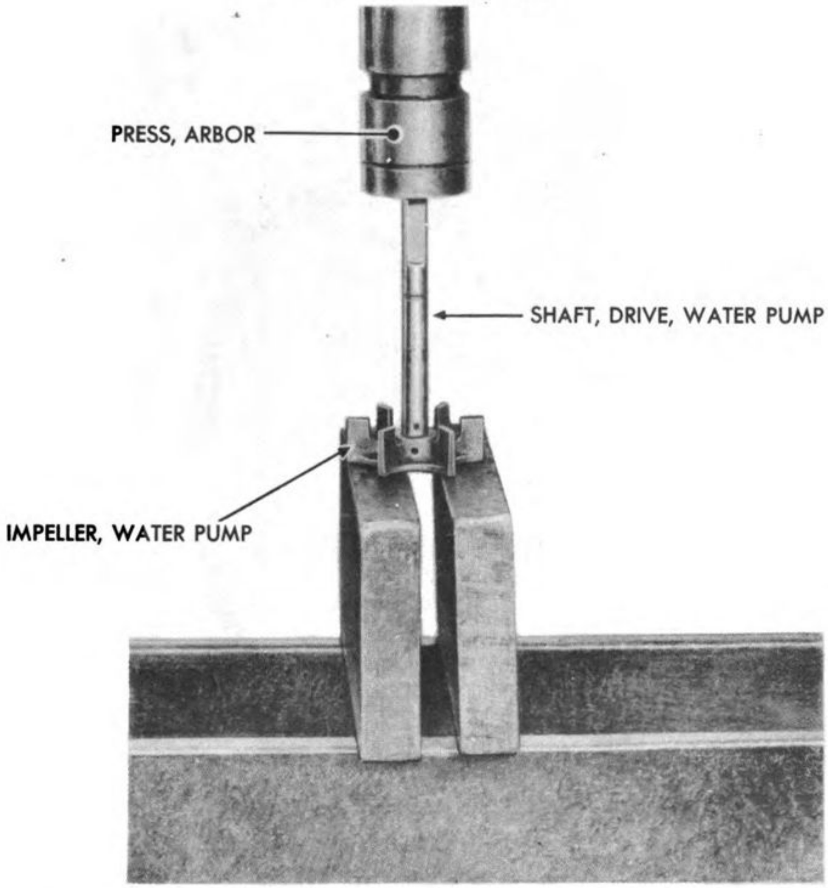


Figure 85 — Pressing Water Pump Shaft Into Impeller

(11) Assemble drain cock (11/16-in. open-end wrench) to water pump inlet elbow, and assemble drain pipe to drain cock (9/16-in. open-end wrench).

77. WATER PUMP INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Place water pump assembly in position on engine (fig. 78).

(2) Install mounting stud nuts and lock washers (9/16-in. open-end wrench) (fig. 78).

(3) Connect bypass tube to water pump inlet elbow (1/2-in. open-end wrench) (fig. 78).

(4) Assemble discharge pipe hose to discharge side of pump, and tighten hose clamp screw (screwdriver) (fig. 78).

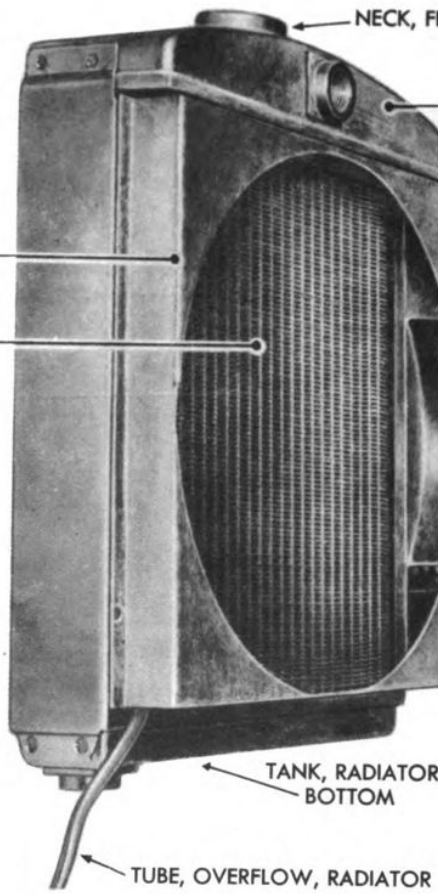


Figure 86 — Radiator Core and Tank Assembly

(5) Install radiator (par. 78).

(6) Install battery (par. 113).

(7) Install housing (par. 19).

78. RADIATOR.

a. Removal (fig. 87).

SCREWDRIVER
WRENCH, socket, $^9/_{16}$-in.
WRENCH, open-end, ½-in. (2)

(1) Open drain cock and drain cooling system.

(2) Remove housing (par. 14).

(3) Remove battery (par. 113).

(4) Loosen upper and lower radiator hoses (screwdriver), and remove hoses from radiator pipes (fig. 2).

(5) Remove radiator tie rod (two ½-in. open-end wrenches) (fig. 2).

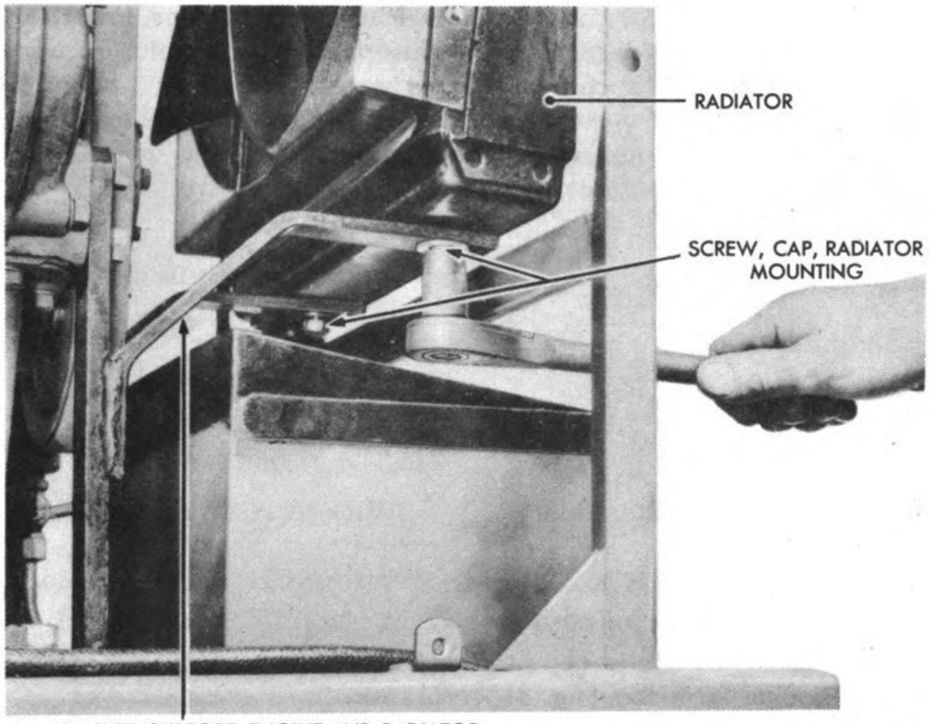


Figure 87 — Removing Radiator

(6) Remove two radiator mounting cap screws, plain washers, and lock washers ($^9/_{16}$-in. socket wrench).

(7) Lift radiator from engine and radiator support brackets.

b. Disassembly.

WRENCH, Stillson, 14-in.

(1) Remove inlet pipe from radiator (Stillson wrench) (fig. 77).

(2) Remove outlet pipe from radiator (Stillson wrench) (fig. 77).

(3) Remove radiator cap.

c. Inspection and Repair.

BLOCK, dolly
COMPRESSED AIR
HAMMER, sheet metal
PLUG, air inlet
PLUG, rubber or cork (4)
SOLDERING EQUIPMENT
WELDING EQUIPMENT

(1) See that radiator filler cap fits tightly on filler neck hole. If cap is not tight, bend lugs on cap, or in filler neck, until cap fits snugly.

(2) Visually inspect fan shield and side members for dents or breaks. Remove dents and weld breaks (dolly block, hammer, and welding equipment).

(3) Inspect radiator core for leaks. Plug overflow pipe, lower tank opening, and radiator filler opening. Insert an air inlet plug in upper tank opening. Immerse core in tank of water, and apply 3-pound air pressure in radiator core. Mark places where air bubbles out of core. Solder leaks, and repeat inspection (soldering equipment). CAUTION: Three pounds of air pressure is sufficient.

d. Assembly.

LEAD, red	WRENCH, Stillson

(1) Put a little LEAD, red, on threaded end of inlet pipe, and assemble to radiator (Stillson wrench) (fig. 77).

(2) Put a little LEAD, red, on threaded end of outlet pipe, and assemble to radiator (Stillson wrench) (fig. 77).

e. Installation.

BUCKET, radiator filler	WRENCH, open-end, ½-in. (2)
PLIERS	WRENCH, socket, 9/16-in.
SCREWDRIVER	

(1) Place radiator in position on unit (fig. 77).

(2) Install mounting cap screws, flat washers, and lock washers (9/16-in. socket wrench) (fig. 87).

(3) Install upper and lower hoses (screwdriver) (fig. 2).

(4) Install tie rod (two ½-in. open-end wrenches) (fig. 2).

(5) Install battery (par. 113).

(6) Install canopy (par. 19).

(7) Close radiator drain cock (pliers).

(8) Fill radiator (capacity of cooling system is 5 quarts) (radiator filler bucket).

79. FAN.

a. Removal.

WRENCH, open-end, 9/16-in.	WRENCH, open-end, 15/16-in.

(1) Remove muffler (par. 115).

(2) Loosen fan clamp nut (15/16-in. open-end wrench) (fig. 88).

(3) Remove fan bracket mounting cap screws and lock washers (9/16-in. open-end wrench) (fig. 88).

(4) Remove fan belt from pulley (fig. 88).

(5) Lift assembly and fan belt from unit.

b. Disassembly.

PLIERS	WRENCH, open-end, ⅜-in.
SCREWDRIVER	WRENCH, open-end, 15/16-in.

(1) Remove oil filler plug, and drain oil from fan hub (screwdriver) (fig. 89).

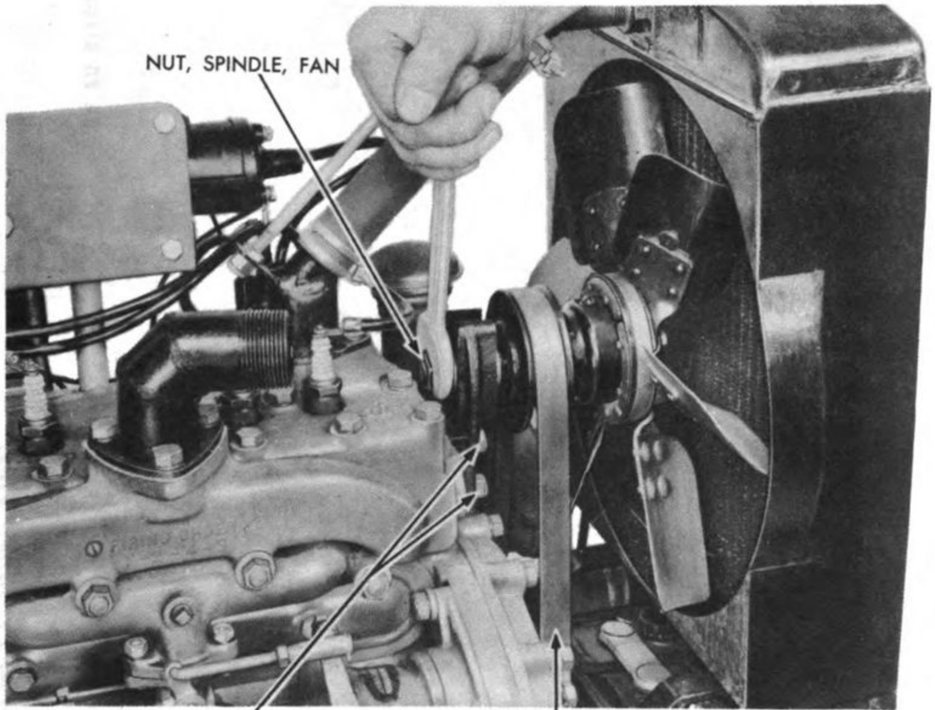


Figure 88 — Removing Fan

(2) Remove nut and flat washer from end of fan spindle, and remove fan mounting bracket (15/16-in. open-end wrench) (fig. 89).

(3) Remove eight cap screws, and lock washers, and four double-tapped nuts which hold fan blade to hub and fan spindle bearing (3/8-in. open-end wrench) (fig. 89).

(4) Lift fan blade spacer and gasket from hub (fig. 89).

(5) Remove cotter pin and clamp washer from spindle (pliers) (fig. 89).

(6) Remove hub from spindle and bearing (fig. 89).

(7) Remove spindle and gasket from bearing (fig. 89).

c. Inspection.

(1) Check fit of spindle in bearing.

(2) Check hub for tightness of pulley flanges.

(3) Check fan blades for loose rivets and cracks.

d. Maintenance and Repair.

(1) Keep fan hub filled at all times with OIL, engine (seasonal grade).

(2) Tighten all loose rivets, and straighten fan blades.

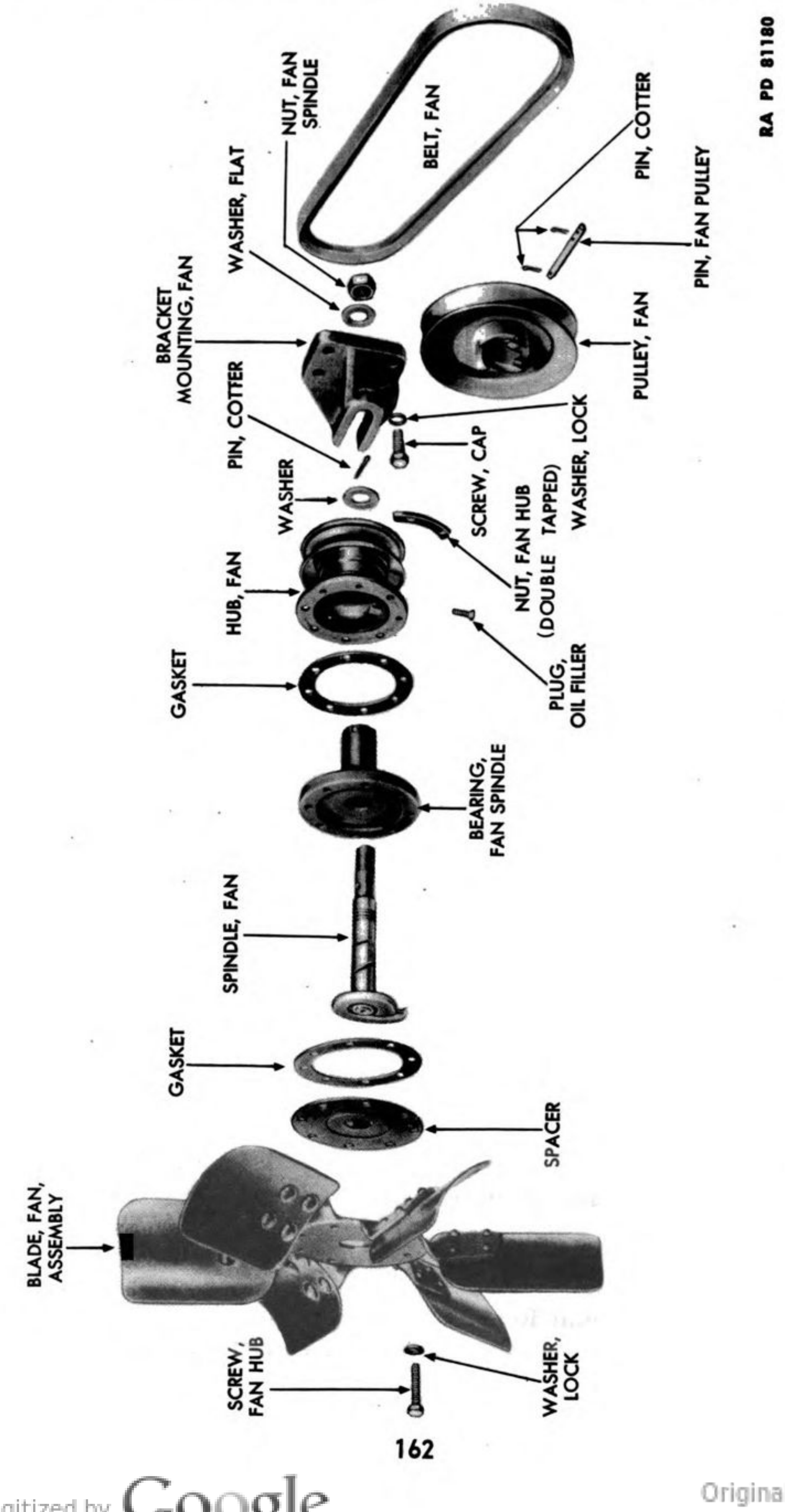


Figure 89 — Fan Assembly — Exploded View

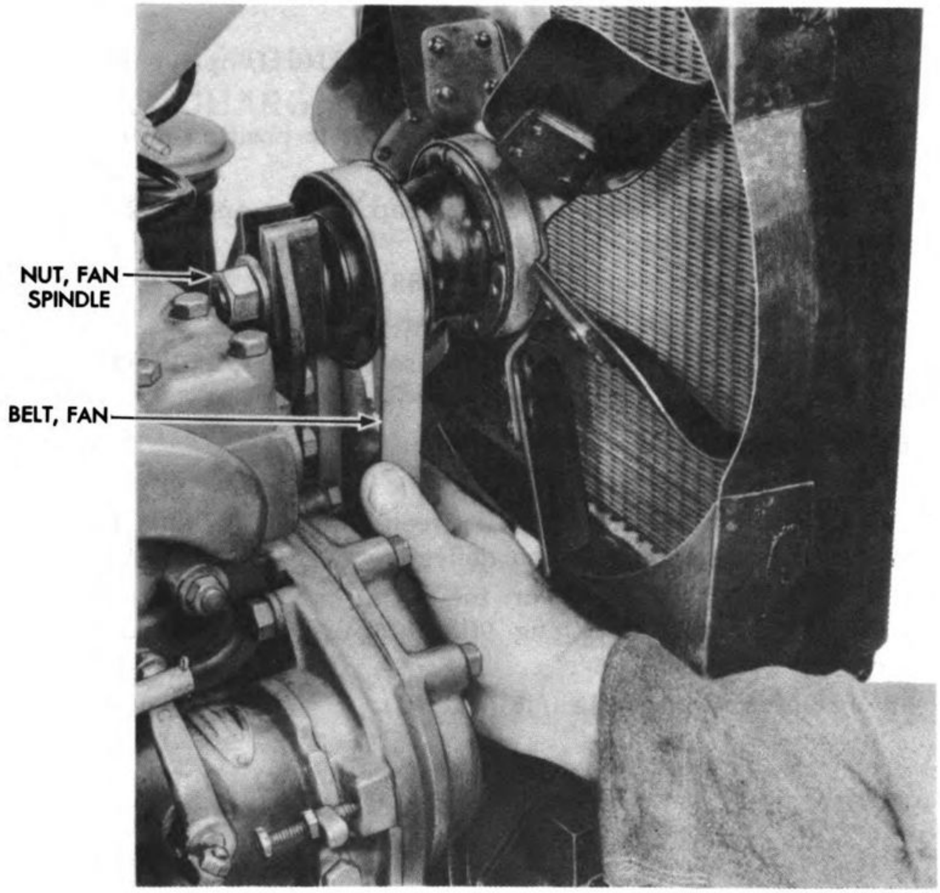


Figure 90 — Adjusting Fan Belt Tension

(3) Check spindle bearing clearance, and, if loose, replace worn parts.

e. Assembly.

PLIERS
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 15/16-in.

(1) Assemble fan spindle to fan spindle bearing (fig. 89).

(2) Assemble hub gasket to fan spindle bearing (fig. 89).

(3) Assemble hub to bearing and spindle (fig. 89).

(4) Assemble clamp washer and cotter pin to spindle (pliers) (fig. 89).

(5) Assemble gasket and spacer to hub (fig. 89).

(6) Place fan blade in position, and assemble to hub and bearing with eight cap screws and lock washers and four double-tapped nuts (3/8-in. open-end wrench) (fig. 89).

(7) Assemble fan assembly to bracket with flat washer and fan spindle nut (15/16-in. open-end wrench) (fig. 89).

f. Installation.

OIL, engine, SAE 20
SCREWDRIVER
WRENCH, open-end, 9/16-in.

(1) Place assembled fan and fan bracket in position on front end of cylinder block (fig. 88).

(2) Install fan bracket mounting cap screws and lock washers (9/16-in. open-end wrench) (fig. 88).

(3) Slip fan belt over pulley (fig. 88).

(4) Adjust fan belt tension (subpar. g below).

(5) Fill hub with OIL, engine (seasonal grade), and install filler plug (screwdriver).

g. Adjustment of Fan Belt Tension.

WRENCH, open-end, 15/16-in.

(1) Grasp fan belt midway between pulleys. It must be loose enough to allow about a 1-inch deflection (fig. 90).

(2) If belt is too loose or too tight, loosen fan spindle nut (15/16-in. open-end wrench) (fig. 90) and push fan up or down until tension is correct.

(3) Tighten fan spindle nut (fig. 90).

Section XI

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

80. DESCRIPTION.

a. Generator Circuit.

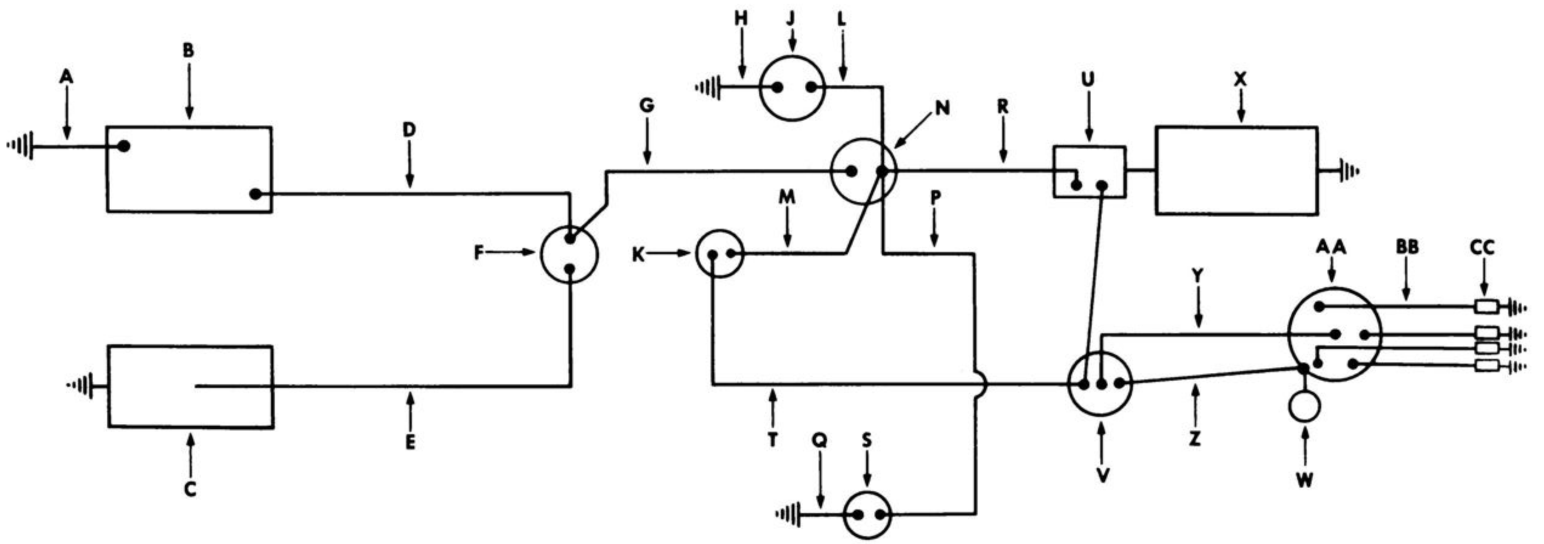
(1) The battery charging generator circuit consists of a generator, regulator, ammeter, battery, and connecting wires (fig. 92).

(2) Its function is to convert a small amount of mechanical energy from the engine into electrical energy, and store it for future use. This electrical energy, produced by the generator, is carried from the generator through the wiring to the storage battery. In actual operation some of the energy may be used directly from the generator.

b. Generator.

(1) The generator is a device for changing mechanical energy into electrical energy. It consists of four main subassemblies which are the frame and field, the armature, the commutator end plate, and the drive end head.

(2) The frame and field consists of the iron shell which supports the units and also forms part of the magnetic circuit, and the field coils which supply the magnetic field. The field coils are mounted on pole pieces which hold the coils in place, and also distribute the flux so that it flows evenly through the armature core and back through the frame. The armature is composed of the shaft, laminated iron core, the commutator, and the armature coils. The coils are wound in slots in the armature core, and the ends of the coils are clinched and soldered to the commutator bars. The commutator is composed



A—STRAP, GROUND, BATTERY
B—BATTERY
C—MOTOR, STARTING
D—CABLE, BATTERY TO STARTING SWITCH
E—CABLE, STARTING SWITCH TO STARTING MOTOR
F—SWITCH, STARTING
G—WIRE, STARTING SWITCH TO AMMETER
H—WIRE, INSTRUMENT PANEL LAMP TO OIL PRESSURE GAGE (GROUND)
J—LAMP, INSTRUMENT PANEL
K—SWITCH, IGNITION
L—WIRE, AMMETER TO INSTRUMENT PANEL
M—WIRE, AMMETER TO IGNITION SWITCH
N—AMMETER
P—WIRE, AMMETER TO TROUBLE LIGHT SOCKET
Q—WIRE, TROUBLE LIGHT SOCKET TO OIL PRESSURE GAGE (GROUND)
R—WIRE, GENERATOR REGULATOR TO AMMETER
S—SOCKET, TROUBLE LIGHT
T—WIRE, IGNITION SWITCH TO IGNITION COIL
U—REGULATOR, GENERATOR
V—COIL, IGNITION
W—CONDENSOR, IGNITION COIL
X—GENERATOR, BATTERY CHARGING
Y—CABLE, IGNITION COIL TO DISTRIBUTOR (SECONDARY)
Z—WIRE, IGNITION COIL TO DISTRIBUTOR (PRIMARY)
AA—DISTRIBUTOR, IGNITION
BB—CABLE, SPARK PLUG
CC—PLUG, SPARK

RA PD 44104

Figure 91 — Engine Wiring Diagram

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

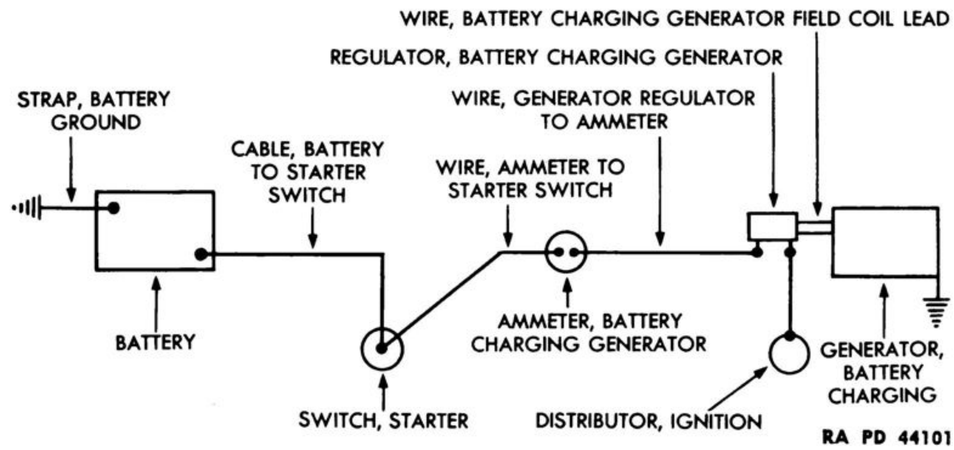


Figure 92 — Diagram of Battery Charging Generator Circuit

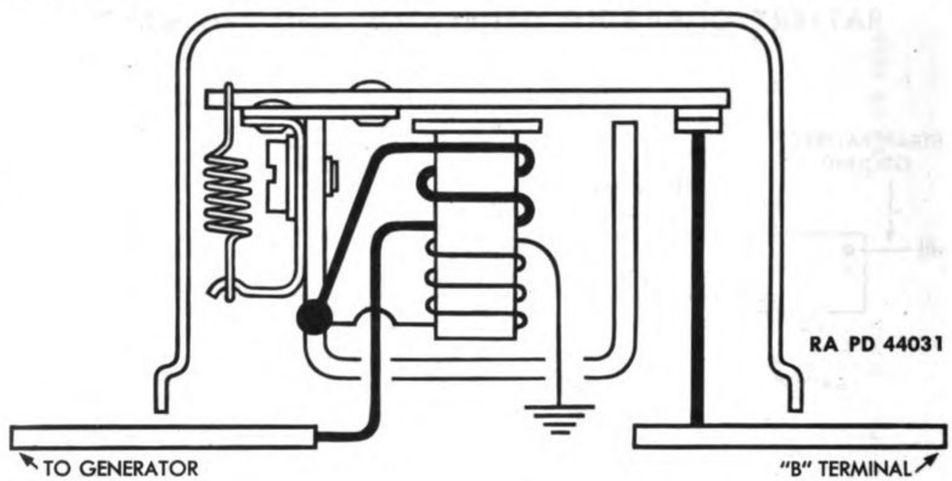
of copper wedges insulated from each other and from the shaft. The drive end head provides the support for the ball bearing and also supplies the mounting flange. The commutator end plate also supports a ball bearing and provides the support for the brush plates and arms. The brushes are mounted in these plates and are held against the commutator by the brush springs and arms. One of the brushes is grounded, and the other is connected to the armature terminal on the frame.

(3) To produce electrical energy, it is necessary to turn the armature. This causes the windings of the armature to cut the magnetic flux produced by the field coils. This cutting of a magnetic field by an electrical conductor produces a voltage in the armature conductors. The commutator and brushes are arranged so that the generated voltage is carried from the revolving armature to the armature terminal outside the generator. A small fraction of the current produced by the generator is bypassed through the field coils to produce the magnetic field. The output of the generator is determined by the strength of the field, and by the speed of the armature in cutting through the field. Since the speed of the generator cannot be regulated, the control of the generator output is accomplished by changing the field current. This is done by the action of the generator regulator.

(4) The generator windings are cooled by the action of a centrifugal fan mounted on the commutator end of the armature shaft. This fan draws air into the generator through the openings on the under side of the frame. The air passes over the armature and field windings, and through the holes in the commutator end plate, where it is expelled by the fan.

c. Generator Regulator.

(1) The generator regulator is a combination circuit breaker and



RA PD 44031

Figure 93 — Circuit Breaker Wiring Diagram

voltage regulator. The circuit breaker automatically opens and closes the circuit between generator and storage battery.

(2) The circuit breaker consists of an electromagnet and a set of contacts. The electromagnet has two windings; in one, the shunt coil is connected across the generator; in the other, the shunt coil is connected in series with the generator output (fig. 93).

(3) When the generator is charging the battery, the current is flowing through the shunt coil in one direction, and through the series coil in the opposite direction.

(4) The circuit breaker contacts consist of one movable contact mounted on an armature operated by the electromagnet and a stationary contact. These contacts are held open by an armature spring (fig. 94).

(5) When the generator is not running, the contacts are open. When the generator is started, the voltage builds up at the generator terminal and in the shunt coil. As soon as the voltage reaches the value for which the circuit breaker is calibrated, there is sufficient magnetism created by the shunt coil to pull down the armature. Close the contacts, and automatically connect the generator to the battery.

(6) With the contacts closed, the current in the series coil is flowing from the generator to the battery, or in the same direction as the current in the shunt coil, so that the pull on the armature is increased by the magnetism of the series coil.

(7) When the engine is stopping and the generator loses speed, the voltage falls. As soon as the generator voltage drops below the battery terminal voltage, the current flows from the battery to the generator, reversing the direction of the current in the series coil.

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

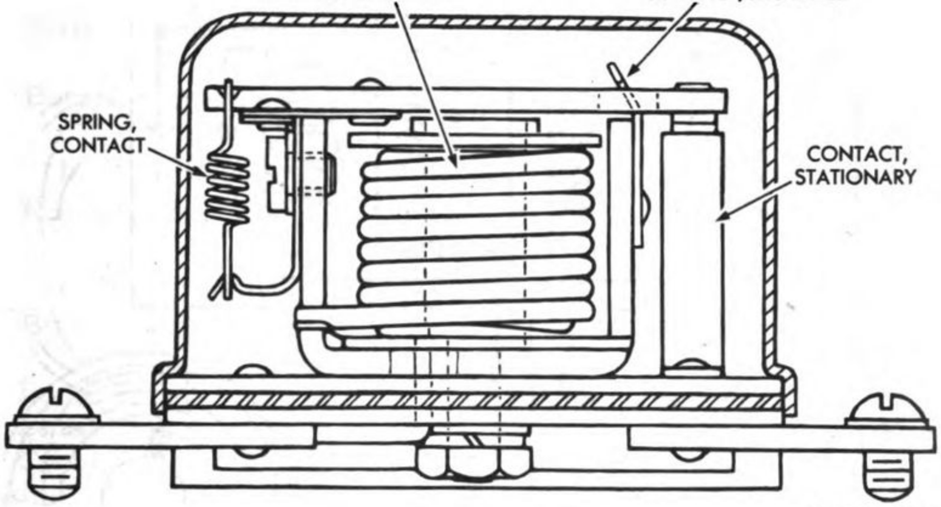


Figure 94 — Circuit Breaker — Cross Section View

Then the magnetism created by the series coil is opposed to the magnetism created by the shunt coil. This reduces the magnetic pull on the armature, and the spring opens the contacts, disconnecting the generator from the battery (fig. 94).

(8) The voltage regulator operates on the principle of inserting a resistance in the generator field circuit when the generator voltage reaches a predetermined value. To meet battery characteristic changes resulting from temperature changes, a magnetic bypass is used (fig. 95).

(9) The magnetic bypass type of compensation operates by varying the amount of magnetic pull exerted on the armature at any given voltage, according to the temperature.

(10) The magnetic bypass is a small piece of nickel-iron across the top of the magnetic core. The magnetic conductivity of this bypass gradually increases as its temperature is reduced. Thus, at low temperatures, much of the magnetic pull of the core, which would normally affect the cutting-in of the field resistance, flows through this bypass instead of the regulator armature. The result is that a higher generator voltage is required to open the contacts and cut in the field resistance.

(11) At high temperatures the magnetic conductivity of the bypass is reduced, allowing the magnetic pull of the core to have full effect on the regulator armature, and to cut in the field resistance at a lower generator voltage.

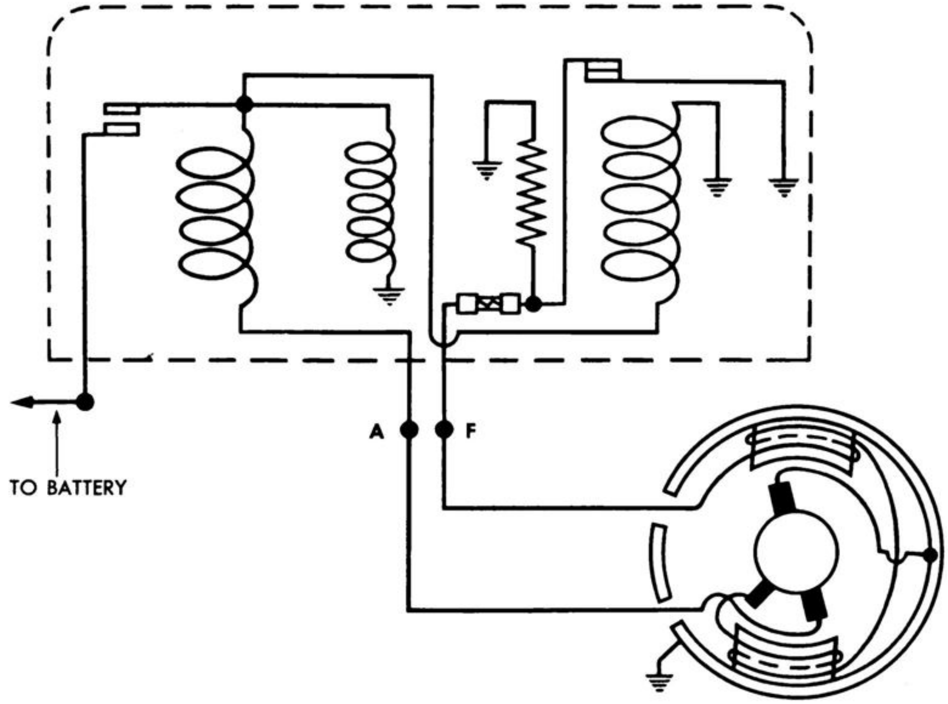


Figure 95 — Generator Regulator Wiring Diagram

81. SPECIFICATIONS.

a. Generator.

Make	Delco-Remy
Model	6-volt
Rotation	Clockwise, viewed from drive end
Number of brushes	3
Number of poles	4

b. Circuit Breaker.

Make	Auto-Lite
Model	TC-4323-C
Circuit breaker armature air gap	0.010 to 0.030 in.
Contact point gap	0.015 to 0.045 in.
Voltage regulator armature air gap	0.044 to 0.046 in.
Voltage regulator contact point gap	0.005 in. minimum

82. TROUBLE SHOOTING.

a. Low or No Generator Output.

Possible Cause	Possible Remedy
Dry battery.	Refill battery cells.
Poor battery condition.	Replace battery (par. 113).
Loose connections.	Tighten connections (par. 113).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

Possible Cause	Possible Remedy
Dirty connections.	Clean and tighten connections (par. 113).
Burned contacts on regulator.	Clean or replace contacts (par. 90).

b. High Discharge on Ammeter.

Regulator circuit breaker closed.	Repair or adjust circuit breaker (par. 90).

c. Noise at Engine Idle Speed.

Broken bearing.	Replace bearing (pars. 84 and 86).
Loose pulley.	Tighten pulley (par. 86).
Loose pole piece.	Tighten pole piece (par. 86).
Commutator damaged.	Repair commutator or replace armature (pars. 84 and 85).

d. Low Charging Rate.

Dirty commutator.	Clean commutator (par. 85).
Fan belt loose.	Adjust fan belt (par. 79).
Voltage regulator improperly adjusted.	Adjust regulator (par. 92).
High resistance in charging circuit.	Clean and tighten battery terminals and check circuit for loose connections (par. 113).
Third brush improperly adjusted.	Adjust third brush (par. 86).

e. High Charging Rate.

Third brush improperly adjusted.	Adjust third brush (par. 86).

83. GENERATOR REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.

b. Procedure.

(1) Disconnect ignition coil wire from battery charging generator regulator (screwdriver) (fig. 110).

(2) Disconnect ammeter wire from battery charging generator regulator (screwdriver) (fig. 110).

(3) Remove drive belt tension adjusting cap screw, lock washer, plain washer, and spacer (½-in. open-end wrench) (fig. 96).

(4) Remove generator mounting cap screw lock nut (⅝-inch open-end wrench) (fig. 96).

(5) Loosen the two mounting cap screws (½-in. open-end wrench) (fig. 96).

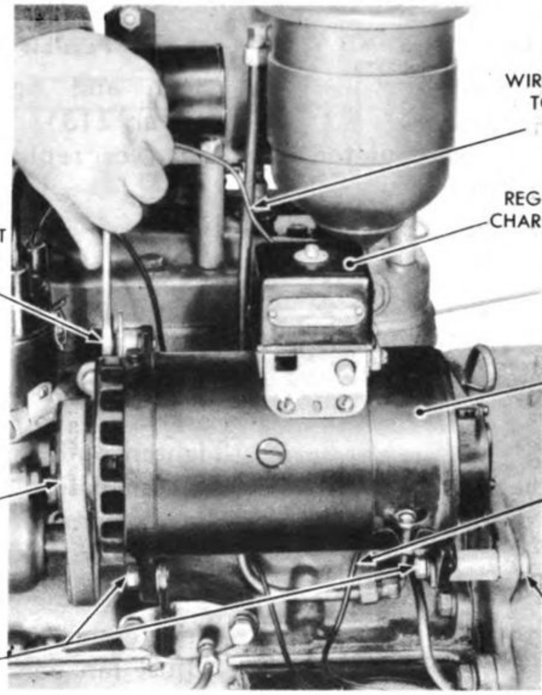


Figure 96 — Removing Battery Charging Generator

(6) Push generator toward engine, and lift off drive belt (fig. 96).

(7) Remove the two mounting cap screws, lock washers, and plain washers (½-in. open-end wrench). Also remove spacer at commutator end (fig. 96).

(8) Lift generator from engine (fig. 96).

84. GENERATOR DISASSEMBLY.

a. Equipment.

CHISEL, small	PULLER, pulley
DRIVER, bushing	SCREWDRIVER, large
HAMMER	SCREWDRIVER, small
HOOK, brush arm	WRENCH, adjustable
PLIERS	WRENCH, open-end, 1-in.
PRESS, arbor	

b. Procedure.

(1) Remove four generator regulator mounting screws (screwdriver), and lock washers.

(2) Remove two generator field coil lead screws (screwdriver) from regulator, and remove regulator. NOTE: The red lead from the generator is attached to terminal "A," and the black is attached to terminal "F" (fig. 97).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

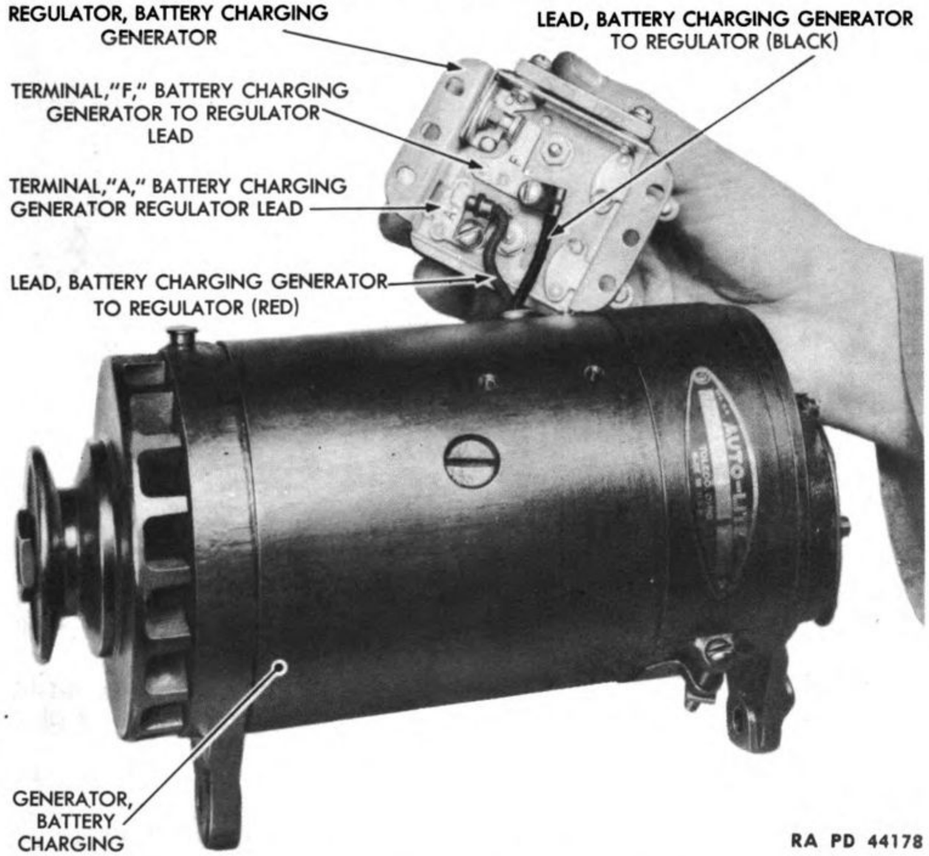


Figure 97 — Lifting Generator Regulator from Generator

(3) Remove clamp screw (screwdriver) and nut from cover band, and remove cover band from generator.

(4) Remove armature shaft nut (1-in. open-end wrench), and lift washer from drive pulley. Remove drive pulley key from armature shaft (fig. 98). Pull drive pulley from shaft (puller) (fig. 98). Remove driven pulley key and driven pulley.

(5) Remove brush lead screws and lock washers that hold brush leads to brush holder (screwdriver) (fig. 99).

(6) Make a hook on the end of a piece of wire, lift brush arms, and remove brushes from plates (fig. 99).

(7) Remove frame screws and lock washers from generator, and remove commutator end plate from frame and field assembly (screwdriver) (fig. 99).

(8) Pull brush arms and springs from brush plates (fig. 106).

(9) Remove screws and lock washers which hold main brush plate (grounded) to commutator end plate, and remove plate (screwdriver).

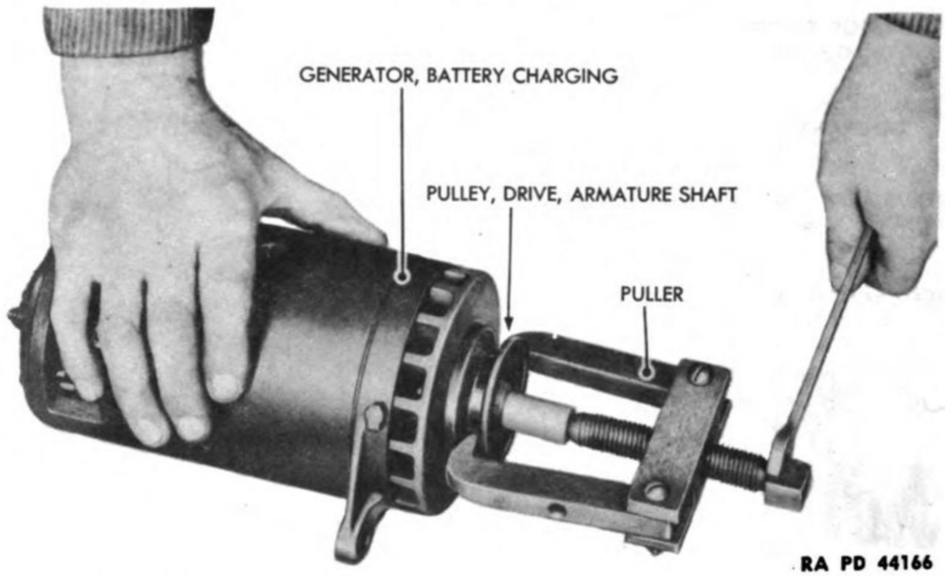


Figure 98 — Removing Drive Pulley from Armature Shaft

(10) Remove screw which holds third brush plate retaining spring, and remove spring and third brush plate from commutator end plate (screwdriver) (fig. 106).

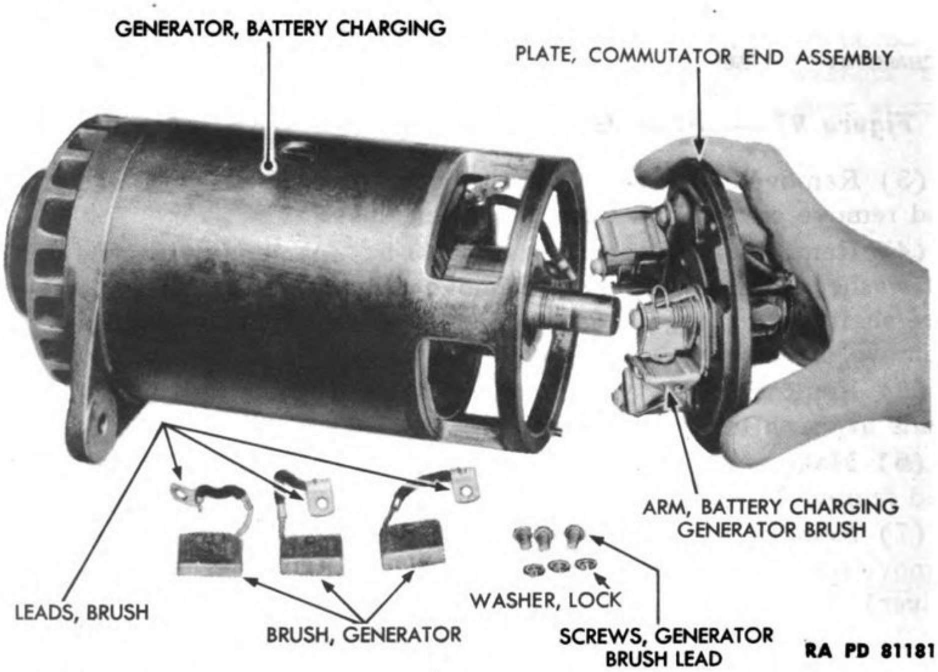


Figure 99 — Removing Commutator End Plate Assembly from Frame

**ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR**

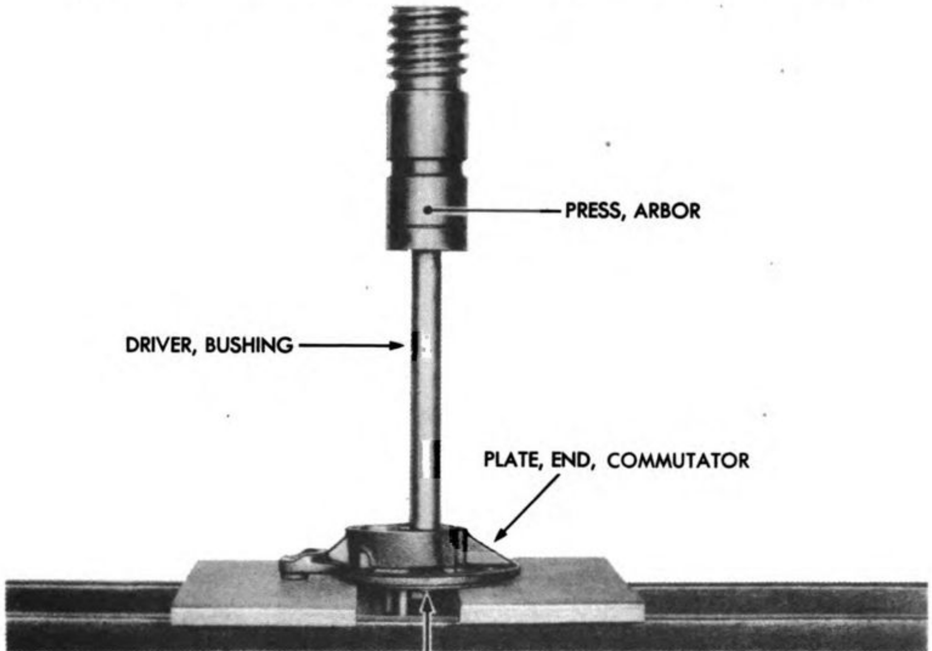


Figure 100 — Removing Commutator End Plate Bearing

(11) Remove screws and lock washers which secure commutator end cap cover to end plate, and remove cover and gasket (screwdriver).

(12) Press commutator end plate bearing (bushing driver and arbor press) from end plate (fig. 100). Commutator end plate, oil guard, and oil retaining gasket are forced from their positions while removing bearing.

(13) Remove commutator end plate oil wick cover (small chisel and hammer) and oil wick from commutator end plate.

(14) Remove drive end head and armature assembly from frame and field assembly.

(15) Remove screws (screwdriver), lock washers, and nuts which attach the two drive end head bearing retainers, felt washers, and felt guards to drive end head, and remove outer retainer, felt washer, and guard. The inner retainer, felt washer, and guard remain on armature and cannot be removed until ball bearing is pressed from the armature (fig. 106).

(16) Securely support inner race of ball bearing in an arbor press, and press ball bearing from armature shaft (driver and arbor press) (fig. 101).

(17) Remove inner felt guard, felt washer, felt washer retainer, bearing retainer from armature shaft (fig. 101).

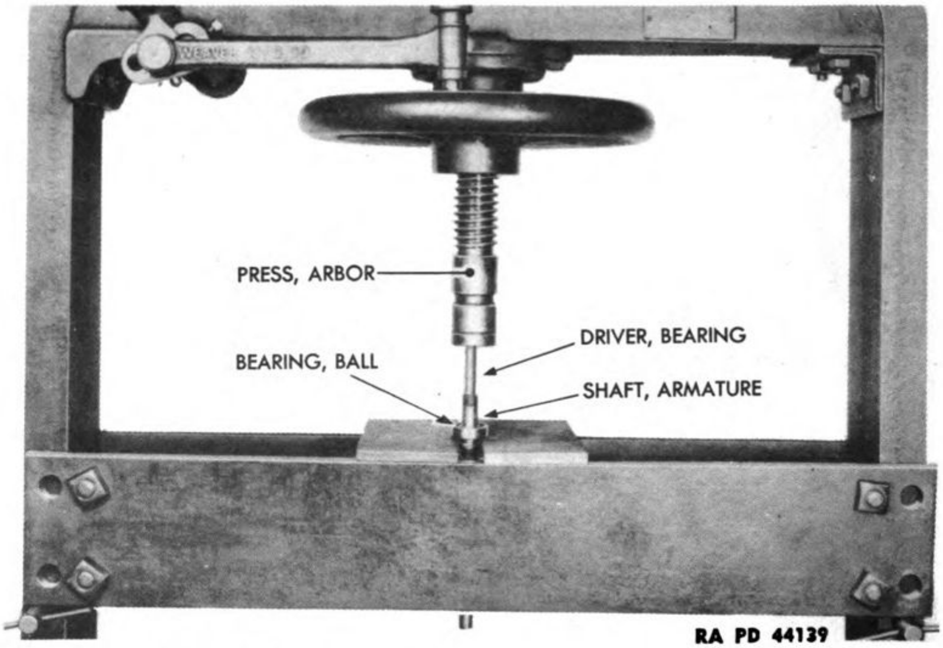


Figure 101 — Pressing Ball Bearing from Armature Shaft

(18) Remove snap ring from armature shaft (pliers and screwdriver).

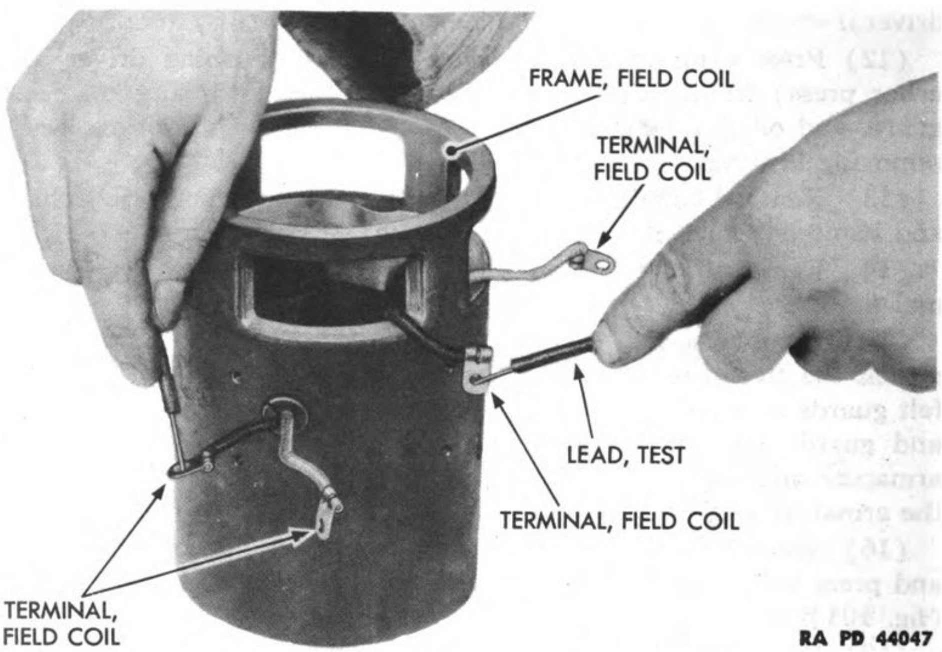


Figure 102 — Field Coil Test for Continuous Circuit

ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR

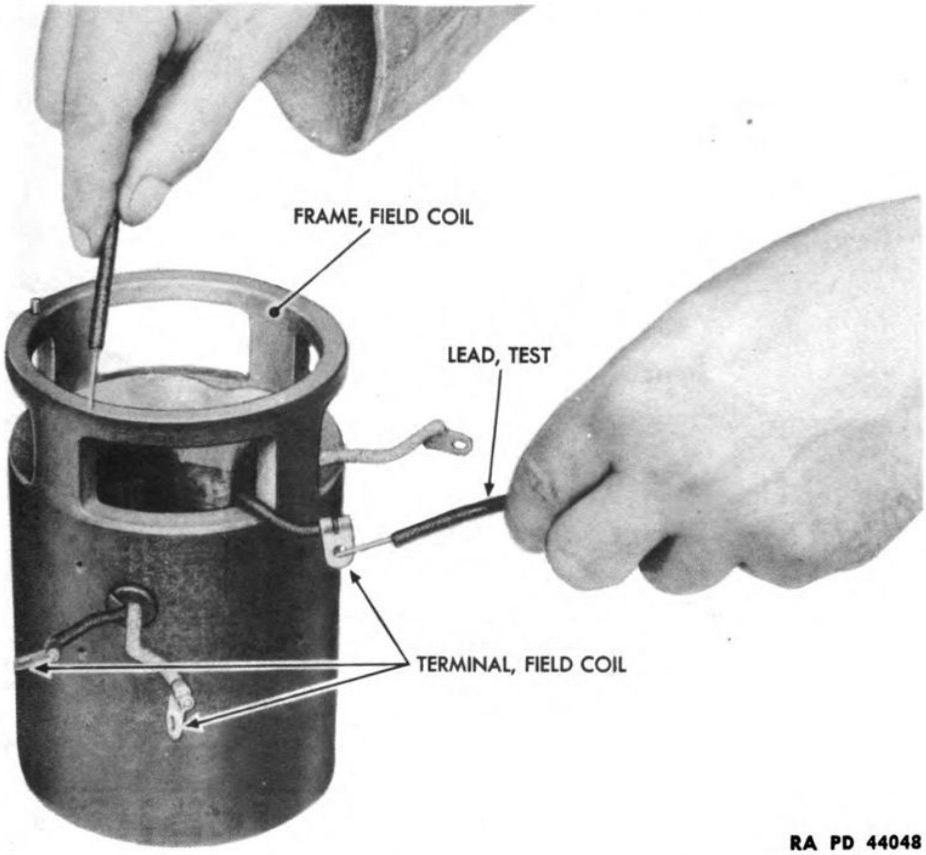


Figure 103 — Field Coil Test for Ground

(19) Remove two pole piece screws (large screwdriver and adjustable wrench) from frame.

(20) Remove insulating bushing from the frame by hand.

(21) Pull field coil leads to inside of frame, and remove field coil assembly and two pole pieces from frame.

(22) Remove pole pieces from field coil assembly.

85. GENERATOR INSPECTION AND REPAIR.

a. Equipment.

AMMETER, testing	LATHE
BATTERY, 6-volt	LEAD, test (2)
COMPRESSED AIR	PAPER, flint, class B, No. 00
GROWLER and TEST LAMP	SOLVENT, dry-cleaning
	UNDERCUTTER, mica

b. Procedure.

(1) FIELD COIL TEST FOR CONTINUOUS CIRCUIT (fig. 102).

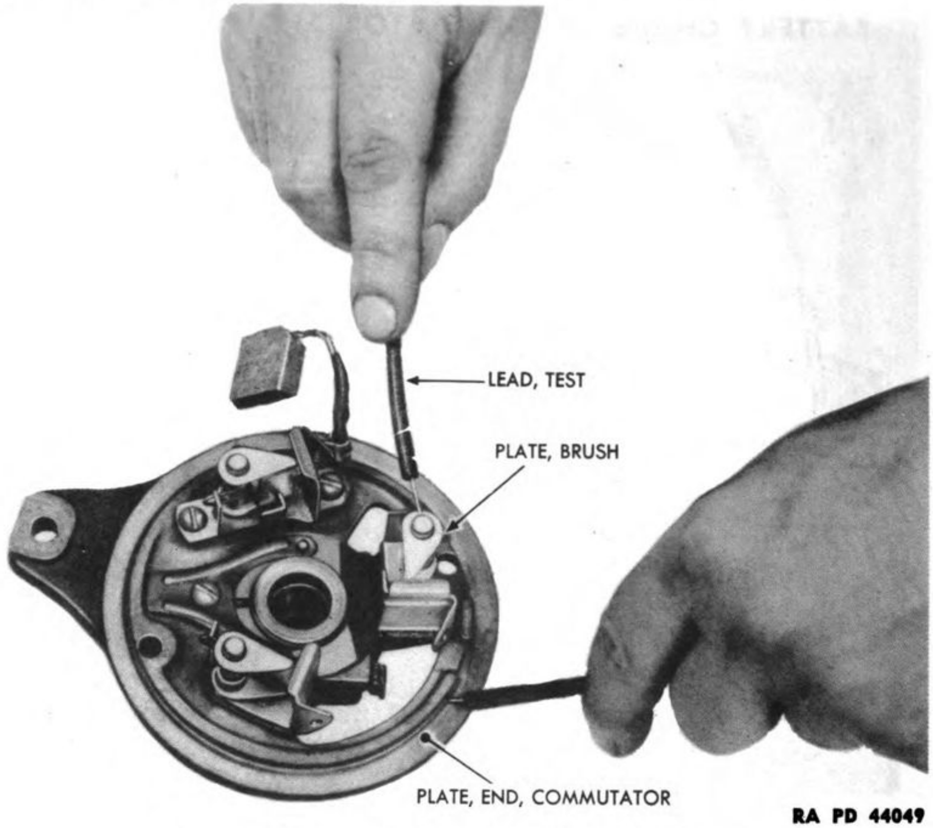


Figure 104 — Brush Plate Test for Ground

(a) Place test prod leads on the two leads from the field coils. If the test lamp lights, the field coils have no open circuit. If lamp does not light, one or both of field coils are open-circuited and should be replaced.

(b) To determine if one or both field coils are open-circuited, place one test prod lead on terminal lead from field coil, and the other on connection between field coils. If test lamp lights, field coils have no open circuit. If lamp does not light, field coil is open-circuited and must be replaced. Proceed in same manner to test other field coil.

(2) Place one end of a test lead on soldered connection, and the other end on positive terminal of battery. Place another test lead on one of the field coil terminals and on a testing ammeter. Take a reading from ammeter. Remove lead from field coil terminal and place on the other field coil terminal, and take reading from ammeter. If one field coil draws more current than the other, there is an internal short in field coil. Coil that draws the most current should be replaced.

(3) Place test prod leads, one on field coil frame and the other on a field coil terminal (fig. 103). If test lamp lights, field coil is

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

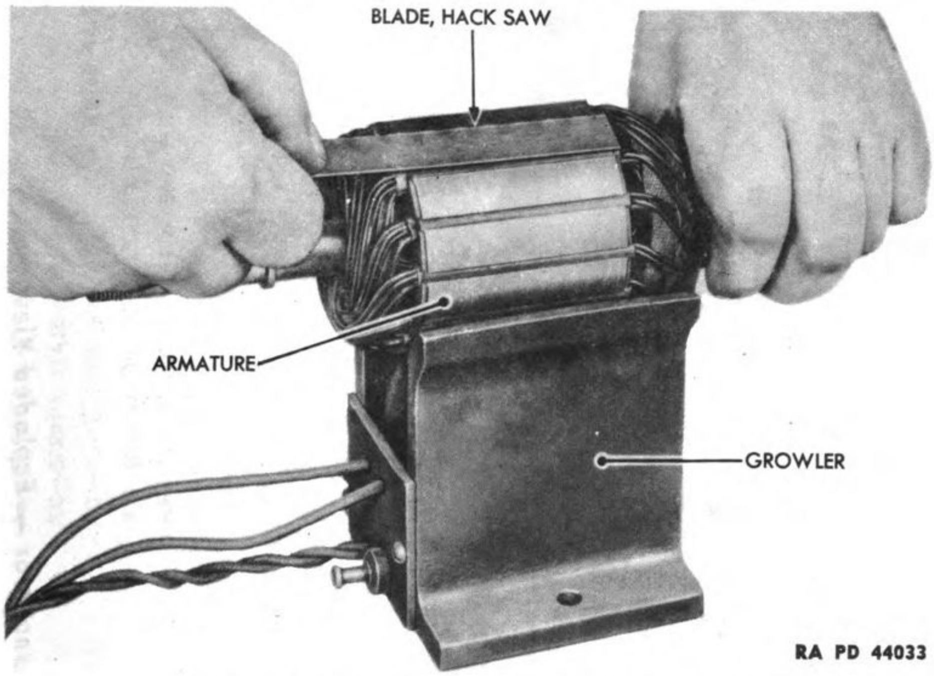


Figure 105 — Armature Test for Short

grounded and must be replaced. If test lamp does not light, field coil is satisfactory. Check other field coil in same manner.

(4) Place test prod leads, one on brush plate and the other on commutator end plate (fig. 104). If test lamp lights, positive brush holder is grounded and should be replaced. If test lamp does not light, brush holder is free of grounds.

(5) Place one test prod lead on armature and the other on one of the commutator bars. If test lamp lights, armature is grounded and should be replaced. If test lamp does not light, armature is not grounded. Proceed to test each commutator bar in turn until all have been tested.

(6) Place armature on growler and, with a hacksaw blade over armature core, rotate armature and test (fig. 105). If saw blade does not vibrate, armature has no shorts. If saw blade vibrates, armature is short-circuited. To determine whether armature windings or the commutator is shorted, clean out between commutator bars and re-check armature. If the saw blade still vibrates, armature windings are short-circuited, and armature must be replaced.

(7) Check fit of armature shaft in commutator end bearing. If bearing is worn, replace it.

(8) Clean drive end ball bearing in SOLVENT, dry-cleaning, and blow out with compressed air. Check ball bearing for wear or roughness. Replace if necessary.

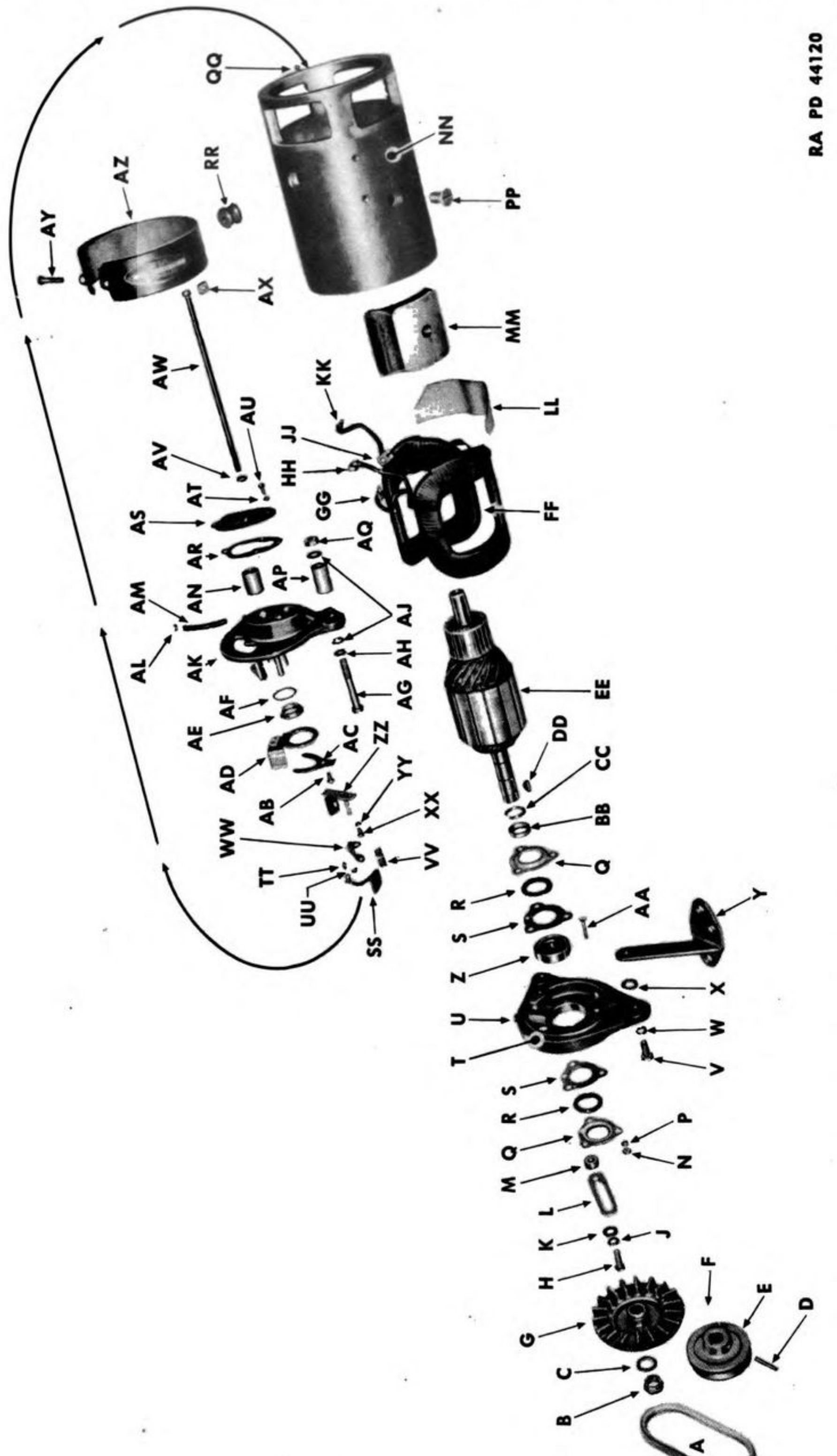


Figure 106 — Battery Charging Generator — Exploded View

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

A—BELT, DRIVE
B—NUT, ARMATURE SHAFT
C—WASHER, LOCK, ARMATURE SHAFT
D—PIN, DRIVE PULLEY
E—PULLEY, DRIVE
F—KEY, DRIVE PULLEY
G—PULLEY, DRIVEN
H—SCREW, ATTACHING
J—WASHER, LOCK
K—WASHER, PLAIN
L—BRACKET, ADJUSTABLE
M—SPACER, ADJUSTABLE BRACKET
N—NUT, BEARING RETAINER SCREW
P—WASHER, LOCK, BEARING RETAINER SCREW
Q—RETAINER, BEARING
R—WASHER, FELT, DRIVE END HEAD
S—GUARD, DRIVE END HEAD FELT WASHER
T—HEAD, DRIVE END
U—OILER, DRIVE END HEAD
V—SCREW, SUPPORT BRACKET
W—WASHER, LOCK, SUPPORT BRACKET
X—WASHER, PLAIN, SUPPORT BRACKET
Y—BRACKET, SUPPORT, GENERATOR
Z—BEARING, BALL, ARMATURE

AA—SCREW, BEARING RETAINER
BB—RETAINER, FELT WASHER
CC—RING, SNAP, ARMATURE SHAFT
DD—KEY, DRIVE PULLEY
EE—ARMATURE
FF—COIL, FIELD
GG—TERMINAL, FIELD COIL
HH—TERMINAL, FIELD COIL
JJ—TERMINAL, FIELD COIL
KK—TERMINAL, FIELD COIL
LL—INSULATION, FIELD CONNECTION
MM—PIECE, POLE, FRAME
NN—FRAME
PP—SCREW, POLE PIECE
QQ—PIN, DOWEL, FRAME
RR—BUSHING, FRAME INSULATING
SS—BRUSH
TT—WASHER, LOCK, BRUSH LEAD
UU—SCREW, BRUSH LEAD
VV—SPRING, BRUSH
WW—ARM, BRUSH
XX—SCREW, BRUSH PLATE
YY—WASHER, BRUSH PLATE
ZZ—PLATE, MAIN BRUSH (GROUNDED)

AB—SCREW, PLATE RETAINING
AC—SPRING, PLATE RETAINING
AD—PLATE, THIRD BRUSH
AE—GUARD, OIL, COMMUTATOR END PLATE
AF—GASKET, COMMUTATOR END PLATE OIL RETAINING
AG—BOLT
AH—WASHER, LOCK
AJ—WASHER, PLAIN
AK—PLATE, END, COMMUTATOR
AL—COVER, END PLATE OIL WICK
AM—WICK, OIL, END PLATE
AN—BEARING, END PLATE, COMMUTATOR
AP—SPACER, GENERATOR
AQ—NUT
AR—GASKET, COMMUTATOR END PLATE COVER
AS—COVER, END CAP
AT—WASHER, END CAP
AU—SCREW, END CAP COVER
AV—WASHER, LOCK, FRAME SCREW
AW—SCREW, FRAME
AX—NUT, HEAD BAND
AY—SCREW, HEAD BAND
AZ—BAND, HEAD

RA PD 44120B

Legend for Figure 106 — Battery Charging Generator — Exploded View

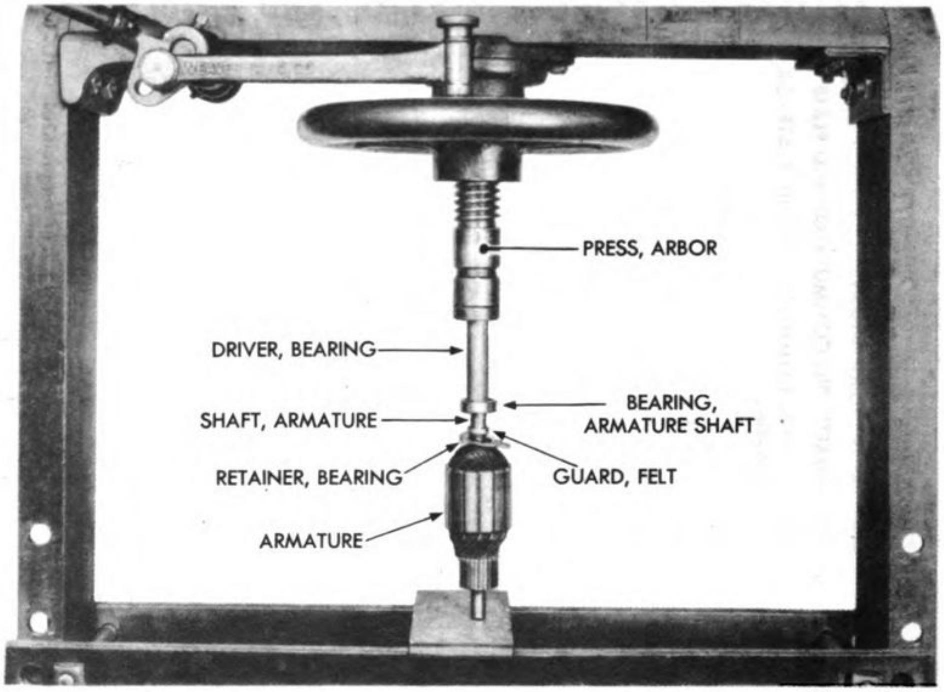


Figure 107 — Pressing Bearing on Armature Shaft

(9) Check armature to commutator leads. See that they are properly soldered to commutator.

(10) Check the commutator for roughness, and, if rough, turn it down on a lathe until it is thoroughly clean, after which sand off with PAPER, flint, class B, No. 00. Undercut the mica and again check armature for shorts on growler (fig. 105).

(11) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(12) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

86. GENERATOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
HOOK, brush arm
PLIERS
PRESS, arbor
SCREWDRIVER, heavy-duty
SCREWDRIVER, small
WRENCH, adjustable
WRENCH, open-end, 1-in.

b. Procedure (fig. 106).

(1) Assemble field coil assembly (FF) into frame (NN) and bring the field coil leads (GG, HH, JJ, and KK) to outside of frame (NN).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

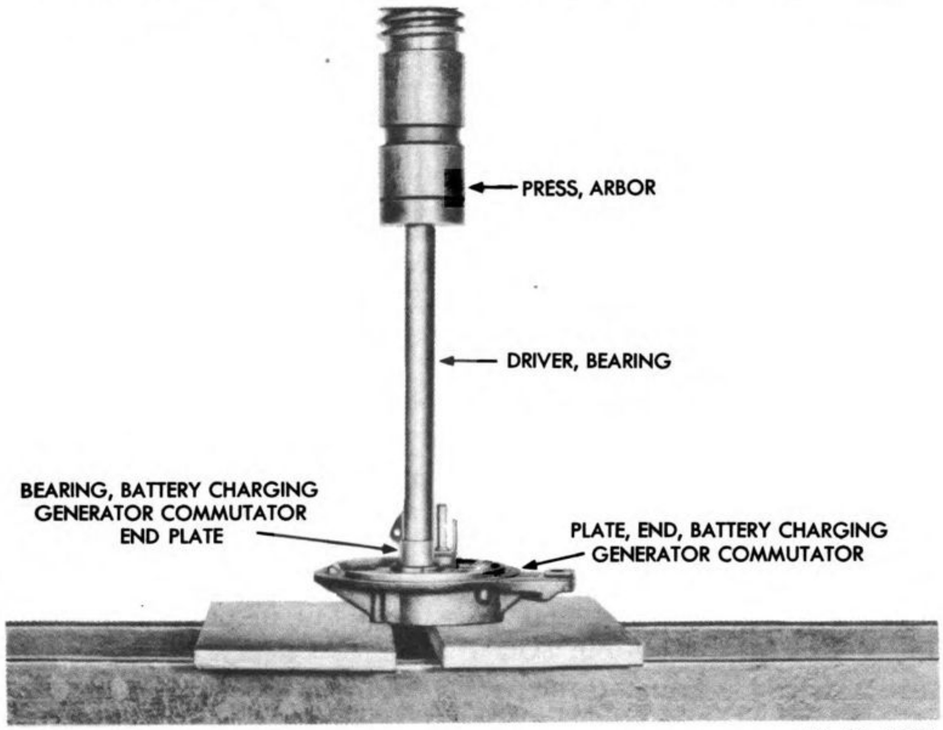


Figure 108 — Pressing Commutator End Plate Bearing into End Plate

(2) Assemble 2-pole pieces (MM) to inside of field coil (FF) and secure with pole piece screws (PP) (heavy-duty screwdriver and adjustable wrench).

(3) Assemble frame insulating bushing (RR) over field coil leads (GG, HH, JJ, and KK) and into frame (NN).

(4) Assemble snap ring (CC) to shaft of armature (EE) (pliers and screwdriver).

(5) Assemble felt retainer (BB), inner bearing retainer (Q), felt washer (R), and felt washer guard (S) onto armature shaft.

(6) Support armature (EE) in an arbor press, and press bearing (Z) (arbor press and bushing driver) on armature shaft. CAUTION: Pressure must be against inner race, as pressing on outer race will damage bearing (fig. 107).

(7) Assemble armature and bearing assembly to drive end head (T), and place outer felt guard (S), felt washer (R), and bearing retainer (Q) over armature shaft. Secure in place with three screws (AA) (screwdriver), lock washers (P), and nuts (N).

(8) Press bearing (AN) (arbor press and bushing driver) into commutator end plate (AK). Assemble oil retaining gasket (AF) over oil guard (AE), and tap (hammer) into place in end plate (AK) (fig. 108).

(9) Soak commutator end plate oil wick (AM) in OIL, engine (seasonal grade), and assemble oil wick (AM) and cover (AL) to end plate (AK).

(10) Assemble commutator end cap cover (AS) and gasket (AR) to end plate (AK), and secure in place with four screws (AU) and lock washers (AT) (screwdriver).

(11) Assemble third brush plate (AD) in its approximate position on end plate (AK), and secure in place retaining spring (AC) and screw (AB) (screwdriver) (fig. 106).

(12) Assemble main brush plate (ZZ) (grounded) to commutator end plate (AK), securing with two screws (XX) (screwdriver) and lock washers (YY).

(13) Place brush springs (VV) into brush arms (WW) and assemble to brush plate (ZZ).

(14) Place brushes (SS) in brush plates (ZZ) so that they will clear commutator when armature is assembled to frame. Attach brush lead wire terminal to brush plates with screws (UU) and washers (TT) (screwdriver).

(15) Place commutator end plate assembly in position on the frame (NN) over dowel pin (QQ).

(16) Assemble armature and drive end head assembly to frame and commutator end plate.

(17) Secure commutator end plate and drive end head to frame with two frame screws (AW) (screwdriver) and lock washers (AV).

(18) Place driven pulley (G) and key (DD) in armature shaft. Install drive pulley key (F) and drive pulley (E).

(19) Assemble armature shaft lock washer (C) and nut (B) on armature shaft. Tighten nut (1-in. open-end wrench) until drive pulley (E) is forced into its proper position, and insert drive pulley pin (D).

(20) Assemble two generator field coil leads to generator regulator, securing with two screws (screwdriver) and lock washers. NOTE: The red lead from generator is attached to terminal "A", and the black lead to terminal "F" (fig. 97).

(21) Secure generator regulator to generator with four screws and lock washers.

87. GENERATOR INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ⅝-in.
WRENCH, open-end, ½-in.

b. Procedure.

(1) Place battery charging generator in position on engine (fig. 96).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

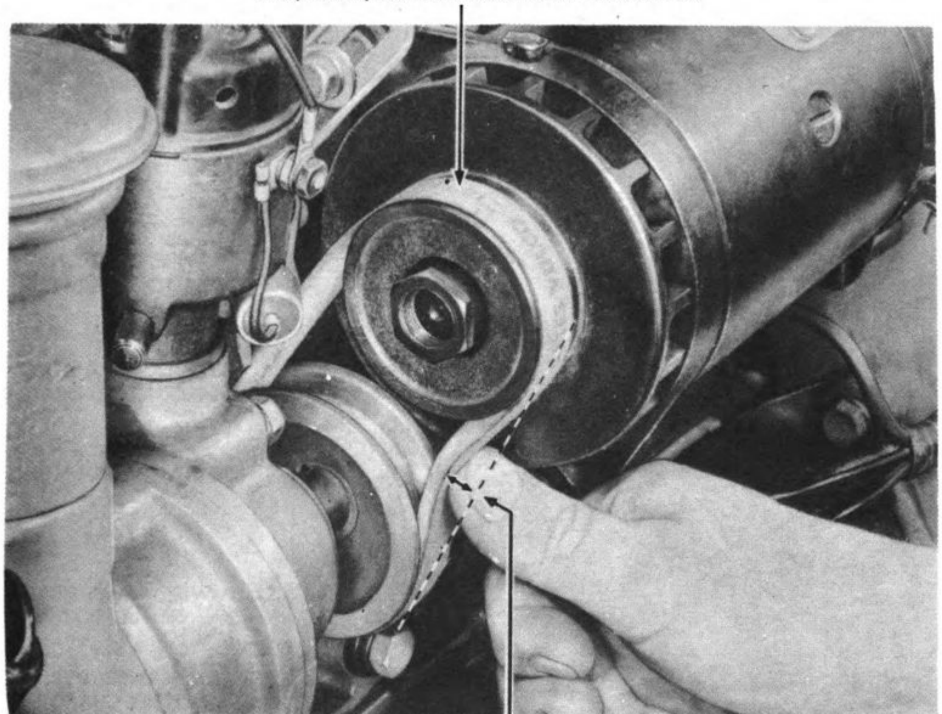


Figure 109 — Adjusting Generator Drive Belt Tension

(2) Install the two generator mounting cap screws, lock washers, and plain washers, placing the spacer between the commutator end plate and the tapped lug on the bell housing (fig. 96). Tighten cap screws finger tight.

(3) Place drive belt on its pulleys (fig. 96).

(4) Install adjustable bracket spacer (M), plain washer (K), lock washer (J), and cap screw (H) fingertight (fig. 106).

(5) Test tension of drive belt by pushing midway between pulleys (fig. 109). Push generator toward engine, or pull generator away from engine, until play of one-half inch is obtained. Tighten adjusting cap screw and mounting cap screws (½-in. open-end wrench) (fig.96).

(6) Install and tighten generator mounting cap screw lock nut (⅝-in. open-end wrench) (fig. 96).

(7) Connect ammeter wire to terminal marked "B" on engine side of battery charging generator regulator (screwdriver) (fig. 110).

(8) Connect ignition coil wire to terminal marked "T" on engine side of battery charging generator regulator (screwdriver) (fig. 110).

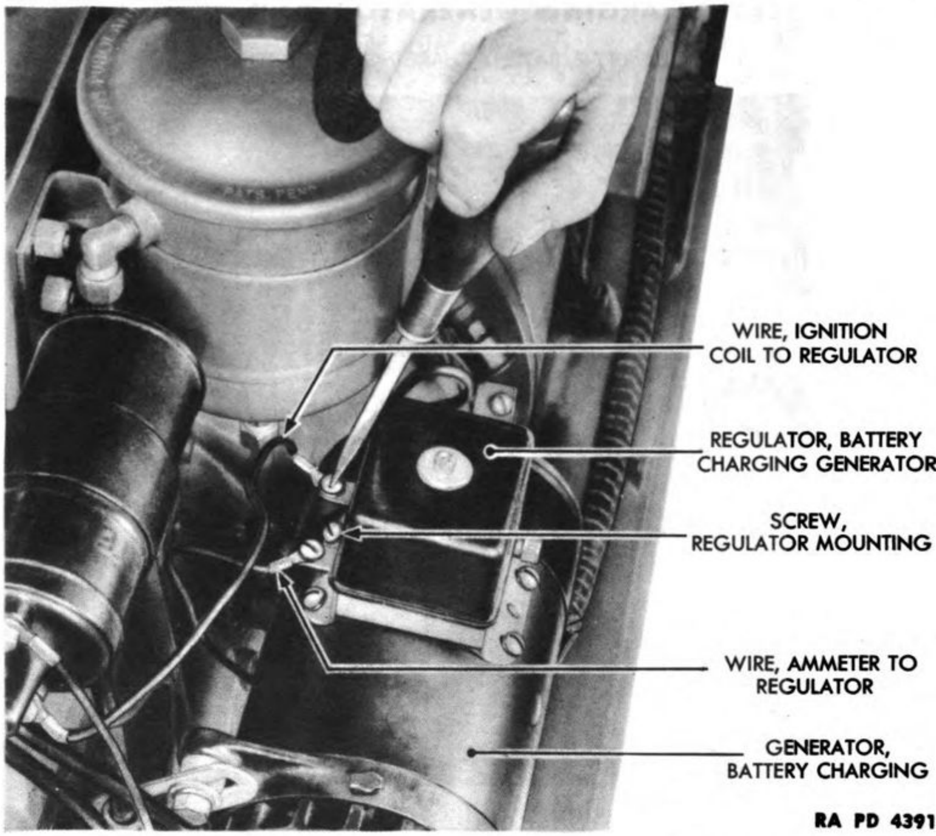


Figure 110 — Removing Generator Regulator

88. GENERATOR REGULATOR REMOVAL.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) Disconnect ignition coil wire from regulator (fig. 110).

(2) Disconnect ammeter wire from regulator (fig. 110).

(3) Remove the four regulator mounting screws and lock washers (fig. 110).

(4) Lift regulator from generator.

(5) Disconnect field and armature leads from bottom of regulator (fig. 97).

89. GENERATOR REGULATOR DISASSEMBLY.

a. Equipment.

PLIERS, thin-nosed SCREWDRIVER

b. Procedure.

(1) Remove cover nut (screwdriver) and lift cover from regulator (fig. 112).

ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR

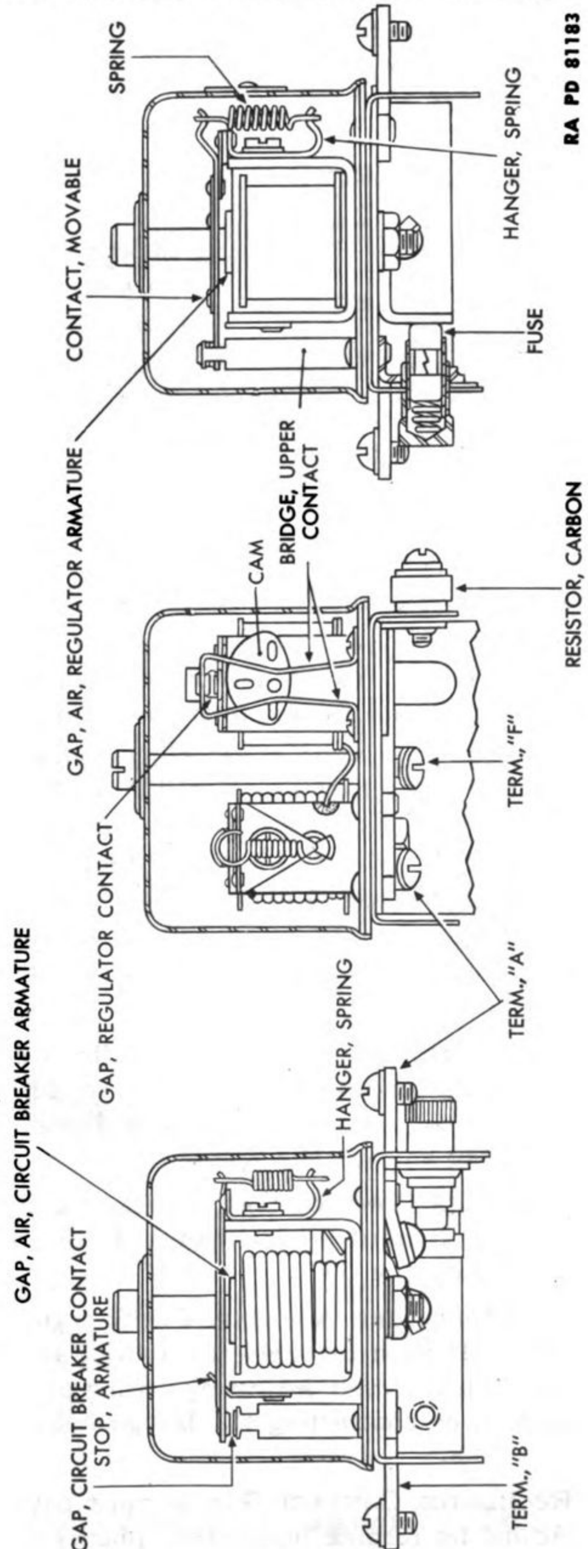


Figure 111 — Adjustment of Generator Regulator

(2) Remove carbon resistor screws (screwdriver), lock washers, and insulating washers, and lift off carbon resistor (fig. 112).

(3) Remove fuse cap, fuse insulation, and fuse from regulator body (thin-nosed pliers).

90. GENERATOR REGULATOR INSPECTION AND REPAIR.

a. Equipment.

CARBON TETRACHLORIDE
FILE (ST-290)
GAGE, set, feeler, 0.005- to 0.050-in.
OHMMETER
PLIERS, thin-nosed
SOLDERING EQUIPMENT
TAPE, linen

b. Procedure.

(1) Examine for evidence of burning, or abnormally high temperatures, at the coils, contacts, insulation, external terminals, or other points.

(2) Examine for loose connections resulting from poor soldering. Resolder loose connections.

(3) Examine for loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.

(4) CONTACTS. Clean all contacts by filing, parallel with length of the armature, with a very fine file (ST-290) so that they are free from pits and burning. Clean points with CARBON TETRACHLORIDE to remove any dirt or grease. Pull a piece of clean linen tape between contacts to remove any residue.

(5) CARBON RESISTOR. Check resistance of the carbon resistor with an ohmmeter. It must read 7 ohms, plus or minus 5 percent. Replace if necessary.

(6) CIRCUIT BREAKER ARMATURE AIR GAP. Check circuit breaker armature air gap (feeler gage). This check is made with contacts closed, and is adjusted by raising or lowering stationary contact. Adjust to 0.010 to 0.030 of an inch (fig. 111).

(7) CIRCUIT BREAKER CONTACT GAP. Check circuit breaker contact gap (feeler gage). It must be 0.015 to 0.045 of an inch. Adjust by bending armature stop (fig. 111).

(8) REGULATOR ARMATURE AIR GAP. Check regulator armature air gap (feeler gage). It must be 0.044 to 0.046 of an inch. Measure gap with regulator contact closed. Adjust by raising or lowering upper contact, by expanding or contracting the bridge holding upper contact (fig. 111).

(9) CHECK REGULATOR CONTACT GAP. It must have a 0.005-inch minimum gap. Adjust by turning brass cam (pliers) (fig. 111).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

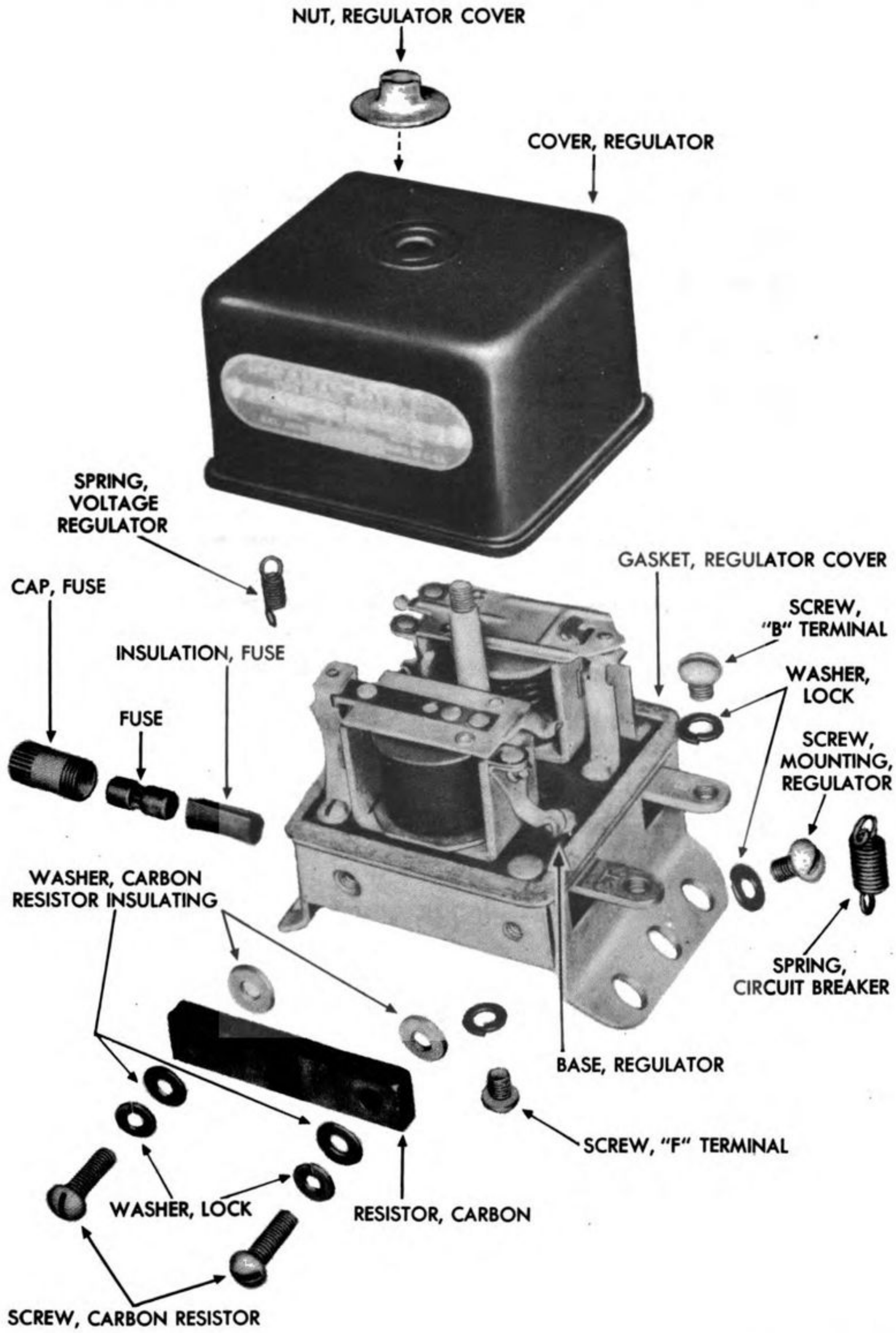


Figure 112 — Generator Regulator — Exploded View

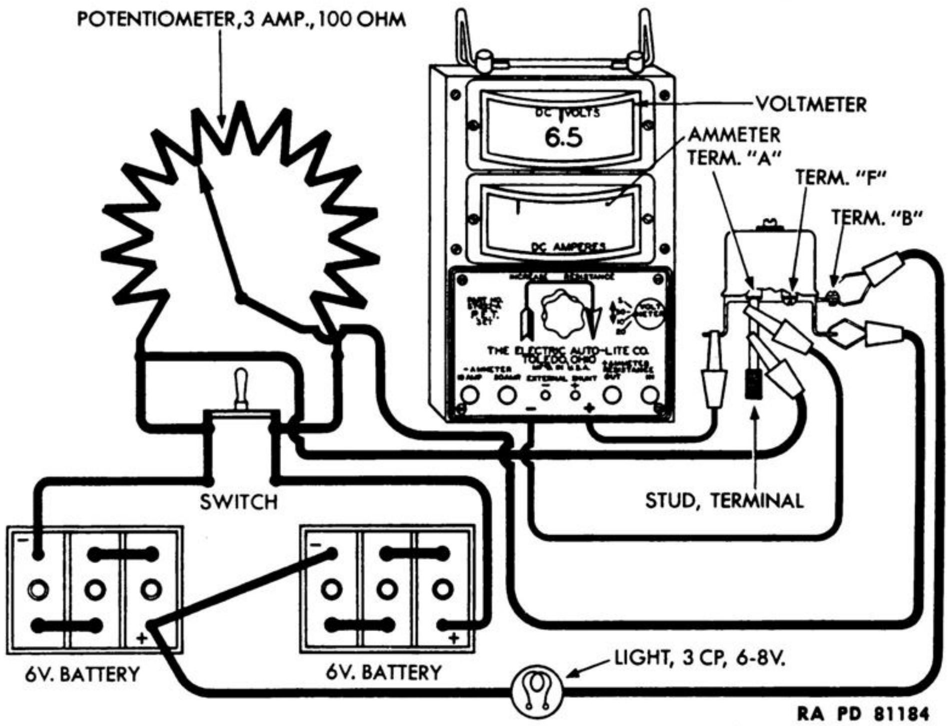


Figure 113 — Testing Generator Regulator — First Operation

91. BATTERY CHARGING GENERATOR REGULATOR ASSEMBLY.

a. Equipment.

PLIERS, thin-nosed	SCREWDRIVER

b. Procedure.

(1) Assemble fuse, fuse insulation, and fuse cap to regulator body (pliers) (fig. 112).

(2) Assemble carbon resistor, carbon resistor screw insulating washers, and two screws (screwdriver) and lock washers to regulator body (fig. 112).

(3) Place gasket on regulator body and assemble cover and cover nut (screwdriver) to regulator body (fig. 112).

92. BATTERY CHARGING GENERATOR REGULATOR TESTS.

a. Equipment.

AMMETER	POTENTIOMETER, 3-amp, 100-ohm
BATTERY, 6-volt (2)	VOLTMETER
LAMP, 3-cp, 6- to 8-volt	WIRE
LEAD	

b. Procedure.

(1) CHECK CIRCUIT BREAKER OPERATION.

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

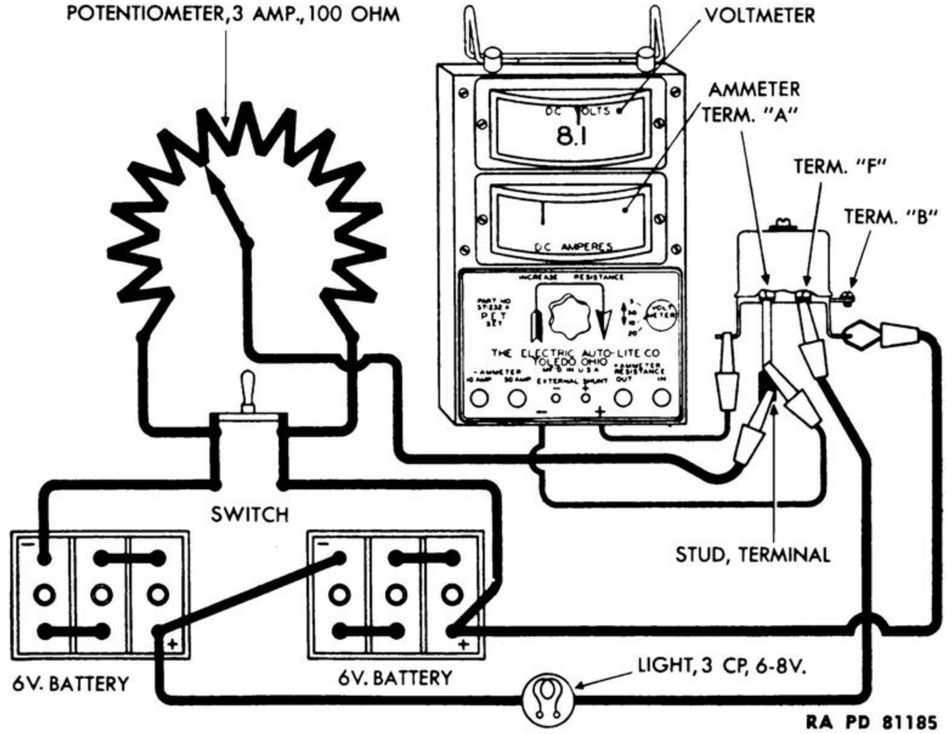


Figure 114 — Testing Generator Regulator — Second Operation

(a) Connect a voltmeter, ammeter, potentiometer, two 6-volt batteries, and a lamp, in series as per diagram (fig. 113).

(b) Increase voltage from zero and note voltage at which contact points close, as indicated by the lamp lighting (fig. 113).

(c) Voltage must be 6.4 to 7.0 volts. Adjust circuit breaker gap until voltmeter reading is within these limits (par. 90 **b** (6) and (7)).

(2) CHECK REGULATOR OPERATION.

(a) Connect a voltmeter, ammeter, potentiometer, two 6-volt batteries, and a lamp, in series as per diagram (fig. 114).

(b) Increase voltage from zero, and note voltage at which contacts open as indicated by lamp dimming or going out.

(c) This voltage figure must be within the specifications and at temperature shown in the following scale:

TEMPERATURE Fahrenheit	VOLTAGE High	Low	Ideal
50	8.40	7.90	8.15
60	8.32	7.82	8.07
70	8.25	7.75	8.00
80	8.18	7.68	7.93
90	8.10	6.60	7.85
100	8.03	7.53	7.78
110	7.96	6.46	7.71

(d) Adjust the regulator movable contact spring tension by bending spring hanger until readings fall within above scale (par. 90 **b** (8) and (9)).

(e) Reduce voltage and check contact closing voltage as indicated by lamp lighting. This voltage reading must be from 1.8 to 2.0 volts. Adjust gap by turning brass cam (fig. 111).

93. BATTERY CHARGING GENERATOR REGULATOR INSTALLATION.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) Attach generator field lead (red wire) to terminal marked "A" on bottom of regulator.

(2) Attach generator armature lead (black wire) to terminal marked "F" on bottom of regulator.

(3) Place regulator in position on generator (fig. 110).

(4) Install the four mounting screws and lock washers (fig. 110).

(5) Attach ignition coil wire to terminal marked "T" on engine side of battery regulator.

(6) Attach ammeter wire to terminal marked "B" on engine side of regulator.

Section XII

ENGINE ELECTRICAL SYSTEM: IGNITION

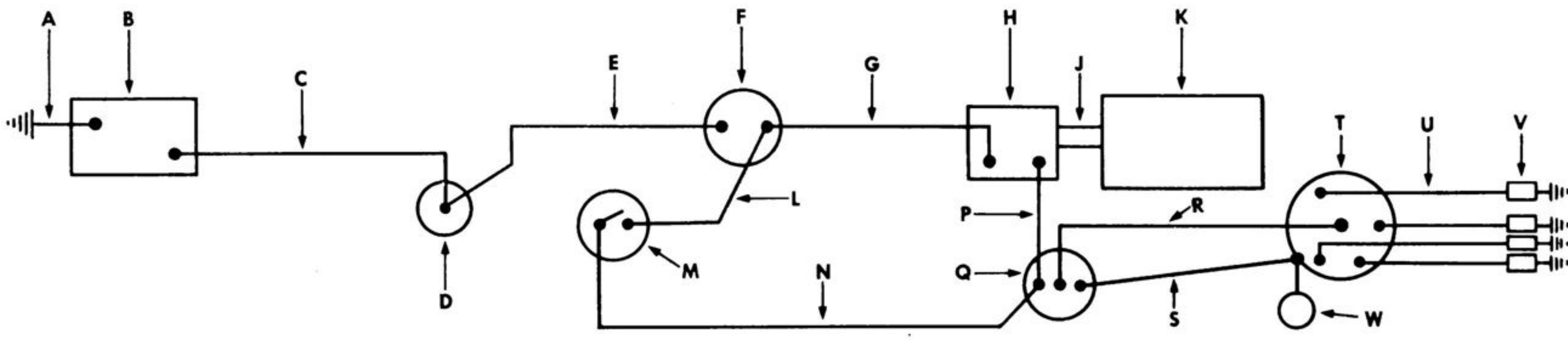
94. ENGINE IGNITION SYSTEM DESCRIPTION.

a. The engine ignition system consists of a coil, ignition distributor, condenser, spark plugs, and connecting wires. Its function is to provide electric current for operation of the engine.

b. The ignition coil is a self-contained unit consisting of an iron core around which are wound a few turns of wire to form the primary circuit, and several turns of wire to form the secondary circuit. The core and wires are enclosed in a sealed case to form the complete coil. Its function is to step up the low-tension current of the primary circuit to the high-tension current of the secondary circuit, which is needed to produce a spark across the points of the spark plugs by which the gasoline and air mixture in the cylinder is ignited.

c. The ignition distributor consists of a housing in which is enclosed a set of electrical contacts known as breaker points. A vertical shaft, driven by a gear on the engine camshaft, extends through the distributor housing. A cam is attached to this shaft within the housing, and is the means by which the breaker points are opened at proper intervals. Another contact, known as a rotor, is attached to the upper end of this shaft. A cap is attached to the top of the housing, and provides the means of connecting wires from the distributor to the spark plugs. The function of the distributor is to distribute high-tension electric current from the coil to the spark plugs at the instant it is needed to ignite the gasoline and air mixture in the cylinder.

d. A condenser is mounted on the lower half of the distributor and its wire is attached to a terminal at the top of the distributor housing. Its function is to stop the flow of low-tension current across



A—STRAP, GROUND, BATTERY
B—BATTERY
C—CABLE, BATTERY TO STARTER SWITCH
D—SWITCH, STARTER
E—WIRE, STARTER SWITCH TO AMMETER
F—AMMETER, BATTERY CHARGING GENERATOR
G—WIRE, REGULATOR TO AMMETER
H—REGULATOR, BATTERY CHARGING GENERATOR
J—LEADS, BATTERY CHARGING GENERATOR TO REGULATOR
K—GENERATOR, BATTERY CHARGING
L—WIRE, AMMETER TO IGNITION SWITCH
M—SWITCH, IGNITION
N—WIRE, IGNITION SWITCH TO IGNITION COIL
P—WIRE, REGULATOR TO IGNITION COIL
Q—COIL, IGNITION
R—CABLE, IGNITION COIL TO DISTRIBUTOR (SECONDARY)
S—WIRE, IGNITION COIL TO DISTRIBUTOR (PRIMARY)
T—DISTRIBUTOR, IGNITION
U—CABLE, IGNITION DISTRIBUTOR TO SPARK PLUG
V—PLUG, SPARK
W—CONDENSOR, IGNITION DISTRIBUTOR

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Figure 115 — Wiring Diagram of Ignition System

the distributor points the instant the points are opened. This permits more rapid energization of the secondary windings in the coil, and at the same time prevents burning the distributor breaker points.

e. The spark plug consists of a metal shell within which is located an insulator having a central electrode stem. The shell is threaded at one end to permit screwing into the cylinder head. The inner end of the shell carries a fixed, bent electrode extending from the side of the shell inward toward the central electrode stem located in the insulator. These electrodes are separated by an air gap. The outer end of the central electrode is threaded and fitted with a nut by which the wire from the distributor is attached.

95. SPECIFICATIONS.

a. Ignition Coil.

Make .... Auto-Lite
Model IG-4065
Primary voltage .... 6 volts

b. Distributor.

Make .... Auto-Lite
Type .... Full automatic
Model IGW-4120-B
Number of cylinders 4
Direction of rotation .... Right hand (viewed from top)
Breaker point gap .... 0.018 in.

c. Spark Plug.

Make .... Titan
Model 6
Type .... General purpose
Gap .... 0.025 in.

96. TROUBLE SHOOTING.

a. Ignition Coil.

(1) ENGINE FAILS TO FIRE.

Possible Cause	Possible Remedy
Excessive moisture on end of coil.	Wipe coil clean and dry.
Open circuit in primary or secondary circuit, or either circuit grounded outside of coil.	Check and tighten connections.
Windings grounded inside of coil.	Replace coil (par. 97).

Possible Cause	Possible Remedy
Short-circuited turns in primary or secondary windings, or high-voltage break-down in secondary windings.	Replace coil (par. 97).

(2) ENGINE MISSES DUE TO WEAK SPARK.

Internal short circuit in coil.	Replace ignition coil (par. 97).

b. Distributor.

(1) ENGINE WILL NOT START.

Breaker points not closing.	Check and adjust breaker points (par. 101). Replace if necessary (par. 100).
Breaker points worn.	Check breaker points and replace if necessary (par. 100).
Breaker point lever grounded.	Replace breaker points (par. 100).
Worn rotor or cap.	Examine and replace rotor or cap (par. 100).

(2) ENGINE MISFIRES IN ONE OR MORE CYLINDERS.

Broken cap or rotor.	Replace cap or rotor (par. 100).

(3) ENGINE MISSES AT LOW SPEED.

Breaker point gap too small.	Check and adjust gap (0.018 in.) (par. 101).

(4) ENGINE MISSES AT HIGH SPEED UNDER LOAD.

Breaker lever spring tension spring weak.	Replace breaker points (par. 100).
Breaker point gap too large.	Adjust gap (0.018 in.) (par. 101).

(5) WEAK SPARK AT PLUGS.

Breaker cam worn.	Install new cam assembly (pars. 99 and 101).
Breaker contact points worn or pitted.	Examine and replace contact points (par. 100).
Condenser shorted or disconnected.	Test connection or replace condenser (par. 100).

(6) TIMING INCORRECT OR IRREGULAR.

Breaker cam loose or wobbly.	Replace bushings in distributor housing.

c. Spark Plug.

(1) ENGINE MISSING SLIGHTLY; SLUGGISH OR IRREGULAR PERFORMANCE.

Improper spark plug gap.	Adjust spark plug gap to 0.025 inch (par. 104).

ENGINE ELECTRICAL SYSTEM: IGNITION

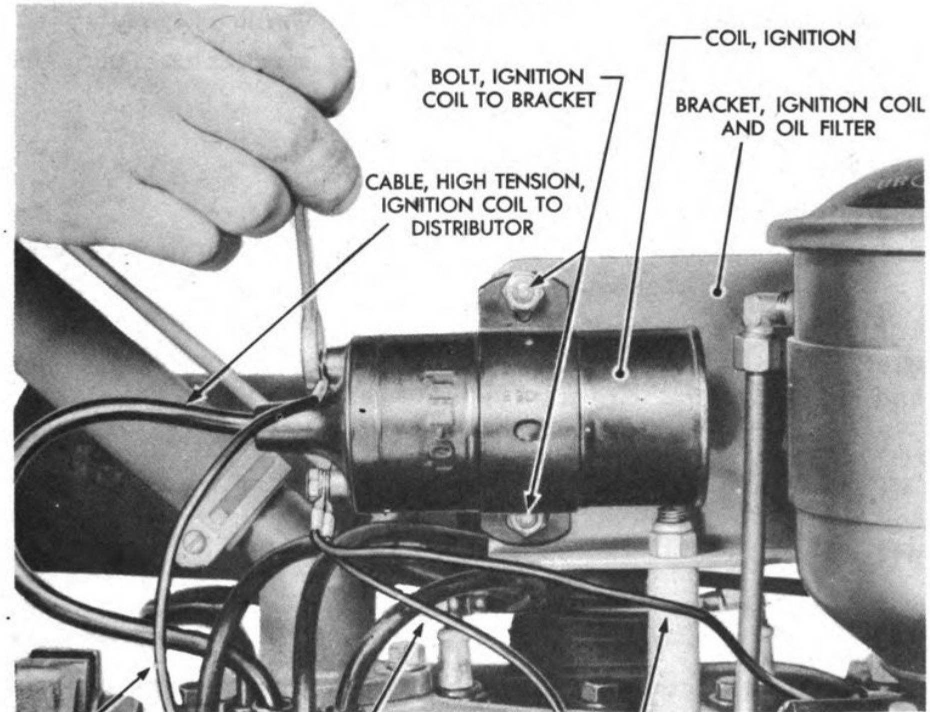


Figure 116 — Removing Ignition Coil

Possible Cause	Possible Remedy
Loose leaky spark plug threads.	Tighten or replace plugs or gaskets (par. 104).
Dirty spark plugs.	Clean and adjust spark plugs (par. 104).

(2) FAILURE TO GIVE SPARK.

Insulation broken.	Replace spark plug (par. 104).
Side electrode worn excessively.	Replace spark plug (par. 104).
Plug carbonized at inner end.	Clean spark plug (par. 104).
Insulation swollen, blistered, fused, or broken.	Replace spark plug (par. 104).
Electrodes showing signs of disintegration.	Replace spark plug (par. 104).
Leak around insulation, showing carbon streaks on outside.	Replace spark plug (par. 104).
Moisture on outside of spark plugs.	Wipe dry.
Points forced into contact due to careless handling when plug was installed.	Separate points and adjust gap (0.025 in.) (par. 104).

(3) ENGINE MISSING AT LOW SPEED ONLY.

Possible Cause	Possible Remedy
Insulator cracked at point outside of engine.	Replace spark plug (par. 104).

97. IGNITION COIL.

a. **Removal** (fig. 116).

WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

(1) Remove distributor wire from ignition coil (3/8-in. open-end wrench). Using the same wrench, remove generator regulator wire and ignition switch wire from ignition coil.

(2) Pull distributor high-tension cable from ignition coil.

(3) Remove the two nuts, lock washers, and bolts, and lift ignition coil from ignition coil and oil filter bracket (1/2- and 7/16-in. open-end wrenches).

b. **Inspection.**

TESTER, coil

(1) Place ignition coil in a coil tester, and check spark gap while running free and under load. If spark will jump a 1/4-inch gap under load, coil is suitable for further service.

(2) In the absence of coil testing equipment, compare performance with another coil known to be good. Replace coil if performance is not equal to ignition coil known to be good.

c. **Installation** (fig. 116).

WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

(1) Hold ignition coil in place on ignition coil and oil filter bracket. Install two bolts, lock washers, and nuts (1/2- and 7/16-in. open-end wrenches).

(2) Push distributor high-tension cable into tower on end of ignition coil.

(3) Attach distributor wire to positive terminal of ignition coil (3/8-in. open-end wrench).

(4) Attach generator regulator wire and ignition switch wire to negative terminal of ignition coil (3/8-in. open-end wrench).

98. DISTRIBUTOR REMOVAL.

a. **Equipment.**

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 11/16-in.

ENGINE ELECTRICAL SYSTEM: IGNITION

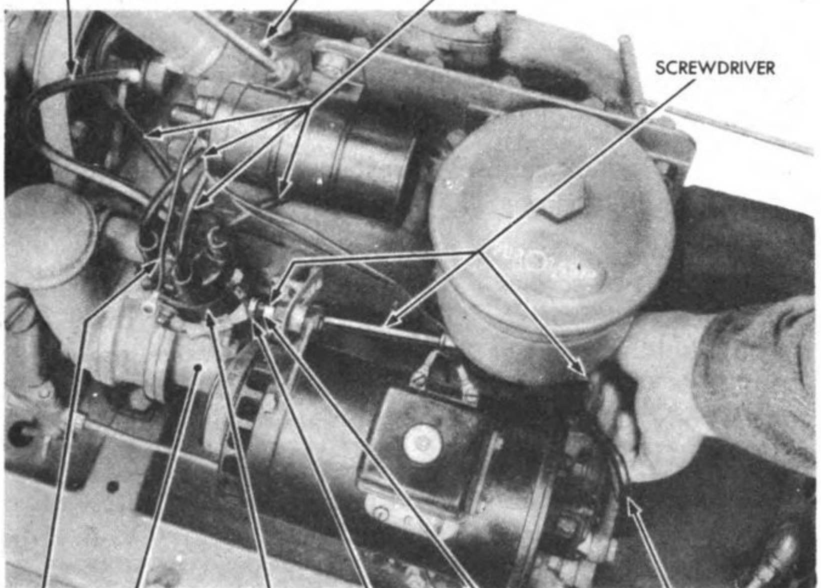


Figure 117 — Removing Distributor

b. Procedure (fig. 117).

(1) Pull spark plug wires from spark plugs. Pull ignition coil high-tension cable from ignition coil.

(2) Disconnect ignition coil wire from distributor (3/8-in. open-end wrench).

(3) Loosen distributor setscrew lock nut (11/16-in. open-end wrench).

(4) Loosen distributor setscrew (screwdriver).

(5) Lift distributor and distributor spacer from accessory drive housing.

99. DISTRIBUTOR DISASSEMBLY.

a. Equipment.

DRIVER, bushing	PUNCH
HAMMER	SCREWDRIVER
PLIERS, thin-nosed	WRENCH, open-end, 1/4-in.
PRESS, arbor	WRENCH, open-end, 3/8-in.

b. Procedure (fig. 119).

(1) Remove distributor cap (A) from body (X), and lift rotor (B) from cam (P) (fig. 119).

(2) Remove terminal nut (LL) from terminal (D), and remove lock washer (KK), condenser wire terminal, lock washer (JJ), and two terminal insulating washers (FF) from terminal (D) (3/8-in. open-end wrench) (fig. 119).

(3) Remove breaker arm of breaker point set (C) from circuit breaker plate (K), and lift out terminal (D) (fig. 119).

(4) Remove small terminal washer (G), insulation plate (F), terminal insulation bushing (H), and stop washer (E) from terminal (D) (fig. 119).

(5) Remove two screws (MM) and lock washers (NN) securing the two cap holding springs (PP) to the distributor body (X), and lift off cap holding springs (screwdriver). Remove machine screw (V) and lock washer (W) securing circuit breaker plate (K) to distributor body (X), and lift circuit breaker plate from body (screwdriver) (fig. 119).

(6) Unscrew point nut (J), and remove breaker screw of breaker point set (C) from circuit breaker plate (K) (1/4-in. open-end wrench).

(7) Remove screw (HH) and lock washer (GG) securing condenser (EE) to distributor body (X), and remove condenser (screwdriver) (fig. 119).

(8) Remove drive shaft gear pin (DD) from drive shaft gear (CC) and drive shaft (S) (punch and hammer) (fig. 119).

(9) Remove drive shaft gear (CC) and drive gear thrust washer (BB) from drive shaft (S) (fig. 119).

(10) Remove drive shaft and lower weight plate assembly (S), with governor weights (P) and upper weight plate and cam (P) attached, from body (X). Remove drive shaft thrust washer (T) from assembly (fig. 119).

(11) Remove governor weight springs (L) from lower-weight-plate-spring brackets and governor weights (R) (thin-nosed pliers) (fig. 119).

(12) Remove cam retaining spring (N) (hair pin type) (thin-nosed pliers) (fig. 119).

(13) Remove distributor cam and upper weight plate assembly (P) from distributor drive shaft (S) (fig. 119).

(14) Remove distributor governor weights (R) (fig. 119).

(15) Remove distributor governor weight spacer (Q) from distributor drive shaft (S) (fig. 119).

(16) Press drive shaft bushings (U and Z) from distributor body (X) (arbor press and bushing driver) (fig. 118).

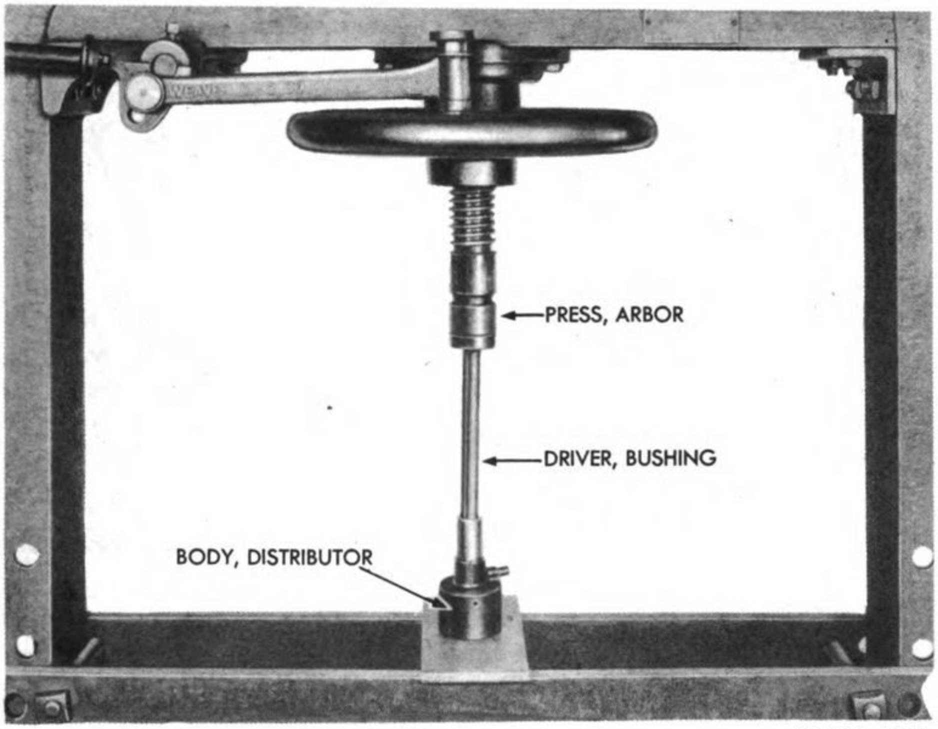


Figure 118 — Removing Bushings from Distributor Body

100. DISTRIBUTOR INSPECTION AND REPAIR.

a. Equipment.

INDICATOR, dial	SOLVENT, dry-cleaning
LAMP, test	STONE, honing
PRESS, arbor	TESTER, ignition circuit, M1

b. Procedure.

(1) DISTRIBUTOR CAP.

SOLVENT, dry-cleaning

(a) Inspect distributor cap for cracks, carbon streaks, and corroded high-tension terminals. Replace cap if any of these conditions are found.

(b) Inspect inserts on inside of cap. After a distributor has had normal use, the vertical face of the inserts becomes slightly burned. Clean with SOLVENT, dry-cleaning. *Do not file.* If burning is excessive, replace cap.

(c) Examine inserts for signs of burning on horizontal faces. If burning is noticeable at this point, it is an indication that gap between rotor and insert is too large. Replace both cap and rotor if this condition is found.

(2) ROTOR.

SOLVENT, dry-cleaning

(a) Inspect rotor for cracks, and replace if any are found. Inspect contact for evidence of burning on top of metal strip. After normal use, the end of metal strip will become slightly burned. Clean with SOLVENT, dry-cleaning. If evidence of burning is found on top of metal strip, replace rotor and cap.

(3) CONDENSER.

TESTER, ignition circuit, M1

(a) Check condenser on a Circuit Tester M1. Connect bare clip of low-tension lead to a ground on engine. Connect red clip to battery or starting switch terminal. Insert condenser in clip on tester, and attach short test lead to condenser pigtail.

(b) Place coil test switch at "test coil."

(c) Turn rotor switch on.

(d) Adjust variable spark gap to highest setting obtainable without missing.

(e) Move condenser test switch to "vehicle cord," and observe effect on high-tension output and on arcing at tester breaker contacts. Repeat test several times, changing position of condenser pigtail lead. If switching to "vehicle cord" does not result in arcing. and spark does not miss, condenser is satisfactory. If arcing does occur or spark misses, condenser is not functioning normally and must be replaced. If moving condenser lead affects action, it indicates a faulty lead and condenser must be replaced.

(4) BREAKER CONTACTS.

STONE, honing

Inspect the breaker contacts. If they are grayish in color and only slightly pitted, they need not be replaced. Make sure breaker arm turns freely on its pivot without excessive side play. Replace rough or pitted breaker contacts. If it is necessary to reinstall the old breaker contacts, hone them to a smooth flat surface on a stone before reinstalling. CAUTION: Do not file.

(5) SHAFT AND GOVERNOR.

SOLVENT, dry-cleaning

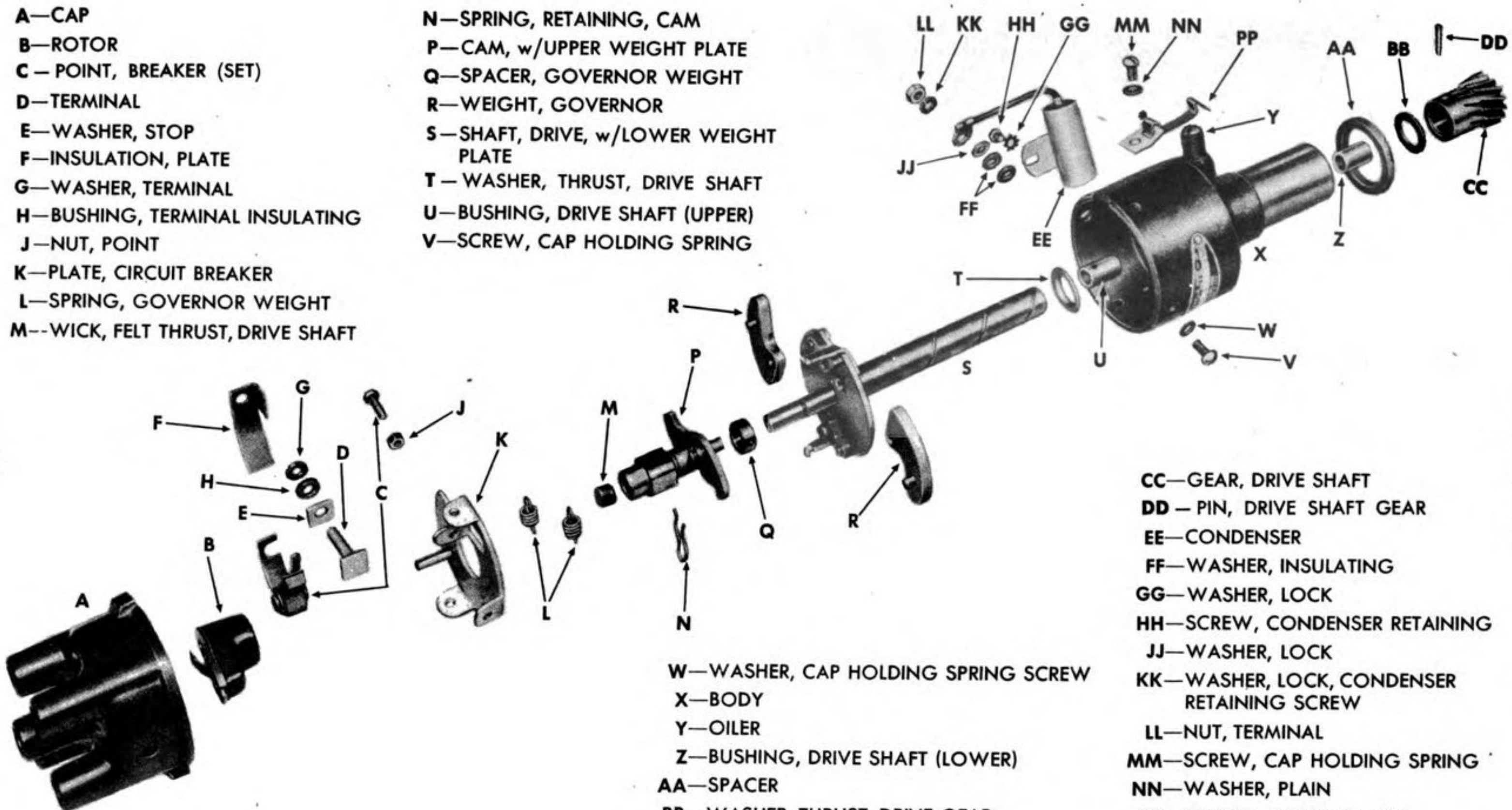
Clean the parts thoroughly in SOLVENT, dry-cleaning. Inspect governor weights and lower plate for wear. Inspect springs for distortion. Replace damaged parts.

(6) BASE.

ARBOR ( ) — PRESS, arbor
INDICATOR, dial — SOLVENT, dry-cleaning

(a) Clean base thoroughly in SOLVENT, dry-cleaning, and inspect for evidence of breakage.

ENGINE ELECTRICAL SYSTEM: IGNITION



A—CAP
B—ROTOR
C—POINT, BREAKER (SET)
D—TERMINAL
E—WASHER, STOP
F—INSULATION, PLATE
G—WASHER, TERMINAL
H—BUSHING, TERMINAL INSULATING
J—NUT, POINT
K—PLATE, CIRCUIT BREAKER
L—SPRING, GOVERNOR WEIGHT
M—WICK, FELT THRUST, DRIVE SHAFT

N—SPRING, RETAINING, CAM
P—CAM, w/UPPER WEIGHT PLATE
Q—SPACER, GOVERNOR WEIGHT
R—WEIGHT, GOVERNOR
S—SHAFT, DRIVE, w/LOWER WEIGHT PLATE
T—WASHER, THRUST, DRIVE SHAFT
U—BUSHING, DRIVE SHAFT (UPPER)
V—SCREW, CAP HOLDING SPRING

W—WASHER, CAP HOLDING SPRING SCREW
X—BODY
Y—OILER
Z—BUSHING, DRIVE SHAFT (LOWER)
AA—SPACER
BB—WASHER, THRUST, DRIVE GEAR

CC—GEAR, DRIVE SHAFT
DD—PIN, DRIVE SHAFT GEAR
EE—CONDENSER
FF—WASHER, INSULATING
GG—WASHER, LOCK
HH—SCREW, CONDENSER RETAINING
JJ—WASHER, LOCK
KK—WASHER, LOCK, CONDENSER RETAINING SCREW
LL—NUT, TERMINAL
MM—SCREW, CAP HOLDING SPRING
NN—WASHER, PLAIN
PP—SPRING, HOLDING, CAP

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Figure 119 — Distributor Assembly — Exploded View

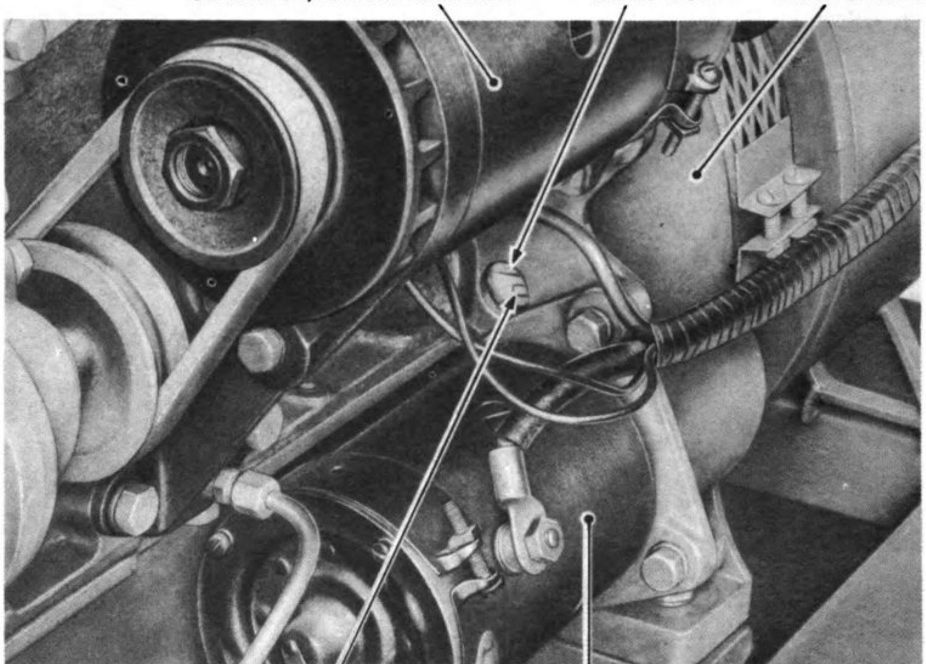

Figure 120 — Flywheel Timing Marks

(b) Place shaft and governor in base and, with a dial indicator, measure side play of shaft. Clamp indicator to base with point against shaft. Move shaft sideways and read indicator. If side play in any direction is over 0.005 inch, replace bushings (fig. 118). Drive bushings out of base and install new bushings (arbors).

(c) Place bushings on the arbor press and press into base, making lower bushing flush with base, and countersink upper bushing.

(7) CAM.

SOLVENT, dry-cleaning

Clean cam and upper weight plate in SOLVENT, dry-cleaning. Inspect cam and weight slots for evidence of wear. Replace cam if worn, or if slots do not have smooth, straight sides.

(8) BREAKER PLATE.

LAMP, test — SOLVENT, dry-cleaning

Clean breaker plate in SOLVENT, dry-cleaning, and inspect for stripped threads. With test lamp, check terminal for grounds. Touch one probe to plate and the other probe to terminal. If lamp lights, terminal is grounded and plate must be replaced.

ENGINE ELECTRICAL SYSTEM: IGNITION

101. DISTRIBUTOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
PLIERS, thin-nosed
PRESS, arbor
SCREWDRIVER
WRENCH, open-end, ¼-in.
WRENCH, open-end, ⅜-in.

b. Procedure (fig. 119).

(1) Place distributor body (X) in arbor press, and press upper drive shaft bushing (U) into body (X), making sure oilhole in bushing alines with oilhole in body. Press lower drive shaft bushing (Z) into body (X) (arbor press and bushing driver) (fig. 119).

(2) Assemble distributor governor weight spacer (Q) to the distributor drive shaft (S) with countersunk portion to top (fig. 119).

(3) Assemble distributor governor weights (R) to lower weight plate (fig. 119).

(4) Assemble cam and upper weight plate assembly (P) to drive shaft (S), making sure pins in upper weight plate enter holes in governor weights (R) and elongated holes in lower weight plate (fig. 119).

(5) Assemble the two governor weight springs (L) to plate and to pins in weights (R) (thin-nosed pliers) (fig. 119).

(6) Assemble cam and upper weight plate retaining spring (N) (hairpin type) to secure cam to drive shaft (S) (thin-nosed pliers) (fig. 119).

(7) Assemble distributor drive shaft thrust washer (T) to lower end of distributor drive shaft (S) (fig. 119).

(8) Assemble distributor drive gear thrust washer (BB) onto distributor drive shaft (fig. 119).

(9) Assemble distributor drive shaft (S), cam, and weight assembly (P) to distributor body (X) (fig. 119).

(10) Assemble distributor drive shaft gear (CC) to shaft (S), alining pinhole in gear (CC) with pinhole in shaft (S). Drive distributor drive pin (DD) in place and peen over both ends (hammer) (fig. 119).

(11) Install breaker screw of breaker point set (C) to circuit breaker plate (K) (¼-in. open-end wrench) (fig. 119).

(12) Assemble circuit breaker plate (K) to distributor body (X). Assemble cap-holding spring (PP), screws (V and MM), and plain washers (W and NN) to body and circuit breaker plate (screwdriver) (fig. 119).

(13) Assemble circuit breaker terminal stop washer (E), insulating bushing (H), and terminal washer (G) (small) to circuit breaker terminal (D) (fig. 119).

(14) Install terminal assembly in distributor body (X), and assemble terminal outside insulating washers (FF), shakeproof lock washer (JJ), condenser wire terminal, lock washer (KK), and nut (LL) to terminal. NOTE: Do not tighten nut (LL) (fig. 119).

(15) Assemble breaker arm of breaker point assembly (C) between square end of terminal (D) and square washer (E), and over pin in circuit breaker plate (K). Tighten terminal nut (LL) (3/8-in. open-end wrench) (fig. 119).

(16) Assemble condenser (EE) to distributor body (X) with screw (HH) and shakeproof lock washer (GG) (screwdriver) (fig. 119).

(17) With cam of breaker arm of breaker point set (C) on lobe of distributor cam, adjust breaker point gap to 0.018 inch. Install and tighten distributor point lock nut (J) (1/4-in. open-end wrench) (fig. 119).

(18) Assemble rotor (B) to distributor cam, and cap (A) to distributor body (X) (fig. 119).

102. DISTRIBUTOR TESTS AND ADJUSTMENTS.

a. Equipment.

FIXTURE, distributor test SCREWDRIVER

b. Procedure.

(1) Place distributor on a distributor test fixture, and set controls to measure cam angle or dwell. Operate distributor up and down the speed range, and note fluctuations in meter. Excessive fluctuation is caused by a worn cam or sticking contact pivot. Adjust reading to 41 degrees by changing contact point gap (screwdriver). Tighten lock nut after each adjustment. (This operation can be done on the unit only if the Ignition Circuit Tester M1 is available.)

(2) Adjust centrifugal advance. This operation can be done only on a fixture that will show the firing point in degrees and distributor speed in revolutions per minute.

(a) Run distributor at 250 distributor revolutions per minute and set dial at zero degrees.

(b) Increase speed up to 1,200 revolutions per minute and note advance. Specifications are 12 distributor degrees. If maximum advance is not within specifications, reduce speed below 250 revolutions per minute and note whether or not degree indicator drops below zero. If an indication below zero is shown, stop distributor. Bend out slightly outer spring bracket (fig. 119) (to which the weak weight spring is hooked), and again check at 1,200 revolutions per minute. If advance is still not 12 degrees, stop distributor and relieve the strong spring tension slightly by bending outer spring

bracket. Advance specifications at distributor revolutions per minute as follows:

Degrees:	0	2	9	11	12
Revolutions per minute:	250	310	500	970	1,200

103. DISTRIBUTOR INSTALLATION AND TIMING.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 11/16-in.
WRENCH, spark plug, 13/16-in.

b. Procedure.

(1) Remove spark plug (13/16-in. spark plug wrench) from No. 1 cylinder, and, with finger over spark plug hole, crank engine with hand crank until compression is felt.

(2) Continue cranking engine (very slowly) until the spark mark on the front face of the flywheel lines up with the mark on the bell housing casting across the center of the timing hole. Measured in inches on the flywheel, this mark is roughly 1 to 1 3/8 inches ahead of the "DC" mark. NOTE: Timing hole is located on the left or accessory drive side of the engine, just above the starting motor (fig. 120).

(3) Place distributor cap in position on distributor, and mark on distributor body the location of the No. 1 spark plug wire in distributor cap. Remove distributor cap.

(4) Position distributor spacer on top of accessory drive housing (fig. 121).

(5) Start gear end of distributor through its hole in accessory drive housing, with the oiler pointing toward the engine breather pipe, and the distributor rotor pointing toward the location mark made in step (4) above. Push distributor in position, allowing the distributor drive shaft gear to mesh with accessory drive gear, until distributor body rests on distributor spacer (fig. 121).

(6) Slightly rotate distributor base until breaker points are just beginning to open, when the rotor is moved to a clockwise direction. Lock distributor in this position with setscrew and lock nut (screwdriver and 11/16-in. open-end wrench). NOTE: Rotor can be sufficiently moved without cranking engine. After distributor is locked in position, the rotor must point toward location mark made on its base.

(7) Install spark plug (13/16-in. spark plug wrench) and distributor cap, and connect ignition coil wire (3/8-in. open-end wrench). NOTE: Engine firing order is 1-2-4-3. Spark plug wires removed from distributor cap should be replaced in this order, following around distributor cap in clockwise direction, with No. 1 spark plug

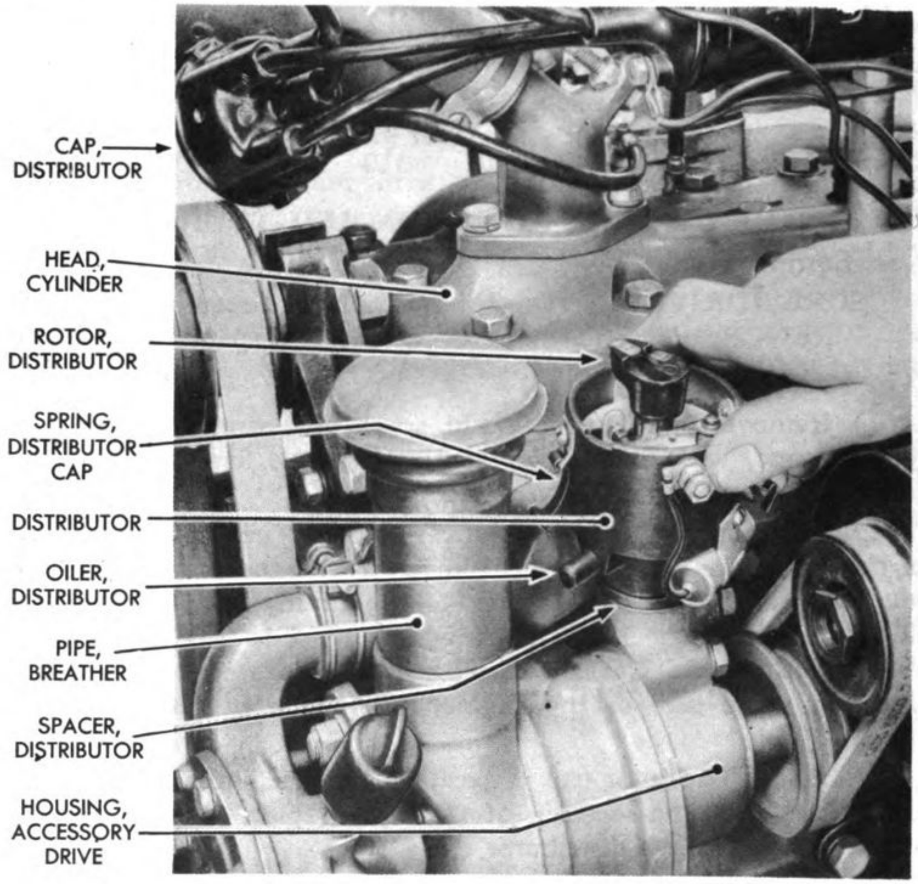

Figure 121 — Timing Distributor

wire in line with distributor rotor while No. 1 cylinder is in firing position.

104. SPARK PLUGS.

a. Removal (fig. 122).

WRENCH, spark plug, $^{13}\!/_{16}$-in.

(1) Pull spark plug wires from spark plugs (fig. 122).

(2) Remove spark plugs from cylinder head ($^{13}\!/_{16}$-in. spark plug wrench).

b. Inspection and Repair.

CLEANER, sand blast spark plug
GAGE, feeler
TESTER, spark plug
TOOL, spark plug adjusting

(1) TYPE OF SPARK PLUG. Examine the manufacturer's symbols on spark plug porcelain. Replace spark plug with proper type if wrong type is in use. Proper type is Titan No. 6, or its equivalent.

ENGINE ELECTRICAL SYSTEM: IGNITION

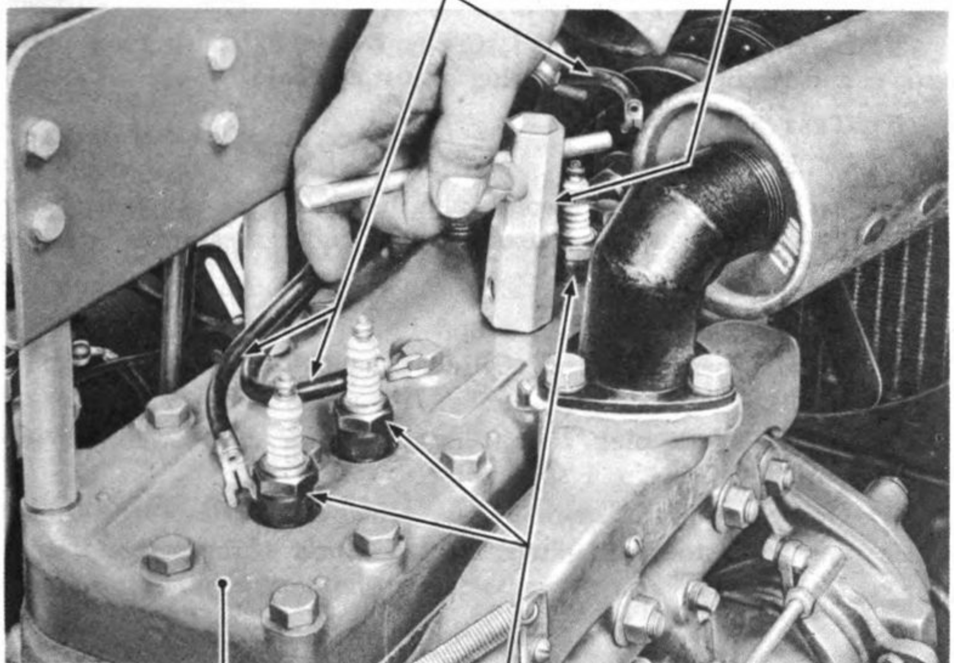

Figure 122 — Removing Spark Plug

(2) Inspect Electrodes. Examine the electrodes. Replace spark plug if electrodes are burned.

(3) Inspect Porcelain.

(a) Examine the porcelain. Replace spark plug if porcelain is cracked or broken.

(b) Note the color of the porcelain at the center electrode tip.

1. A light brown color indicates that the plug is operating correctly.

2. A glossy, black deposit indicates an excessive amount of oil in the combustion chamber. Check piston rings and pistons. Correct the fault.

3. A dull, black deposit indicates a rich fuel mixture, weak ignition, improper spark plug gaps, or weak compression. Locate and correct the cause.

(4) Clean Spark Plugs.

CLEANER, sand blast spark plug

(a) Clean each spark plug in a sand blast spark plug cleaner, or its equivalent.

(5) Set Spark Plug Gaps.

GAGE, feeler TOOL, spark plug adjusting

(a) Measure gap between electrodes of each spark plug (feeler gage). Proper clearance is 0.025 inch.

(b) Bend electrode attached to metal base of spark plug until proper gap is obtained (spark plug adjusting tool).

(6) TEST SPARK PLUGS.

TESTER, spark plug

Test each spark plug in a spark plug tester. Replace plug if spark fails to flow freely across electrodes while under pressure.

c. Installation.

WRENCH, spark plug, $^{13}/_{16}$-in.

(1) Install spark plugs in cylinder head ($^{13}/_{16}$-in. spark plug wrench) (fig. 122).

(2) Attach spark plug wire from distributor cap tower nearest No. 1 spark plug, to No. 1 spark plug.

(3) Going around distributor cap clockwise, attach remaining spark plug wires to spark plugs Nos. 2, 4, and 3, respectively.

Section XIII

ENGINE ELECTRICAL SYSTEM: STARTING MOTOR AND BATTERY

Paragraph

105. DESCRIPTION AND CONSTRUCTION.

a. General. The starting system consists of a battery, starter switch, and starting motor, connected with heavy cables.

b. Starting System Construction.

(1) The starting motor is of the four brush type with Bendix drive. It is mounted on the flywheel housing at the lower left-hand side of the engine. The motor consists of a frame and field assembly, armature, and end plates. The four pole pieces and the four field coils are mounted in the frame. The field coils are connected in series. One lead of the coils is connected to an insulated terminal post, which passes through the frame. The other lead is connected to the brushes, which are held in brush holders in the commutator end plate. The commutator end plate is held to the frame by four screws and lock washers, and carries the four brush holders and springs. The armature shaft is mounted on bronze bearings in the commutator end plate and in the drive end head.

(2) The Bendix drive is mounted on the drive end of the armature. It gears the starting motor to the engine when the starter switch is closed, and releases it when the engine is started. It consists of a gear mounted on a hollow spiral shaft connected by splines to the armature shaft.

(3) The battery is a 6-volt, 120-ampere-hour battery. It is connected to the unit on the negative side by a battery ground strap. The positive post is connected to the starter switch by a cable.

(4) The starter switch is a manual type, mounted on the instrument panel. It has a set of contacts that are closed when the switch is depressed, and opened by a spring when released.

c. Operation of Starting System. When the starting switch is depressed, current from the battery flows to the starting motor terminal,

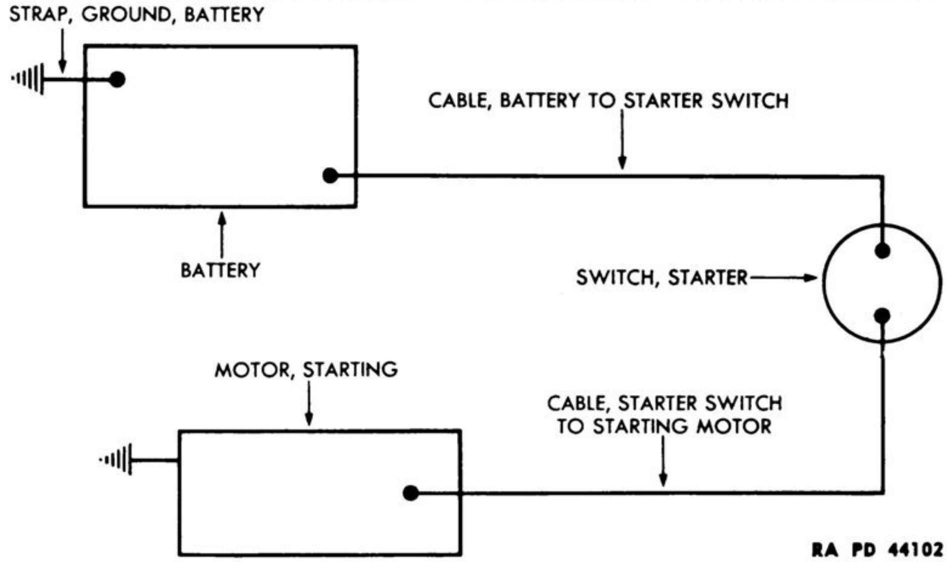

Figure 123 — Starting Motor Circuit

through the field coils to the insulated brushes, then through the armature coils and back through the commutator to the grounded brushes. The current in the field coils sets up a magnetic field, and the current in the armature coils sets up an opposing magnetic field. It is the force of these opposing fields which causes the armature to turn and produce the cranking torque. When the armature revolves, it turns a sleeve within the Bendix pinion and forces the gear forward, meshing it with the flywheel gear. The sudden shock of meshing is absorbed by the spring. When the engine starts, the pinion is driven faster than the sleeve, and is forced back along the threads, which automatically disengages the pinion from the flywheel.

106. SPECIFICATIONS.

a. Starting Motor.

Make .... Auto-Lite
Model MZ-4063
Rotation .... Clockwise, viewed from front

b. Bendix Drive.

Make .... Bendix-Eclipse
Model EBA-6
Rotation .... Clockwise, viewed from front

c. Battery.

Make .... Delco
Voltage .... 6 volts
Amperes .... 120 ampere-hours

d. Starting Switch.

Make .... Auto-Lite
Type 2-pole

ENGINE ELECTRICAL SYSTEM: STARTING MOTOR AND BATTERY

107. TROUBLE SHOOTING.

a. Starting Motor Fails to Operate.

Possible Cause	Possible Remedy
Battery discharged.	Recharge battery (par. 113).
Loose and dirty connections.	Clean and tighten connections.
Bendix gear jammed.	Free gear from flywheel.
Starting motor switch faulty.	Replace switch.
Bendix drive inoperative.	Remove starter and repair, or replace Bendix drive (pars. 108, 109, 110, and 111).

b. Starting Motor Cranks Weakly.

Battery weak.	Recharge battery (par. 113).
Loose or dirty connections.	Clean and tighten connections.
Commutator dirty.	Clean commutator with PAPER, flint, class B, No. 00 (par. 110).
Starting motor inoperative.	Remove, repair or replace starting motor (pars. 108, 109, 110, and 111).

c. Bendix Drive Fails to Operate When Starting Motor Revolves.

Dirty or gummy Bendix drive.	Remove starting motor (par. 108). Clean drive.
Drive spring broken.	Remove starting motor and replace drive spring (pars. 108, 109, 110, and 111).
Motor runs in wrong direction.	Change field leads to brushes or rotate brush assembly 90 degrees.

108. STARTING MOTOR REMOVAL (fig. 124).

a. Equipment.

WRENCH, open-end, $^{9}/_{16}$-in.

b. Procedure.

(1) Remove starting motor terminal nut ($^{9}/_{16}$-in. open-end wrench). Lift off starter switch to starting motor cable.

(2) Remove the three starting motor mounting cap screws and lock washers ($^{9}/_{16}$-in. open-end wrench).

(3) Lift starting motor from bell housing.

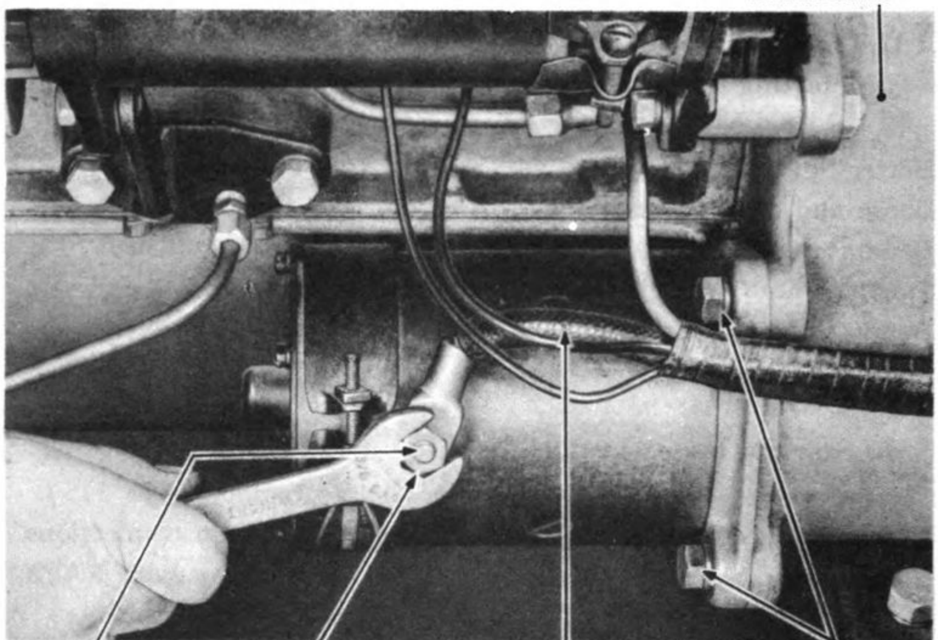

Figure 124 — Removing Starting Motor

109. STARTING MOTOR DISASSEMBLY (fig. 131).

a. Equipment.

CHISEL	SCREWDRIVER
DRIVER, bushing	SCREWDRIVER, heavy-duty
HAMMER	VISE
PLIERS	WRENCH, open-end, $^9/_{16}$-in.
PRESS, arbor	WRENCH, open-end, $^{25}/_{32}$-in.
PULLER	

b. Procedure.

(1) Remove starting motor commutator cover band screw nut (A) and screw (C), from cover band (B) (screwdriver). Remove cover band (B) from starting motor frame (fig. 131).

(2) Remove field coil brushes (R) from brush holders (H) by lifting brush holder spring (M) from end of brushes (fig. 131).

(3) Remove screws (D) and lock washers (E) which hold commutator end plate assembly (G) to starting motor frame (N), and remove commutator end plate assembly (G) (screwdriver) (fig. 131). Mark commutator end plate before removing. If the commutator end plate is placed 90 degrees out, it will cause the motor to run in reverse.

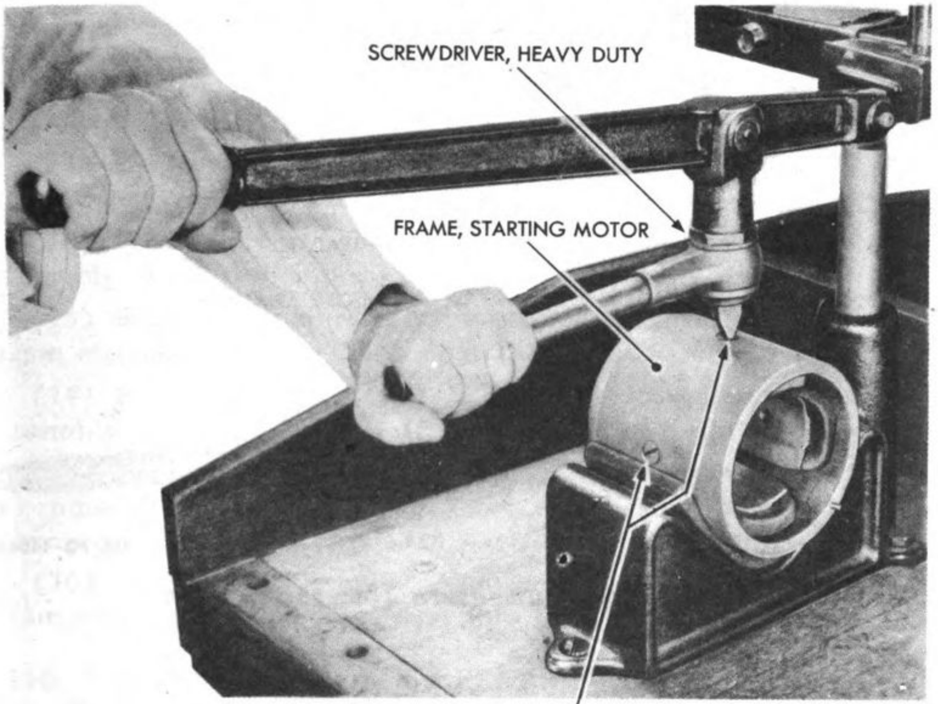

Figure 125 — Removing Pole Piece Screw

(4) Holding commutator end of armature (Y) in a vise, remove Bendix drive lock nut cotter pin (SS) from nut (TT) and armature shaft (pliers) (fig. 131).

(5) Remove Bendix drive lock nut (TT) from end of armature shaft ($^{25}/_{32}$-in. open-end wrench) (fig. 131).

(6) Remove Bendix drive lock nut collar (RR), drive lock nut washer (QQ), main spring (PP), spring support (NN), secondary spring (MM), secondary spring washer (LL), shaft (JJ), pinion (KK), retainer and spring assembly (HH), and hold-out spring cup (GG) from end of armature shaft (fig. 131).

(7) Remove screws (FF) and lock washers (EE) which hold drive end head (CC) to starting motor frame (N), and remove drive end head assembly (CC) (screwdriver) (fig. 131).

(8) Remove field coil terminal post nuts (UU), lock washers (VV), flat washer (WW), and terminal post insulation washer (XX) and bushing (YY) from terminal post (U) ($^{9}/_{16}$-in. open-end wrench) (fig. 131). Remove terminal post by hand.

(9) Mark position of field coils (T) in frame (N). Remove flat-head pole piece screws (P), and remove the pole pieces (X) (heavy-duty screwdriver) (figs. 125 and 131).

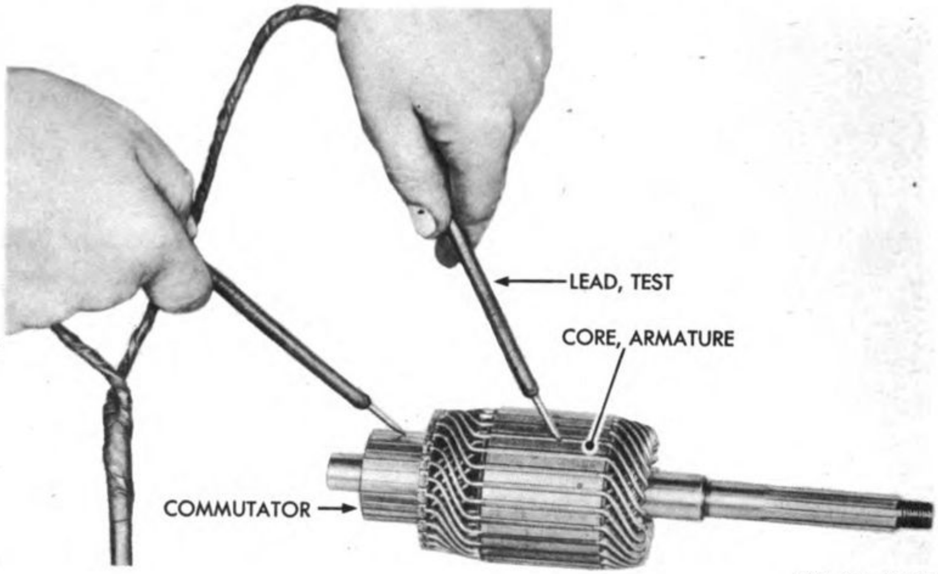

Figure 126 — Armature Test for Ground

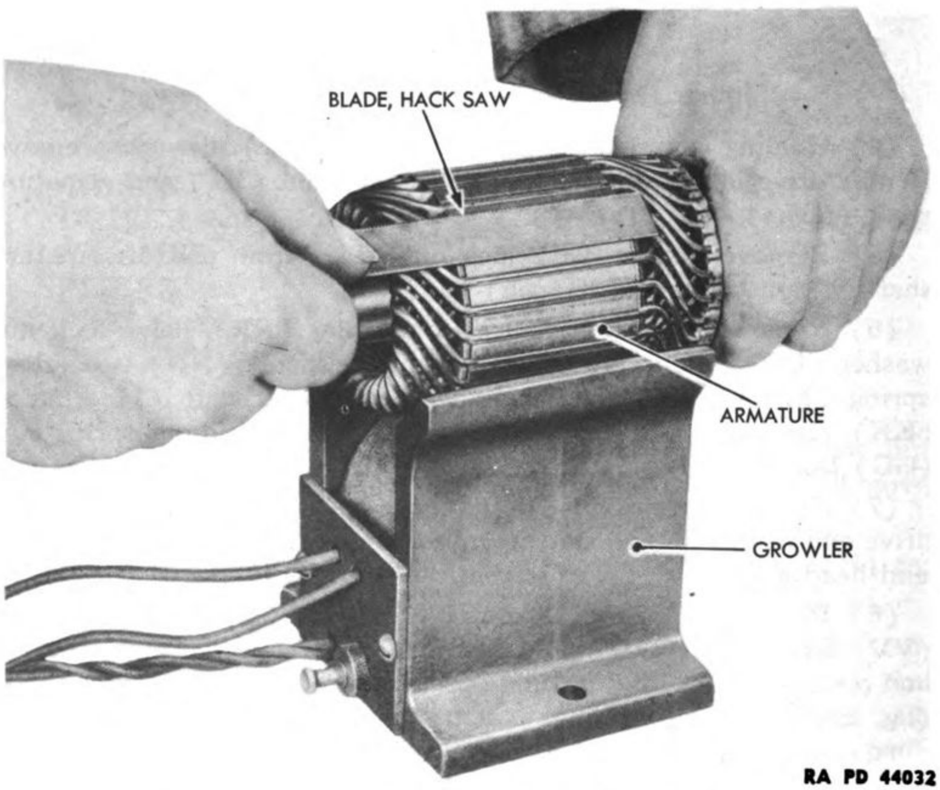

Figure 127 — Armature Test for Shorts

(10) Remove field coils (T). NOTE: Terminal stud field coil commutator terminals (S) and brushes (R) can be removed from field coils (T) if necessary by heating connections until solder is melted.

(11) Remove field coil terminal post insulation washer (Q) and insulation (W) (fig. 131).

(12) Press armature shaft bearing (DD) from drive end head assembly (CC) (arbor press and bushing driver) (fig. 131).

(13) Remove armature thrust washer (L) from commutator end plate assembly (G) by hand (fig. 131).

(14) Remove brush springs (M) from commutator end plate assembly (G) (fig. 131).

(15) Remove rivets (F) holding grounded brush holders (H) to commutator end plate (G), being careful not to damage holders (hammer and chisel) (fig. 131).

(16) With a suitable puller, remove commutator end bearing (J) from commutator end plate assembly (G) (fig. 131).

110. STARTING MOTOR INSPECTION AND REPAIR.

a. Equipment.

BLADE, hacksaw	LATHE
COMPRESSED AIR	PAPER, flint, class B, No. 00
GROWLER	SOLDERING EQUIPMENT
LAMP, test	

b. Procedure.

(1) CLEAN COMMUTATOR.

COMPRESSED AIR PAPER, flint, class B, No. 00

(a) If the commutator is dirty or discolored, hold a piece of PAPER, flint, class B, No. 00, against commutator while turning armature slowly. Blow sand off commutator after sanding (compressed air).

(2) REPAIR OF ROUGH OR WORN COMMUTATOR.

LATHE

If commutator is rough or worn, place armature in lathe. Take as light a cut as possible to remove roughness and true-up commutator. Do not undercut mica between commutator bars.

(3) TEST ARMATURE FOR GROUNDS.

LAMP, test

Hold one test prod lead on the armature, and the other on the commutator (fig. 126). If test lamp lights, armature is grounded and must be replaced. If test lamp does not light, armature is not

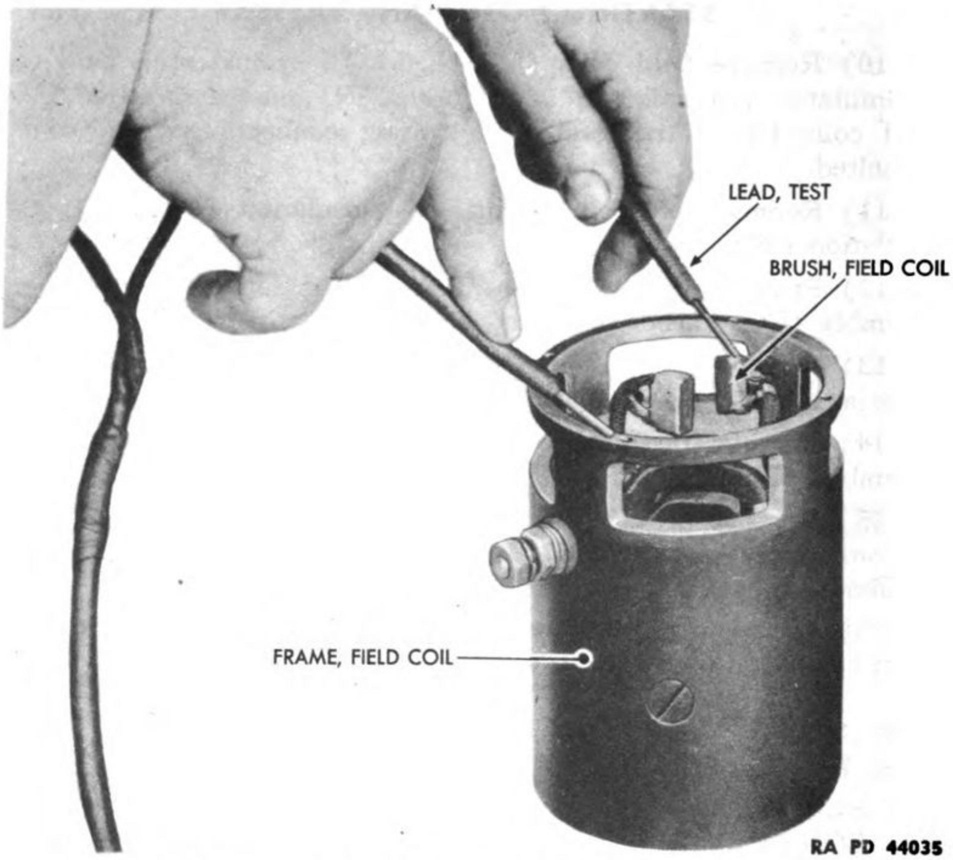

Figure 128 — Field Coil Test for Ground

grounded. NOTE: Test each commutator segment with test prod lead.

(4) Test Armature for Shorts.

BLADE, hacksaw GROWLER

Place armature on a growler. Hold a hacksaw blade over armature core. Rotate armature slowly by hand (fig. 127). If hacksaw blade does not vibrate, armature is not short-circuited. If hacksaw blade vibrates, armature is short-circuited and must be replaced.

(5) Test Frame and Field Coil for Ground.

LAMP, test

Place one test prod lead on frame, and the other on the field coil lead (fig. 128). If test lamp does not light, field coils are not grounded. If test lamp lights, one or both field coils are grounded. Replace field coils if grounded.

(6) Test Field Coil for Continuous Circuit.

LAMP, test

Place test prod leads on field coil leads (fig. 129). If test lamp lights, field coils have no open circuit. If test lamp does not light,

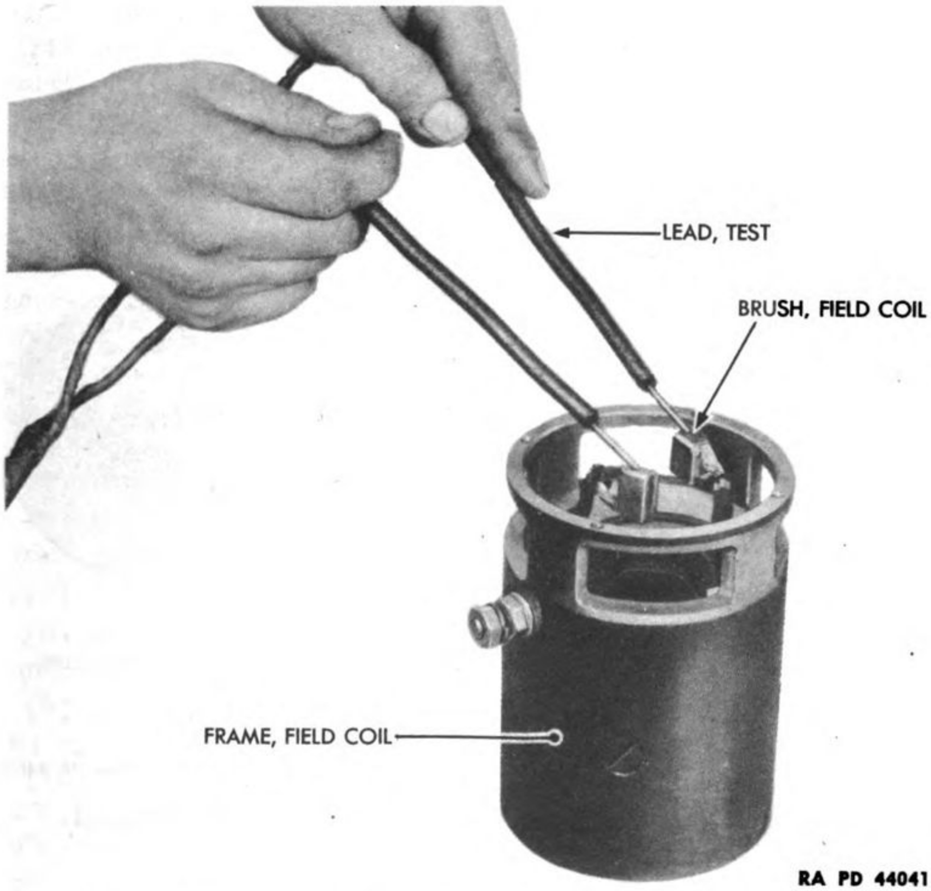

Figure 129 — Field Coil Test for Continuous Circuit

there is an open circuit in one or both of the field coils. Replace field coils.

(7) Test Insulated Brush Holder for Ground.

LAMP, test

Place on test prod lead on commutator end plate, and the other on the brush holder (fig. 130). If test lamp lights, brush holder is grounded, and insulation between brush holder and plate, as well as between the two rivets and plate, must be replaced.

(8) Inspect Field Coil Leads.

Inspect field coil leads where they are soldered to connections, to be sure they are tight.

(9) Inspect Brushes.

Check condition of all brushes, and if pitted or worn, replace them.

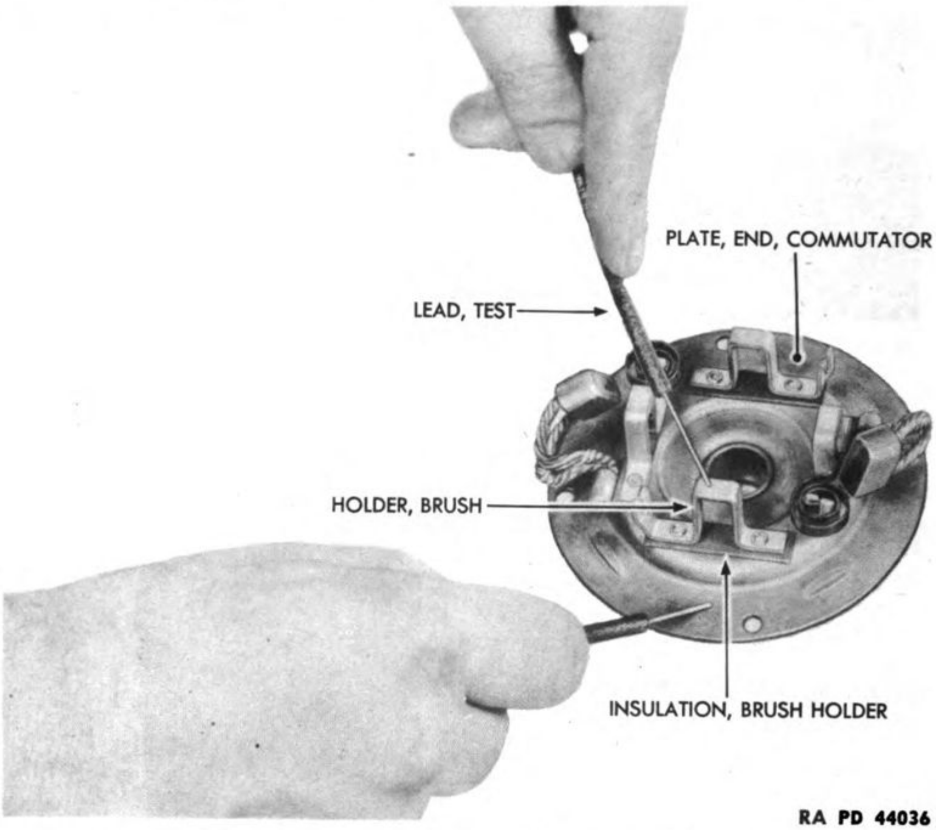

Figure 130 — Insulated Brush Holder Test for Ground

(10) CHECK TENSION OF THE BRUSH HOLDER SPRINGS.

Brush holder springs must have enough tension to hold brushes snugly against commutator. Replace weak or broken springs.

(11) INSPECT BRUSH LEADS.

SOLDERING EQUIPMENT

Check soldered connections of the two grounded brushes on commutator end frame to be sure they are tight. If loose, resolder (soldering equipment). Check insulation of brush to field coil leads. If insulation is damaged, replace leads.

111. STARTING MOTOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
PRESS, arbor
RIVET SET
SCREWDRIVER
SCREWDRIVER, heavy-duty
VISE
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 25/32-in.

ENGINE ELECTRICAL SYSTEM: STARTING MOTOR AND BATTERY

b. Procedure. (fig. 131).

(1) Press commutator bearing (J) in the commutator end plate assembly (G) (arbor press and bushing driver) (fig. 131).

(2) Assemble grounded brushes (K) and two brush holders (H) to commutator end plate (G), and securely rivet in place (rivet set and hammer) (fig. 131).

(3) Assemble two brush holders (H), with insulation between brush holders and end plate. Place insulation over rivets (F), and secure brush holders (H) and insulation to plate (G) by peening rivets securely (hammer) (fig. 131).

(4) Assemble four brush holder springs (M) to the four brush holders (fig. 131).

(5) Place armature thrust washer (L) in position in end plate assembly (G) by hand (fig. 131).

(6) Press armature shaft bearing (DD) in drive end head (CC) (arbor press and bushing driver) (fig. 131).

(7) Assemble field coil insulation (W) to frame (fig. 131).

(8) Assemble field coils (T) and pole pieces (X) to frame (N) in same position as before removal (heavy-duty screwdriver) (fig. 131).

(9) Assemble terminal washer (Q) between field coil connection (S) and frame (N) (fig. 131).

(10) Assemble terminal post (U) to frame (N). Assemble bushing (YY), insulation washer (XX), flat washer (WW), lock washers (VV), and terminal post nuts (UU) to terminal post (U) ($^9/_{16}$-in. open-end wrench) (fig. 131).

(11) Assemble drive end head assembly (CC) to frame (N), securing in place with four screws (FF) and lock washers (EE) (screwdriver) (fig. 131).

(12) Assemble armature (Y) to frame (N) and drive end head assembly (CC) (fig. 131).

(13) Securely hold armature (Y) (commutator end) in vise, and assemble Bendix-hold-out spring cup (GG), retainer and spring assembly (HH), pinion (KK), shaft (JJ), washer (LL), secondary spring (MM), secondary spring support (NN), main spring (PP), washer (QQ), drive lock nut collar (RR) and drive lock nut (TT), and cotter pin (SS) to end of armature shaft ($^{25}/_{32}$-in. open-end wrench) (fig. 131).

(14) Assemble commutator end plate assembly (G) over end of armature (Y), holding grounded brushes (K) away from commutator, and secure in place with screws (D) and lock washers (E) (screwdriver) (fig. 131).

(15) Assemble field coil brushes (R) to brush holders (H), and place brush holder springs (M) in position (fig. 131).

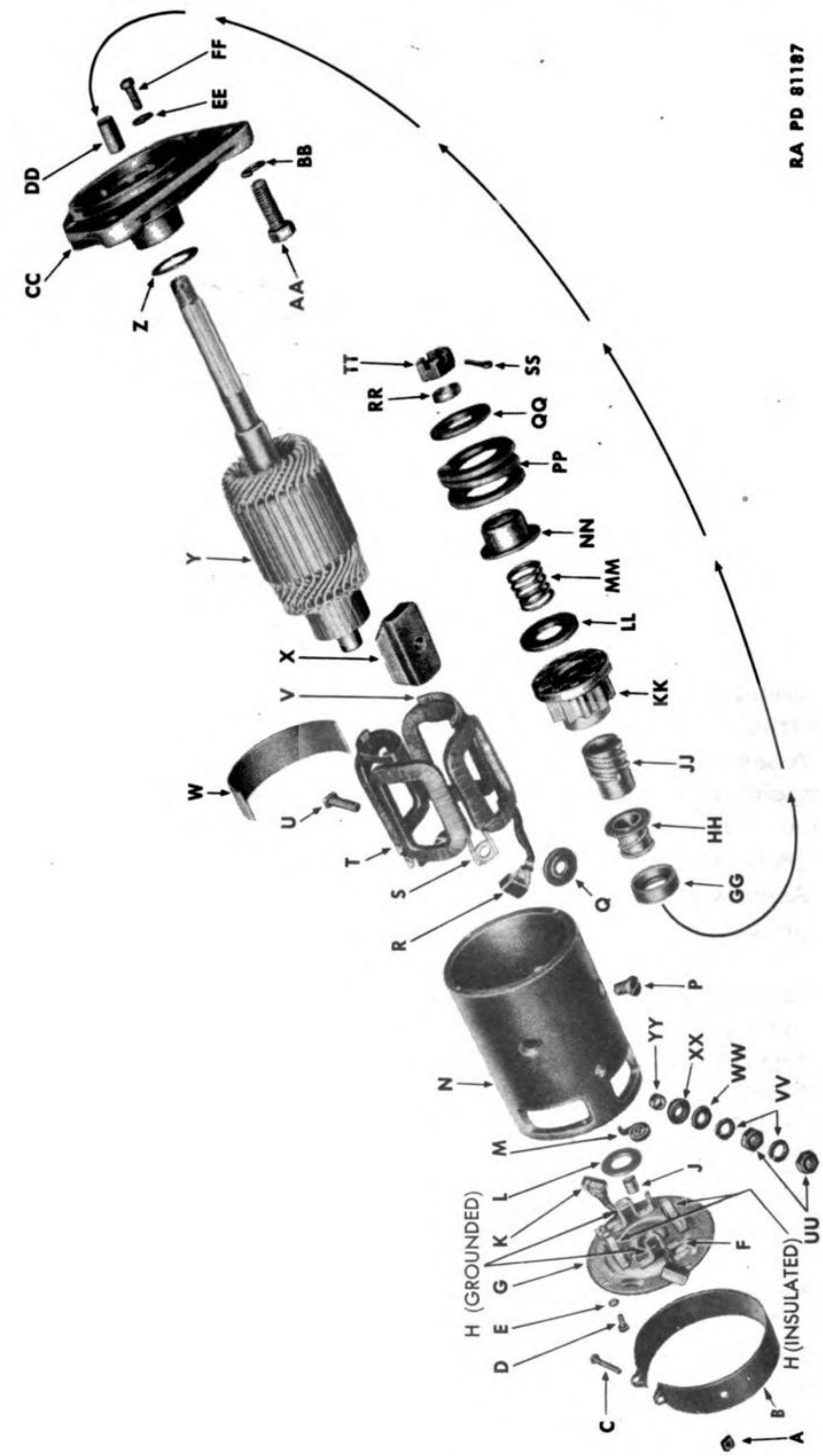

Figure 131 — Starting Motor Assembly — Exploded View

A — NUT, COVER BAND SCREW
B — BAND, COVER
C — SCREW, COVER BAND
D — SCREW, COMMUTATOR END FRAME
E — WASHER, LOCK
F — RIVET, BRUSH HOLDER
G — PLATE, COMMUTATOR END, ASSEMBLY
H — HOLDER, BRUSH
J — BEARING, COMMUTATOR END
K — BRUSH, GROUNDED
L — WASHER, ARMATURE THRUST (COMMUTATOR END)
M — SPRING, BRUSH HOLDER
N — FRAME
P — SCREW, POLE PIECE
Q — WASHER, FIELD COIL TERMINAL POST INSULATION
R — BRUSH, FIELD COIL
C — CONNECTION, FIELD COIL
T — COIL, FIELD
U — POST, TERMINAL
V — CONNECTOR, FIELD COIL
W — INSULATION, FIELD COIL
X — PIECE, POLE
Y — ARMATURE
Z — WASHER, THRUST, ARMATURE (DRIVE END)
AA — SCREW, CAP, GENERATOR MOUNTING
BB — WASHER, LOCK, GENERATOR MOUNTING CAP SCREW
CC — HEAD, DRIVE END
DD — BEARING, ARMATURE SHAFT
EE — WASHER, LOCK
FF — SCREW
GG — CUP, BENDIX DRIVE HOLD-OUT SPRING
HH — RETAINER AND SPRING, ASSEMBLY
JJ — SHAFT
KK — PINION
LL — WASHER, SECONDARY SPRING
MM — SPRING, SECONDARY
NN — SUPPORT, SPRING
PP — SPRING, MAIN
QQ — WASHER, DRIVE LOCK NUT
RR — COLLAR, DRIVE LOCK NUT
SS — PIN, COTTER, BENDIX DRIVE LOCK NUT
TT — NUT, LOCK, BENDIX DRIVE
UU — NUT, TERMINAL POST
VV — WASHER, LOCK
WW — WASHER, FLAT
XX — WASHER, INSULATION
YY — BUSHING, TERMINAL POST

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Legend for Figure 131 — Starting Motor Assembly — Exploded View

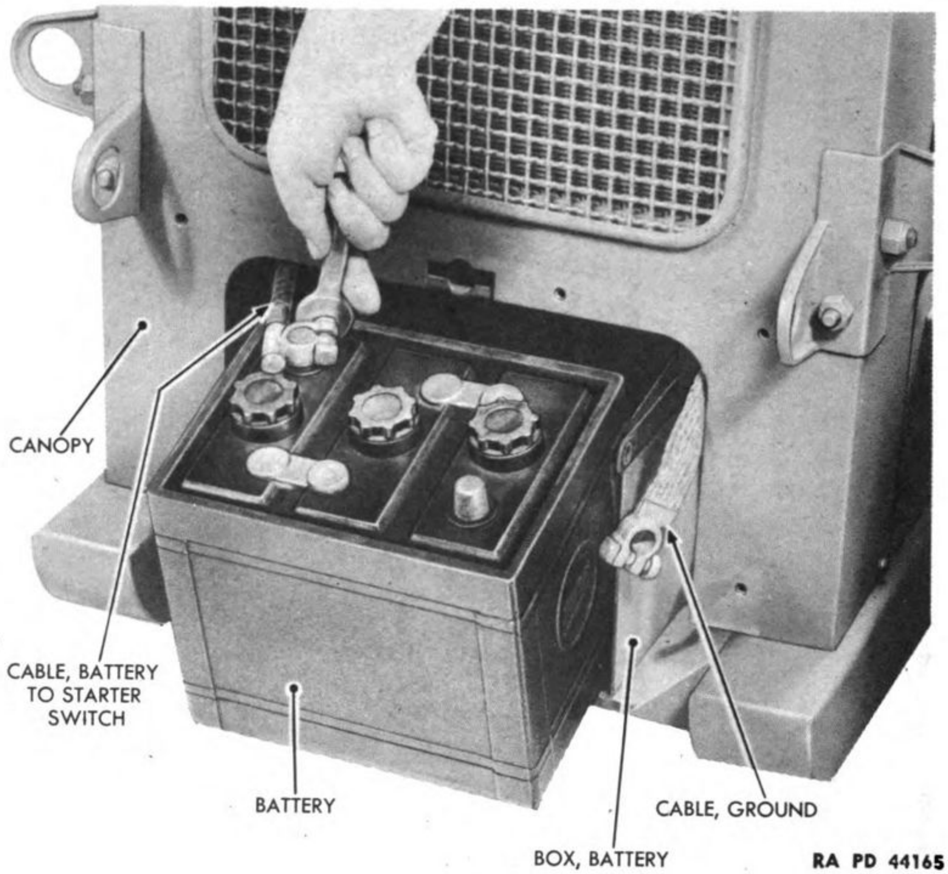


Figure 132 — Removing Battery

(16) Assemble commutator cover band (B) with screw (C), and nut (A) to starting motor (screwdriver) (fig. 131).

(17) Connect starting motor to a battery, and operate for running test to be sure all repairs have been satisfactorily made. If starting motor fails to operate, disassemble it; locate and repair trouble (steps (1) through (17) above).

112. STARTING MOTOR INSTALLATION.

a. Equipment.

WRENCH, open-end, $^9/_{16}$-in.

b. Procedure (fig. 124).

(1) Place starting motor in position on bell housing.

(2) Install the three starting motor mounting cap screws and lock washers ($^9/_{16}$-in. open-end wrench).

(3) Connect cable to starting motor terminal. Install starting motor terminal nut ($^9/_{16}$-in. open-end wrench).

113. BATTERY.

a. Equipment.

CHARGER, battery
HYDROMETER
SCREWDRIVER
TESTER, battery cell
VOLTMETER
WIRE brush
WRENCH, open-end, ½-in. (2)
WRENCH, open-end, 9⁄16-in.

b. Procedure.

(1) REMOVAL (fig. 132).

SCREWDRIVER
WRENCH, open-end, 9⁄16-in.
WRENCH, open-end, ½-in. (2)

(a) Remove battery cover from housing (screwdriver) (fig. 1).

(b) Remove battery clamp bolt which secures battery in battery box (two ½-in. open-end wrenches).

(c) Slide battery forward, and remove battery cables from battery (9⁄16-in. open-end wrench). NOTE: Remove ground (negative) cable first.

(2) INSPECTION AND REPAIR.

CHARGER, battery
TESTER, battery cell

(a) Recharge the battery (battery charger).

(b) Allow battery to stand for 24 hours after removal from battery charger.

(c) Test each cell of battery. If any cell is dead or weaker than the rest, replace or rebuild battery.

(3) TEST.

HYDROMETER
VOLTMETER
WIRE BRUSH

(a) Battery Capacity.

HYDROMETER
VOLTMETER

1. Take a specific gravity reading with a hydrometer. Reading should be 1.250 to 1.290 at 70 F. If reading is less than 1.250, charge battery on a battery charger.

2. Test voltage of battery with a voltmeter. It should register 6 volts. Recharge if less than 6 volts. Replace or rebuild battery if all cells do not have the same voltage.

(b) Battery Voltage Drop.

VOLTMETER
WIRE BRUSH

1. Connect a voltmeter positive lead to battery positive terminal. Connect voltmeter negative lead to battery negative terminal. Turn ignition switch off. Press starter switch and note voltmeter reading.

2. Connect voltmeter positive lead to a clean place on the engine. Connect voltmeter negative lead to the starter switch battery terminal. Turn the ignition switch off. Press starting motor switch and note voltmeter reading. The difference between voltmeter readings in this and the immediately preceding step should not exceed 0.25 volt. If it is higher, remove battery cables, and clean cable connections with a wire brush.

(c) Battery Cable and Cable Connections.

VOLTMETER

1. Connect voltmeter positive lead to the battery positive terminal. Connect voltmeter negative lead to a clean ground on the engine. Press starting motor switch and read voltmeter. The reading should not exceed 0.1 volt. If it is higher, clean and tighten battery cable connections.

2. Connect voltmeter positive lead to battery terminal of the starting motor switch. Connect voltmeter negative lead to the battery negative terminal. Press starter switch and read voltmeter. Reading should not exceed 0.1 volt. If it is higher, clean and tighten battery cable connections.

(4) INSTALLATION (fig. 132).

SCREWDRIVER
WRENCH, open-end, ½-in. (2)
WRENCH, open-end, 9/16-in.

(a) Slide battery into battery box. Be sure battery post marked "-" is on side of ground cable.

(b) Connect starter switch cable to positive battery post (½-in. open-end wrench).

(c) Connect ground cable to negative battery post (½-in. open-end wrench).

(d) Push battery to back of battery box and install battery clamp bolt (two ½-in. open-end wrenches).

(e) Install battery cover (screwdriver) (fig. 1).

Section XIV

ENGINE REMOVAL AND DISASSEMBLY

114. REMOVAL.

a. Equipment.

HOIST, chain	WRENCH, open-end, 9/16-in.
SCREWDRIVER	WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/8-in.	WRENCH, open-end, 3/4-in.
WRENCH, open-end, 1/2-in.	WRENCH, Stillson

b. Procedure.

(1) Remove oil drain pipe cap and drain oil from engine (Stillson wrench) (fig. 3). Remove bayonet oil gage (fig. 117).

(2) Remove housing (par. 14).

(3) Remove battery (par. 113).

(4) Remove radiator (par. 78).

(5) Remove main generator and instrument panel assembly (par. 23 **b** (2) through (14)) (figs. 134 and 135).

(6) Remove drain cock (5/8-in. open-end wrench).

(7) Remove rear engine mounting cap screws and lock washers (3/4-in. open-end wrench) (fig. 134). Also remove front engine mounting bracket to frame, cap screws, and lock washers (fig. 134) with same wrench.

(8) Lift engine from frame to work bench (two men).

115. ACCESSORIES, REMOVAL.

a. Equipment.

DRIFT, small	WRENCH, box, 1/2-in.
HAMMER	WRENCH, open-end, 3/8-in.
HAMMER, soft	WRENCH, open-end, 1/2-in.
PILOT, special	WRENCH, open-end, 9/16-in.
PRESS, arbor	WRENCH, open-end, 11/16-in.
PULLER, gear	WRENCH, socket, 1/2-in.
REMOVER, stud	WRENCH, socket, 9/16-in.
SCREWDRIVER	WRENCH, Stillson

b. Procedure.

(1) Remove Muffler.

WRENCH, Stillson

Remove muffler from exhaust pipe adapter (Stillson wrench) (fig. 136).

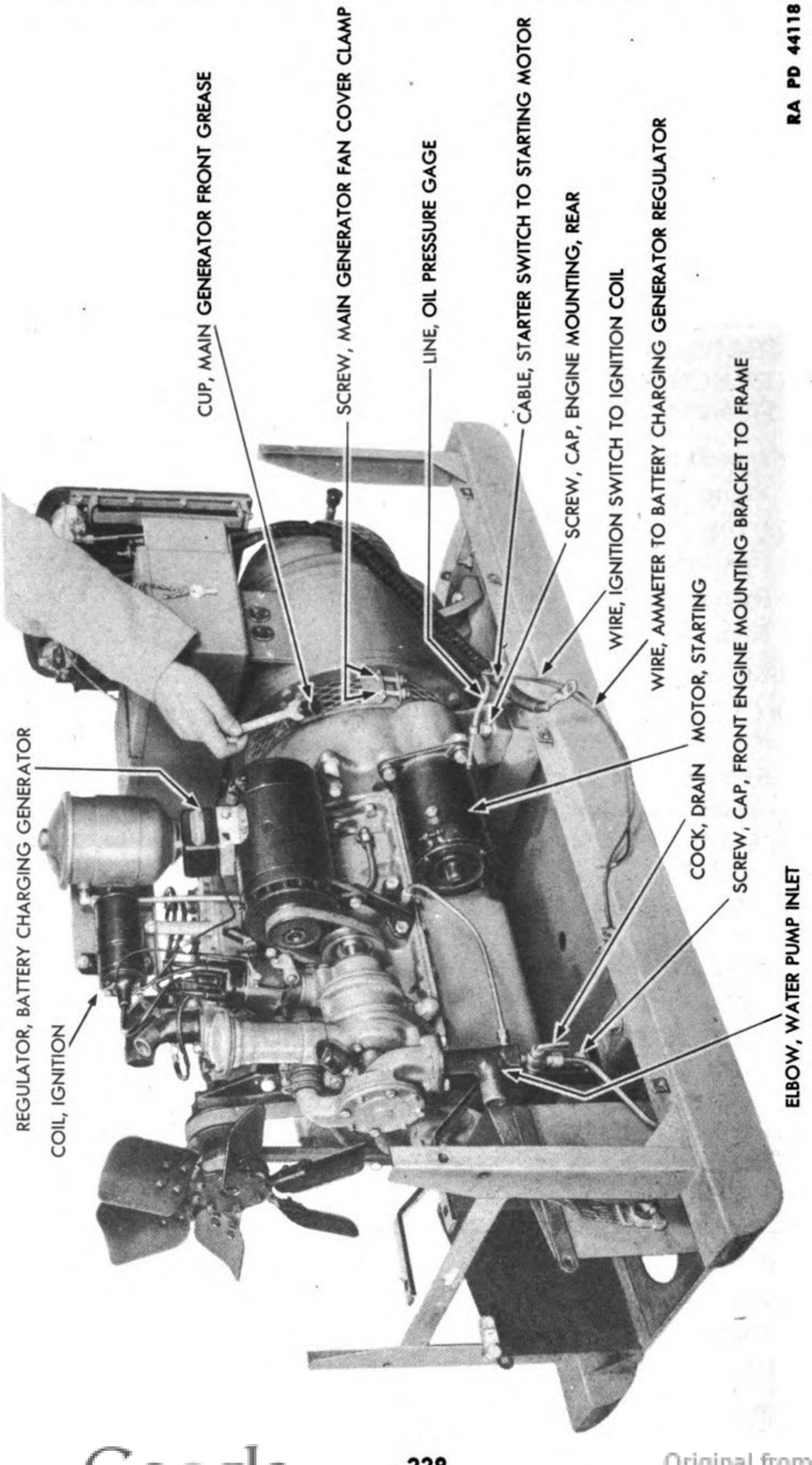


Figure 133 — Disconnecting Engine for Removal

ENGINE REMOVAL AND DISASSEMBLY

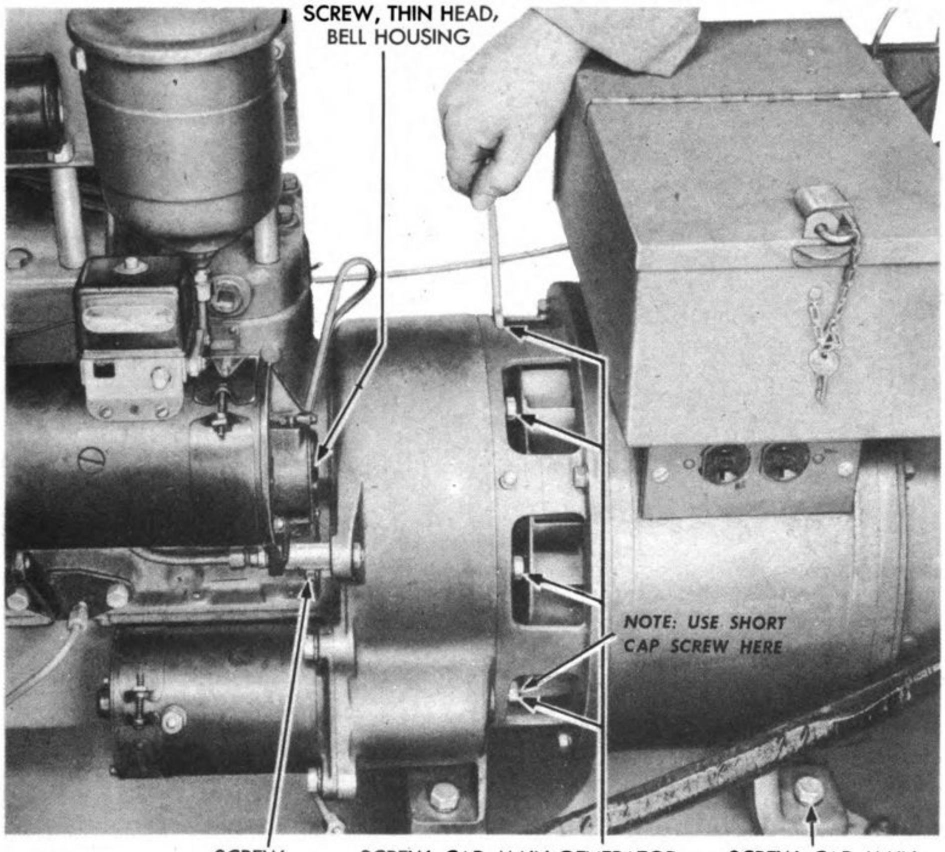


Figure 134 — Removing Main Generator to Bell Housing Cap Screws

(2) REMOVE EXHAUST PIPE ADAPTER.

WRENCH, open-end, $^9/_{16}$-in.

Remove exhaust pipe adapter to manifold cap screws and lock washers ($^9/_{16}$-in. open-end wrench). Lift exhaust pipe adapter from manifold (fig. 136).

(3) REMOVE FAN AND FAN BELT (par. 79).

(4) REMOVE WATER PUMP AND WATER PUMP DISCHARGE PIPE HOSE.

SCREWDRIVER

Remove water pump (par. 72) and water pump discharge pipe hose (screwdriver). To prevent breaking water discharge bracket, bottom stud should be removed first and replaced last.

(5) REMOVE WATER OUTLET ELBOW.

WRENCH, open-end, $1/2$-in.

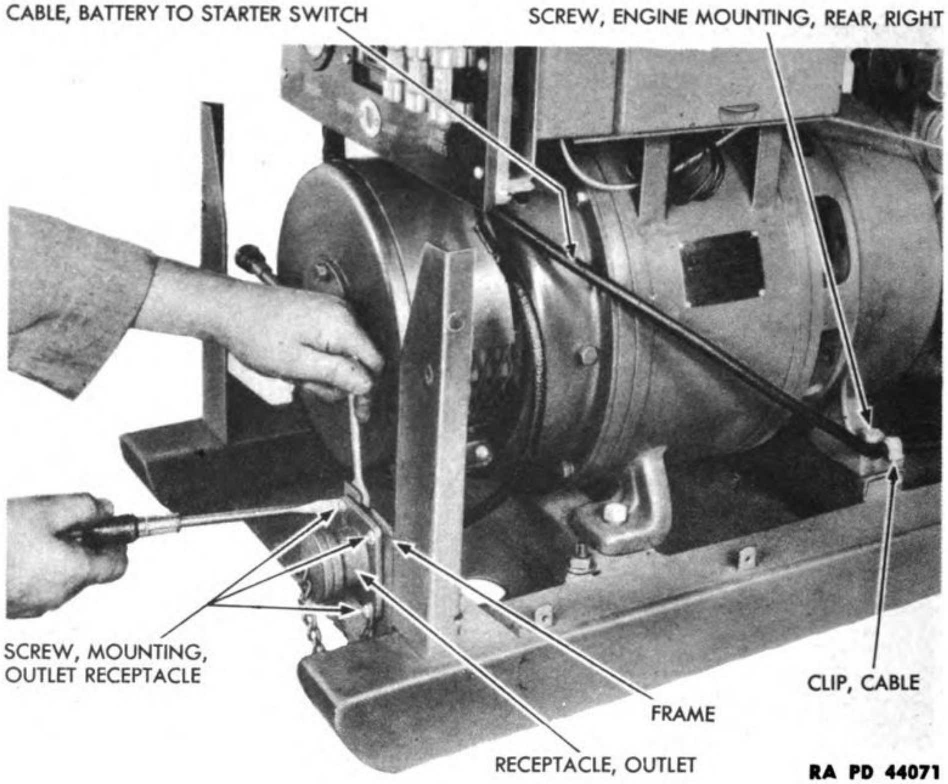


Figure 135 — Removing Outlet Receptacle

Remove water outlet elbow to cylinder head cap screws and lock washers (½-in. open-end wrench). Lift water outlet elbow gasket and thermostat from cylinder head (fig. 136).

(6) Remove Distributor (par. 98).

(7) Remove Battery Charging Generator Regulator (par. 88).

(8) Remove Battery Charging Generator (par. 83).

(9) Remove Water Pump Discharge Pipe.

WRENCH, socket, ½-in.

Remove water pump discharge pipe to cylinder block cap screws and lock washers (½-in. socket wrench). Lift battery charging generator adjustable bracket, water pump discharge pipe, and gasket from cylinder block (fig. 137).

(10) Remove Water Bypass Tube.

WRENCH, open-end, ½-in.

Remove water bypass tube from thermo-siphon cover and generator bracket (½-in. open-end wrench) (fig. 137).

ENGINE REMOVAL AND DISASSEMBLY

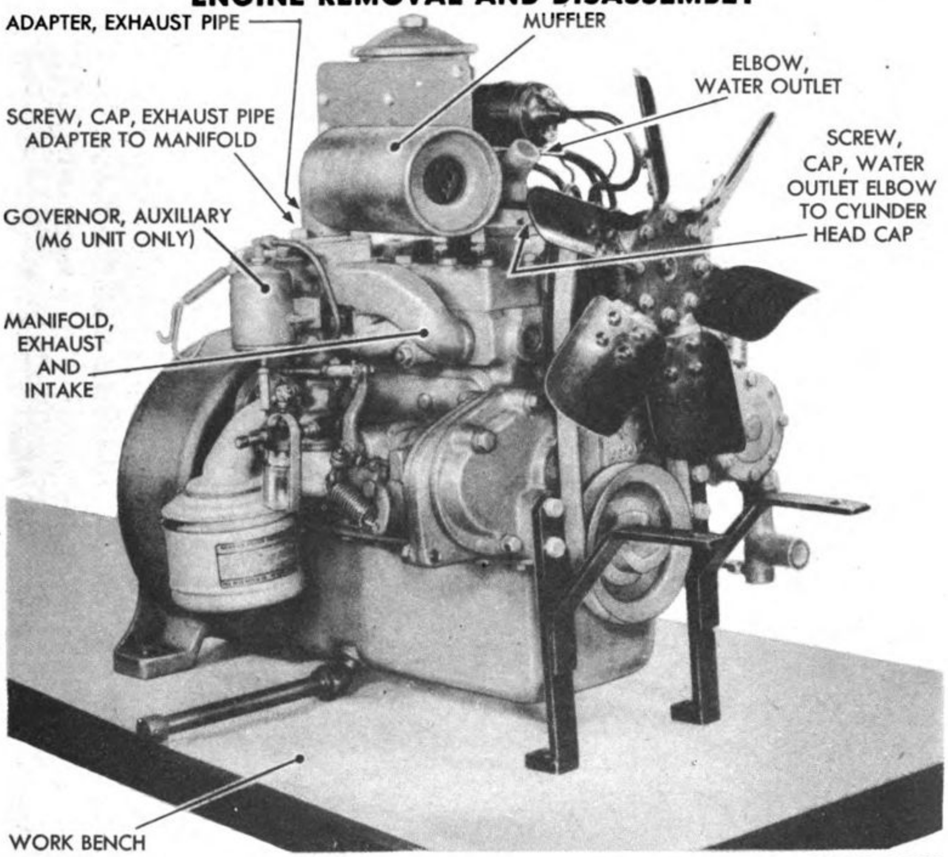


Figure 136 — Position of Engine for Removal of Acccessories

(11) REMOVE GENERATOR SUPPORT BRACKET.

WRENCH, socket, $\frac{9}{16}$-in.

Remove generator support bracket to cylinder block cap screws and lock washers ($\frac{9}{16}$-in. socket wrench). Lift bracket and gasket from cylinder block (fig. 137).

(12) REMOVE IGNITION COIL (par. 97).

(13) REMOVE OIL FILTER AND FITTINGS.

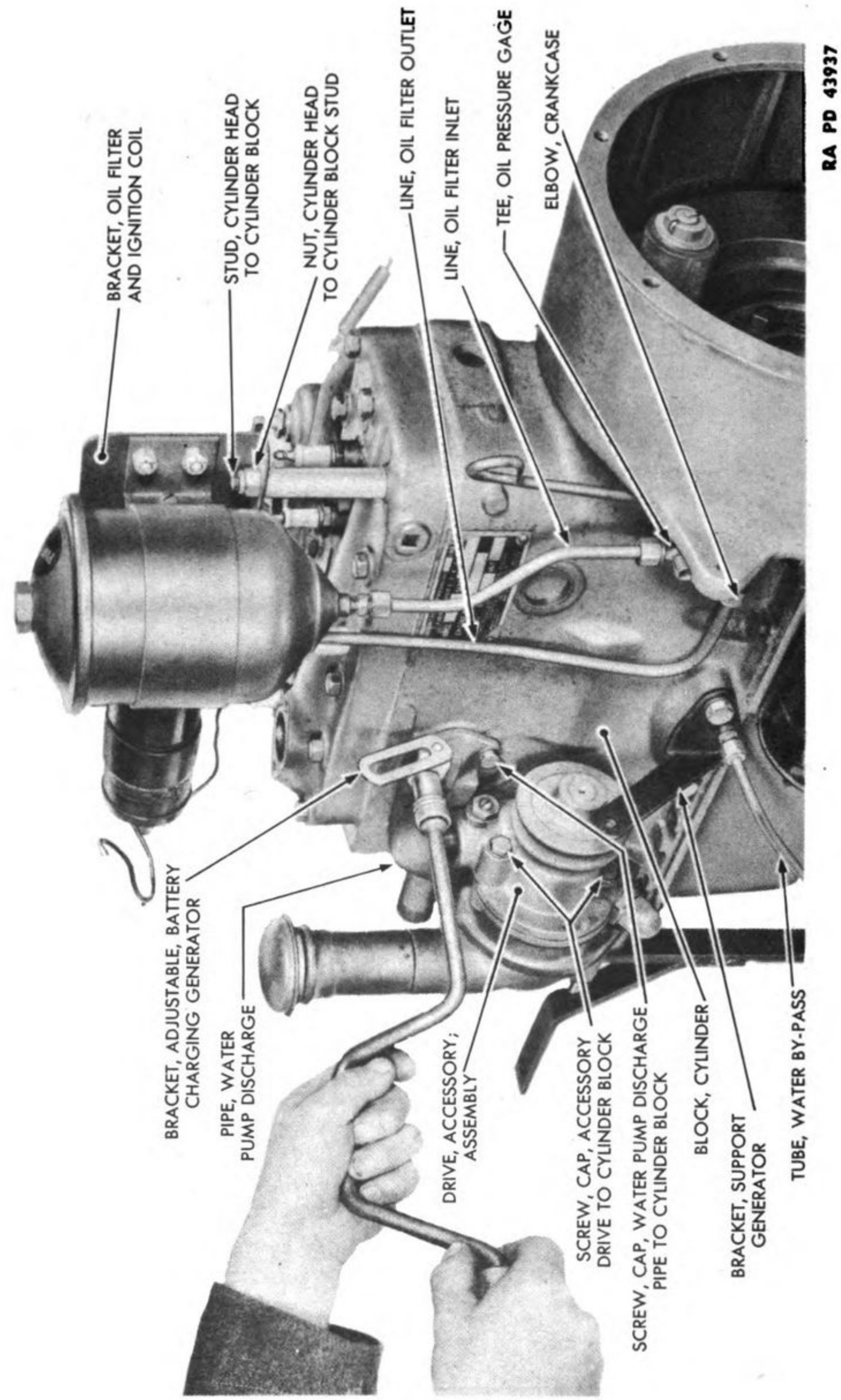
WRENCH, open-end, $\frac{3}{8}$-in. **WRENCH**, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{1}{2}$-in.

Remove oil filter (par. 159), oil filter outlet line (to crankcase elbow), and oil filter inlet line (to oil pressure gage "T") ($\frac{9}{16}$-in. open-end wrench). Drain oil from filter into a suitable container. Remove oil pressure gage "T" from cylinder block ($\frac{1}{2}$-in. open-end wrench). Remove crankcase elbow from cylinder block ($\frac{3}{8}$-in. open-end wrench) (fig. 137).

(14) REMOVE STARTING MOTOR (par. 108).

(15) REMOVE ACCESSORY DRIVE.

WRENCH, box, $\frac{1}{2}$-in.



Fgiure 137 — Removing Water Pump Discharge Pipe

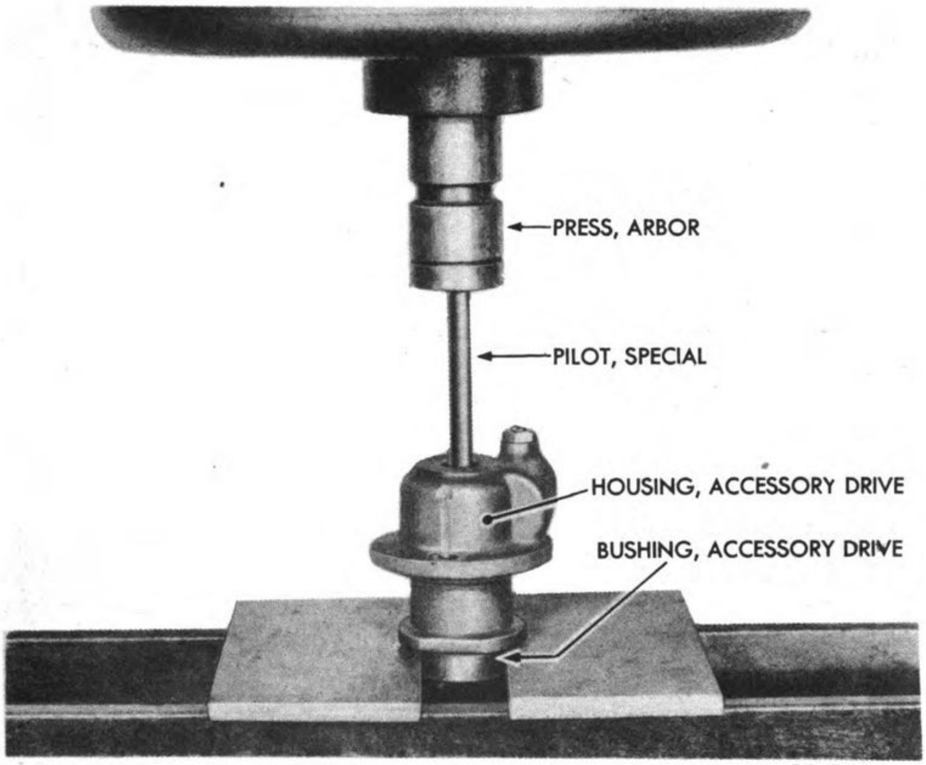


Figure 138 — Pressing Accessory Drive Bushing from Accessory Drive Housing

Remove the two accessory drive to cylinder block cap screws and lock washers (½-in. box wrench). Lift accessory drive assembly and gasket from cylinder block (fig. 137).

(16) DISASSEMBLE ACCESSORY DRIVE.

DRIFT, small	PRESS, arbor
HAMMER	PULLER, gear
HAMMER, soft	SCREWDRIVER
PILOT, special	WRENCH, open-end, $^{11}/_{16}$-in.

(a) Using a small drift and a hammer, drive the generator drive pulley tapered pin from pulley and shaft. NOTE: Be sure to drive on small end of pin.

(b) Using a puller, remove generator drive pulley from accessory drive shaft. Tap generator drive pulley Woodruff key from shaft with a soft hammer.

(c) Press generator drive pulley from accessory drive shaft (arbor press). Tap Woodruff key from shaft (soft hammer).

(d) Push accessory drive shaft assembly from accessory drive housing.

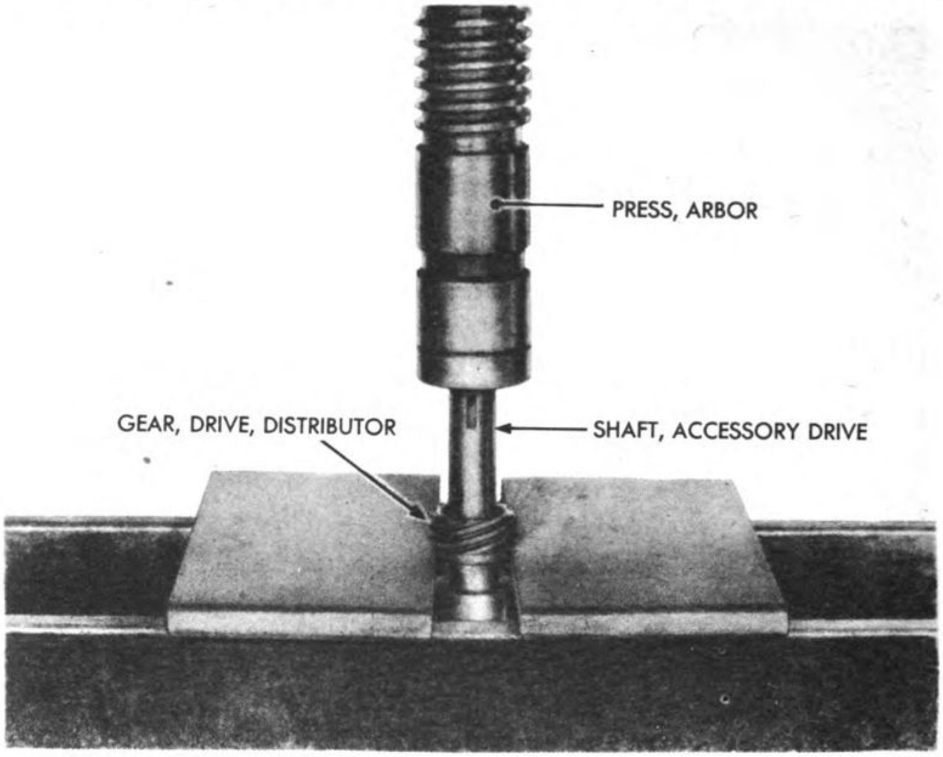


Figure 139 — Pressing Distributor Drive Gear from Accessory Drive Shaft

(e) Press accessory drive bushing from accessory drive housing (arbor press and special pilot) (fig. 138). This is done by inserting disk (fig. 226) through the bushing, into the housing. Turn it over so that it rests flat on top of bushing. Insert rod through opening in top of housing, and press against disk (fig. 138). The disk forces bushing from housing.

(f) Using a small drift and a hammer, tap accessory drive oil retainer and accessory drive cork washer from accessory drive housing.

(g) Lift accessory drive thrust washer from accessory drive shaft.

(h) Press the distributor drive gear from accessory drive shaft (arbor press) (fig. 139). Tap distributor drive gear key from shaft (soft hammer).

(i) Press the accessory drive gear from accessory drive shaft (arbor press) (fig. 140). Tap accessory drive gear key from shaft (soft hammer).

(j) Remove distributor setscrew and lock nut from accessory drive housing (screwdriver). Remove lock nut from setscrew ($^{11}/_{16}$-in. open-end wrench).

(17) Remove Air Cleaner (par. 136).

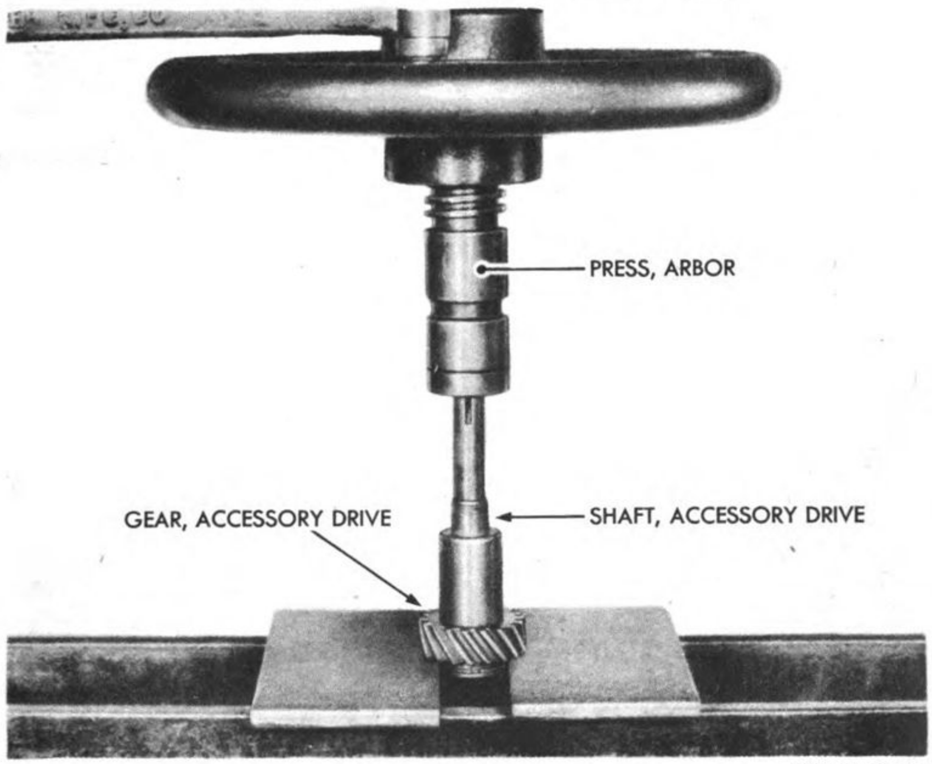


Figure 140 — Pressing Accessory Drive Gear from Accessory Drive Shaft

(18) REMOVE GASOLINE STRAINER (par. 155).

(19) REMOVE VACUUM THROTTLE CONTROL (Unit M6 only) (par. 149).

(20) REMOVE CARBURETOR (par. 137).

(21) REMOVE GOVERNOR (par. 143).

(22) REMOVE MANIFOLD.

WRENCH, socket, $^{9}/_{16}$-in.

Remove four manifold to cylinder block stud nuts and flat washers ($^{9}/_{16}$-in. socket wrench) (fig. 188). Lift exhaust and intake manifold from cylinder block. Lift manifold gaskets from cylinder block.

(23) REMOVE SPARK PLUGS (par. 104).

(24) REMOVE OIL FILLER CAP.

Lift oil filler cap from breather pipe.

(25) REMOVE OIL FILTER AND IGNITION COIL BRACKET.

REMOVER, stud | **WRENCH**, open-end, $^{9}/_{16}$-in.

Remove the two stud nuts which secure oil filter and ignition coil bracket to cylinder head ($^{9}/_{16}$-in. open-end wrench). Lift bracket and

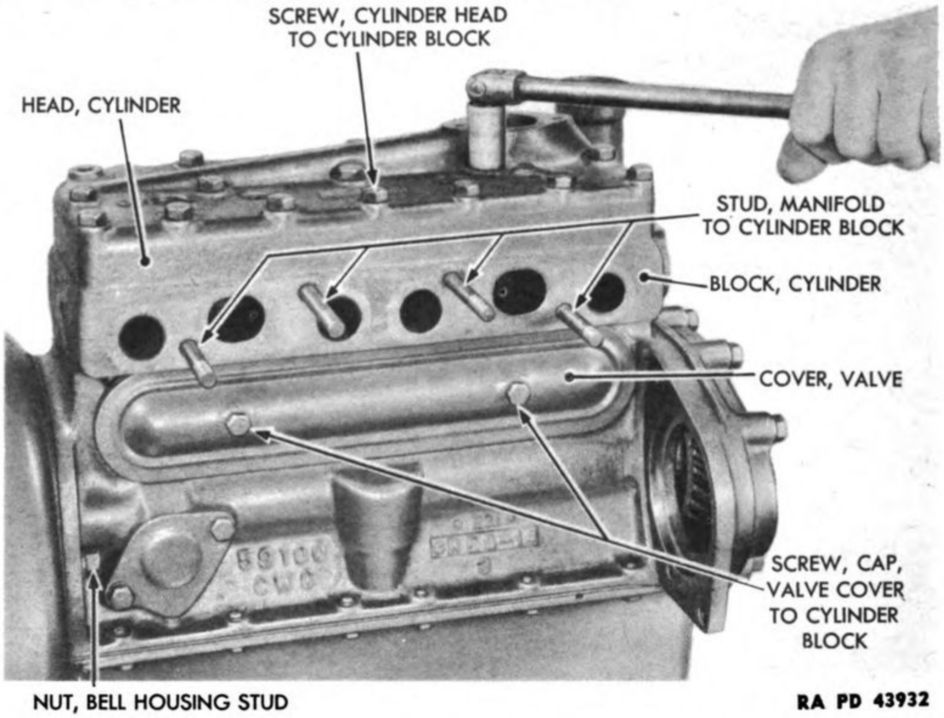


Figure 141 — Removing Cylinder Head

two bracket spacers from studs (fig. 137). Remove studs (stud remover).

(26) REMOVE OIL DRAIN PIPE.

WRENCH, Stillson

Remove oil drain pipe from oil drain pipe elbow (Stillson wrench) (fig. 136).

116. DISASSEMBLY.

a. Equipment.

DRIFT	SCREWDRIVER
DRIFT, soft	WOOD BLOCK
DRILL, electric	WRENCH, box, $\frac{9}{16}$-in.
EXPANDER, piston ring	WRENCH, open-end, $\frac{3}{8}$-in.
HAMMER	WRENCH, open-end, $\frac{7}{16}$-in.
HAMMER, soft	WRENCH, open-end, $\frac{9}{16}$-in.
LIFTER, valve	WRENCH, open-end, $\frac{13}{16}$-in.
PLIERS, thin-nosed	WRENCH, socket, $\frac{7}{16}$-in.
PRESS, arbor	WRENCH, socket, $\frac{1}{2}$-in.
PULLER, gear	WRENCH, socket, $\frac{9}{16}$-in.
REMOVER, stud	WRENCH, socket, $\frac{5}{8}$-in.
REMOVER, valve guide	WRENCH, socket, $\frac{3}{4}$-in.
	WRENCH, Stillson

ENGINE REMOVAL AND DISASSEMBLY

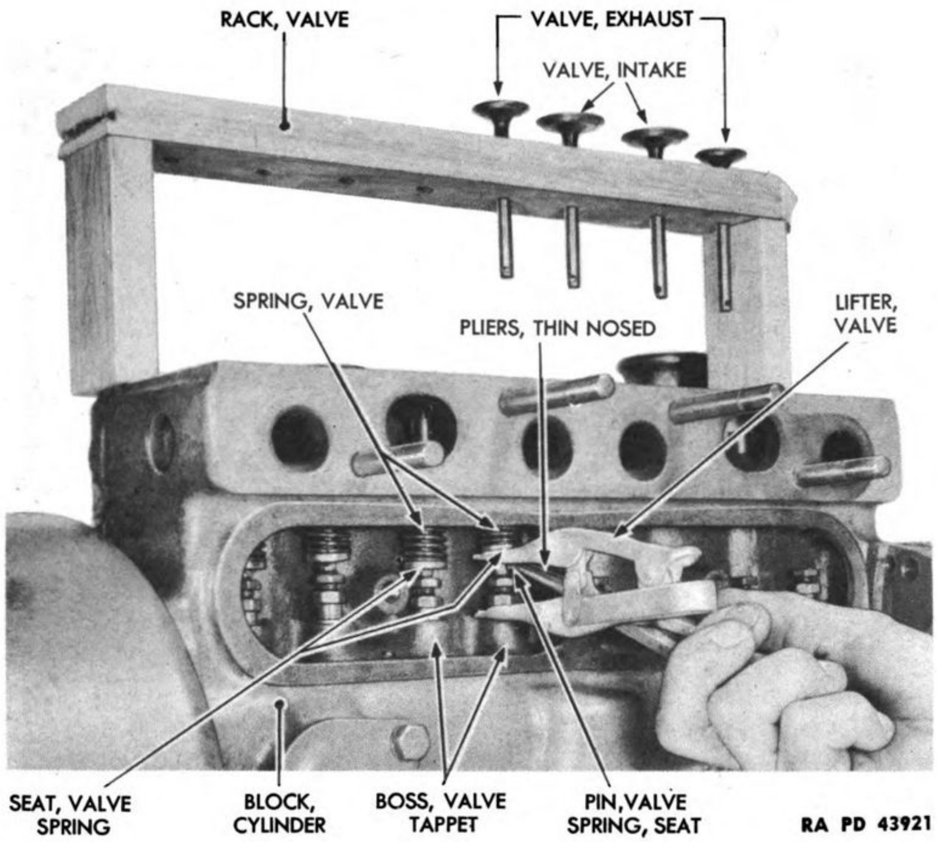


Figure 142 — Removing a Valve

b. Procedure.

(1) REMOVE CYLINDER HEAD.

WRENCH, socket, $^{9}/_{16}$-in.

(a) Remove 16 cylinder head to cylinder block cap screws ($^{9}/_{16}$-in. socket wrench) (fig. 141).

(b) Lift cylinder head and cylinder head gasket from cylinder block.

(2) REMOVE VALVES.

LIFTER, valve — WRENCH, socket, ½-in.
PLIERS, thin-nosed

(a) Remove the two valve cover to cylinder block cap screws (½-in. socket wrench). Lift valve cover and gasket from cylinder block (fig. 141).

(b) Insert valve lifter between valve tappet boss and valve spring seat. Compress valve spring. Using thin-nosed pliers, remove valve spring seat pin. Lift valve from top of cylinder block. Release valve lifter and remove from cylinder block. Lift valve spring seat and valve spring from cylinder block (fig. 142).

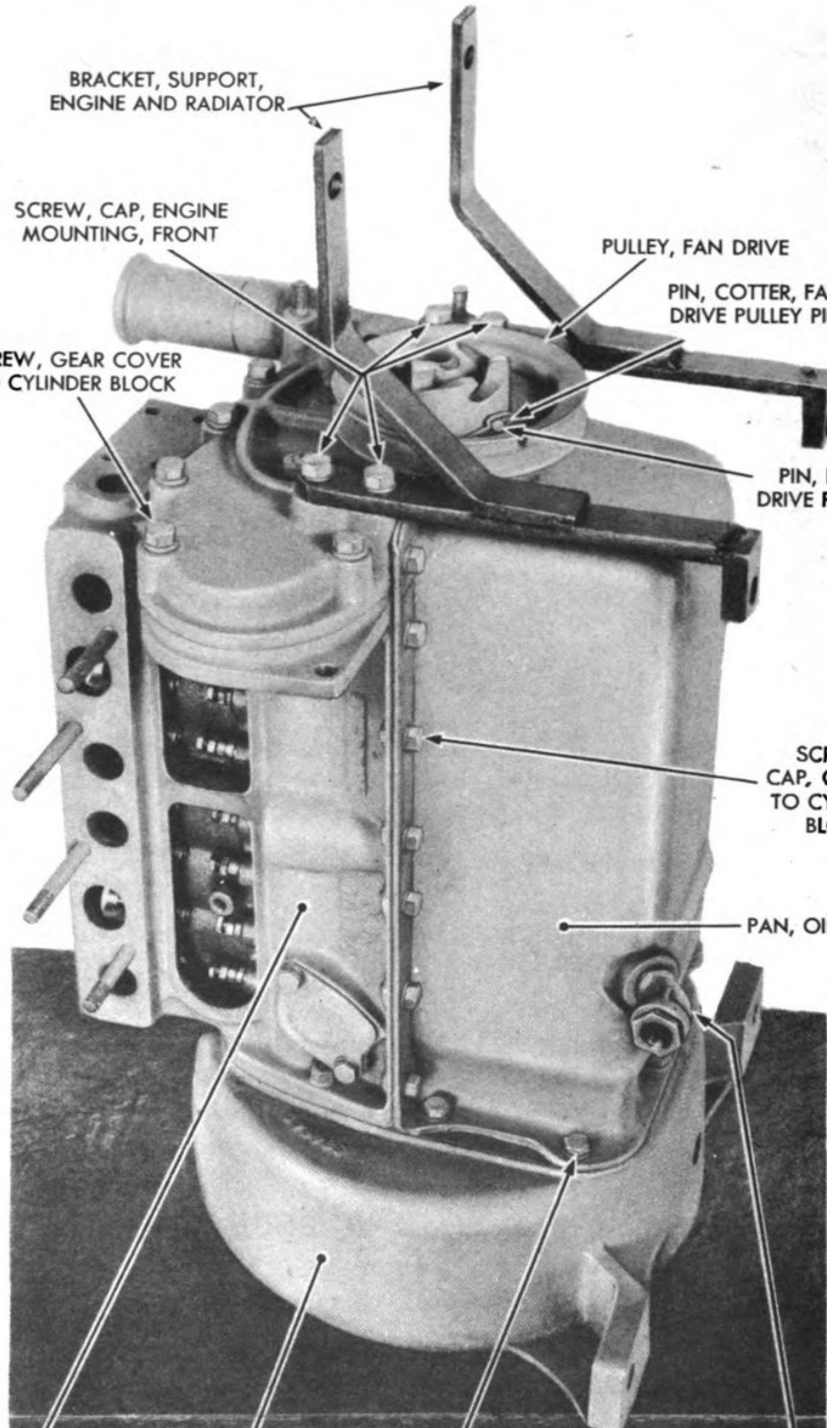


Figure 143 — Position of Engine for Further Disassembly

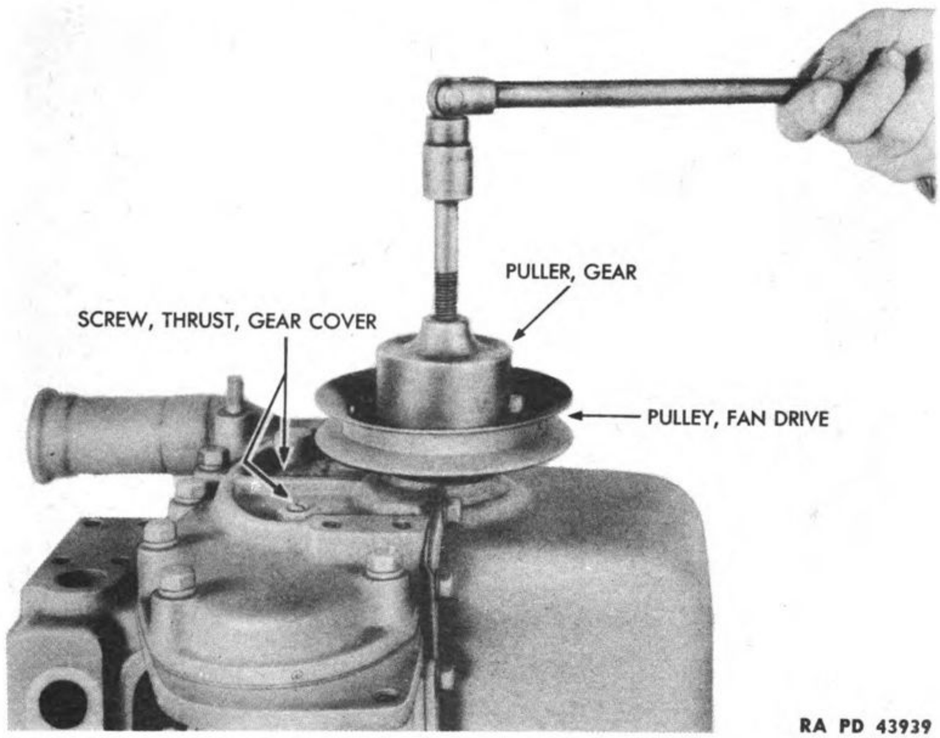


Figure 144 — Pulling Fan Drive Pulley

(c) Repeat substep *(b)* above, to remove each of seven remaining valves. NOTE: Valves must be kept in order so that they can be assembled in same cylinders from which they were removed. Construct a valve rack by drilling eight ¼-inch holes in a strip of wood. Saw a point on one end of strip to indicate front end. Place valves in proper hole upon removal from engine. This device will prevent confusion as to proper order of valves upon assembly (fig. 142).

(3) REMOVE VALVE GUIDES.

HAMMER — REMOVER, valve guide

Remove valve guides by driving out from the top down (hammer and valve guide remover).

(4) REMOVE ENGINE AND RADIATOR SUPPORT BRACKETS.

WRENCH, box, $^9/_{16}$-in.

(a) Place engine on bell housing (fig. 143).

(b) Remove engine front mounting cap screws and lock washers which secure engine and radiator support brackets to gear cover ($^9/_{16}$-in. box wrench).

(c) Lift brackets from engine.

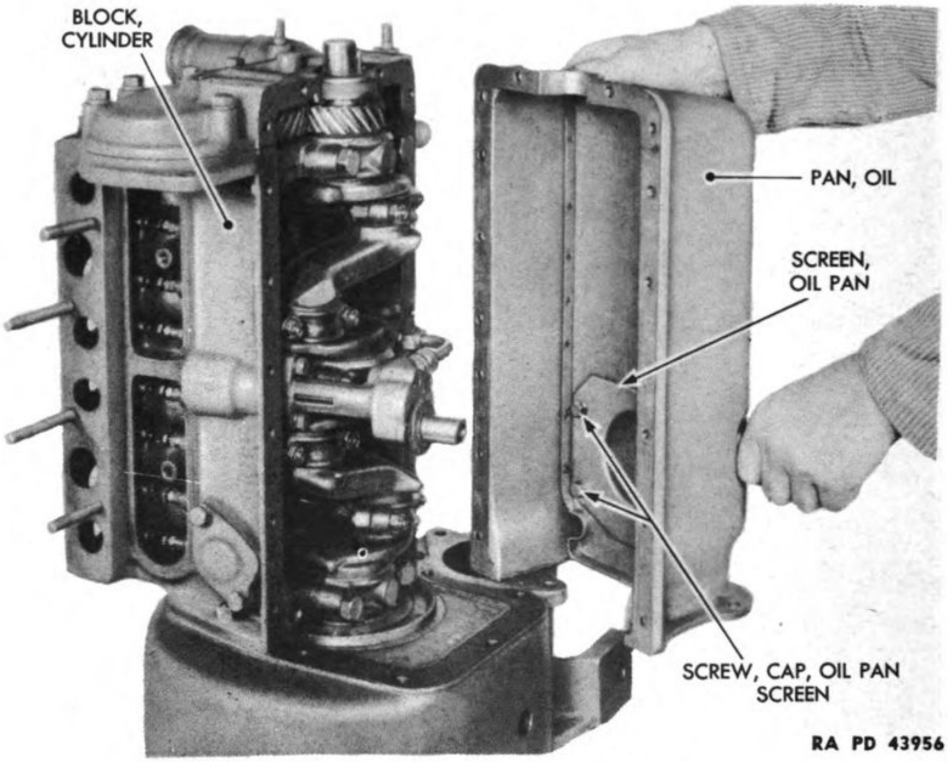


Figure 145 — Removing Oil Pan

(5) Remove Fan Drive Pulley.

DRIFT	PLIERS, thin-nosed
HAMMER	PULLER, gear

(a) Using thin-nosed pliers, remove two fan drive pulley pin cotter pins (fig. 143).

(b) Drive fan drive pin from fan drive pulley (drift and hammer) (fig. 143).

(c) Pull fan drive pulley from front end of crankshaft (gear puller) (fig. 144).

(d) Tap Woodruff key from crankshaft (drift and hammer).

(6) Remove Oil Pan.

WRENCH, box, $\frac{9}{16}$-in.	WRENCH, socket, ½-in.

(a) Remove oil pan to cylinder block cap screws and lock washers (½-in. socket wrench) (fig. 143).

(b) Remove oil pan to bell housing cap screws and lock washers ($\frac{9}{16}$-in. box wrench) (fig. 143).

(c) Lift oil pan and gaskets from cylinder block and bell housing (fig. 145).

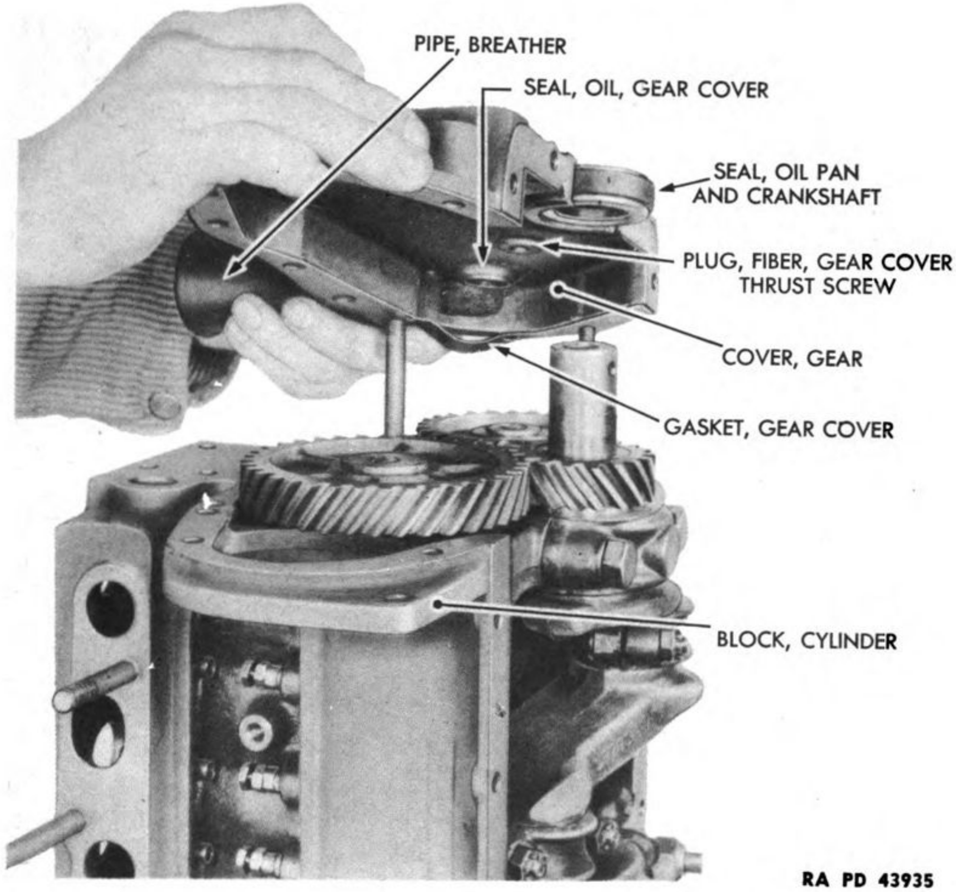


Figure 146 — Removing Gear Cover

(7) DISASSEMBLY OF OIL PAN.

WRENCH, socket, 7/16-in. WRENCH, Stillson

(a) Remove oil pan screen screws and lock washers which hold oil screen to oil pan (7/16-in. socket wrench) (fig. 145).

(b) Lift screen from oil pan.

(c) Remove oil drain pipe elbow from oil pan (Stillson wrench) (fig. 143).

(8) REMOVE GEAR COVER.

WRENCH, socket, 9/16-in.

(a) Remove gear cover to cylinder block cap screws and lock washers (9/16-in. socket wrench) (fig. 143).

(b) Lift gear cover and gasket from cylinder block (fig. 146).

(9) DISASSEMBLE GEAR COVER.

DRIFT
DRIFT, soft
HAMMER
SCREWDRIVER
WRENCH, open-end, 13/16-in.

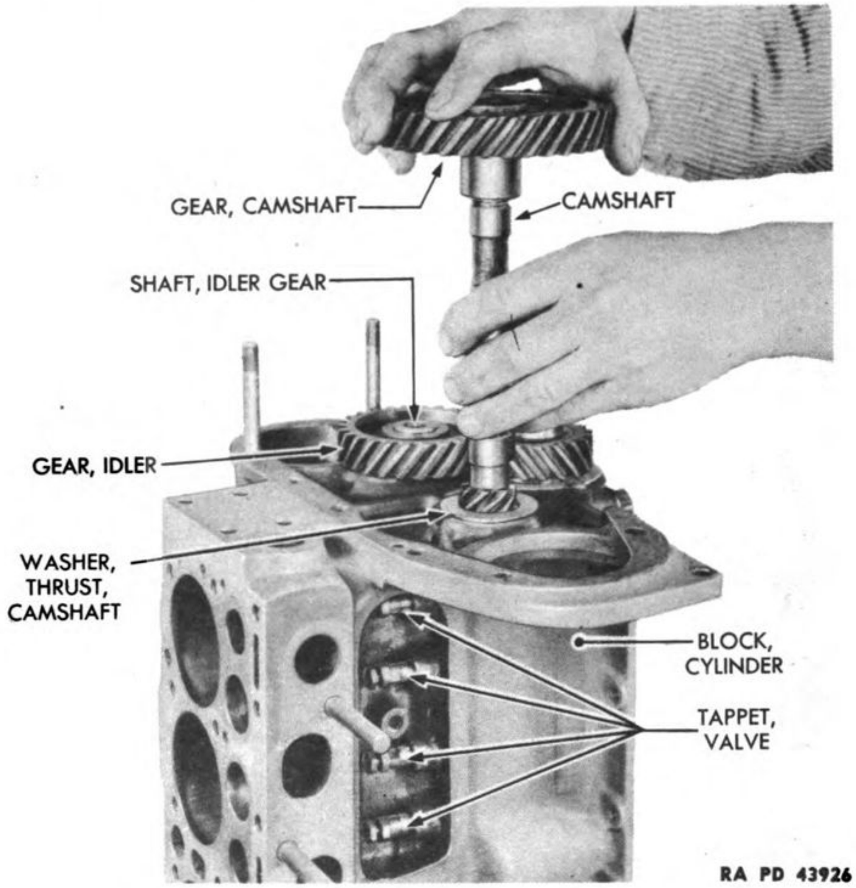


Figure 147 — Removing Camshaft

(a) Drive breather pipe from gear cover (soft drift and hammer) (fig. 146).

(b) Remove gear cover thrust screw assemblies from gear cover (screwdriver and 13/16-in. open-end wrench) (fig. 144).

(c) Drive gear cover thrust screw fiber plug from gear cover thrust screw (hammer and drift) (fig. 146). Repeat operation to remove other thrust screw.

(d) Tap oil pan and crankshaft seal from gear cover (drift and hammer) (fig. 146).

(e) Lift oil pan and crankshaft seal from gear cover (fig. 146).

(10) REMOVE OIL PUMP (par. 160).

(11) REMOVE CAMSHAFT AND IDLER GEAR.

(a) Pull all eight valve tappets away from camshaft. Lift camshaft gear and attached camshaft from cylinder block. Lift camshaft thrust washer from cylinder block (fig. 147).

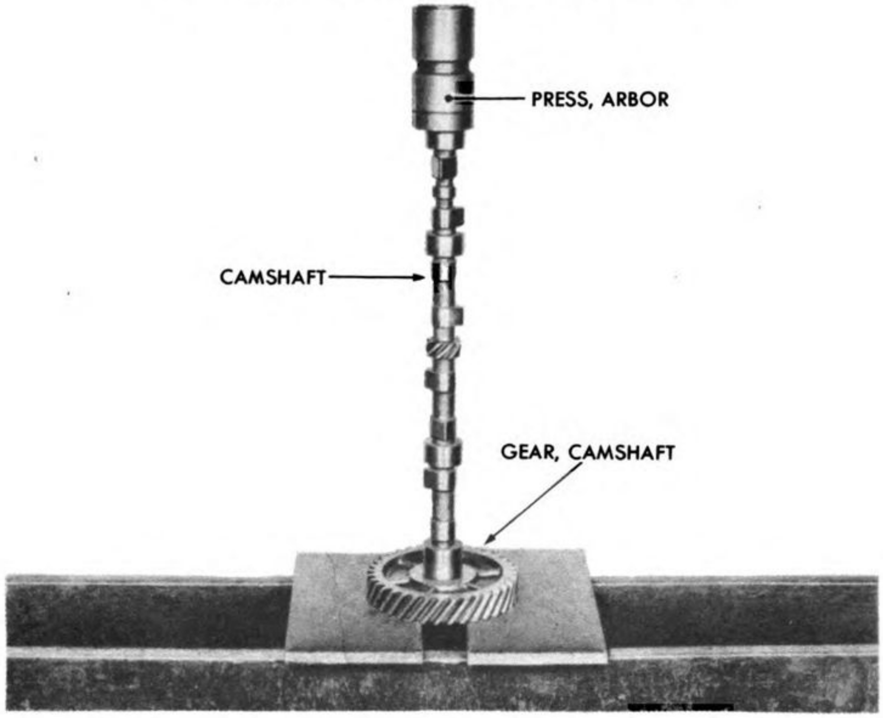


Figure 148 — Pressing Camshaft Gear Onto Camshaft

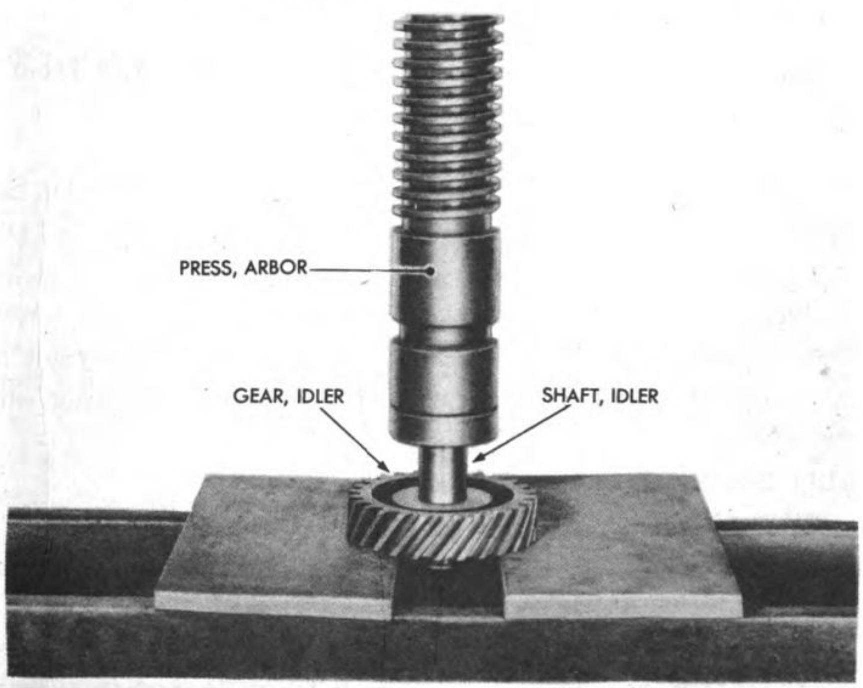


Figure 149 — Pressing Idler Gear from Idler Shaft

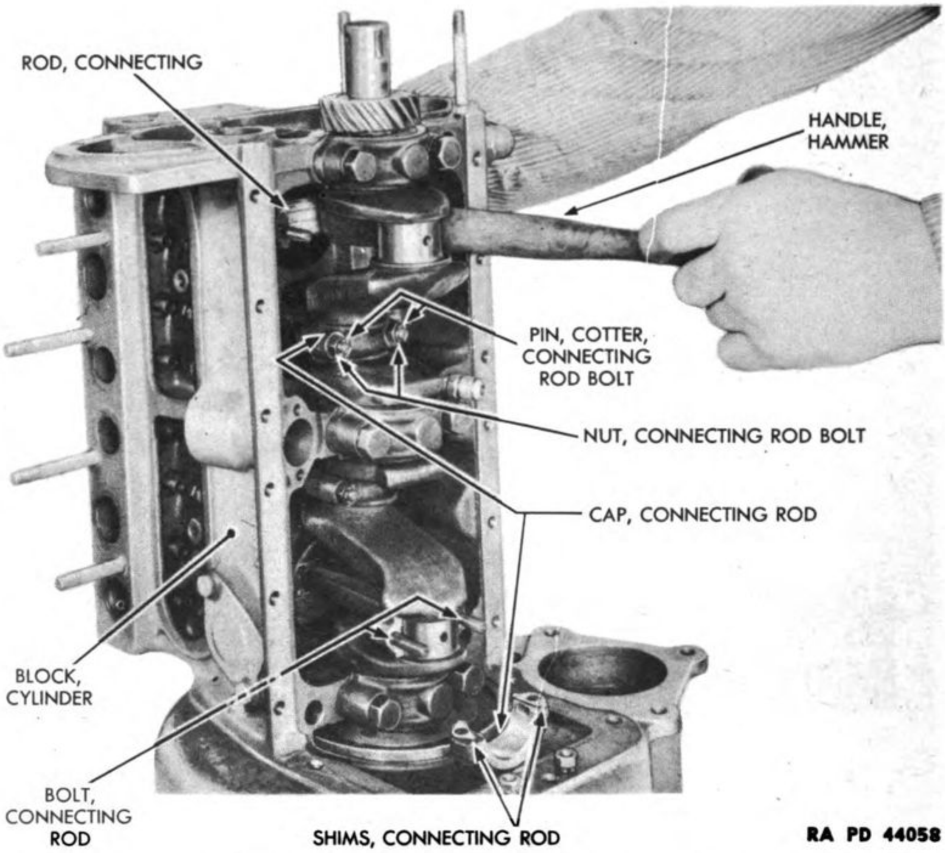


Figure 150 — Pushing Piston and Connecting Rod from Cylinder Block

(b) Lift idler gear and attached idler shaft from cylinder block. Pick idler shaft thrust washer from cylinder block (fig. 147).

(12) DISASSEMBLE CAMSHAFT.

HAMMER, soft	PRESS, arbor

Press camshaft gear from camshaft (arbor press). Tap (soft hammer) camshaft gear key from camshaft (reverse of operation shown in fig. 148).

(13) DISASSEMBLE IDLER SHAFT.

PRESS, arbor

Press idler gear from idler shaft (arbor press) (reverse of operation shown in fig. 149).

(14) REMOVE PISTONS AND CONNECTING RODS.

HAMMER	WRENCH, socket, ½-in.
PLIERS, thin-nosed	

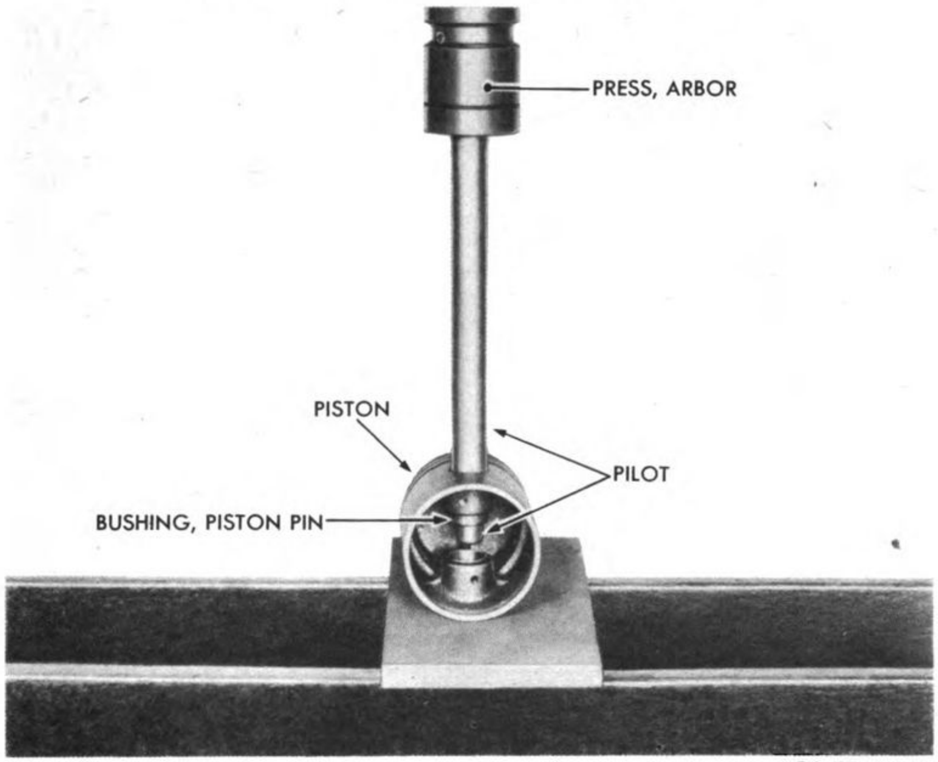


Figure 151 — Pressing Piston Pin Bushing from Piston

(a) Remove connecting rod bolt cotter pins from connecting rod (thin-nosed pliers) (fig. 150).

(b) Remove connecting rod bolt nuts (½-in. socket wrench) (fig. 150).

(c) Lift connecting rod cap and shims from connecting rod bolts (fig. 150).

(d) Place a hammer handle against end of connecting rod (*not against bearing surface*) and push connecting rod and piston out through top of cylinder block (fig. 150). NOTE: If engine is equipped with replacement pistons, be sure both rod and cap are marked with cylinder number on camshaft side of rod and cap.

(e) Repeat substeps *(a)* through *(d)* above, to remove each of the three remaining pistons and connecting rods.

(15) Disassemble Piston and Connecting Rod.

DRIFT, soft	PLIERS, thin-nosed
EXPANDER, piston ring	PRESS, arbor
HAMMER	WRENCH, socket, $\frac{7}{16}$-in.

(a) Remove two compression and one oil piston ring from piston (piston ring expander).

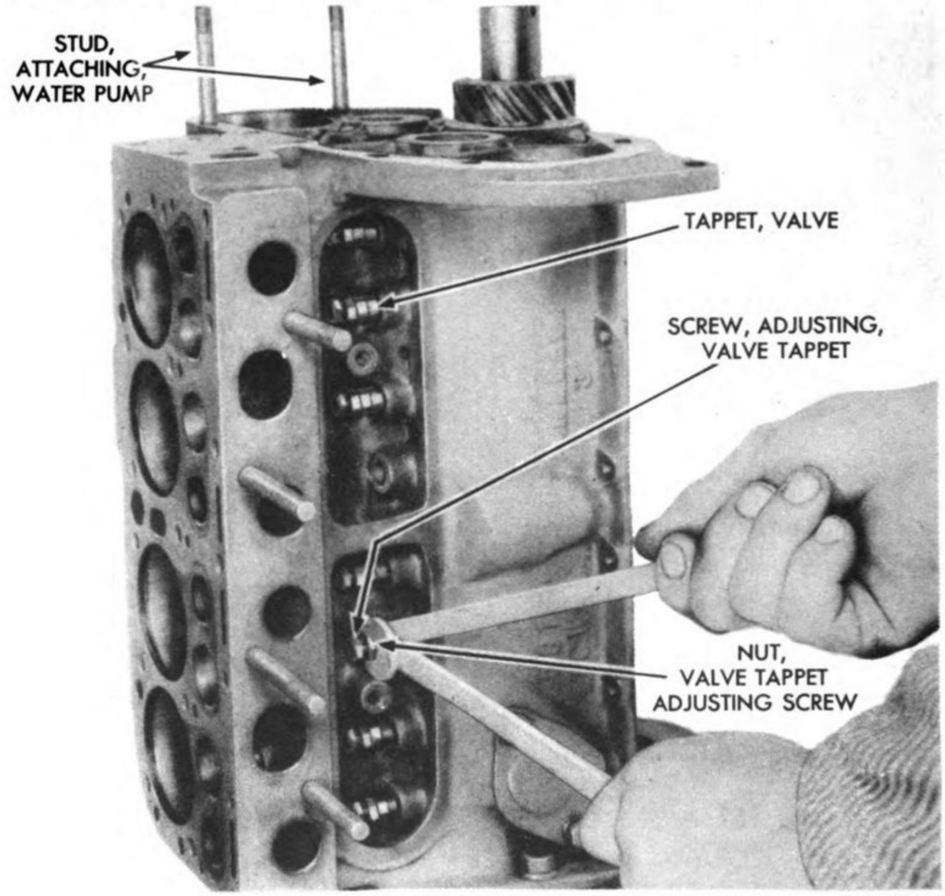


Figure 152 — Removing Valve Tappet

(b) Remove lock wire which locks the connecting rod piston pin lock screw (thin-nosed pliers).

(c) Remove connecting rod piston pin lock screw from connecting rod (7/16-in. socket wrench).

(d) Tap piston pin from the piston and connecting rod (soft drift and hammer). Lift piston from connecting rod.

(e) Press piston pin bushings from piston (arbor press) (fig. 151).

(f) Repeat substeps *(a)* through *(e)* above, to disassemble each of remaining three piston and connecting rod assemblies.

(16) REMOVE VALVE TAPPETS.

WRENCH, open-end, 3/8-in. **WRENCH**, open-end, 7/16-in.

(a) Using a 3/8-inch open-end wrench to hold tappet, remove loosened valve tappet adjusting screw nut (7/16-in. open-end wrench). Remove valve tappet adjusting screw from valve tappet (7/16-in. open-end wrench) (fig. 152).

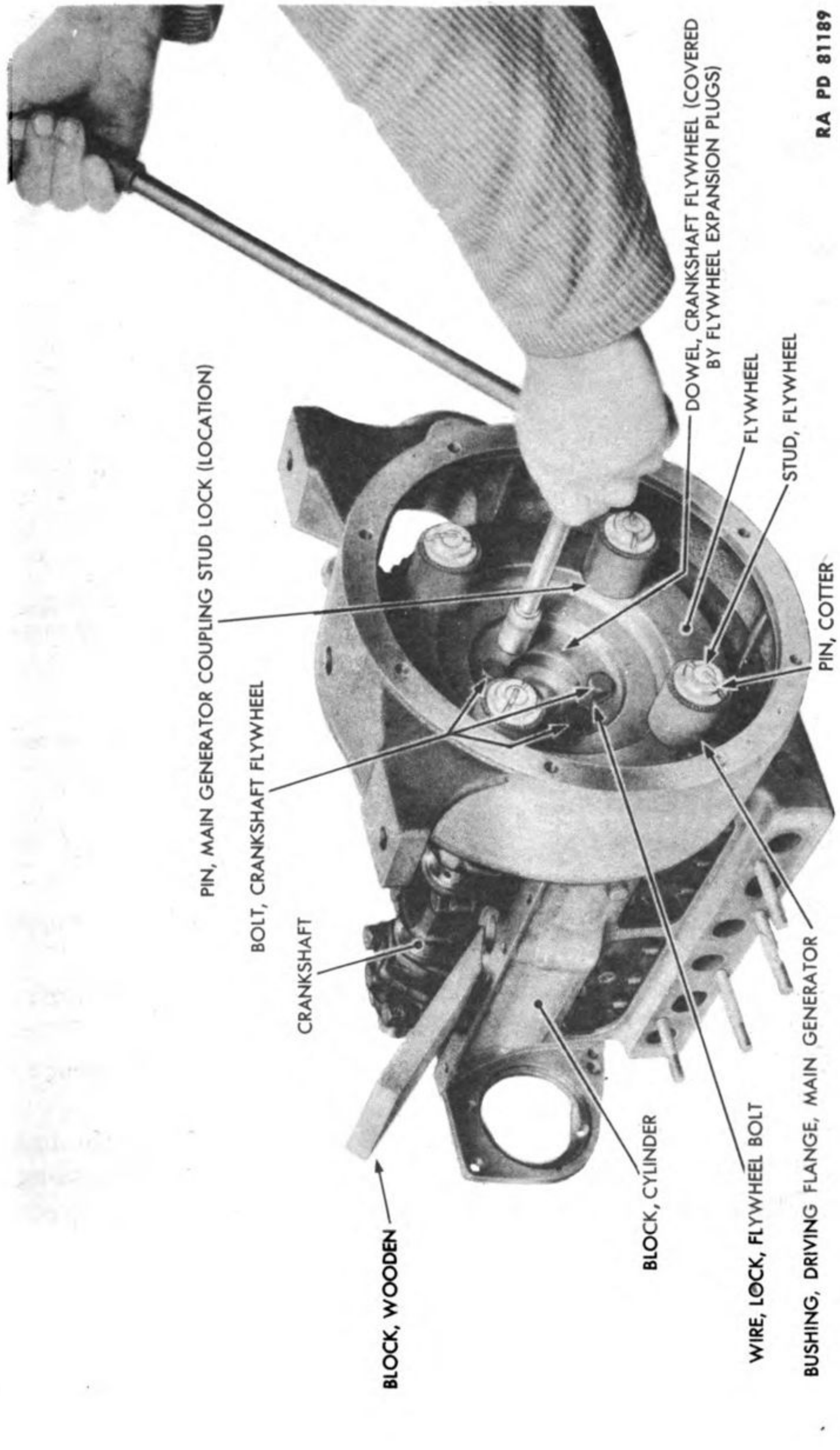


Figure 153 — Removing Flywheel

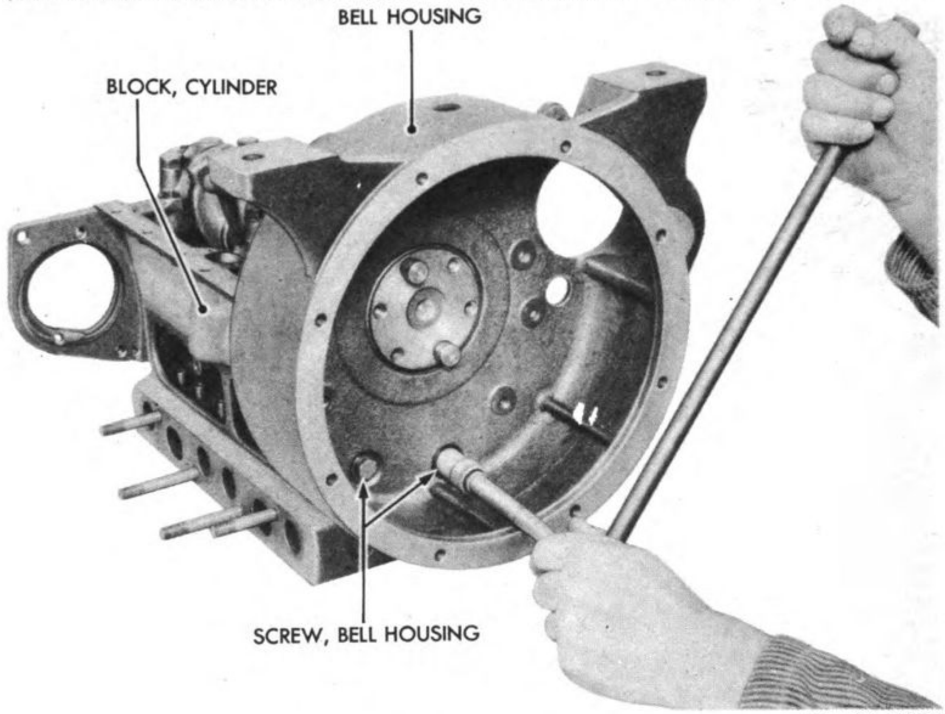


Figure 154 — Removing Bell Housing

(b) Repeat substep *(a)* above, to remove each of remaining seven valve tappets (fig. 152).

(17) REMOVE FLYWHEEL.

PLIERS, thin-nosed	WRENCH, socket, ⅝-in.
WOOD BLOCK	

(a) Remove crankshaft flywheel bolt lock wire (thin-nosed pliers) (fig. 153).

(b) Place a wood block between cylinder block and crankshaft to keep crankshaft from revolving (fig. 153).

(c) Remove four crankshaft flywheel bolts (⅝-in. socket wrench) (fig. 153).

(d) Tap flywheel loose from crankshaft with wood block through starting motor opening in bell housing. Lift flywheel from bell housing.

(18) DISASSEMBLE FLYWHEEL ASSEMBLY.

DRIFT	HAMMER
DRIFT, soft	PLIERS, thin-nosed
DRILL, electric	REMOVER, stud

(a) Remove a main generator driving flange bushing cotter pin (thin-nosed pliers) and fiber retaining nut (by hand). Lift main generator driving flange bushing from stud. Drill stud lock pin from flywheel and stud (electric drill). Remove stud from flywheel (stud

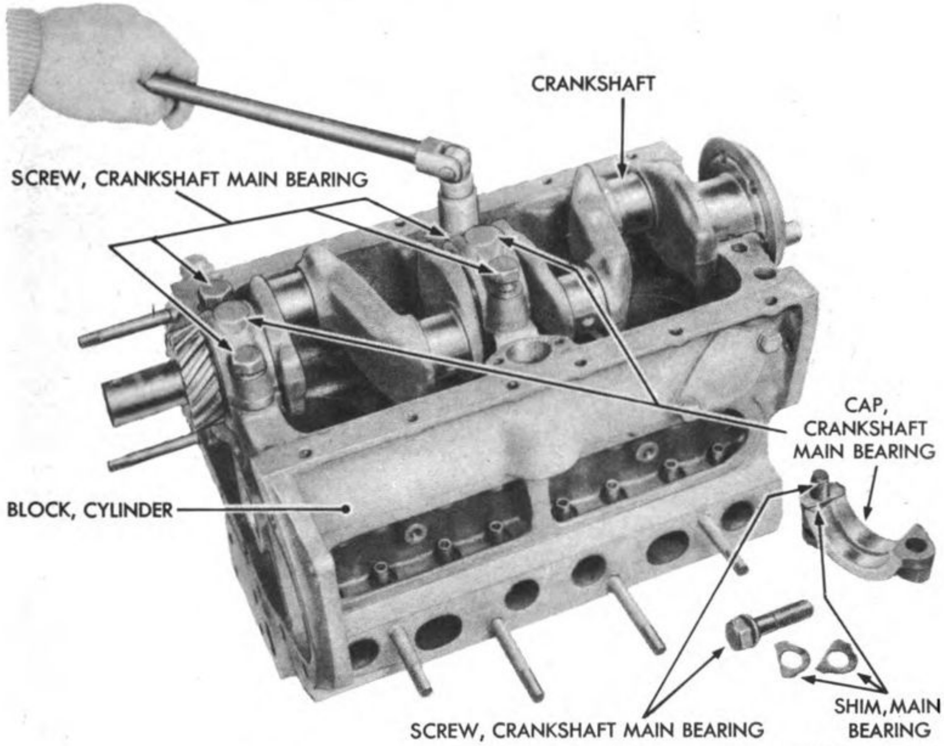


Figure 155 — Removing Crankshaft

remover). Repeat operation to remove each of three remaining main generator driving flange bushings.

(b) Tap the two flywheel expansion plugs from flywheel (drift and hammer).

(c) Drive ring gear from flywheel (soft drift and hammer). CAUTION: Do not hold drift against teeth of ring gear.

(19) REMOVE BELL HOUSING.

WRENCH, open-end, $\frac{9}{16}$-in. WRENCH, socket, $\frac{9}{16}$-in.

(a) Remove, from inside bell housing, bell housing screws and lock washers which secure bell housing to cylinder block ($\frac{9}{16}$-in. socket wrench) (fig. 154).

(b) From accessory side of cylinder block, remove bell housing screw and lock washer, and thin head bell housing screw and lock washer, which secure bell housing to cylinder block ($\frac{9}{16}$-in. open-end wrench) (fig. 134).

(c) From valve tappet side of cylinder block, remove bell housing stud nut and lock washer which secure bell housing to cylinder block ($\frac{9}{16}$-in. open-end wrench) (fig. 141).

(d) Lift bell housing and gasket from cylinder block (fig. 154).

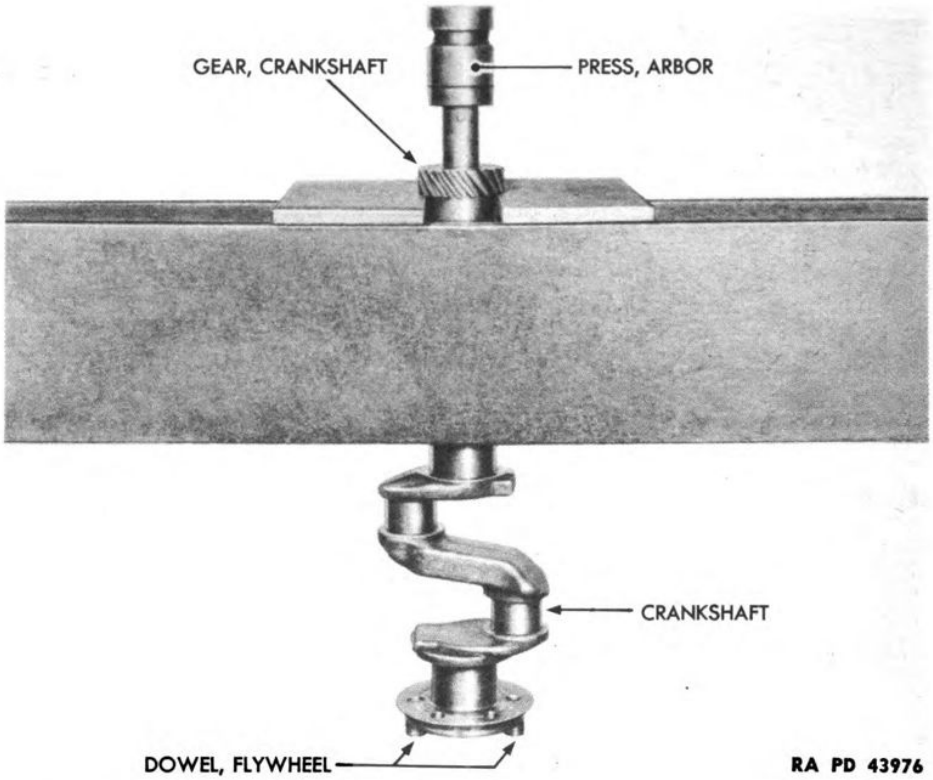


Figure 156 — Pressing Crankshaft Gear from Crankshaft

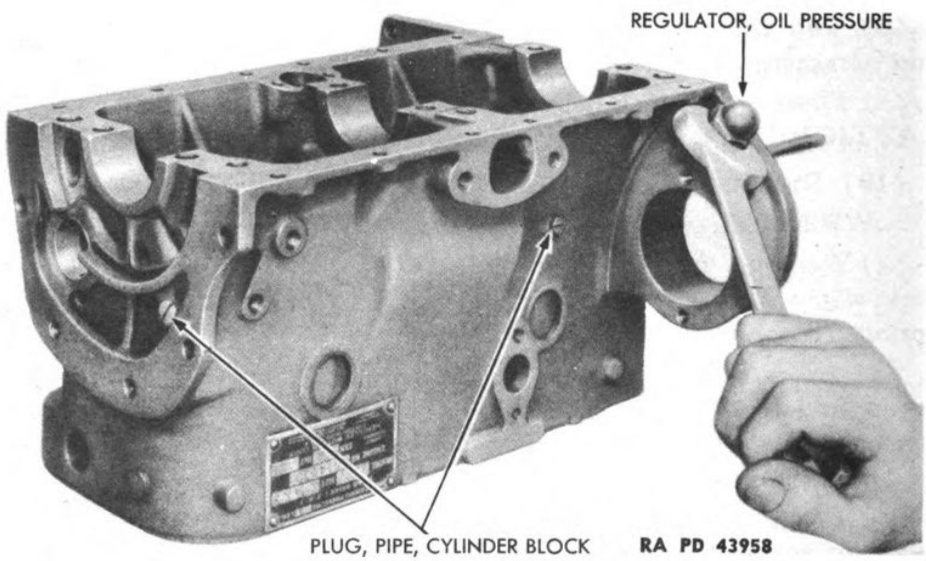


Figure 157 — Removing Oil Pressure Regulator

ENGINE REMOVAL AND DISASSEMBLY

(20) REMOVE CRANKSHAFT.

WRENCH, socket, ¾-in.

(a) Remove the crankshaft main bearing screws and lock washers which secure each of the three main bearing caps to cylinder block (¾-in. socket wrench) (fig. 155).

(b) Lift main bearing caps, six screws, and shims from cylinder block (fig. 155). Put shims in envelopes and mark positions from which taken, to facilitate assembly.

(c) Lift crankshaft from cylinder block (fig. 155).

(d) Lift main bearings from cylinder block (fig. 155), and scratch identifying marks on backs of bearings so they can be assembled in same position.

(21) DISASSEMBLE CRANKSHAFT.

DRIFT
PRESS, arbor
HAMMER

(a) Press crankshaft gear from crankshaft (arbor press) (fig. 156). CAUTION: Do not perform this step unless gear needs replacing.

(b) Drive the two flywheel dowels from rear end of crankshaft (drift and hammer) (fig. 156).

(22) REMOVE OIL PRESSURE REGULATOR AND CYLINDER PIPE PLUGS.

SCREWDRIVER

(a) Remove oil pressure regulator (par. 161) (fig. 157).

(b) Remove cylinder block pipe plugs at each end of oil gallery in cylinder block (screwdriver). Also remove cylinder block pipe plug on accessory side of cylinder block.

Section XV

DISASSEMBLED ENGINE INSPECTION

Paragraph

117. ENGINE COMPONENT CLEANING.

a. Equipment.

BRUSH, power driven rotary wire
BRUSH, wire
COMPRESSED AIR
KNIFE, putty
SOLVENT, dry-cleaning
TOOL, carbon removing

b. Procedure.

(1) Clean all metal parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Clean carbon deposits on valves with a power-driven rotary wire brush.

(3) Clean carbon from piston ring grooves in piston with a carbon removing tool, or with a segment of a broken piston ring.

(4) Scrape carbon from tops of pistons, from cylinder head (fig. 158), and from cylinder block with a carbon removing tool.

(5) Blow compressed air through oil passages in cylinder block and crankshaft. Remove any obstructions with SOLVENT, dry-cleaning, and a wire brush.

(6) Scrape all gaskets from metal parts with a putty knife.

(7) Remove sealing compound with SOLVENT, dry-cleaning, and a wire brush.

(8) Blow compressed air through water jacket of cylinder head and cylinder block.

118. CYLINDER BLOCK AND CYLINDER HEAD INSPECTION.

a. Equipment.

GAGE, feeler
INDICATOR, dial

b. Procedure.

(1) INSPECT CYLINDER BLOCK.

GAGE, feeler
INDICATOR, dial

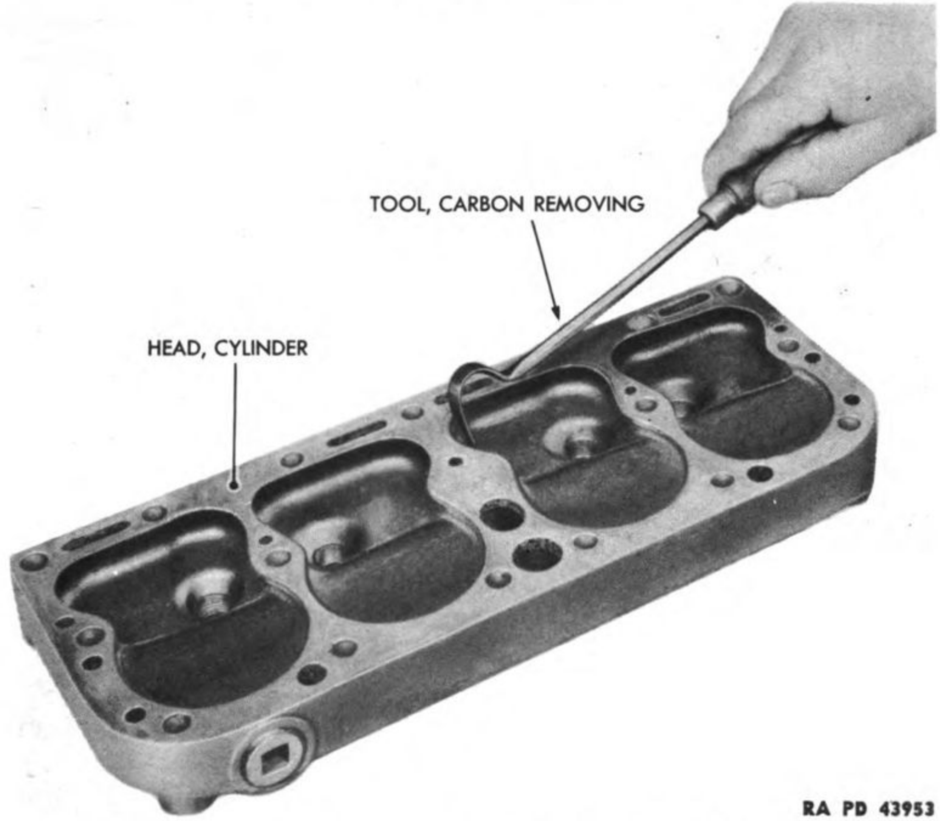


Figure 158 — Scraping Carbon from Cylinder Head

(a) Inspect the four manifold studs and two water pump and gear cover studs for broken or damaged threads.

(b) Inspect cylinder block for cracks, especially between valve seats and cylinders.

(c) Run a dial indicator up and down and around each cylinder. Note if readings vary as much as 0.003 to 0.005 inch. This indicates taper or out-of-round.

(d) Insert valve stem into valve guide and move valve back and forth sidewise. Since a 0.0015-inch clearance is maximum allowable clearance, more than a barely perceptible movement indicates worn valve guides and valve stems. If loose, repeat check using a new valve. If new valve stem is loose, guide is worn. NOTE: Be sure to check each valve guide with the valve that goes in that particular guide.

(e) Slide idler shaft into idler shaft bearing. More than a barely perceptible side play (0.0015 in.) indicates a worn bearing.

(f) Slide camshaft into camshaft bearings. Measure clearance between bearing and journal with a feeler gage. Excess of a 0.0025-inch clearance indicates worn camshaft bearings.

(g) Slide each valve tappet, one at a time, into its guide hole in cylinder block, and test side play by attempting to move the tappet sidewise. Since maximum clearance is 0.001 inch, more than a barely perceptible side play indicates worn cylinder block or tappets. If loose, repeat check using a new tappet. If new tappet is loose, cylinder block is worn.

(h) Inspect all tapped threads for damage.

(i) Inspect all cylinder expansion plugs for looseness or leakage. Leakage will be indicated if cylinder block is discolored around plug.

(j) Examine valve seats to see if they are eccentric, pitted, or burned.

(2) INSPECT CYLINDER HEAD.

(a) Examine cylinder head for cracks.

(b) Examine machined face of cylinder heads for nicks or scratches serious enough to allow water leakage or compression loss.

(c) Examine threads on cylinder head screws and studs for damage.

(d) Examine threads in holes tapped for spark plugs.

119. VALVES AND VALVE OPERATING MECHANISM INSPECTION.

a. Inspect Valves.

(1) Examine valve faces to see if they are warped, pitted, cracked, or burned.

(2) Test wear of valve stems by inserting them in valve guides. Presence of side play indicates wear.

(3) Examine valve springs, spring seats, and spring seat pins for wear or breakage.

b. Inspect Valve Tappets.

(1) Examine faces and stems of valve tappets for score marks or breakage.

(2) Examine valve tappet adjusting screws and nuts to see if they are broken or have damaged threads.

(3) Examine threads in valve tappet stem. NOTE: Valve tappets were tested for wear in paragraph 118 **b** (1) *(g)*.

c. Inspect Camshaft.

(1) Examine camshaft gear and oil pump drive gear for broken or worn teeth.

(2) Examine cams and journals for score marks.

(3) Examine thrust washer to see if it is worn or scored.

DISASSEMBLED ENGINE INSPECTION

120. PISTON AND CONNECTING ROD INSPECTION.

a. Equipment.

FIXTURE, connecting rod alining
GAGE, feeler
MICROMETER

b. Procedure.

(1) Examine connecting rod bearing for score marks, or broken, chipped, or burned babbitt.

(2) Examine threads on connecting rod cap bolts, nuts, and connecting rod piston pin lock screw for damage.

(3) Place assembled connecting rod and piston on a connecting rod alining fixture, and check for bend, twist, and offset (par. 126 **b** (5)).

(4) Test fit of piston pin in piston pin bushings by attempting to rock the assembled connecting rod sidewise in the piston. Correct clearance is 0.0005 inch. No side play should be noticeable. Presence of rocking motion indicates worn bushings or pin, or both. NOTE: Do not confuse sidewise motion of pin in bushing for rocking motion.

(5) Examine piston for score marks.

(6) Using a 2- to 3-inch micrometer, measure distance across skirt of piston at intervals around piston. If measurements vary, piston is out-of-round.

(7) Inspect piston rings for breakage. Using a feeler gage, measure clearance of rings in piston ring groove. A maximum of 0.0025 inch is permissible in an unworn ring. Place piston rings, one at a time, in running position in cylinder. Measure clearance at end gap with a feeler gage. Safe maximum end gap is 0.020 inch.

121. ACCESSORY DRIVE INSPECTION.

a. Equipment.

GAGE, feeler

b. Procedure.

(1) Inspect accessory drive gear and distributor drive gear for broken or worn teeth.

(2) Inspect accessory drive shaft and thrust washer for score marks or wear.

(3) Slide accessory drive shaft into accessory drive bushing and test side play. A 0.002-inch maximum is permissible (feeler gage). More than a barely perceptible side play indicates a worn bushing.

(4) Examine accessory drive oil retainer for breakage. Tap retainer into position in housing to test fit. If loose, retainer is worn. NOTE: Accessory drive cork washer should be replaced each time accessory drive is disassembled.

(5) Examine accessory drive housing for breakage.

122. CRANKSHAFT AND MAIN BEARINGS, INSPECTION.

a. Equipment.

BLOCK, V— (2)
BRUSH, wire
INDICATOR, dial
LATHE
MICROMETER

b. Procedure.

(1) INSPECT CRANKSHAFT.

BLOCK, V— (2)
BRUSH, wire
INDICATOR, dial
LATHE
MICROMETER

(a) Examine teeth of crankshaft gear to see if they are worn or broken.

(b) Inspect threads tapped in flywheel end of crankshaft for damage.

(c) Examine bearing journals for scoring or burning.

(d) Run a wire brush through the four oil passages to be sure that they are free of obstruction.

(e) Measure diameter of each bearing journal at intervals with a micrometer. If size of any journal varies more than 0.003 inch, journal is out-of-round.

(f) Revolve crankshaft in a lathe or V-blocks. Place a dial indicator against center main bearing journal. If reading is not constant as crankshaft is rotated, crankshaft is bent. Maximum allowable runout is 0.002 inch. NOTE: If step *(e)* above indicates out-of-round center main bearing journal, this test cannot be made until out-of-round condition is corrected.

(2) INSPECT CRANKSHAFT MAIN BEARINGS.

(a) Examine bearing in cap and insert for chipped, broken, burned, or scored babbitt.

(b) Examine main bearing screws and lock washers to see if they are broken or have damaged threads.

123. REMAINING ENGINE COMPONENT INSPECTION.

a. Inspect Fan Drive Pulley. Inspect fan drive pulley pin and key for breakage.

b. Inspect Engine and Radiator Support Brackets. Inspect engine and radiator support brackets to see if they are broken or bent.

c. Inspect Oil Pan.

(1) Examine oil pan for dents or cracks.

(2) Examine oil screen for carbon deposits.

(3) Examine oil pan screws and oil pan screen screws to see if they are broken or have damaged threads.

(4) Examine threads on oil drain pipe assembly and in oil pan drain pipe opening.

d. Inspect Gear Cover.

(1) Inspect gear cover for cracks.

(2) Measure distance each thrust screw fiber plug projects from thrust screw. If less than three-sixteenths inch, plug is worn out. Also note whether plug is broken.

(3) Examine threads on all screws and nuts for damage.

e. Inspect Idler Shaft Assembly.

(1) Examine teeth of idler gear for breakage or wear.

(2) Examine idler shaft for score marks.

(3) Examine thrust washer to see if it is worn or scored.

f. Inspect Flywheel.

(1) Examine flywheel for cracks.

(2) Test fit of dowel pins in dowel pin holes. They should be a drive fit. If pins go in easily, test fit with a new pin. If new pin fits easily, dowel pin hole is too large.

(3) Examine threads in the four main generator driving flange bushing stud holes for damage.

(4) Examine main generator driving flange bushings for wear or breakage.

(5) Inspect teeth of ring gear for breakage or wear.

g. Inspect Bell Housing.

(1) Examine bell housing for cracks.

(2) Inspect threads in all tapped holes for damage.

(3) Examine all cap screws, studs, nuts, and lock washers for breakage or damaged threads.

h. Inspect Oil Pressure Regulator and Cylinder Pipe Plugs.

(1) Examine oil pressure regulating piston, spring, adjusting screw, and nut for breakage and/or damaged threads.

(2) Examine oil pressure regulating piston to see if it is scored.

(3) Examine threads on cylinder pipe plugs for damage.

Section XVI

ENGINE MAINTENANCE AND REPAIR

124. CYLINDER BLOCK AND CYLINDER HEAD REPAIRS.

a. Equipment.

BAR, boring
DIE, thread
DRILL, electric
FILE, mill
GAGE, feeler
HAMMER
HONE, cylinder
MACHINE, milling
PILOT
PILOT, valve guide
PUNCH, sharp
REAMER
REMOVER, stud
SCALE
SOFT BLOCK
STRAIGHTEDGE
TAP, thread
TOOL, carbon removing
TOOL, cutting
VARNISH, shellac
WELDING EQUIPMENT
WRENCH, open-end, $\frac{9}{16}$-in.

b. Procedure.

(1) REMOVE BROKEN STUDS.

DRILL, electric
HAMMER
REMOVER, stud

(a) Remove studs broken above the surface of the cylinder block or cylinder head with a stud remover.

(b) Remove studs broken flush with cylinder block or below surface of cylinder block as follows:

1. Using an electric drill with a bit about one-half the diameter of the stud, drill a hole the length of stud through its center.

2. Tap a stud removing tool into the drilled hole (hammer).

3. Screw the stud from the cylinder block.

(2) WELDING CRACKED CYLINDER BLOCK.

WELDING EQUIPMENT

If possible, replace cracked cylinder blocks. If crack is not on a cylinder wall or machined surface, cylinder block may be temporarily repaired by welding.

(3) REBORING CYLINDER BLOCK.

BAR, boring
FILE, mill
HONE, cylinder
TOOL, cutting
WRENCH, open-end, $\frac{9}{16}$-in.

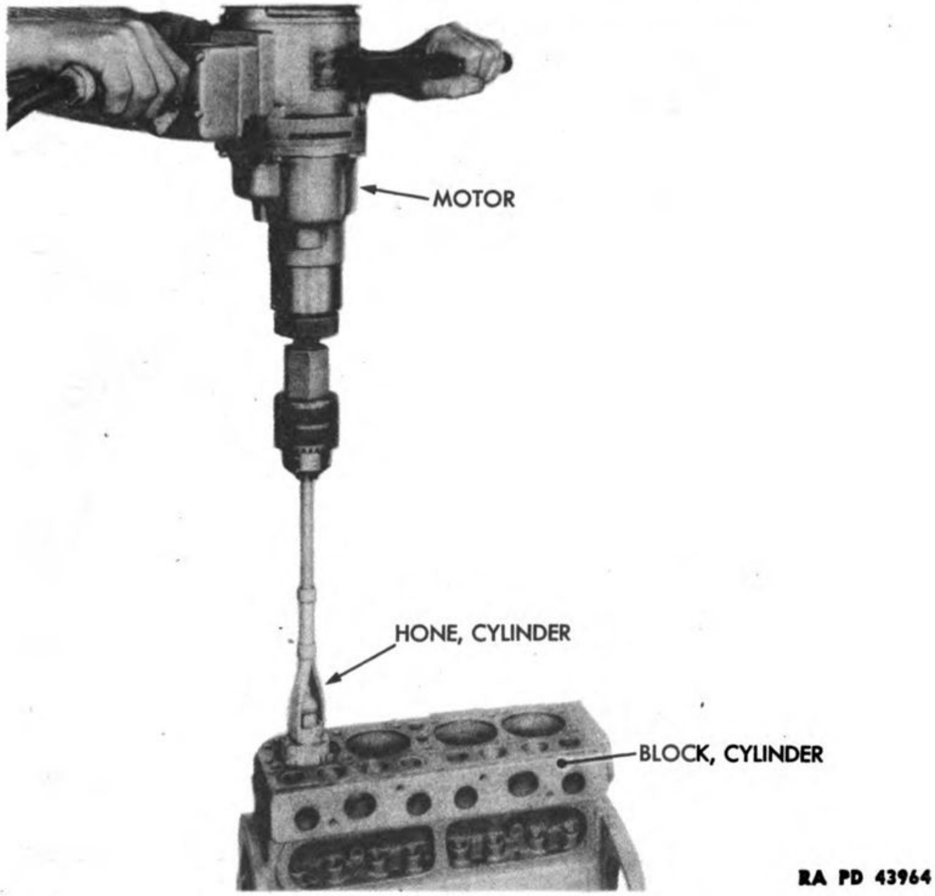


Figure 159 — Honing Cylinders

(a) If inspection reveals tapered, out-of-round, or scored cylinders, rebore cylinders with a boring bar. Directions for operation are furnished with each make of boring bar. General steps in reboring cylinders follow:

1. Machined surface of top of cylinder block must be cleaned by taking a light cut with a mill file.

2. Place boring bar in position over cylinder. Secure it to the cylinder block with cylinder head cap screws ($^{9}/_{16}$-in. open-end wrench).

3. Center bar over cylinder to be rebored, and adjust the cutting tool to the size the cylinder is to be cut. This depends upon the size of the oversize piston to be fitted (par. 126 **b** (4)).

4. Start boring bar motor and engage the cutting tool.

5. Stop boring bar motor as soon as the cutting tool has cut entire length of cylinder bore.

6. Return cutting tool to top of cylinder block and detach boring bar from cylinder block.

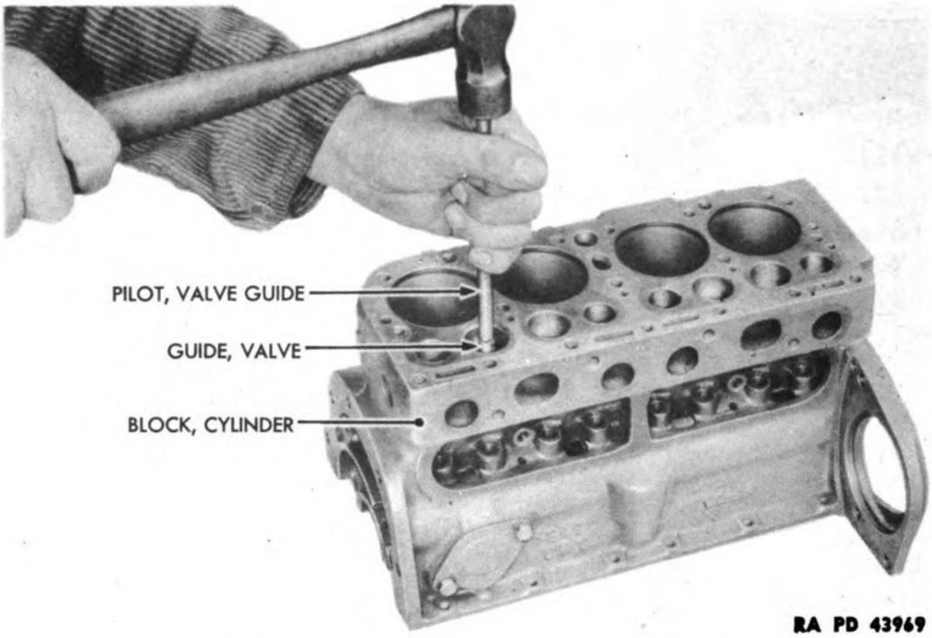


Figure 160 — Installing Valve Guide

7. Repeat substeps *2* through *6* above to rebore each of the three remaining cylinders.

(b) Hone each cylinder (step (4) below) to remove any tool marks from cylinder wall.

(c) Fit oversize pistons to cylinder (par. 126 **b** (4)).

(4) HONING CYLINDERS (fig. 159).

HONE, cylinder

(a) Cylinders only slightly tapered, out-of-round, or scored (less than 0.005 inch) can be corrected by honing without first reboring. Honing is a slower method. Cylinders are polished by honing after reboring (step (3) above).

(b) Two types of hones, wet and dry, are in common use. Each consists of a grinding tool which is revolved in the cylinder with an electric motor. In a wet hone, cylinder wall is lubricated with diesel fuel during the operation. No lubrication is provided for a dry hone, but vacuum dust collecting equipment is set up under cylinder block.

(c) Refer to manufacturer's directions to use the particular hone available for use. Following are general directions which apply to most hones:

1. Set up dirt collecting vacuum equipment under cylinder block if a dry hone is used. Set up lubricating equipment on top of cylinder block if hone is the wet type.

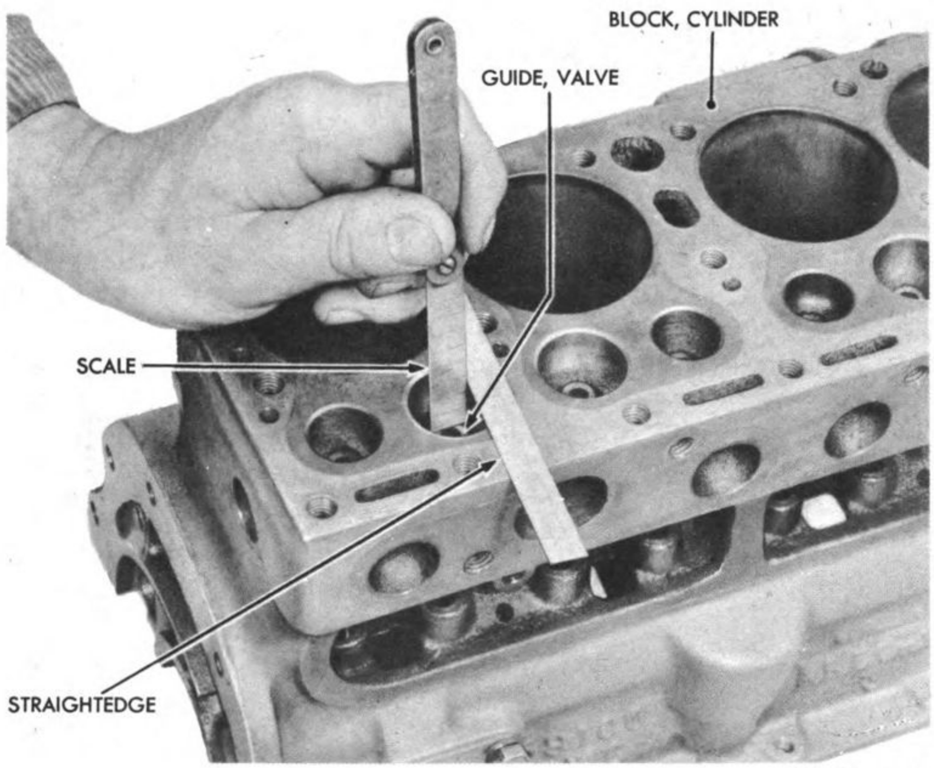


Figure 161 — Measuring Position of Installed Valve Guide

2. Place hone in position in cylinder, and adjust rough cutting stones to cylinder size.

3. Start hone motor and move hone slowly up and down as it revolves in the cylinder. Hone high spots first (determined in inspection (par. 118 **b** (1) *(c)*) with a dial indicator). Then run hone up and down full length of cylinder bore until size of oversize piston to be fitted (par. 126) is obtained (fig. 159).

4. Remove hone and install polishing stones. Hone until piston fits with proper clearance (par. 126).

5. Repeat substeps *1* through *4* above to hone each of remaining three cylinders.

(5) REPLACING WORN VALVE GUIDES (fig. 160).

HAMMER	SCALE
PILOT, valve guide	STRAIGHTEDGE

(a) Place valve guide pilot in top of valve guide to be removed.

(b) Drive valve guide down until it falls from cylinder block (hammer).

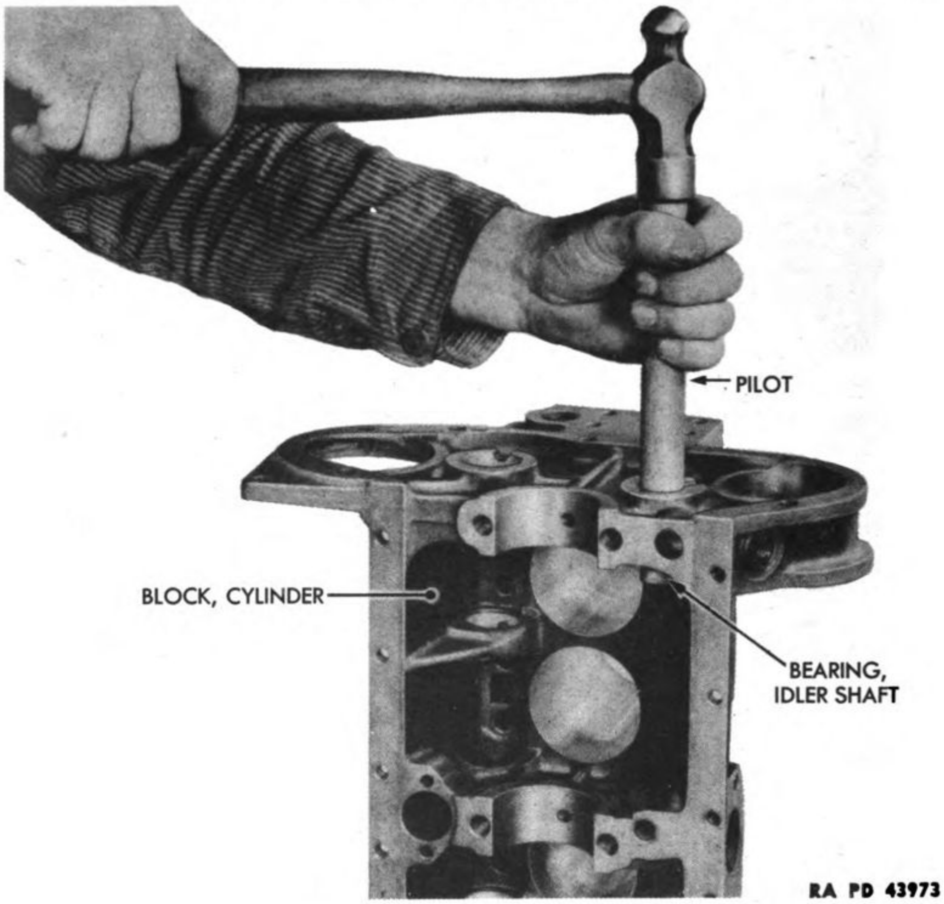


Figure 162 — Removing Idler Shaft Bearing

(c) Place new valve guide in position on top of cylinder block. Insert valve guide pilot in top of valve guide.

(d) Drive valve guide into block until its top is $^{19}/_{32}$ inch from the machined surface of cylinder block (hammer, scale, and straightedge) (fig. 161).

(6) REPLACING WORN IDLER SHAFT BEARING.

GAGE, feeler	PILOT
HAMMER	REAMER

(a) Using a pilot with an outside diameter of $^{31}/_{32}$ inch and an inside diameter of $^{27}/_{32}$ inch, drive idler shaft bearing out of cylinder block (hammer) (fig. 162).

(b) Line up oil channel in cylinder block with semicircular slot in end of bearing. Drive bearing into place in cylinder block (end without slot first) (pilot and hammer) (fig. 162).

(c) Insert idler gear in installed bearing, and measure clearance with a feeler gage. If less than 0.001 inch, ream bearing (fig. 163)

until a 0.001-inch clearance is obtained (reamer). If over 0.0015 inch, replace idler shaft, and ream bearing to a clearance of from 0.001 to 0.0015 inch for new shaft (fig. 163).

(7) REPLACING WORN CAMSHAFT BEARINGS.

GAGE, feeler	PILOT
HAMMER	REAMER

(a) Using a pilot with an outside diameter of $1\frac{11}{32}$ inch and an inside diameter of $1\frac{7}{32}$ inch, drive the four camshaft bearings out of cylinder block (hammer) (fig. 162). NOTE: These bearings have no collar and can be driven either way.

(b) Install new camshaft bearings, one at a time (pilot and hammer). Be sure to line up oilholes in bearing with oilholes in cylinder block.

(c) Examine installed bearings and remove burs (reamer). NOTE: These bearings are reamed to proper size and need no further reaming.

(d) Insert camshaft in installed bearings and measure clearance (feeler gage). If it exceeds 0.0025 inch, replace camshaft.

(8) REPAIRING WORN VALVE TAPPET GUIDE HOLE.

REAMER

If valve tappet guide holes are worn, oversize, or scored, ream them to 0.005 inch oversize. Replace valve tappets with 0.005-inch oversize valve tappet.

(9) REPAIRING DAMAGED THREADS.

DRILL, electric	TAP, thread
REAMER	WELDING EQUIPMENT

(a) Burred threads are corrected by running a thread tap through them.

(b) Stripped threads are corrected by one of the three following methods:

1. Cut threads oversize (thread tap). Replace stud or cap screw with an oversize part. Ream out stud or cap screw hole in attaching part (reamer).

2. Using welding equipment, fill stud hole. Drill hole to proper size (electric drill). Cut new threads with thread tap.

(10) LEAKING CYLINDER CUP PLUGS.

HAMMER	TOOL, carbon removing
PUNCH, sharp	VARNISH, shellac
SOFT BLOCK	

Remove loose or defective cylinder cup plugs by driving a sharp punch through them and prying them out (hammer). Clean cylinder block by scraping (carbon removing tool). Coat the new plug with

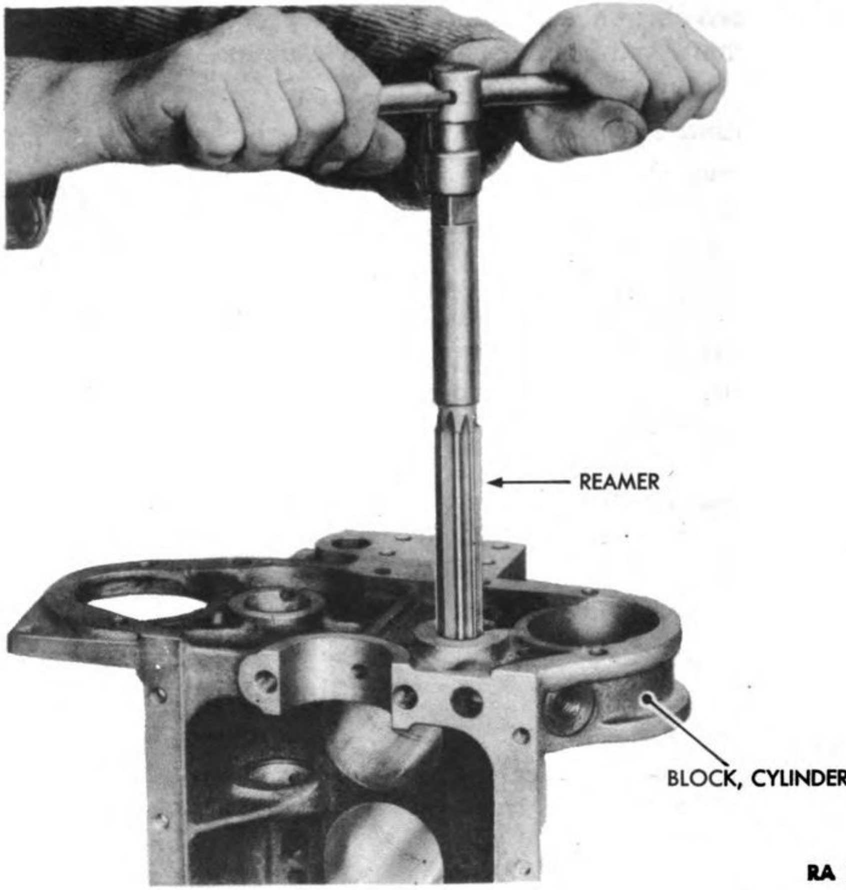


Figure 163 — Reaming Idler Shaft Bearing

VARNISH, shellac, and drive it to seat in cylinder block (soft block and hammer).

(11) RESEATING VALVES (fig. 164).

REAMER

(a) If valve seats are pitted, burned, scored, or off-center, reseat valve as follows:

1. Place a 30-degree finishing reamer (1⅛ inch for exhaust valve and 1⅜ inch for intake valve) in valve guide. Bear down on reamer so that reamer presses against valve seat in cylinder block.

2. Turn reamer clockwise.

3. Remove reamer. Examine valve seat. Repeat substeps *1* and *2* above until valve seat shows a clean cut all the way around.

4. Reface valves (par. 125 **b** (2)), lap valves (par. 125 **b** (3)), and test fit of valve in valve seat (par. 125 **b** (4)).

(12) REPAIRING CRACKED CYLINDER HEAD.

WELDING EQUIPMENT

Replace cylinder head if cracked. A temporary repair for a cylinder

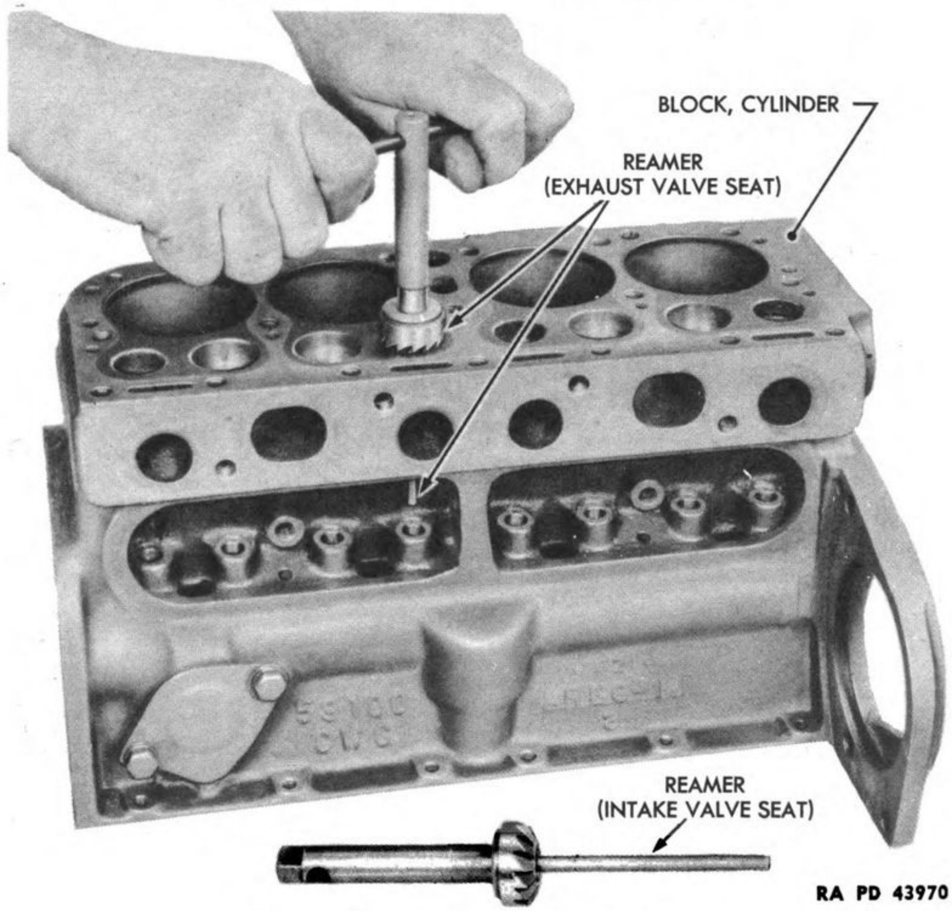


Figure 164 — Reseating Valves

head cracked outside can be made by welding.

(13) SCRATCHED OR NICKED MACHINED FACE OF CYLINDER HEAD.

MACHINE, milling

If the machined face of the cylinder head has nicks or scratches serious enough to allow water leakage or compression loss, replace cylinder head. If no new head is available, take a light cut from machined surface of head on a milling machine. If a heavy cut is necessary, use two cylinder head gaskets on assembly to prevent too great a change in engine compression.

(14) REPLACING DAMAGED CYLINDER HEAD SCREWS AND STUDS.

DIE, thread

Replace broken cylinder head screws and studs, and repair those having only damaged threads.

(15) REPAIRING DAMAGED THREADS IN SPARK PLUG HOLES.

TAP, thread

Run a thread tap through threads if burred. Replace cylinder head if threads are stripped.

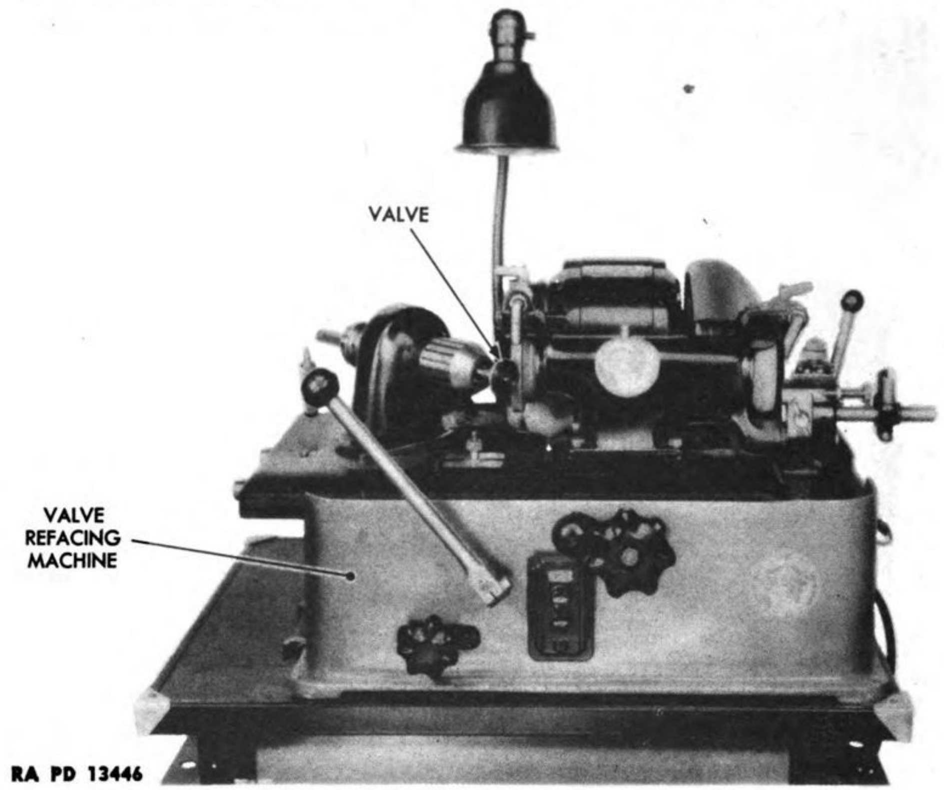


Figure 165 — Refacing Valve

125. VALVES AND VALVE OPERATING MECHANISM REPAIRS.

a. Equipment.

COMPOUND, valve grinding (fine)	REFACER, valve
HONE	SCREWDRIVER
PENCIL	SOLVENT, dry-cleaning
PRESS, arbor	SPRING, coil
	STONE, honing

b. Procedure.

(1) General.

Replace warped, cracked, burned, or badly pitted valves. Replace valves with worn stems. Replace worn or damaged valve springs, spring seats, and spring seat pins.

(2) Refacing Valves.

REFACER, valve

(a) Reface slightly pitted or slightly scored valves (valve refacer). Reface all undamaged valves after 300 hours service (fig. 165).

(b) Set valve face angle at 30 degrees. Reface one valve and test fit on the valve seat (step (4) below). Make any necessary angle

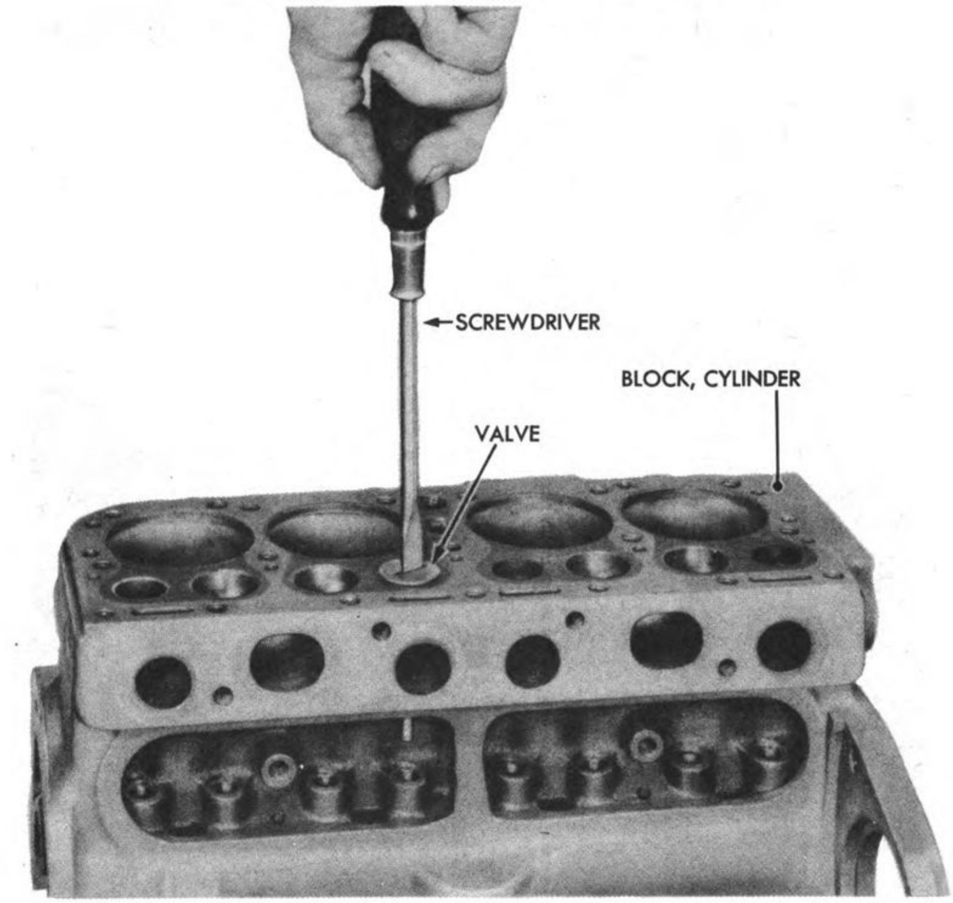


Figure 166 — Testing Valve Fit

correction and repeat test until satisfactory fit is obtained. Lock valve refacer in position and reface all valves.

(3) LAPPING VALVES.

COMPOUND, valve grinding (fine)
SOLVENT, dry-cleaning
SPRING, coil
SCREWDRIVER

(a) After resurfacing valve seats (par. 124 **b** (11)) and valves (step (2) above), lap valves as follows:

1. Rub a small amount of fine valve grinding compound on face of the valve. Slip a light coil spring, long enough to hold valve clear of cylinder block, on valve stem.

2. Place valve stem into its guide.

3. Force valve down on its seat, and with a screwdriver in the slot in valve head, oscillate valve back and forth a few times.

4. Remove valve from cylinder block and remove coil spring from valve stem. Wash valve, valve seat, and valve guide with SOLVENT,

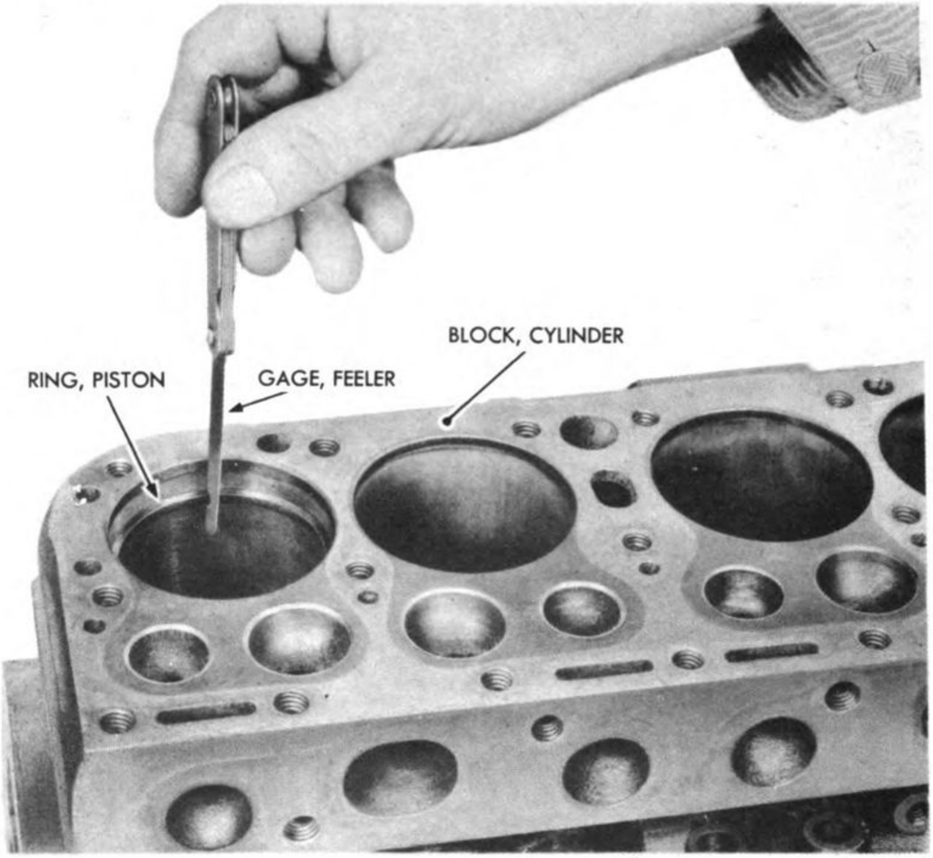


Figure 167 — Measuring Piston Ring End Gap

dry-cleaning, to remove all valve grinding compound. Inspect valve face and seat to see if both have a bright polished appearance.

5. Repeat steps *1* through *4* above to lap each of remaining seven valves.

6. Test valve fit (step (4) below).

(4) TESTING VALVE FIT.

PENCIL SCREWDRIVER

(a) After lapping valves, check fit of valve in valve seat as follows:

1. Place pencil marks at intervals around face of valve.

2. Insert valve in its guide (fig. 166).

3. Press valve down to its seat and turn valve a half turn (screwdriver) (fig. 166).

4. Remove valve and inspect face. If pencil marks are rubbed out, the fit is satisfactory. If pencil marks remain, continue to lap the valve until pencil marks are removed by this test.

(5) Repairing Valve Tappets.

HONE	STONE, honing

(a) If valve tappet faces are lightly scored, hone them smooth (honing stone). Replace tappet if face is badly scored, or if threads in stem are damaged.

(b) Replace broken, worn, or stripped valve tappet adjusting screw nuts.

(c) If valve tappet is scored or worn enough to allow a 0.005-inch clearance in valve tappet hole in block, install a 0.005-inch oversize tappet. Hone valve tappet holes in cylinder block to fit oversize tappet.

(6) Repairing Camshaft.

PRESS, arbor	STONE, honing

(a) Replace camshaft if oil pump drive gear is worn or broken.

(b) Replace camshaft gear if worn or broken (arbor press).

(c) Hone light score marks from cam faces (honing stone). Replace camshaft if bearing journals are scored, or if cams are badly scored.

(d) Replace camshaft thrust washer if worn or scored.

126. PISTON AND CONNECTING ROD REPAIRS.

a. Equipment.

BAR, bending	GAGE, feeler
BLOCK, V—	HONE, cylinder
CLOTH, crocus	HONE, piston pin
EXPANDER, piston ring	INDICATOR, dial
FILE, fine mill	REAMER, ridge
FIXTURE, connecting rod alining	RIBBON, feeler gage, 0.0025-in.
FIXTURE, file holding	WRENCH, socket, ½-in.

b. Procedure.

(1) General.

(a) Replace connecting rod if bearing is scored, broken, chipped, or burned.

(b) Replace piston pin bushings if worn or damaged.

(c) Replace any damaged connecting rod cap bolt, nut, and connecting rod piston pin lock screw.

(d) Replace worn piston rings.

(e) Replace pistons if scored or out-of-round. Install oversize pistons whenever cylinders are rebored or honed. New pistons must be properly fitted (step (4) below).

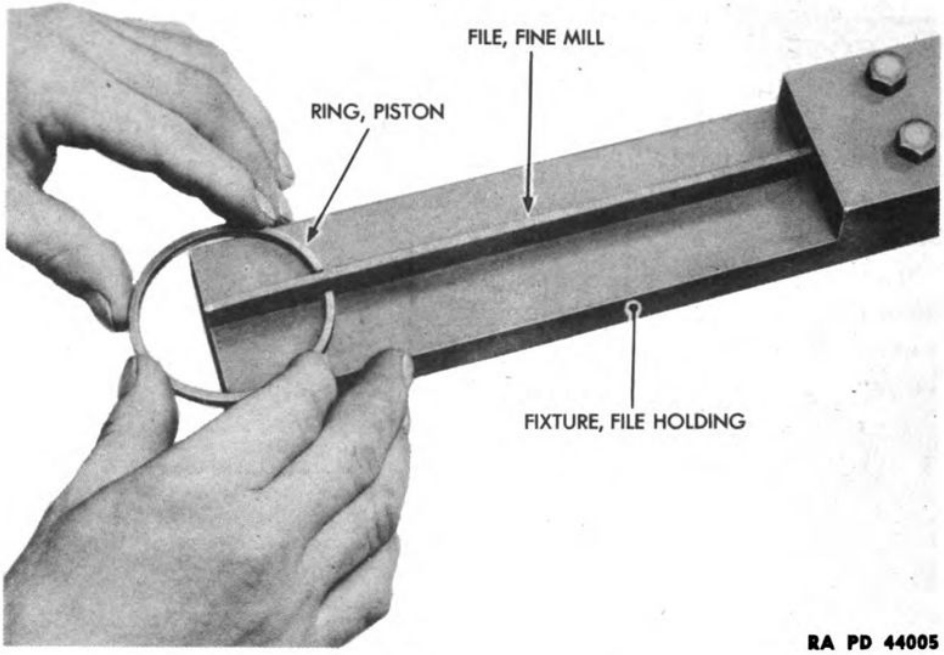


Figure 168 — Filing Ends of Piston Ring

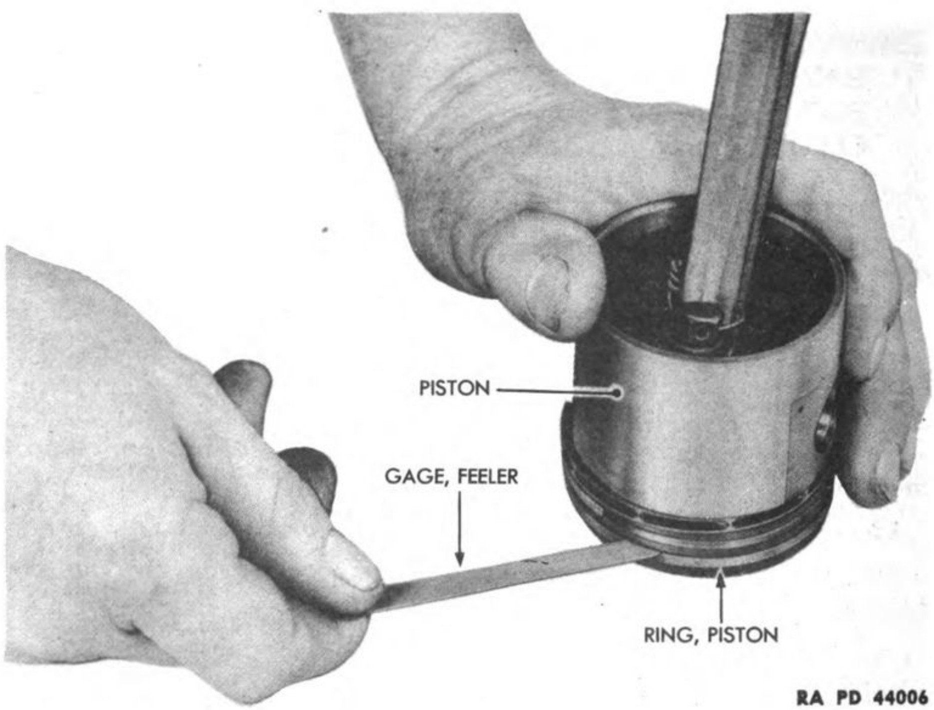


Figure 169 — Measuring Piston Ring Clearance in Groove

(2) FITTING PISTON RINGS.

CLOTH, crocus	GAGE, feeler
EXPANDER, piston ring	INDICATOR, dial
FILE, fine mill	REAMER, ridge
FIXTURE, file holding	

(a) Installation of piston rings will correct oil pumping and loss of compression past the piston, provided the pistons and cylinder walls are not damaged or worn excessively. If cylinder wall wear exceeds 0.005 inch, rebore or hone cylinder walls and fit oversize pistons. If cylinder wall wear is 0.003 to 0.005 inch, install oversize piston rings. If cylinder wall wear is less than 0.003 inch, install standard piston rings.

(b) Inspect tops of cylinder bores. If walls are worn, the top three-sixteenths inch will be unworn, and will appear as a ridge. Remove ridge (ridge reamer).

(c) Measure cylinder wall wear (dial indicator) (par. 118 **b** (1) *(c)*) to determine whether to use standard or oversize piston rings.

(d) Slip a piston ring into the cylinder. Push it down about an inch from top of cylinder block with a piston. (This will ensure ring being properly positioned in cylinder wall.) Using a feeler gage, measure end gap (fig. 167). If end gap exceeds 0.020 inch, use an oversize ring. If end gap is less than 0.015 inch, file ends of ring on a fine mill file secured in a file holding fixture (fig. 168). Repeat the step with the remaining 11 rings. Test each ring in the cylinder in which it is to be used.

(e) Carefully examine the ring grooves in each piston. Remove any carbon with a portion of a broken piston ring or standard piston ring groove cleaner. Carefully remove any burs with a fine file. Clean carbon from oil return holes in oil ring groove.

(f) Install all piston rings in proper grooves on piston (piston ring expander). NOTE: Oil ring (slotted ring) belongs in bottom groove of each piston. Compression rings (rings without slots) go in two upper grooves in each piston.

(g) Measure clearance (feeler gage) of each ring in its groove (fig. 169). Proper clearance is from 0.001 to 0.0025 inch. If clearance is under 0.001 inch, remove ring and lap it on CLOTH, crocus, shellacked to a flat surface (fig. 170). Install ring and again check clearance. Repeat operation until proper clearance is obtained. If clearance exceeds 0.0025 inch, use a new piston ring or piston, or both.

(3) FITTING PISTON PINS.

HONE, piston pin

(a) If inspection showed piston pin bushings or piston pin to be worn, the manufacturer recommends replacing both pin and bush-

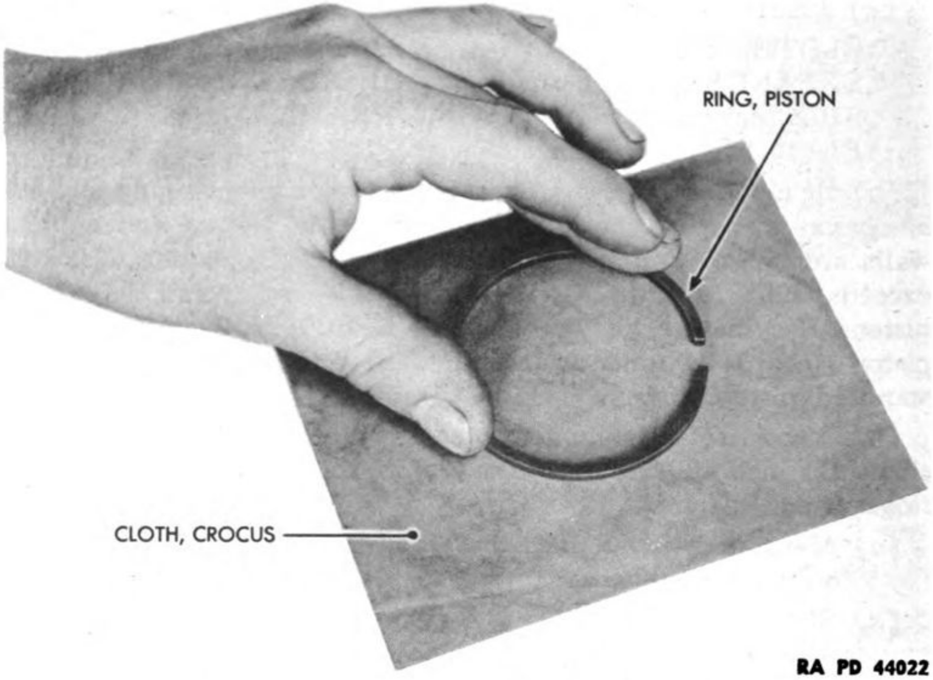


Figure 170 — Lapping a Piston Ring

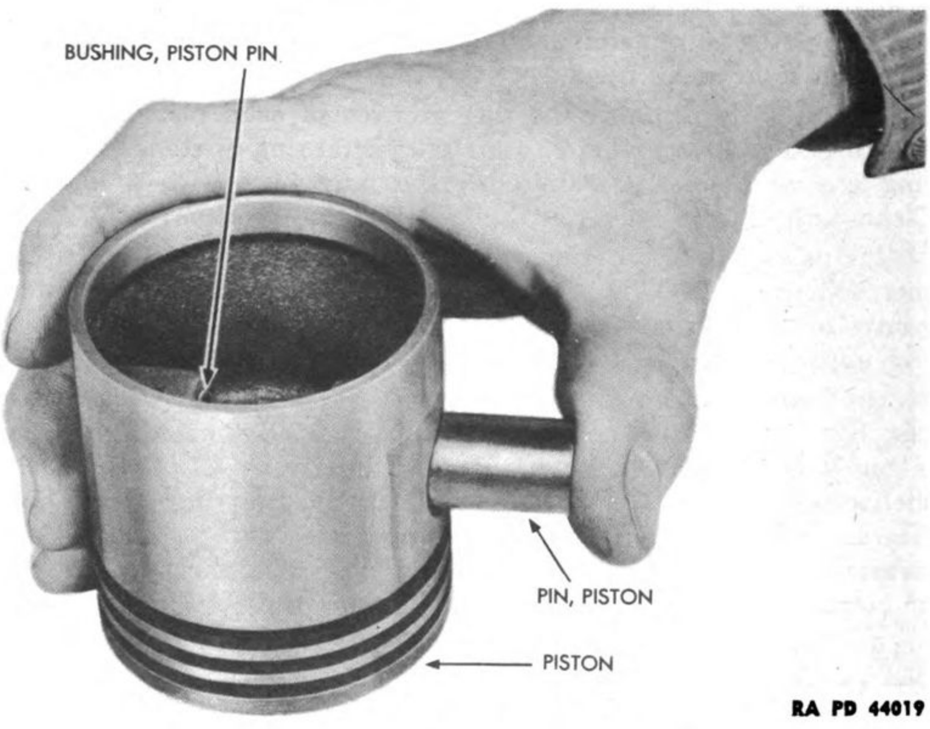


Figure 171 — Testing Fit of Piston Pin

Figure 172 — Measuring Piston Clearance in Cylinder

ings. However, piston pins are supplied 0.003 and 0.005 inch oversize. Oversize pins may be used if bushings are not damaged except for normal wear, provided wear does not exceed 0.005 inch.

(b) Attempt to insert the piston pin into the piston pin bushings installed in the piston. If impossible to insert piston pin in bushings, take a light cut off bushings with a hone. Test the fit again. Repeat the operation until a light push fit of the pin in the bushings is obtained (fig. 171). If the pin fits too loosely, replace the bushings, or replace the pin with an oversize pin.

(4) Fitting Pistons.

HONE, cylinder — RIBBON, feeler gage, 0.0025-in.

(a) Oversize pistons must be fitted to the cylinders after reboring (par. 124 **b** (3)) or honing (par. 124 **b** (4)). The piston is fitted with piston rings and connecting rod removed from the piston (fig. 172).

(b) Insert the end of a 0.0025-inch feeler gage ribbon into the top of cylinder. Push the piston into the cylinder in running position, but upside down. The feeler gage ribbon must be between cylinder

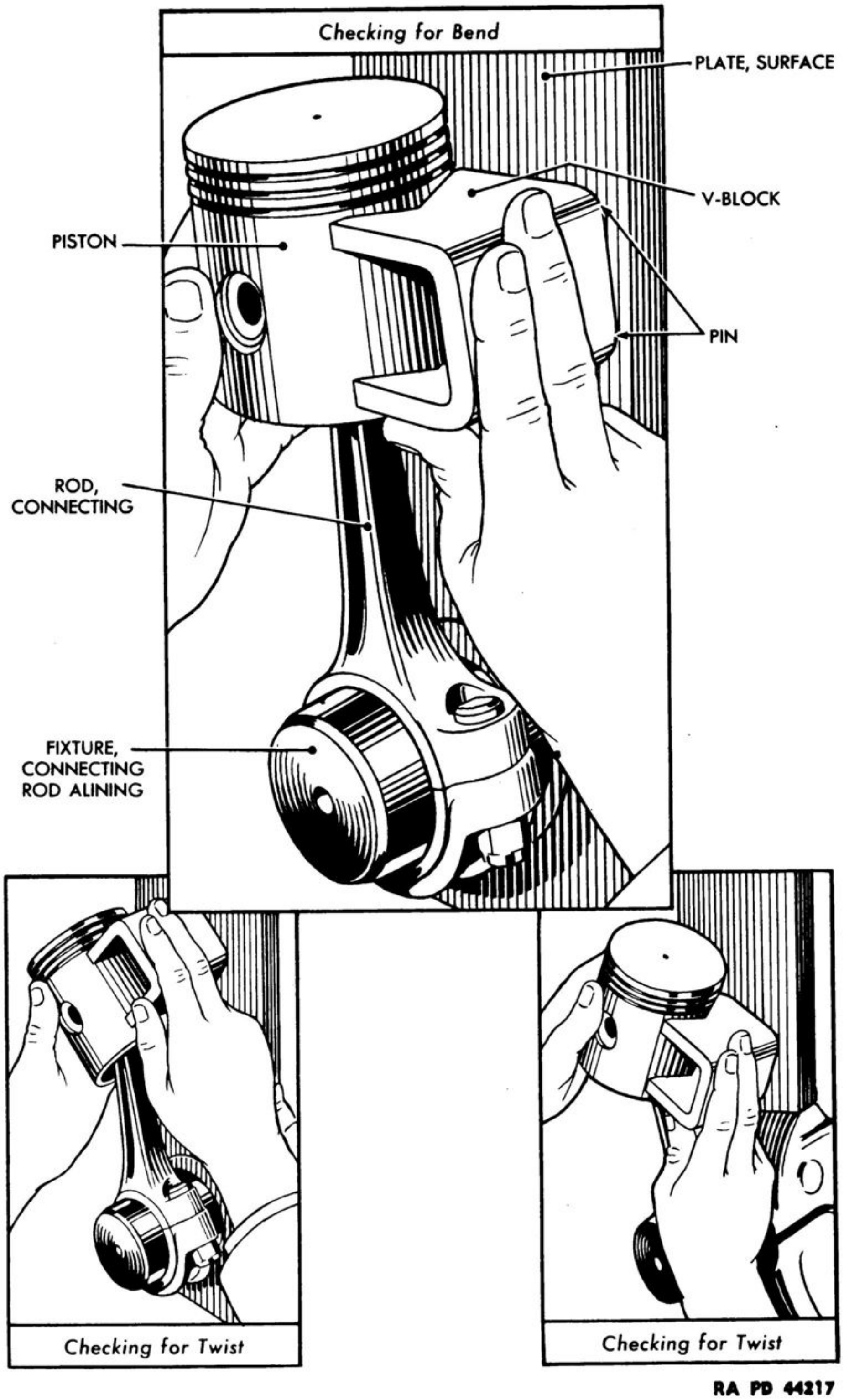


Figure 173 — Connecting Rod Alinement

wall and piston, with end of the feeler gage ribbon projecting from top of cylinder. Pull on feeler gage ribbon. It should pull out with a slight pull. If it binds, hone cylinder wall to provide additional clearance. If it pulls out without resistance, replace piston with a larger oversize and repeat operation.

(5) ALINE CONNECTING RODS.

BAR, bending	FIXTURE, connecting rod alining
BLOCK, V—	WRENCH, socket, ½-in.

(a) Straighten Bent Connecting Rod.

1. Clamp assembled connecting rod and piston, without piston rings, onto a connecting rod alining fixture (½-in. socket wrench) (fig. 173).

2. With piston upright on the connecting rod, hold the V-block against the piston and surface plate (fig. 173). If pins on V-block both touch the surface plate, connecting rod is straight. If only one pin touches the surface plate, connecting rod is bent. Slide a bending bar onto the bent connecting rod, and bend rod until straight.

(b) Straighten Twisted Connecting Rod.

1. Clamp piston and connecting rod assembly onto rod alining fixture as in substep *(a) 1* above. NOTE: A bent rod cannot be checked for twist until straightened.

2. Cock the piston to one side as far as it will go (fig. 173). Place the V-block against piston and surface plate (fig. 173). Slowly rock rod as far as it will go in the opposite direction from which it was cocked. Observe pins of V-block on the surface plate. If neither pin lifts from surface plate as the piston is rocked, connecting rod is free of twist. If one of the pins lifts from surface plate, connecting rod is twisted. Place the bending bar on twisted rod and straighten it.

127. MISCELLANEOUS ENGINE REPAIRS.

a. Equipment.

ANVIL	MACHINE, crankshaft grinding
BAR, straightening	PRESS, arbor (small)
BLOCK, V- (2)	SOLVENT, dry-cleaning
BRUSH, wire	TAP, thread
DOLLY	VISE
DRILL, electric	WELDING EQUIPMENT
HAMMER	

b. Procedure.

(1) REPAIRS TO FAN DRIVE PULLEY.

Replace fan drive pulley, pin, and key if broken.

(2) REPAIRS TO ENGINE AND RADIATOR SUPPORT BRACKETS.

ANVIL	VISE
BAR, straightening	WELDING EQUIPMENT
HAMMER	

(a) Weld engine and radiator support brackets if broken (welding equipment).

(b) Straighten engine and radiator support brackets if bent (vise, straightening bar, hammer, and anvil).

(3) REPAIRS TO OIL PAN.

BRUSH, wire	SOLVENT, dry-cleaning
DOLLY	TAP, thread
HAMMER	WELDING EQUIPMENT

(a) Bump out dents in oil pan (hammer and dolly).

(b) Braze oil pan if cracked (welding equipment).

(c) Clean carbon from oil screen (SOLVENT, dry-cleaning, and wire brush).

(d) Replace damaged oil pan screws and oil screen cover screws.

(e) Tap any burred threads (thread tap).

(4) REPAIRS TO GEAR COVER.

DRILL, electric	PRESS, arbor (small)

(a) Replace gear cover if broken.

(b) Replace thrust screw fiber plug if worn, as follows:

1. Drill worn fiber plug from thrust screw (electric drill).

2. Press new fiber plug into thrust screw (small arbor press).

(c) Replace damaged screws and nuts.

(5) REPAIRS TO IDLER SHAFT ASSEMBLY.

(a) Replace idler gear if teeth are worn or broken.

(b) Replace idler shaft if scored.

(c) Replace idler shaft thrust washer if worn or scored.

(6) REPAIRS TO FLYWHEEL.

TAP, thread

(a) Replace flywheel if broken.

(b) Replace dowel pins with oversize dowels if dowel holes in flywheel are too large. Oversize dowels can be obtained from the engine manufacturer.

(c) If threads are burred in holes tapped for main generator coupling studs, clean up with thread tap. If threads are stripped, the flywheel must be replaced.

(d) Replace ring gear if teeth are worn or broken.

(e) Replace the four main generator couplings if worn or broken.

(7) REPAIRS TO BELL HOUSING.

TAP, thread	WELDING EQUIPMENT

(a) Replace bell housing if broken. A temporary repair can be made by welding if new part is not available.

(b) Tap new threads in tapped holes, if damaged (thread tap).

(c) Replace damaged cap screws, studs, nuts, and lock washers.

(8) REPAIRS TO CRANKSHAFT.

BLOCK, V- (2)
PRESS, arbor (small)
MACHINE, crankshaft grinding

(a) Replace crankshaft gear if worn or broken (arbor press).

(b) Replace crankshaft if threads are stripped in tapped holes on flywheel end (rare).

(c) If bearing journals are scored, burned, or out-of-round, grind the bearing journals to 0.005 to 0.010 inch undersize on a crankshaft grinding machine.

(d) Straighten bent crankshaft in an arbor press. Support its ends on V-blocks. Put pressure on a pilot placed on the high spot on the crankshaft. Remove from arbor press and again check straightness (par. 122 **b** (1) *(f)*). Repeat the straightening and checking operations until crankshaft is straight.

(9) REPAIRS TO CRANKSHAFT MAIN BEARINGS.

(a) Replace cylinder main bearing if babbitt is chipped, broken, burned, or scored.

(b) Replace damaged cylinder main bearing screws and lock washers.

(10) REPAIRS TO OIL PRESSURE REGULATOR AND CYLINDER PIPE PLUGS. Replace broken, worn, or damaged parts.

128. ACCESSORY DRIVE REPAIRS.

a. Replace accessory drive gear and/or distributor drive gear if teeth are worn or broken.

b. Replace accessory drive shaft if scored or worn.

c. Replace accessory drive shaft thrust washer if scored or broken.

d. Replace accessory drive bushing if worn. No honing or reaming is necessary, since the bushing is furnished reamed to size. Insert the accessory drive shaft into the new bushing. If more than a barely perceptible side play is present, the shaft is worn, and it will be necessary to replace the accessory drive shaft.

e. Replace accessory drive shaft cork washer every time the accessory drive is disassembled. Replace accessory drive oil retainer if broken.

f. Replace accessory drive housing if broken.

Section XVII

ENGINE ASSEMBLY AND INSTALLATION

129. ASSEMBLY.

a. Equipment.

BIT, 5/32-in.
CLOTH, wiping
COMPRESSOR, piston ring
DRIFT
DRILL, electric
DRIVER, stud
EXPANDER, piston ring
GAGE, feeler
HAMMER
HAMMER, soft
LEAD, white
LIFTER, valve
MALLET, rawhide
OIL, engine, SAE 10
OIL, engine, SAE 30
OVEN
PILOT, cup
PLIERS
PLIERS, sharp-nosed
PRESS, arbor
PROBE
REMOVER, valve guide
SCREWDRIVER
SOFT BLOCK
TONGS
VARNISH, shellac
VISE
WOOD BLOCK
WRENCH, box, 9/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in. (2)
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 13/16-in.
WRENCH, open-end, 15/16-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, socket, 7/16-in.
WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 5/8-in.
WRENCH, socket, 3/4-in.
WRENCH, Stillson
WRENCH, torque

b. Procedure.

(1) ASSEMBLE CRANKSHAFT.

HAMMER
LEAD, white
OVEN
PILOT, cup
TONGS

If crankshaft gear has been removed, replace with new gear as follows:

(a) Coat crankshaft gear shoulder on crankshaft, where gear seats, with LEAD, white.

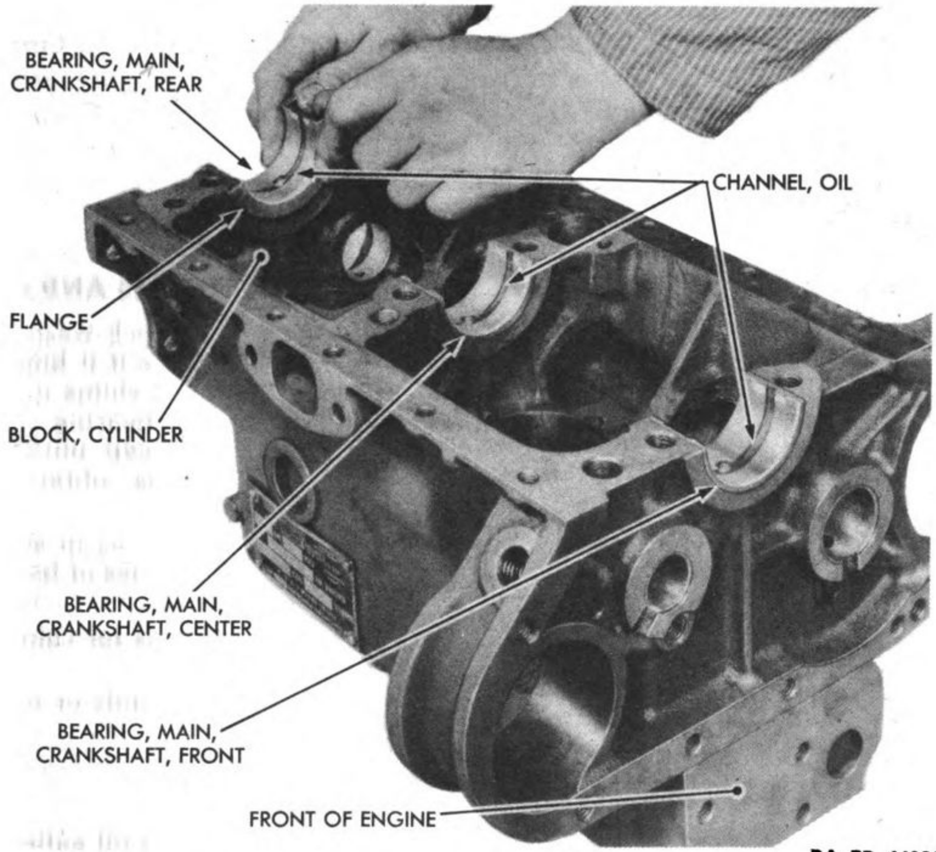


Figure 174 — Installing Crankshaft Main Bearings

(b) Heat crankshaft gear to 160 F in an oven. Using tongs to hold gear, drive gear on crankshaft (hammer and cup pilot). NOTE: Flywheel dowels are not installed in crankshaft until flywheel installation.

(2) INSTALL CRANKSHAFT.

CLEAN CLOTH	WRENCH, socket, ¾-in.
GAGE, feeler	WRENCH, torque
OIL, engine, SAE 10	

(a) Clean cylinder block (clean cloth) and place crankshaft main bearing in place in cylinder block. Oil channels cut in the faces of the bearing go toward the front of the engine. The bearing with the flanges goes to the rear. The bearings were marked at disassembly. Assemble in the same order. If new bearings are being installed, the front and center bearings are interchangeable (fig. 174).

(b) Put a coat of OIL, engine, SAE 10, on crankshaft main bearings. Lay crankshaft in position in bearings (fig. 155).

(c) Install rear main bearing cap, using shims removed at disassembly. If new bearing was installed, use shims totaling 0.005 inch

on each side of bearing. Install main bearing screws and lock washers (¾-in. socket wrench). Revolve crankshaft by hand to see if it binds. Take out enough shims so crankshaft drags slightly. Add shims until binding just disappears. If crankshaft binds on sides of bearing and cap, remove crankshaft and file sides of bearing and cap until a 0.002-inch to 0.0025-inch (feeler gage) clearance is obtained (fig. 155).

(d) Install center main bearing cap. Procedure is same as in substep *(c)* above, except there is no check for clearance on sides of bearing (fig. 155).

(e) Install front main bearing cap. Procedure is same as for center main cap (substep *(d)* above).

(f) Tighten six main bearing cap screws to 75 foot-pounds or 924 inch-pounds pressure (torque wrench with ¾-in. socket).

(3) INSTALL CYLINDER BLOCK PIPE PLUGS.

SCREWDRIVER

Install cylinder block pipe plug at each end of the main oil gallery in cylinder block (screwdriver) (fig. 157). Also install cylinder block pipe plug on accessory side of cylinder block (screwdriver).

(4) INSTALL BELL HOUSING.

GAGE, feeler	WRENCH, open-end, $\frac{9}{16}$-in.
MALLET, rawhide	WRENCH, socket, $\frac{9}{16}$-in.

(a) Using a new gasket, place bell housing in position on cylinder block (fig. 153).

(b) From valve tappet side of cylinder block, install bell housing lock washer and stud nut which secure bell housing to cylinder block ($\frac{9}{16}$-in. open-end wrench) (fig. 154).

(c) From accessory side of engine, install bell housing lock washer and screw, and lock washer and thin head bell housing screw which secure bell housing to cylinder block ($\frac{9}{16}$-in. open-end wrench) (fig. 134). NOTE: Thin head screw goes nearest to cylinder pipe plug hole.

(d) From inside bell housing, install lock washers and screws which secure bell housing to cylinder block ($\frac{9}{16}$-in. socket wrench) (fig. 154).

(e) From inside bell housing, insert a 0.012-inch feeler gage between crankshaft and bell housing (fig. 175). Be certain gage extends clear through opening and is visible on other side of bell housing. Run the gage all the way around the opening between bell housing and crankshaft. A 0.012-inch to 0.025-inch clearance must be maintained at all points. If less than a 0.012-inch clearance exists at any point, loosen bell housing screws and stud nut ($\frac{9}{16}$-in. open-end

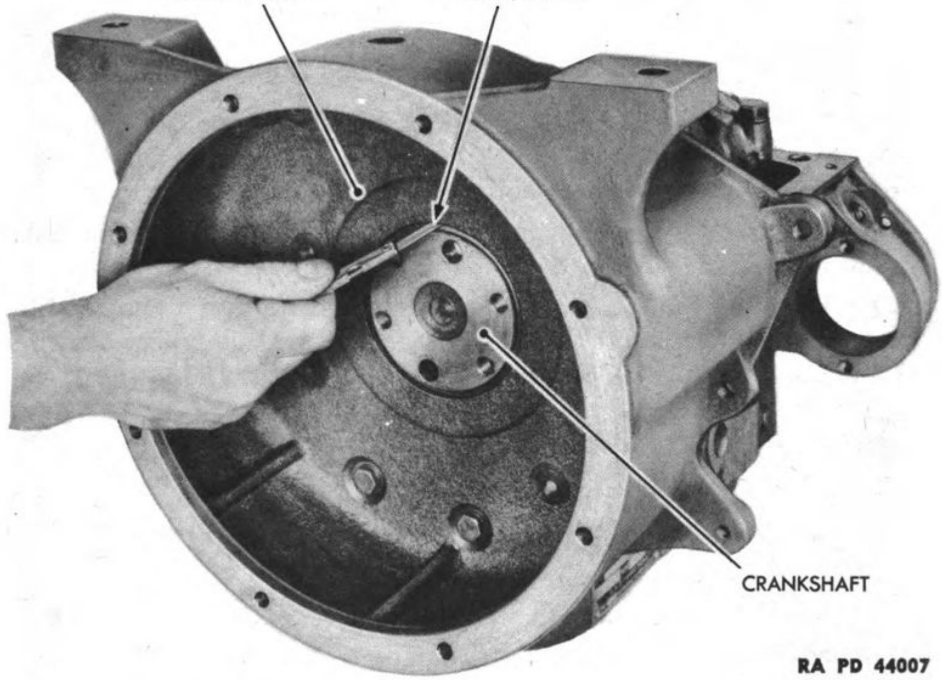


Figure 175 — Checking Crankshaft to Bell Housing Clearance

wrench). Shift position of bell housing by tapping it with a rawhide mallet. Tighten bell housing screws and stud nut ($\frac{9}{16}$-in. open-end wrench). Repeat test and shifting of bell housing until a minimum of a 0.012-inch clearance is obtained at all points (fig. 175).

(5) ASSEMBLE FLYWHEEL ASSEMBLY.

BIT, $\frac{5}{32}$-in.	OVEN
DRILL, electric	PROBE
DRIVER, stud	TONGS
HAMMER, soft	

(a) Heat ring gear to 160 F in an oven. Hold heated ring gear in place on flywheel (tongs) and tap onto flywheel (soft hammer).

(b) Install main generator driving flange studs (stud driver). Tap new lock pins into place in flywheel and stud (hammer). Peen the pins (hammer). Slide main generator driving flange bushings on the studs. Install retaining nuts. If new studs or flywheel or both are used, drill holes for lock pins through inside edge of flywheel rim into studs (electric drill and $\frac{5}{32}$-in. bit). Drill about halfway through the studs. If original flywheel and studs are used, line up pinholes (probe). NOTE: Flywheel expansion plugs are not installed until flywheel installation (step (6) below).

(6) INSTALL FLYWHEEL.

DRIFT
HAMMER
PLIERS
WOOD BLOCK
WRENCH, socket, 5/8-in.

(a) Place flywheel against end of crankshaft inside of bell housing. Line up screw and dowel holes in flywheel and crankshaft. Install the four crankshaft flywheel bolts fingertight (fig. 153).

(b) Drive the two crankshaft flywheel dowels to seat in crankshaft through their holes in flywheel (hammer and drift) (fig. 153).

(c) Place a wood block between crankshaft and cylinder block to keep crankshaft from revolving. Tighten crankshaft flywheel bolts (5/8-in. socket wrench). Remove wood block (fig. 153).

(d) Install flywheel expansion plugs over crankshaft flywheel dowel openings in flywheel (drift and hammer) (fig. 153).

(e) Install flywheel bolt lock wire (pliers) (fig. 153).

(7) INSTALL VALVE TAPPETS.

(a) Tip engine over so it rests on bell housing (fig. 152).

(b) Screw each valve tappet adjusting screw nut up to head of adjusting screw by hand (fig. 152).

(c) Insert the eight valve tappets into valve tappet guides (holes) in cylinder block from crankshaft side of cylinder block (fig. 152).

(d) Hold the tappets in place with the left hand. Screw the valve tappet adjusting screws into the tops of the valve tappets with the right hand (fig. 152).

(8) ASSEMBLE CAMSHAFT.

HAMMER
PRESS, arbor

(a) Tap camshaft gear key into camshaft (hammer).

(b) Line up camshaft gear key with keyway in gear, and press gear onto camshaft (arbor press) (fig. 148).

(c) Slide camshaft thrust washer on camshaft.

(9) ASSEMBLE IDLER SHAFT.

PRESS, arbor

(a) Press idler shaft gear on idler shaft (arbor press).

(b) Slide idler shaft thrust washer on idler shaft (fig. 149).

(10) ASSEMBLE VALVE TIMING GEARS.

(a) Pull all eight valve tappets toward top of cylinder block. Place camshaft in position in cylinder block (fig. 147). Mesh camshaft gear and crankshaft gear so that prick punch marks are together (fig. 176).

(b) Insert idler shaft into idler shaft bearing. Mesh idler gear with crankshaft gear.

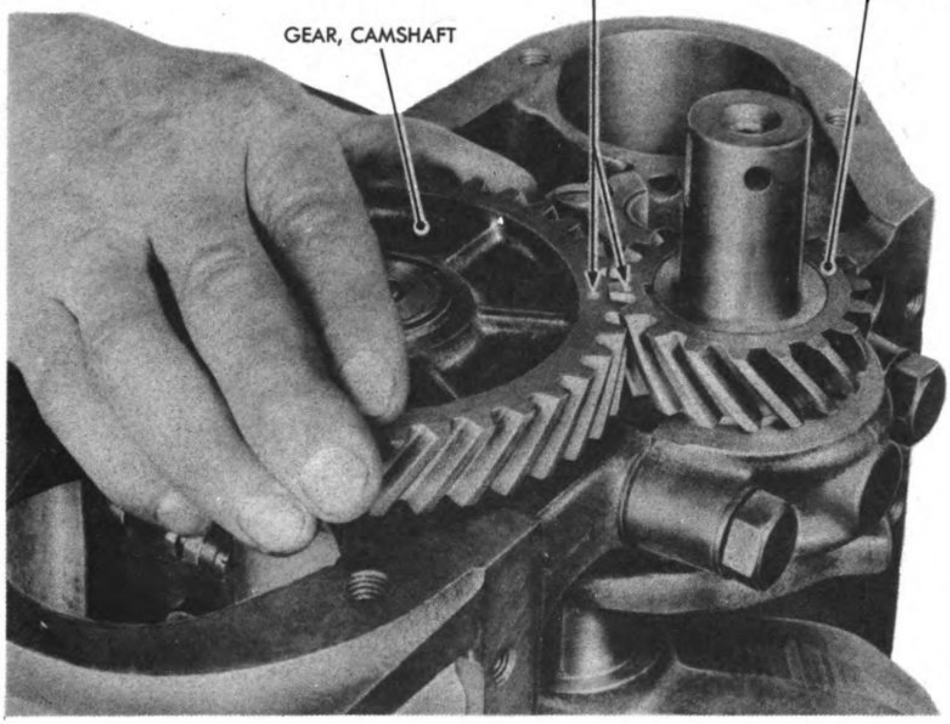


Figure 176 — Valve Timing Gear Assembly

(11) Assemble Gear Cover (fig. 146).

HAMMER	SCREWDRIVER
PRESS, arbor	SOFT BLOCK

(a) Tap gear cover oil seal into gear cover (hammer).

(b) Press gear cover thrust screw fiber plugs into thrust screws (small arbor press).

(c) Install gear cover thrust screw assemblies into gear cover (screwdriver).

(d) Drive breather pipe into gear cover (soft block and hammer).

(e) Place oil pan and crankshaft seal in position in gear cover. Felt side goes to outside of gear cover.

(12) Install Gear Cover.

DRIVER, stud	VARNISH, shellac
GAGE, feeler	WRENCH, socket, $^9/_{16}$-in.

(a) Shellac gear cover gasket to gear cover.

(b) Install water pump attaching studs (stud driver) (fig. 152).

(c) Place assembled gear cover in position on top of studs and crankshaft. Insert a narrow 0.015-inch feeler gage between crankshaft, and oil pan and crankshaft seal. With a circular motion, run

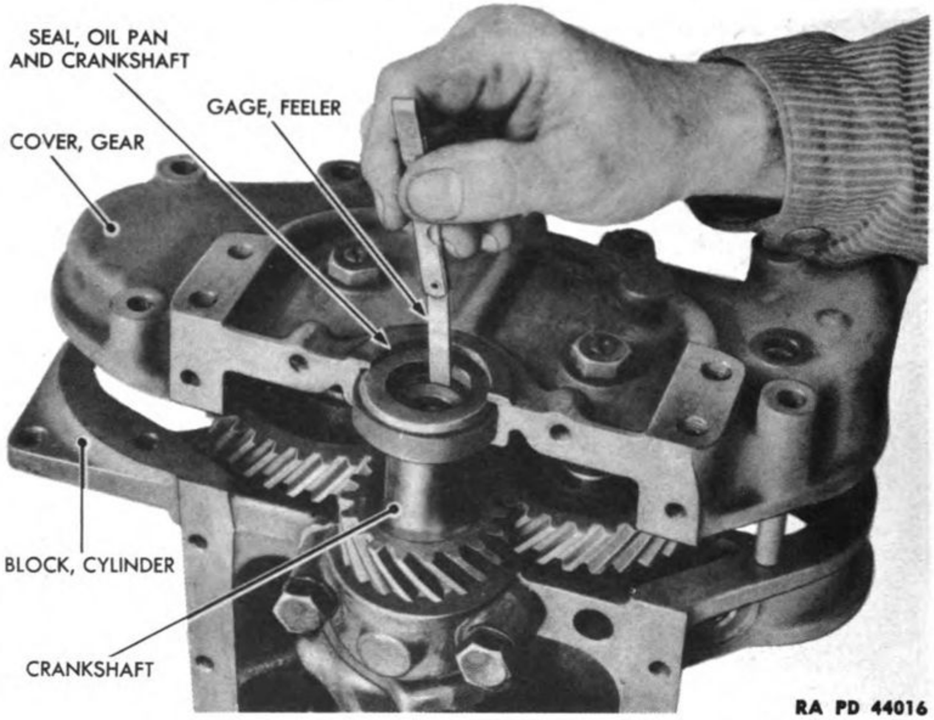


Figure 177 — Installing Gear Cover

feeler gage entirely around crankshaft to start the leather of the seal on the crankshaft (fig. 177).

(d) Push gear cover down into position on cylinder block. Install five lock washers and cap screws ($^9/_{16}$-in. socket wrench) (fig. 143).

(13) ADJUST THRUST OF CAMSHAFT AND IDLER SHAFT.

SCREWDRIVER	WRENCH, open-end, $^{13}/_{16}$-in.

Loosen gear cover thrust screw nuts ($^{13}/_{16}$-in. open-end wrench). Tighten gear cover thrust screws, then back each thrust screw off one-eighth turn (screwdriver). Tighten gear cover thrust screw nuts while holding the thrust screw from turning ($^{13}/_{16}$-in. open-end wrench and screwdriver) (fig. 144).

(14) ASSEMBLE PISTON AND CONNECTING ROD.

DRIFT	PRESS, arbor
EXPANDER, piston ring	VISE
PLIERS	WRENCH, socket, $^7/_{16}$-in.

(a) Line up oilholes in piston and piston pin bushing, and press piston pin bushing into piston (arbor press) (fig. 151). Repeat operaton to install other bushing.

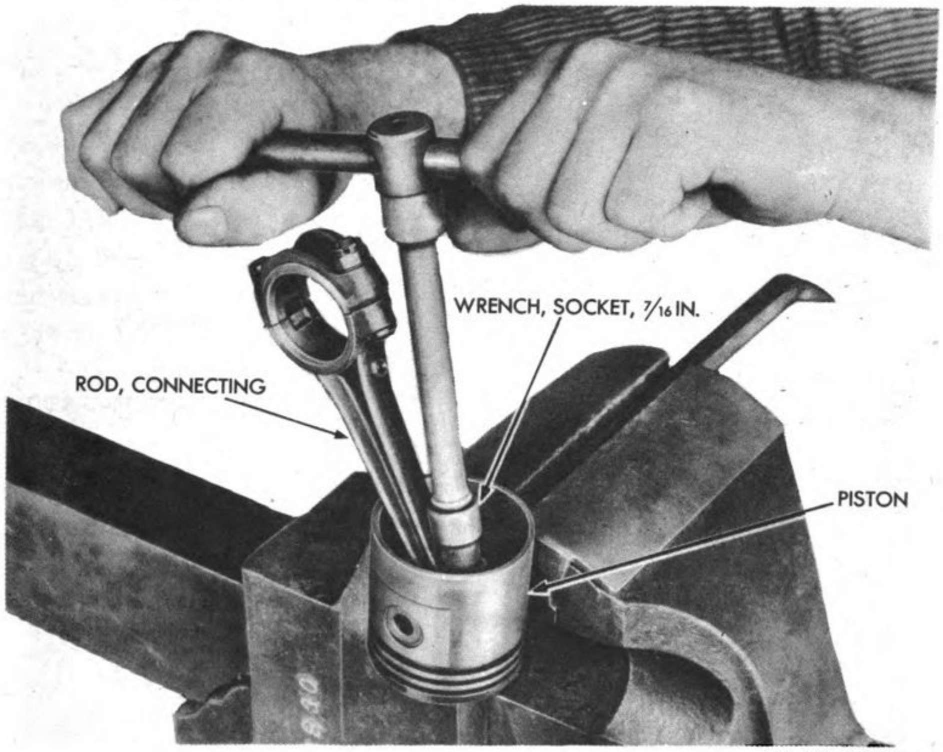


Figure 178 — Tightening Connecting Rod Piston Pin Lock Screw

(b) Hold connecting rod in position in piston. Push piston pin in piston and connecting rod.

(c) Tighten connecting rod piston pin lock screw, with piston held on a drift clamped in a vise and inserted into piston pin ($\frac{7}{16}$-in. socket wrench) (fig. 178).

(d) Install lock wire which locks piston pin lock screw (pliers).

(e) Slide one oil and two compression piston rings on piston (piston ring expander).

(f) Repeat substeps *(a)* through *(e)* above to assemble each of the remaining three connecting rod and piston assemblies.

(15) INSTALL PISTONS AND CONNECTING RODS.

COMPRESSOR, piston ring	WRENCH, socket, ½-in.
OIL, engine, (seasonal grade)	WRENCH, torque
WOOD BLOCK	

(a) Compress piston rings on No. 1 piston (piston ring compressor) (cylinder number stamped on camshaft side of connecting rod and cap). Do not place all ring gaps on one side.

(b) Coat piston and connecting rod bearing with thin coat of OIL, engine (seasonal grade).

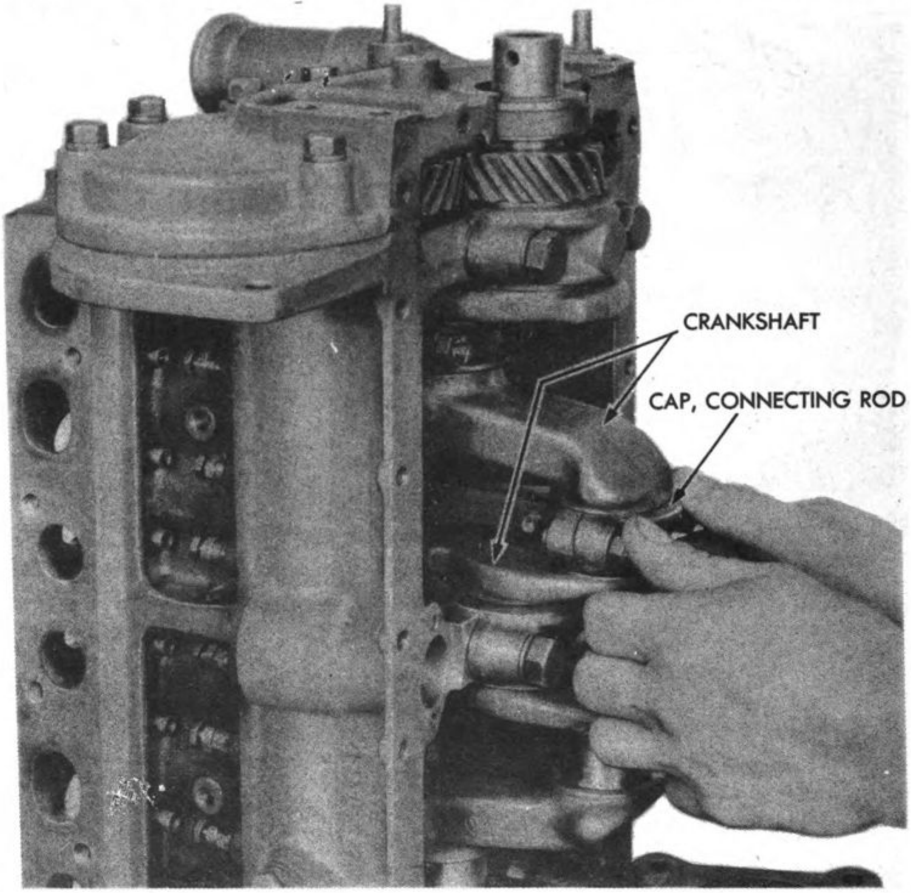


Figure 179 — Adjusting Connecting Rod Bearings

(c) Insert rod and piston assembly, rod first, into top of No. 1 cylinder. Be sure number mark on base of rod is toward camshaft. Tap top of piston in cylinder with wood block. Remove piston ring compressor from piston as piston rings enter cylinder.

(d) Insert connecting rod cap bolts through holes in base of rod. Place three 0.003-inch shims on each bolt. Place connecting rod cap on bolts. Be sure number mark and piston pin lock screw are on side toward camshaft. Install connecting rod bolt nuts, and tighten to 276 inch-pounds pressure (½-in. socket and torque wrenches). Take hold of connecting rod cap with both hands and attempt to move from end to end of bearing journal (fig. 179). Add or remove shims until bearing moves on journal with a definite drag. Then add one shim to each connecting rod cap bolt.

(e) Repeat substeps *(a)* through *(d)* above to install each of remaining connecting rod and piston assemblies.

(16) INSTALL OIL PUMP (par. 160).

ENGINE ASSEMBLY AND INSTALLATION

(17) ASSEMBLY OF OIL PAN.

LEAD, white | WRENCH, Stillson
WRENCH, socket, 7/16-in.

(a) Place oil pan screen in position in oil pan, and install the screen cover screws and lock washers (7/16-in. socket wrench) (fig. 145).

(b) Put a little LEAD, white, on threads of oil drain pipe elbow, and screw elbow in oil pan (Stillson wrench) (fig. 143).

(18) INSTALL OIL PAN.

VARNISH, shellac | WRENCH, socket, 1/2-in.
WRENCH, box, 9/16-in. | WRENCH, socket, 9/16-in.

(a) Shellac oil pan gaskets to oil pan.

(b) Place oil pan in position on cylinder block and bell housing (fig. 145).

(c) Install (fingertight) lock washers and cap screws which hold oil pan to cylinder block and bell housing (fig. 143).

(d) Tighten oil pan to bell housing cap screws adjacent to cylinder block (9/16-in. box wrench). Tighten oil pan to cylinder block cap screws adjacent to bell housing (1/2-in. socket wrench). Tighten remaining 17 cap screws which secure oil pan to cylinder block and bell housing (9/16-in. socket wrench and 1/2-in. socket wrench). Tighten them alternately, each a little at a time.

(19) INSTALL OIL PRESSURE REGULATOR (figs. 157 and 220).

SCREWDRIVER | WRENCH, open-end, 11/16-in.
WRENCH, open-end, 15/16-in.

(a) Slide oil pressure regulating piston (cap end last) in cylinder block.

(b) Slide oil pressure regulating spring in cylinder block.

(c) Screw oil pressure regulating adjusting screw in cylinder block until about half is visible (screwdriver).

(d) Slide gasket on adjusting screw.

(e) Install adjusting screw nut on adjusting screw (11/16-in. open-end wrench).

(f) Place other gasket on adjusting screw.

(g) Install acorn nut on adjusting screw (15/16-in. open-end wrench).

(20) INSTALL FAN DRIVE PULLEY.

DRIFT | PLIERS
HAMMER | SOFT BLOCK

(a) Tap fan pulley Woodruff key in its slot in front end of crankshaft (hammer).

(b) Line up fan drive pulley pin holes in pulley and in crankshaft. Drive fan drive pulley on crankshaft (hammer and soft block) (fig. 143).

(c) Drive fan drive pulley pin through pinhole in pulley and crankshaft (hammer and drift) (fig. 143).

(d) Install cotter pin in each end of pin (pliers) (fig. 143).

(21) INSTALL ENGINE AND RADIATOR SUPPORT BRACKETS.

WRENCH, box, 9/16-in.

(a) Place engine and radiator support brackets in position on front of cylinder block (fig. 143).

(b) Install lock washers and cap screws (9/16-in. box wrench).

(22) INSTALL VALVE GUIDES.

HAMMER — REMOVER, valve guide

Install valve guides by driving in from the top down (hammer and valve guide remover).

(23) INSTALL VALVES.

LIFTER, valve — PLIERS, sharp-nosed

(a) Fit valve spring seat in position on end of valve spring.

(b) Slide other end of spring up over valve guide in cylinder block. Push up on valve spring seat to compress valve spring slightly. Slide valve spring seat in position on top of valve tappet adjusting screw.

(c) Insert valve stem in valve guide from top of cylinder block.

(d) Compress valve spring by inserting valve lifter between cylinder block and valve spring seat (fig. 142).

(e) Insert valve spring seat pin in its hole in valve stem (sharp-nosed pliers).

(f) Remove valve lifter.

(g) Repeat process to install remaining valves. NOTE: Be sure to install valves in the same guides from which they were removed.

(24) ADJUST VALVE TAPPETS.

(a) Turn crankshaft until the piston is in firing position, to adjust the valves for that cylinder. When this is done the cams on the camshaft are at the lowest point for valve adjustment. CAUTION: Valves can be closed without the cam being down to the lowest point. If valves are adjusted when the cam is part way up the clearance will not remain the same.

(b) Loosen tappet adjusting screw nut (two 7/16-in. open-end wrenches) (fig. 180).

(c) Insert an 0.008-inch feeler gage between valve tappet adjusting screw and valve stem (fig. 180). This clearance applies only when the engine is cold.

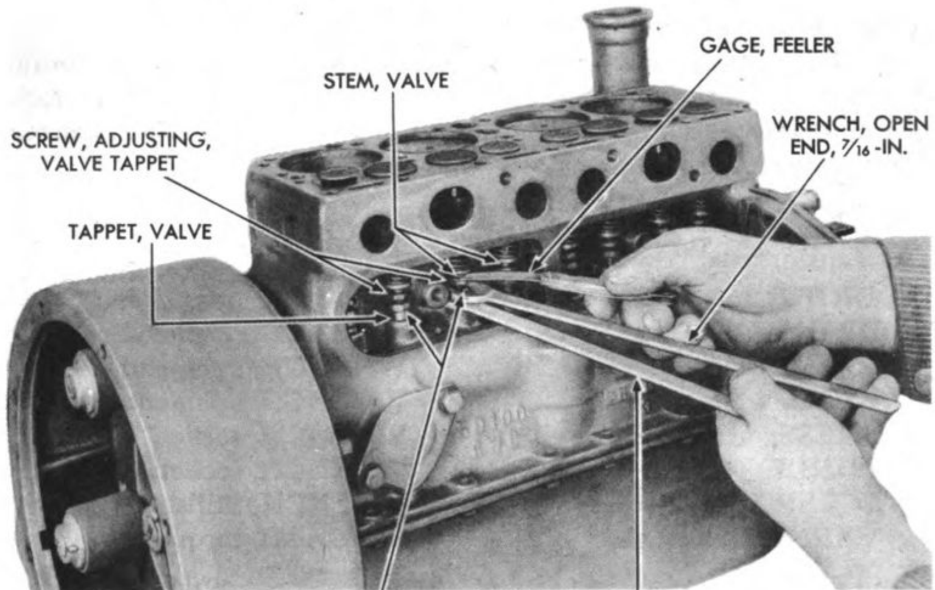


Figure 180 — Adjusting Valve Tappets

(d) Hold tappet to keep it from turning (3/8-in. open-end wrench) and turn tappet adjusting screw in or out (7/16-in. open-end wrench) until feeler gage can be withdrawn with just a slight drag (fig. 180).

(e) Hold tappet adjusting screw to keep it from turning (7/16-in. open-end wrench). Hold tappet to keep it from turning (3/8-in. open-end wrench). Tighten tappet adjusting screw nut against valve tappet (7/16-in. open-end wrench) (fig. 180).

(f) Repeat substeps *(a)* through *(e)* above to adjust remaining seven valve tappets.

(25) INSTALL VALVE COVER.

WRENCH, socket, 1/2-in.

(a) Shellac valve cover gasket to valve cover (fig. 141).

(b) Place valve cover in position on cylinder block, and install screws (1/2-in. socket wrench) (fig. 141).

(26) INSTALL CYLINDER HEAD.

DRIVER, stud	WRENCH, socket, 9/16-in.
OIL, engine (seasonal grade)	WRENCH, torque

(a) Install two cylinder heads to cylinder block studs (stud driver) (fig. 137).

(b) Pour enough OIL, engine (seasonal grade), in each cylinder to coat top of piston.

(c) Place cylinder head gasket and cylinder head in position on top of cylinder block.

(d) Install cylinder head cap screws fingertight.

(e) Tighten cylinder head screws (⁹⁄₁₆-in. socket and torque wrench). Begin with center screw and work around it in a clockwise manner, tightening screws at ends of cylinder head last. Correct tension is 42 foot-pounds or 504 inch-pounds.

130. INSTALLATION OF ACCESSORIES.

a. Equipment.

DRIFT, soft	WRENCH, box, ½-in.
DRIVER, stud	WRENCH, open-end, ⅜-in.
HAMMER	WRENCH, open-end, ½-in.
LEAD, white	WRENCH, open-end, ⁹⁄₁₆-in.
PRESS, arbor	WRENCH, socket, ½-in.
PUNCH	WRENCH, socket, ⁹⁄₁₆-in.
SCREWDRIVER	WRENCH, Stillson
VARNISH, shellac	WRENCH, torque

b. Procedure.

(1) INSTALL SPARK PLUGS (par. 104).

(2) INSTALL OIL DRAIN PIPE.

LEAD, white   WRENCH, Stillson

Put a little LEAD, white, on threads of oil drain pipe. Install drain pipe in elbow (Stillson wrench) (fig. 136).

(3) INSTALL OIL FILTER AND IGNITION COIL BRACKET.

WRENCH, torque

(a) Place bracket spacers on cylinder head studs (fig. 137).

(b) Place oil filter and ignition coil bracket in position on studs and spacers (fig. 137).

(c) Install cylinder head stud nuts which secure bracket to cylinder head. Correct tension is 42 foot-pounds or 504 inch-pounds (⁹⁄₁₆-in. socket and torque wrench) (fig. 137).

(4) INSTALL OIL FILLER CAP.

Place oil filler cap in position on breather pipe.

(5) INSTALL MANIFOLD.

DRIVER, stud   WRENCH, socket, ⁹⁄₁₆-in.

(a) Install manifold studs (stud driver). Long studs go in center (fig. 141).

(b) Place two manifold gaskets in position on cylinder block. Place exhaust and intake manifold in position on studs (fig. 188).

(c) Install manifold stud flat washers and nuts, and tighten (⁹⁄₁₆-in. socket wrench) (fig. 188).

(6) INSTALL GOVERNOR (par. 147).

(7) INSTALL CARBURETOR (par. 142)

(8) INSTALL AUXILIARY GOVERNOR (UNIT M6) (par. 153).

ENGINE ASSEMBLY AND INSTALLATION

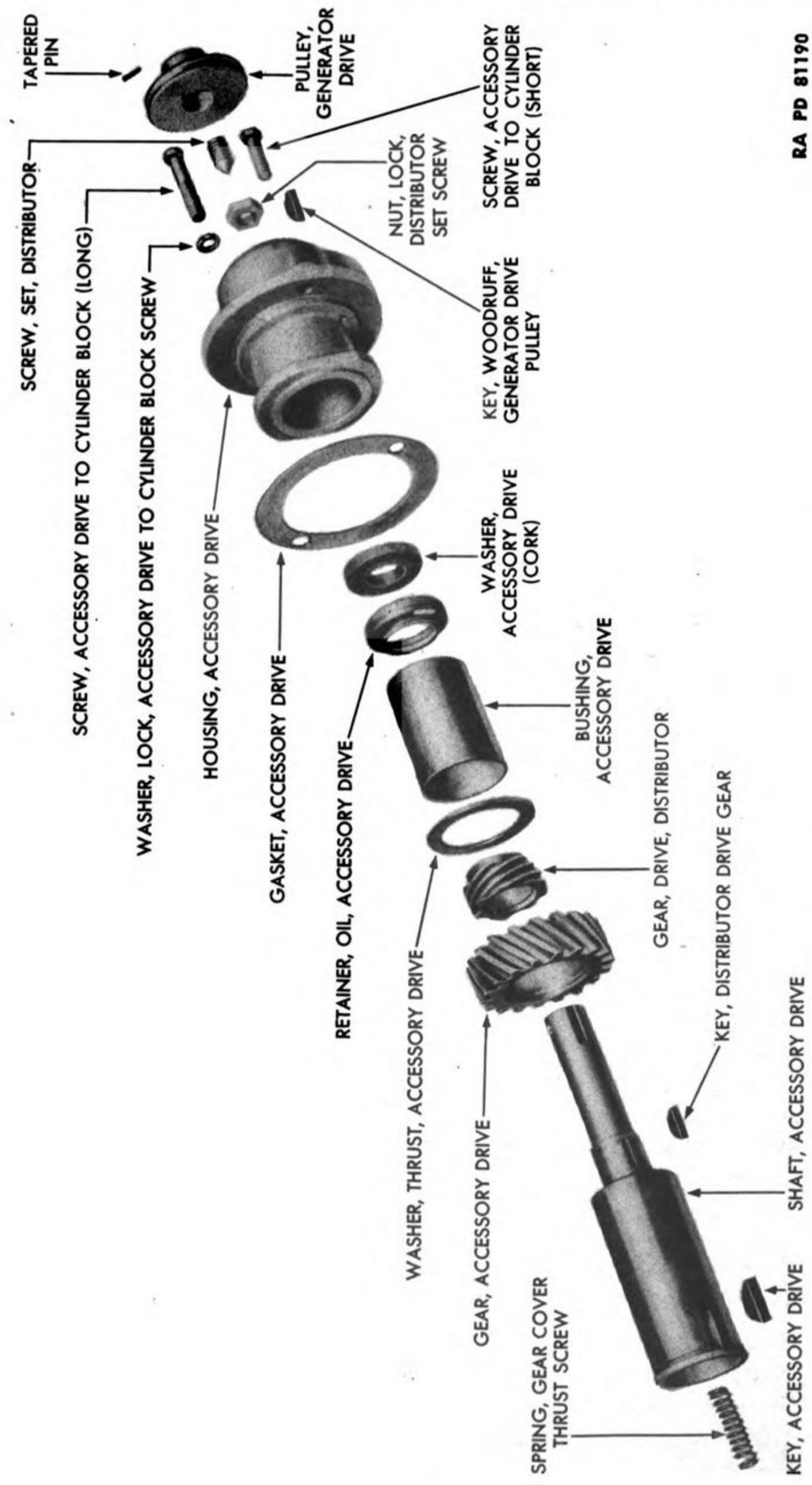


Figure 181 — Accessory Drive Assembly

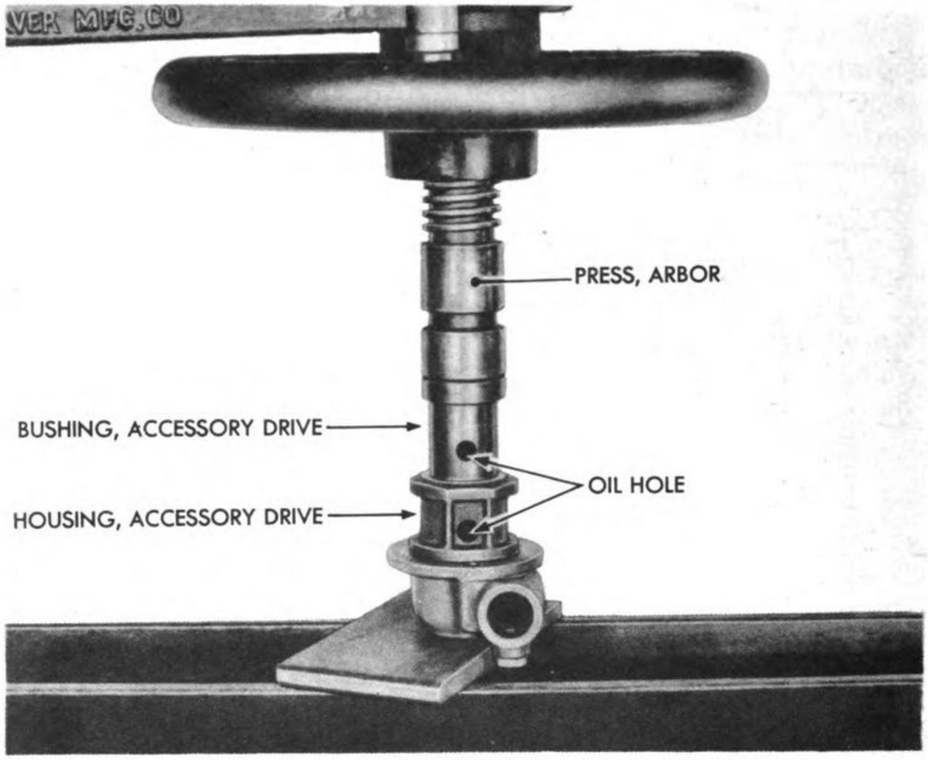


Figure 182 — Pressing Accessory Drive Bushing into Accessory Drive Housing

(9) INSTALL GASOLINE STRAINER (par. 155).

(10) INSTALL AIR CLEANER (par. 136).

(11) ASSEMBLE ACCESSORY DRIVE.

DRIFT, soft	PUNCH
HAMMER	SCREWDRIVER
PRESS, arbor	

(a) Tap distributor driving gear key in accessory drive shaft (hammer). Line up key and keyway. Press distributor driving gear on accessory drive shaft (arbor press) (fig. 139).

(b) Tap accessory drive key in slot in accessory drive shaft (hammer). Line up key in shaft and keyway in gear. Press drive gear on accessory drive shaft (arbor press) (fig. 140).

(c) Slide accessory drive thrust washer on accessory drive shaft (fig. 181).

(d) Install distributor setscrew in accessory drive housing (screwdriver). Install setscrew lock nut on setscrew (fig. 181).

(e) Push accessory drive cork washer and accessory drive oil retainer in place in housing (fig. 181). Tap retainer to seat (soft drift and hammer).

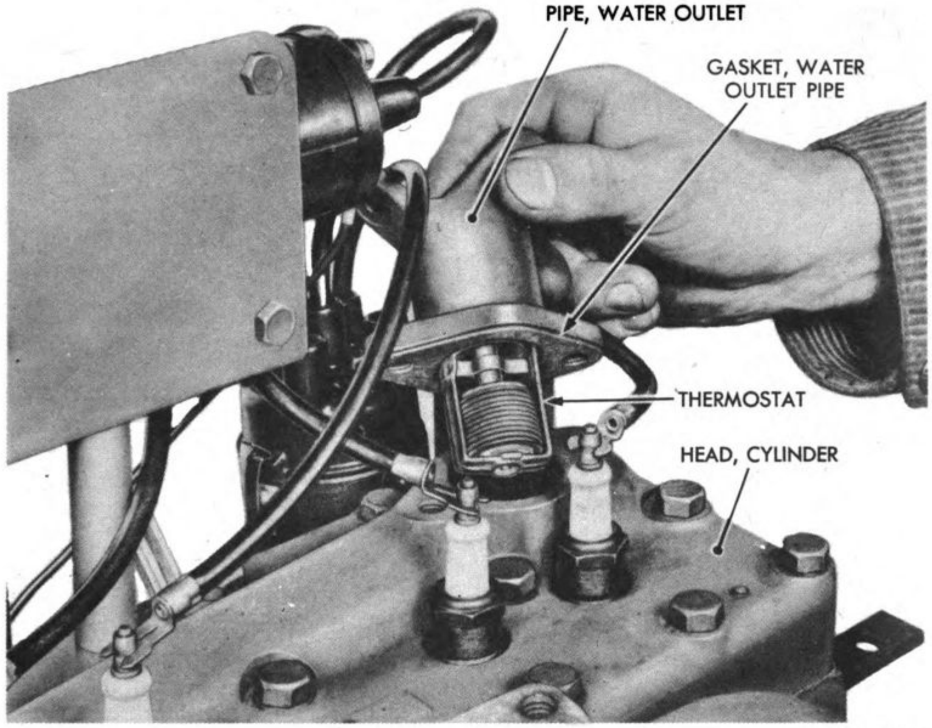


Figure 183 — Installing Water Outlet Pipe and Thermostat Assembly

(f) Line up oilhole in accessory drive bushing with oilhole in housing. Press bushing in housing (arbor press) (fig. 182).

(g) Slide accessory drive shaft assembly in housing assembly (fig. 181).

(h) Tap generator drive pulley Woodruff key in its slot in accessory drive shaft (hammer). Line up keyway in generator drive pulley, and press pulley on shaft (arbor press). Drive tapered pin in its hole through pulley and shaft (hammer). Peen pin in place (hammer and punch) (fig. 181).

(12) INSTALL ACCESSORY DRIVE.

WRENCH, box, ½-in.

(a) Hold accessory drive gasket in place against accessory drive. Push accessory drive in position on cylinder block (fig. 137).

(b) Install lock washers and cap screws (½-in. box wrench) (fig. 137).

(13) INSTALL STARTING MOTOR (par. 112).

(14) INSTALL OIL FILTER AND FITTINGS.

WRENCH, open-end, ⅜-in.
WRENCH, open-end, ½-in.
WRENCH, open-end, 9/16-in.

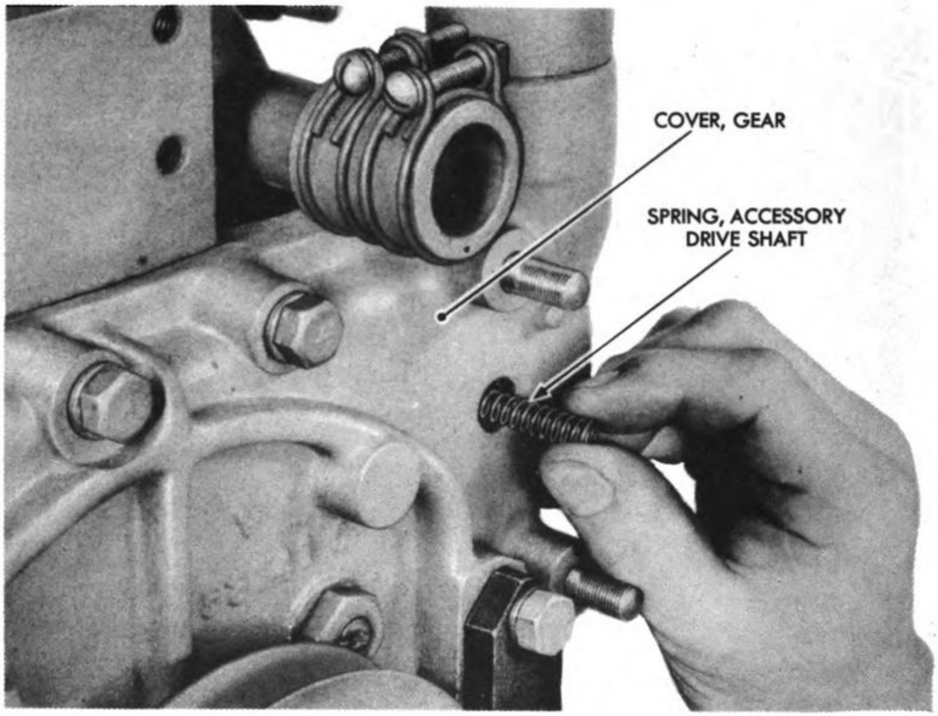


Figure 184 — Installing Accessory Drive Shaft Thrust Spring

(a) Install oil pressure gage "T" on cylinder block (½-in. open-end wrench) (fig. 137).

(b) Install crankcase elbow on cylinder block (⅜-in. open-end wrench) (fig. 137).

(c) Install oil filter (par. 159).

(d) Connect oil filter outlet line to oil filter and to crankcase elbow (9/16-in. open-end wrench) (fig. 137).

(e) Connect oil filter inlet line to oil filter and oil pressure gage "T" (9/16-in. open-end wrench).

(15) INSTALL IGNITION COIL (par. 97).

(16) INSTALL THERMOSIPHON COVER AND GENERATOR BRACKET.

VARNISH, shellac — WRENCH, open-end, 9/16-in.

(a) Shellac gasket to generator support bracket (fig. 137).

(b) Place generator support bracket in position on cylinder block. Install lock washers and cap screws (9/16-in. open-end wrench) (fig. 137).

(17) INSTALL WATER PUMP DISCHARGE PIPE.

VARNISH, shellac — WRENCH, socket, ½-in.

(a) Shellac new gasket to water discharge pipe.

(b) Place discharge pipe in position on cylinder block. Install lower lock washer and cap screw (½-in. socket wrench).

(c) Slide battery charging generator adjustable bracket on upper cap screw and lock washer. Install cap screw (½-in. socket wrench) (fig. 137).

(18) INSTALL BATTERY CHARGING GENERATOR (par. 87).

(19) INSTALL BATTERY CHARGING GENERATOR REGULATOR (par. 93).

(20) INSTALL AND TUNE DISTRIBUTOR (par. 103).

(21) INSTALL WATER OUTLET PIPE AND THERMOSTAT.

VARNISH, shellac — WRENCH, open-end, ½-in.

(a) Place thermostat in position on water outlet pipe and shellac gasket to pipe and thermostat (fig. 183).

(b) Place pipe and thermostat assembly in position on cylinder head (fig. 183).

(c) Install water outlet pipe lock washers and cap screws (½-in. open-end wrench) (fig. 136).

(22) INSTALL WATER PUMP AND WATER PUMP DISCHARGE PIPE HOSE.

SCREWDRIVER — WRENCH, open-end, ½-in.

(a) Clamp water pump discharge pipe hose to water pump discharge pipe (screwdriver) (figs. 79 and 184).

(b) Insert accessory drive shaft thrust spring in front end of accessory drive through water pump shaft opening in gear cover (fig. 184).

(c) Install water pump (par. 77).

(d) Connect water bypass tube to generator support bracket (½-in. open-end wrench) (fig. 78), and to water pump inlet elbow.

(23) INSTALL FAN.

(a) Install fan and fan belt (par. 79).

(b) Adjust fan belt tension (par. 79).

(24) INSTALL EXHAUST PIPE ADAPTER.

WRENCH, open-end, $^9/_{16}$-in.

(a) Place exhaust pipe adapter in position on intake and exhaust manifold (fig. 136).

(b) Install lock washers and cap screws ($^9/_{16}$-in. open-end wrench) (fig. 136).

(25) INSTALL MUFFLER.

WRENCH, Stillson

Screw muffler to exhaust pipe adapter (Stillson wrench) (fig. 136). Be sure end of muffler marked "inlet" is toward exhaust pipe adapter.

(26) INSTALL BAYONET OIL GAGE.

Insert bayonet oil gage in its hole in cylinder block (fig. 117).

131. INSTALLATION.

a. Equipment.

HOIST, chain
SCREWDRIVER
SLING, rope
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/4-in.
WRENCH, Stillson

b. Procedure.

(1) Lift engine in position in frame (two men) (fig. 133).

(2) Install rear engine mounting lock washers and cap screws, and front engine mounting lock washers and cap screws (3/4-in. open-end wrench) (fig. 133). NOTE: Cable clip goes on right-hand rear engine mounting cap screw (fig. 135).

(3) Install main generator and instrument panel assembly (par. 28) (figs. 134 and 135).

(4) Install drain cock in water pump inlet elbow (5/8-in. open-end wrench) (fig. 134).

(5) Install radiator (par. 78).

(6) Install battery (par. 113).

(7) Install housing (par. 19).

(8) Install oil drain pipe cap on oil drain pipe (Stillson wrench) (fig. 3).

132. TESTS AND ADJUSTMENTS.

a. Equipment.

GASOLINE
OIL, engine (seasonal grade)
WATER

b. Procedure.

(1) PRECAUTIONS BEFORE STARTING ENGINE.

GASOLINE
OIL, engine (seasonal grade)
WATER

(a) Fill crankcase to "4/4" mark on bayonet oil gage with OIL, engine (seasonal grade). Capacity of crankcase is 4 quarts.

(b) Fill cooling system with water or antifreeze solution. Capacity is 5 quarts.

(c) Fill gasoline tank with gasoline.

(d) Check cooling system for water leaks. Repair if found.

(e) Check engine for oil leaks. Repair if found.

(f) Open gasoline tank shut-off cock, and check fuel system for gasoline leaks. Repair if found.

(g) Examine ignition wires. See that all connections are made, and that they are tight.

(h) Lubricate engine accessories (pars. 162 and 165).

(i) Crank engine over a few times by hand. This will determine whether the engine is free without causing any damage.

(2) Precautions and Adjustments After Starting Engine.

(a) Immediately after starting engine, observe oil pressure gage and ammeter. Turn ignition off immediately if no oil pressure or no charging rate is indicated. Locate and correct the cause.

(b) Listen for knocks or noises indicating malfunctioning of engine or accessories. Locate and correct the cause of any such noise.

(c) Inspect cooling system for leakage. Repair if leakage is present.

(d) Inspect engine for oil leakage. Repair if leakage is present.

(e) Inspect manifold, exhaust pipe, and muffler for exhaust leakage. Repair if leaking.

(f) Adjust charging rate of battery charging generator. The rate of charging may be decreased by shifting the smaller or third brush away from the nearest main brush, or increased by moving it nearer to the main brush. Remove generator head band to expose brushes.

(g) Add OIL, engine (seasonal grade), to "4/4" mark, to compensate for oil contained in oil filter.

(h) After engine has run for 15 minutes, adjust oil pressure to 15 pounds (par. 161 **d**). With engine warm, adjust valve tappets to a 0.006-inch clearance (par. 129 **b** (24)).

1. After engine has warmed up, check to make sure the engine bolts are down tight.

Section XVIII

FUEL SYSTEM

133. DESCRIPTION.

a. The fuel system consists of a gasoline tank, gasoline strainer, carburetor, air cleaner, governor, and choke control.

b. The gasoline tank is equipped with a gage, filler cap shut-off cock, and gasoline line. This assembly is a part of the housing, and is covered in paragraphs 12 to 19.

c. From the gasoline line, fuel flows into a gasoline strainer attached to the carburetor. It consists of a sediment bowl and disk-type element through which the gasoline must pass. The strainer prevents dirt and other foreign particles, and water from entering the carburetor.

d. The function of the carburetor is to convert liquid gasoline to a highly explosive gasoline vapor and air mixture (fig. 185). Air

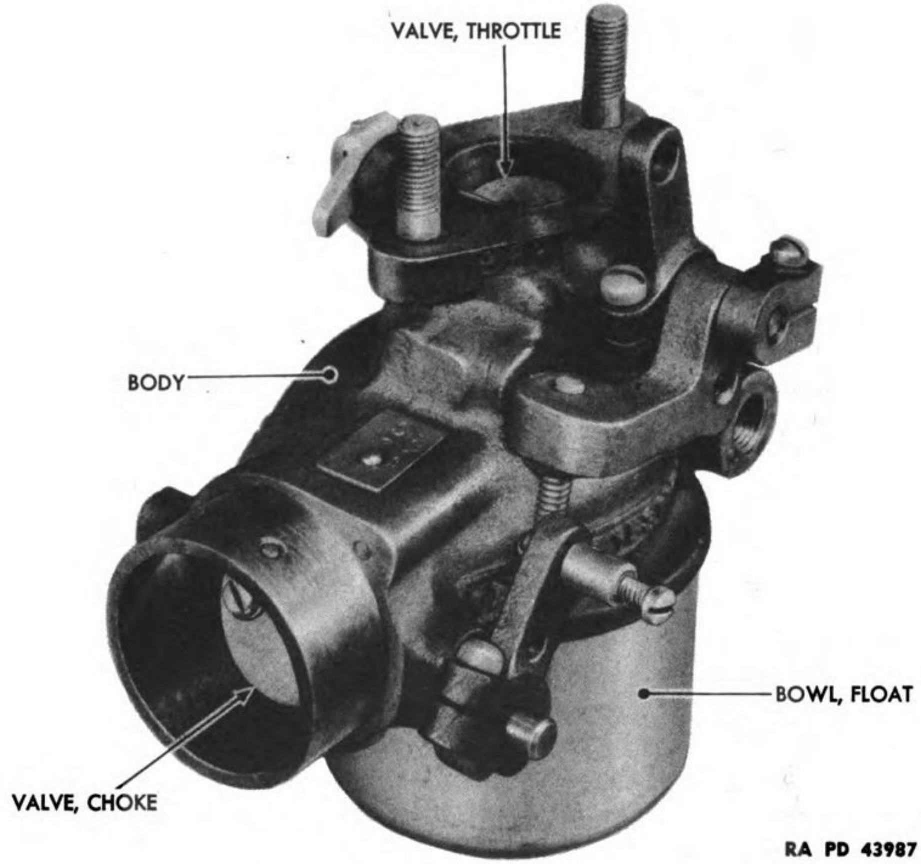


Figure 185 — Carburetor

rushing from the atmosphere through the carburetor to the partial vacuum of the manifold furnishes the force which makes the carburetor operate.

(1) The flow of gasoline from the gasoline strainer to the carburetor is regulated by the carburetor float valve. The float valve is controlled by the carburetor float. As the carburetor float bowl (fig. 185) empties, the float falls and opens the float valve. This allows gasoline to flow into the bowl. As the bowl fills, the float rises and closes the float valve. Thus, the fuel level in the float bowl is kept at an efficient operating level.

(2) Air enters the carburetor body (fig. 185) from the air cleaner, and passes through the body into the intake manifold. As it goes through the body, gasoline is mixed with it, as the gasoline sprays from the carburetor nozzle assembly. The Venturi swirls the mixture, thus insuring complete mixing of gasoline vapor and air.

(3) The carburetor throttle valve (fig. 185) controls engine speed by regulating the quantity of vapor and air mixture to be admitted to the manifold.

(4) To facilitate starting when the engine is cold, a choke valve (fig. 185) is provided. The choke valve partially closes the air passage from the air cleaner to the carburetor body. This causes more gasoline vapor and less air to be used in the mixture.

(5) Of conventional automotive design, the carburetor is of the up draft type. No adjustment is provided, except for regulation of idling speed. This is done by regulating the degree to which the throttle valve can close. If engine performance should indicate a too rich or too lean mixture, the carburetor must be disassembled and cleaned.

e. Abrasive dirt in the air is removed from the air entering the carburetor by the air cleaner. The air is drawn through a screen kept constantly moist with oil vapor. Impurities in the air adhere to the oil. The oil is then washed down into the oil reservoir, taking the dirt with it. The air cleaner mounting bracket is cast iron. The filtering element consists of four layers of crimped 18-mesh iron screen. The two gaskets are cork. All other parts are made of sheet metal.

f. The governor is of the centrifugal mechanical type and is gear-driven by the front end gear train. The flyball weights are counterbalanced with an external spring pressure. The tension of this spring can be changed to operate the engine at the speed desired. At all loads within the rating of the generator, the governor maintains the speed regulation to within ± 3 percent.

g. An auxiliary governor is used on the Unit M6 to prevent surging of the engine as the load varies. This is necessary since the Unit M6 has no throttle control. Vacuum of the intake manifold operates the auxiliary governor. Decreased vacuum, caused by increased engine load, allows the bellows to contract. Contraction of the bellows lowers the plunger which opens the carburetor throttle valve. This allows more fuel to flow from the carburetor into the manifold. The added fuel compensates for the increased engine load, and allows the engine to maintain its speed. Steel, brass, and copper are used in the construction of the auxiliary governor. Steel parts are the support plate, screws, and lock washers. Brass parts are the bellows housing, base, orifice, plunger, and vacuum tube elbow. The vacuum tube is copper.

134. SPECIFICATIONS.

a. Air Cleaner.

Make . . . . Air-Maze
Type . . . . Oil bath
Oil capacity . . . . ⅓ pt

b. Carburetor.

Make	Schebler
Model	TCX-39
Type	Updraft
Adjustment	Idling speed

c. Governor.

Make	Pierce
Model	CS
Type	Mechanical
Speed regulation	± 3 percent

d. Auxiliary Governor (Unit M6 Only).

Make	Hobart
Type	Vacuum

e. Choke Control.

Make	Morse
Model	4K
Type	Manual

f. Gasoline Strainer.

Make	Zenith
Model	ZX-1-G1
Type	Sediment bowl

135. TROUBLE SHOOTING.

a. Carburetor.

(1) CARBURETOR DRIPS GASOLINE.

Possible Cause	Possible Remedy
Saturated float.	Replace float (pars. 138 and 141).
Worn float needle valve.	Replace float needle valve and float needle valve seat (pars. 138 and 141).
Float bowl gasket damaged or defective.	Replace gasket (pars. 138 and 141).
Body or float bowl broken.	Replace broken part (pars. 138 and 141).
Choke valve stuck closed.	Free choke valve (pars. 138 and 141).
Choke lever loose on shaft, and valve closed.	Open valve and tighten choke lever clamp screw (par. 141).

(2) CARBURETOR DOES NOT RESPOND TO CONTROLS.

Throttle lever clamp screw loose.	Tighten throttle lever clamp screw.
Throttle lever stuck.	Free throttle lever.

(3) CARBURETOR DELIVERS TOO RICH OR TOO LEAN MIXTURE.

Possible Cause	Possible Remedy
Dirt in carburetor.	Disassemble and clean carburetor (par. 138).

b. Governor.

(1) ENGINE RUNS TOO FAST OR TOO SLOW.

Governor out of adjustment.	Adjust governor (par. 148).
Governor broken.	Repair governor (par. 145).

(2) ENGINE SURGES.

Governor out of adjustment.	Adjust governor (par. 148).
Governor broken.	Repair governor (par. 145).

c. Auxiliary Governor (Unit M6).

(1) ENGINE SURGES.

Auxiliary governor broken.	Repair auxiliary governor.

d. Choke Control.

(1) CARBURETOR DOES NOT RESPOND TO CHOKE CONTROL.

Choke control disconnected.	Connect choke control (par. 154).
Choke control broken.	Repair or replace choke control (par. 154).

e. Gasoline Strainer.

(1) DRIPS GASOLINE.

Bowl gasket damaged.	Replace bowl gasket (par. 155).
Bail thumbscrew loose.	Tighten bail thumbscrew.
Bowl broken.	Replace bowl (par. 155).
Head broken.	Replace head (par. 155).
Male coupling loose.	Tighten male coupling.
Male coupling broken.	Replace male coupling (par. 155).
Elbow loose.	Tighten elbow.
Elbow broken.	Replace elbow (par. 155).

(2) GASOLINE FAILS TO FLOW THROUGH STRAINER.

Strainer clogged by dirt.	Clean strainer (par. 155).

(3) FAILS TO REMOVE IMPURITIES FROM FUEL.

Disks in strainer element bent.	Replace element (par. 155).

f. Air Cleaner.

(1) FAILS TO REMOVE DIRT FROM AIR.

Out of oil.	Service air cleaner (par. 136).
Bracket loose.	Tighten bracket.
Element fouled.	Service air cleaner (par. 136).
Oil bath fouled.	Service air cleaner (par. 136).

(2) DRIPS OIL.

Wing nut loose.	Tighten wing nut.
Gasket damaged.	Replace gasket (par. 136).

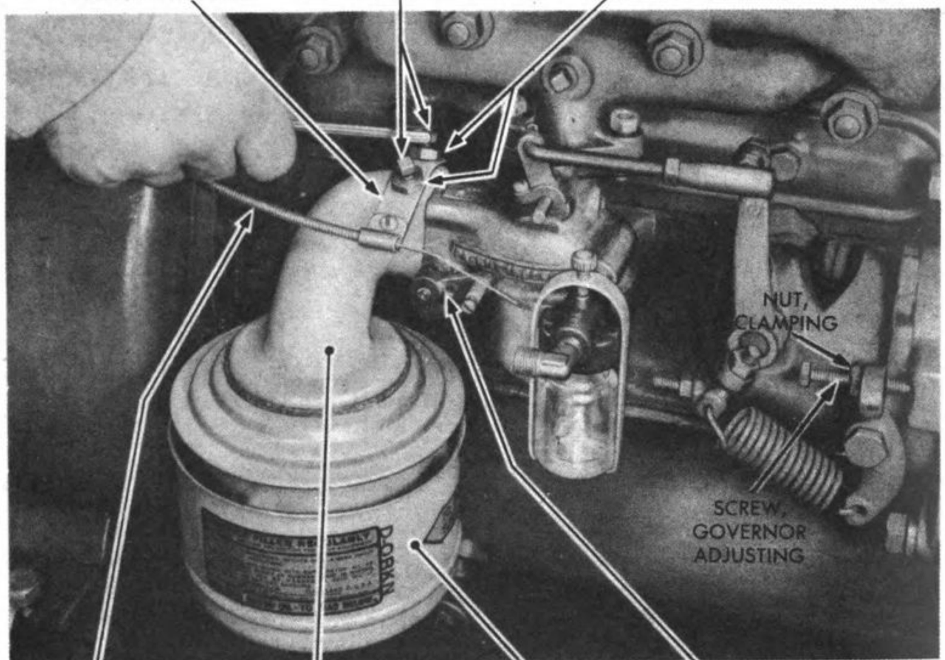


Figure 186 — Removing Air Cleaner

(3) AIR PASSAGE BLOCKED.

Possible Cause	Possible Remedy
Air cleaner assembled incorrectly.	Assemble correctly (par. 136).
Dirt in element.	Service air cleaner (par. 136).

136. AIR CLEANER.

a. Equipment.

DOLLY	SHELLAC
HAMMER	SOLDERING EQUIPMENT
KNIFE	WELDING EQUIPMENT
OIL, engine (seasonal grade)	WRENCH, open-end, 1/4-in.
SCREWDRIVER	WRENCH, open-end, 1/2-in.

b. Procedure.

(1) REMOVAL (fig. 186).

SCREWDRIVER	WRENCH, open-end, 1/2-in.
WRENCH, open-end, 1/4-in.	

(a) Disconnect choke control wire from choke valve lever (screwdriver).

(b) Loosen air cleaner bracket setscrew lock nuts (1/2-in. open-end wrench) (fig. 186).

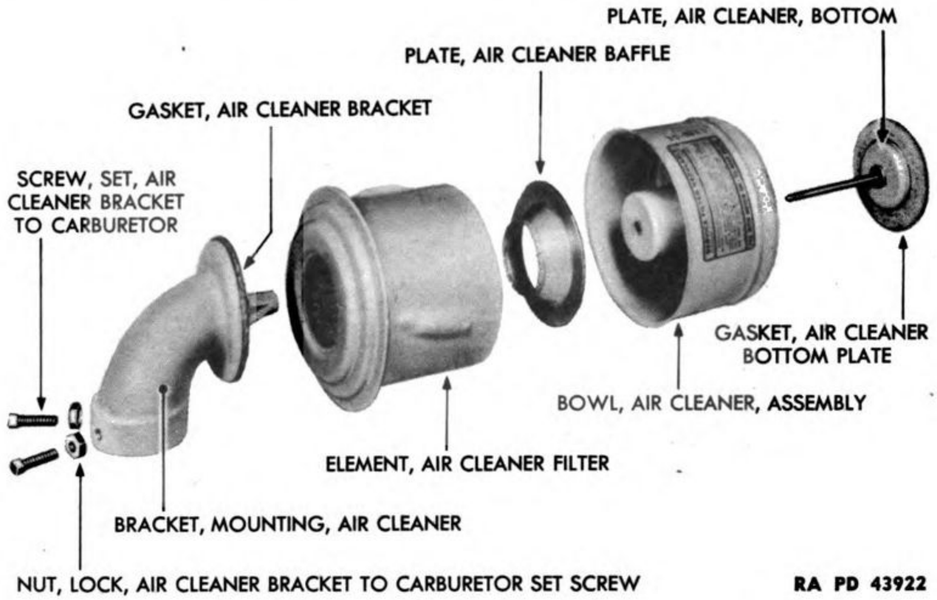


Figure 187 — Air Cleaner Assembly — Exploded View

(c) Remove air cleaner bracket setscrews (¼-in. open-end wrench). Lift off choke control conduit clamp.

(d) Lift air cleaner bracket and air cleaner assembly from carburetor.

(2) Disassembly (fig. 187).

KNIFE	WRENCH, open-end, ½-in.
WRENCH, open-end, ¼-in.	

(a) Loosen wing nut in center of bottom plate.

(b) Lift bottom plate and gasket.

(c) Lift bowl from filter element, and remove baffle plate from bowl.

(d) Lift mounting bracket from element.

(e) Unscrew bracket to carburetor setscrews and lock nuts from bracket (¼-in. open-end wrench and ½-in. open-end wrench).

(f) Remove gaskets from bracket and bottom plate (knife). NOTE: Gaskets will probably be damaged upon removal. Therefore, do not remove gaskets unless replacement is necessary.

(3) Inspection and Repair.

DOLLY	SOLDERING EQUIPMENT
HAMMER	WELDING EQUIPMENT

(a) Examine threads of bottom plate assembly and threads of the setscrews and lock nuts. Replace if damaged.

(b) Inspect bracket for fracture. Weld or replace if broken (welding equipment).

(c) Examine filter element to see if it is bent, or if screen is loose from sheet metal. Straighten if bent (hammer and dolly). Solder screen to sheet metal if loose (soldering equipment).

(d) Inspect baffle plate and bowl to see if bent. Straighten if bent (hammer and dolly).

(e) Pour water in bowl to test for leakage. Solder any leaks (soldering equipment).

(f) Examine bracket gasket and bottom plate gasket. Replace if torn or crushed.

(4) ASSEMBLY (fig. 187).

OIL, engine (seasonal grade) VARNISH, shellac

(a) Shellac gasket to mounting bracket.

(b) Shellac gasket to bottom plate.

(c) Pour OIL, engine (seasonal grade), in bowl to bead level (about one-third pint).

(d) Place filter element in position on bracket. Slip baffle plate in position in bowl. Hold bowl in place on element. Place wing nut and bottom plate assembly in position on bottom of bowl. Tighten wing nut.

(e) Tighten bracket to carburetor setscrew and lock nut by hand.

(5) INSTALLATION (fig. 186).

SCREWDRIVER WRENCH, open-end, ½-in.
WRENCH, open-end, ¼-in.

(a) Place assembled air cleaner and air cleaner bracket in position on carburetor.

(b) Place choke control conduit clamp in position on air cleaner bracket.

(c) Install setscrews (¼-in. open-end wrench).

(d) Tighten setscrew lock nuts (½-in. open-end wrench).

(e) Connect choke control wire to choke valve lever (screwdriver).

(6) SERVICING AIR CLEANER.

OIL, engine (seasonal grade) WRENCH, open-end, ½-in.
WRENCH, open-end, ¼-in.

(a) Daily Inspection.

1. Check tightness of bracket to carburetor setscrews and lock nuts (¼- and ½-in. open-end wrenches), and bottom plate wing nut.

2. Under extremely dusty conditions, change oil in bowl daily (step (2) below).

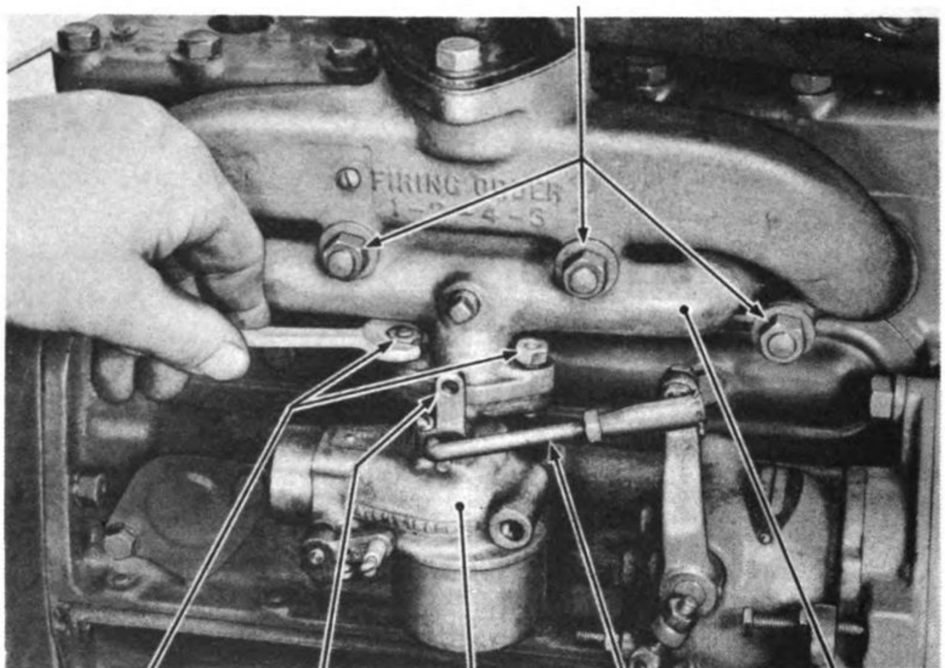


Figure 188 — Removing Carburetor

(b) *Weekly Servicing.*

1. Remove bottom plate and remove bowl from air cleaner. Empty bowl. Refill with OIL, engine (seasonal grade).

2. Wash the filter element in SOLVENT, dry-cleaning. CAUTION: Do not use gasoline.

137. REMOVAL OF CARBURETOR.

a. Equipment.

PLIERS
WRENCH, open-end, $\frac{5}{16}$-in.
WRENCH, open-end, $\frac{7}{16}$-in.

b. Procedure (fig. 188).

(1) Remove air cleaner (par. 136).

(2) Remove gasoline strainer (par. 155).

(3) Remove governor connecting rod cotter pin, and pull governor connecting rod from throttle lever (pliers).

(4) Unscrew auxiliary governor connecting rod from throttle lever ($\frac{5}{16}$-in. open-end wrench).

(5) Remove throttle flange stud nuts and lock washers ($\frac{7}{16}$-in. open-end wrench).

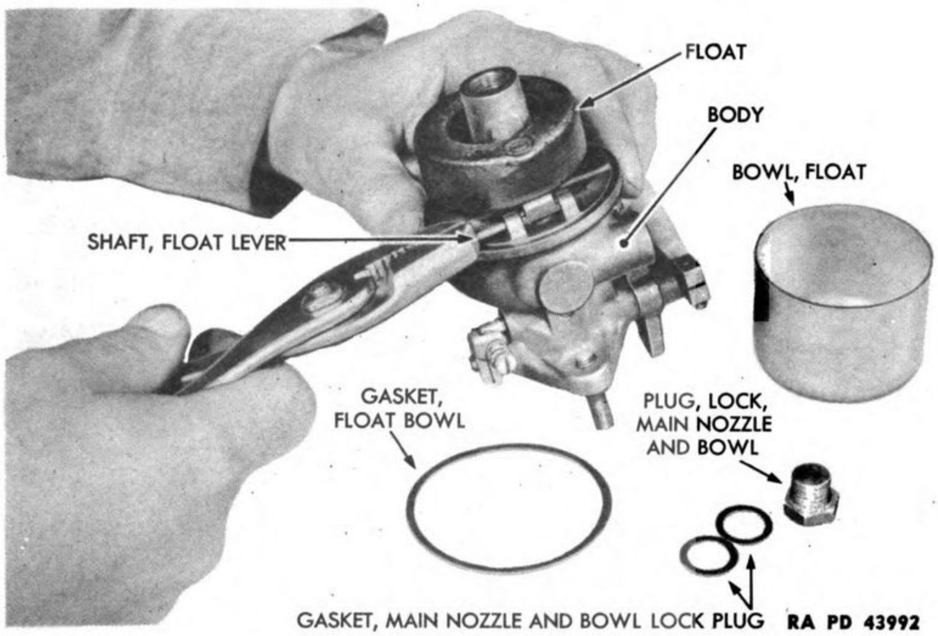


Figure 189 — Removing Carburetor Float Lever Shaft

(6) Lift carburetor from intake and exhaust manifold. Lift gasket from carburetor.

138. DISASSEMBLY OF CARBURETOR.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, ⅝-in.

b. Procedure (fig. 189).

(1) Remove main nozzle and bowl lock plug and outside gasket (⅝-in. open-end wrench).

(2) Lift float bowl from body, and lift main nozzle and bowl lock plug inside gasket, from bowl.

(3) Lift float bowl gasket from body.

(4) Pull float lever shaft from carburetor body (pliers).

(5) Lift float from carburetor body.

(6) Remove float lever screw and washer from float (screwdriver). Lift float lever from float (fig. 190).

(7) Turn body over. Float valve will fall from float valve seat (fig. 190).

(8) Remove float valve seat and gasket (screwdriver) (fig. 190).

(9) Remove main nozzle assembly and gasket from body (screwdriver) (fig. 190).

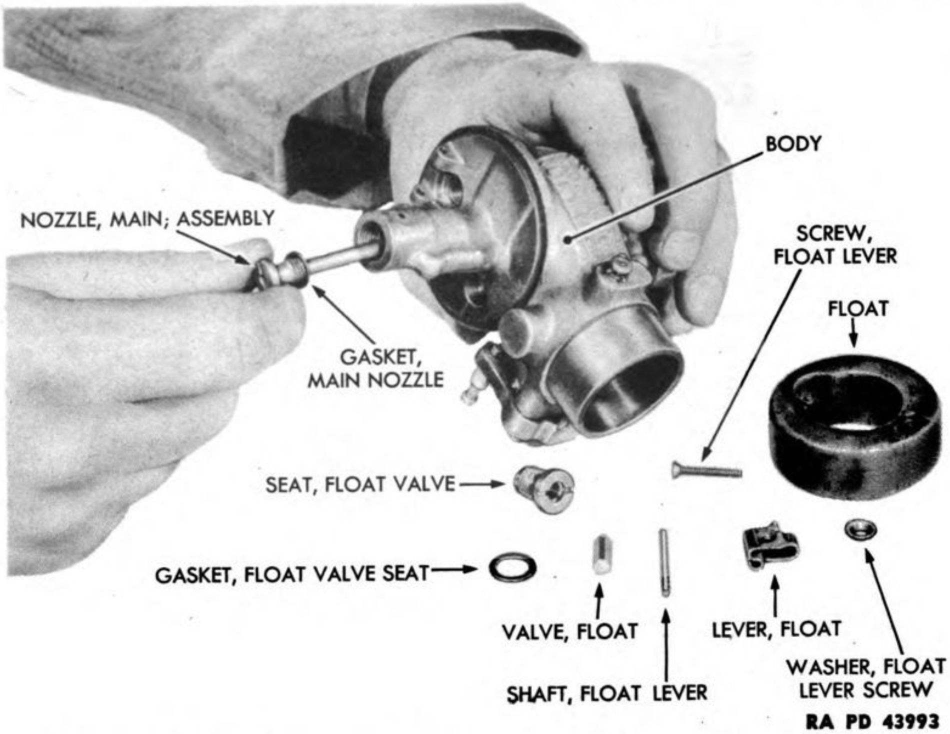


Figure 190 — Removing Carburetor Main Nozzle Assembly

(10) Loosen clamp screw in auxiliary governor throttle lever clamp (screwdriver), and lift clamp from throttle shaft. Lift auxiliary governor throttle lever from throttle shaft (fig. 191).

(11) Loosen throttle lever clamp screw (screwdriver) and lift throttle lever from shaft (fig. 191).

(12) Remove throttle valve screw and lock washer (screwdriver). Pull throttle valve (pliers) from slot in shaft (fig. 191).

(13) Slide throttle shaft assembly from body (fig. 191).

(14) Loosen carburetor choke valve lever clamp screw (screwdriver), and remove lever from choke valve shaft (fig. 192).

(15) Remove cotter pin securing choke valve swivel to choke valve lever, and lift swivel from lever (pliers) (fig. 194).

(16) Remove screws and lock washers securing choke valve to choke valve shaft, and remove valve (screwdriver). Remove pin (hairpin type) from end of choke valve shaft, and slide choke valve shaft from carburetor body (pliers) (fig. 194).

(17) Remove Venturi lock screw from top front portion of carburetor body, and pull Venturi from body (screwdriver) (fig. 193).

139. INSPECTION OF CARBURETOR.

a. Equipment.

COMPRESSED AIR
PRUSSIAN BLUE
SOLVENT, dry-cleaning

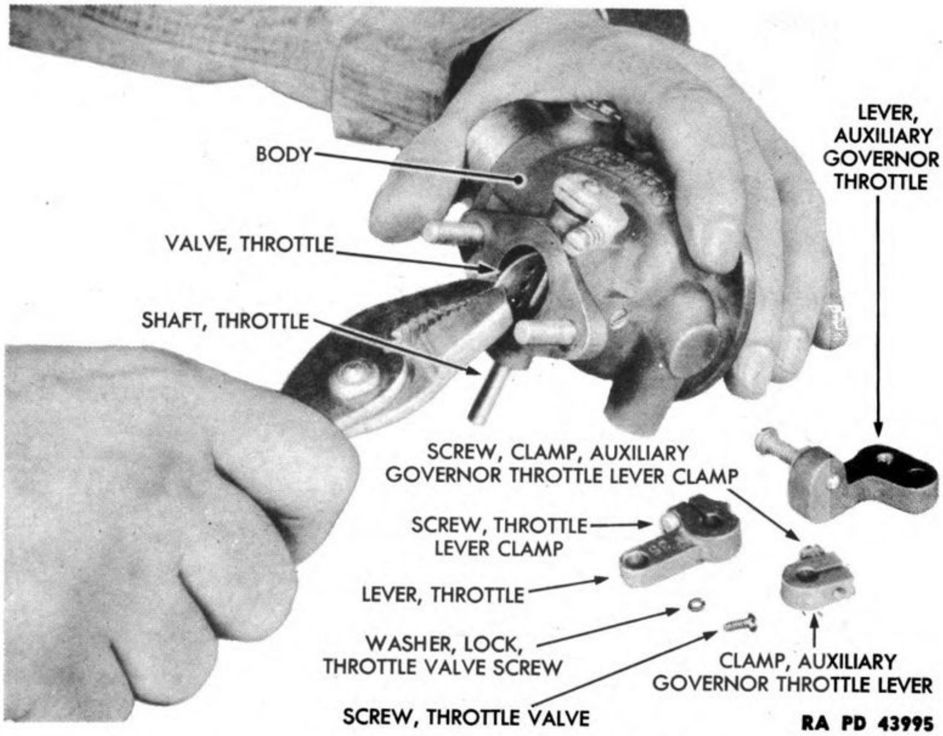


Figure 191 — Removing Carburetor Throttle Valve

b. Procedure.

(1) Clean all parts, except float, in SOLVENT, dry-cleaning. Blow dry with compressed air.

(2) Put a little PRUSSIAN BLUE on float valve. Insert valve in float valve seat. Give valve a complete turn with the fingers. Remove valve and observe valve seat. PRUSSIAN BLUE on seat must show complete seating all the way around if valve and seat are to be used again.

(3) Inspect main nozzle to see that orifices are unobstructed. One main hole runs the length of the nozzle. Three small holes enter the main orifice from side of nozzle.

(4) Examine float for breaks in varnish.

(5) Examine carburetor body to see if broken, or if choke valve stop pin and throttle stop pin are damaged or out of place. See that holes through which gasoline passes from float bowl to nozzle are unobstructed. Blow compressed air through orifice from bottom of body to inside of body near choke valve position to make sure it is unobstructed.

(6) Examine shafts, levers, and valves to see if they are worn or broken. Examine other metal parts to see if broken.

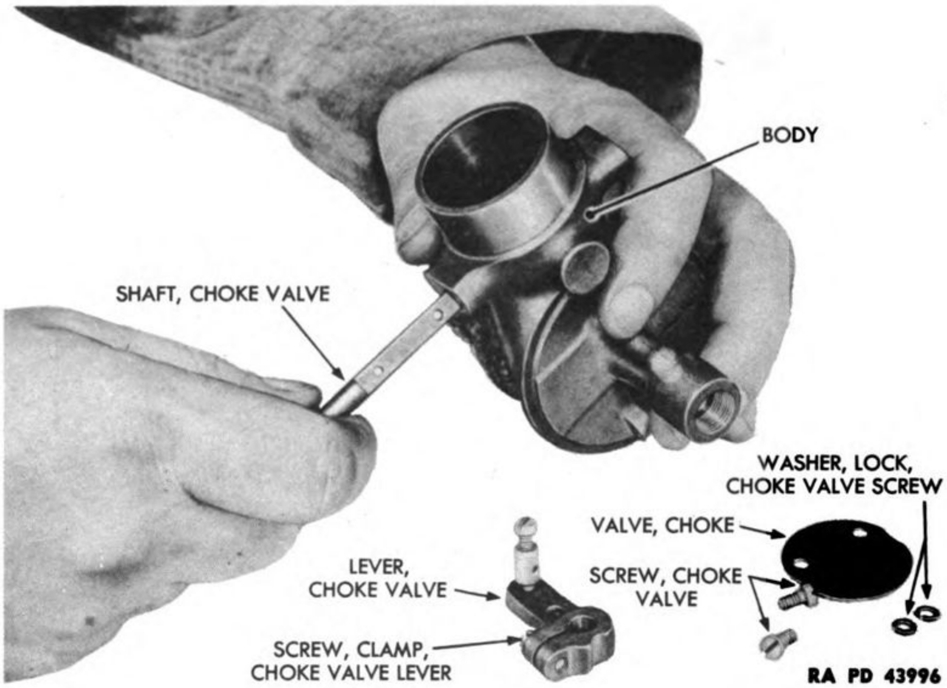


Figure 192 — Removing Carburetor Choke Valve Shaft

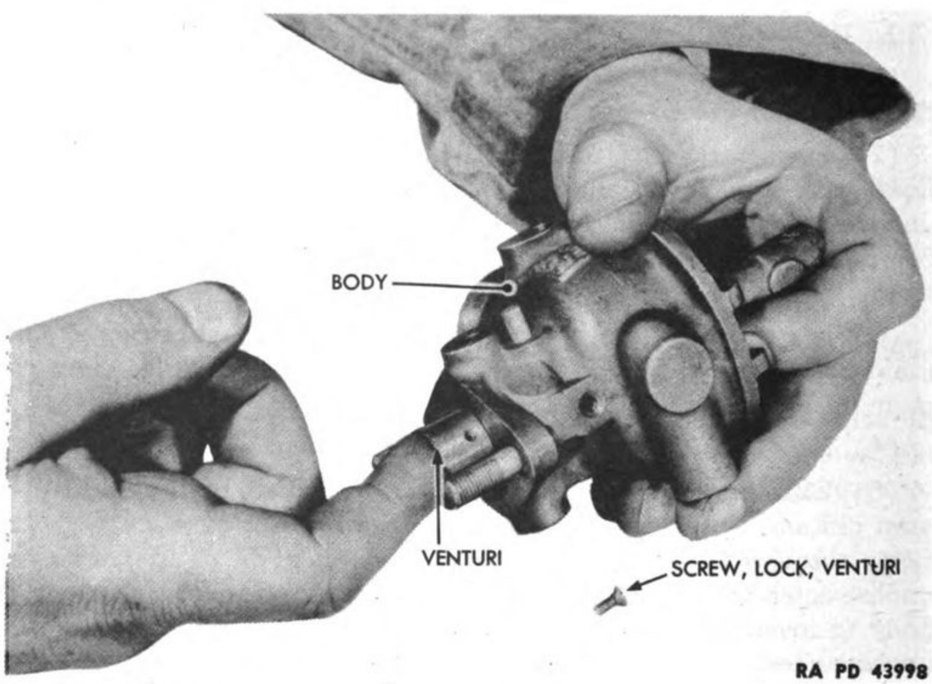


Figure 193 — Removing Carburetor Venturi

140. MAINTENANCE AND REPAIR OF CARBURETOR

a. Equipment.

COMPOUND, valve grinding (fine)
SOLVENT, dry-cleaning
PRUSSIAN BLUE

b. Procedure.

(1) GENERAL.

The only satisfactory repair of carburetor consists of cleaning all metal parts and replacing worn parts. Replace all gaskets each time carburetor is disassembled.

(2) FLOAT.

If varnish is damaged on float, replace float. A saturated float cannot be satisfactorily reclaimed.

(3) FLOAT NEEDLE VALVE.

COMPOUND, valve grinding (fine)
SOLVENT, dry-cleaning
PRUSSIAN BLUE

(a) Replace float needle valve and seat if these parts do not seat airtight. In case of needle valve failure when replacement parts are not available, a temporary repair can be made as follows:

1. Place a little fine valve grinding compound on float needle valve.

2. Insert valve into seat. Oscillate valve a few times.

3. Remove valve from seat, and clean valve and seat with SOLVENT, dry-cleaning.

4. Test fit of valve in its seat with Prussian blue (par. 139 (2)).

5. Repeat substeps *1* through *4* above until a satisfactory seat is obtained. NOTE: At best, this is only a temporary repair and must not be used if replacement parts are available.

141. ASSEMBLY OF CARBURETOR.

a. Equipment.

PLIERS
WRENCH, open-end, $^{11}/_{16}$-in.
SCREWDRIVER

b. Procedure (fig. 194).

(1) Insert Venturi in carburetor body so tapped hole in Venturi lines up with screw hole in body. Install Venturi lock screw (screwdriver).

(2) Insert throttle shaft assembly in carburetor body from throttle stop pin side of body. Insert throttle valve in slot in shaft so beveled edges meet body squarely. Secure throttle valve with screw and lock washer (screwdriver).

(3) Slide throttle lever on throttle shaft so lever is upright with valve open. Tighten clamp screw (screwdriver). Slide auxiliary governor throttle lever and lever clamp in position on throttle lever shaft and tighten clamp screw (screwdriver).

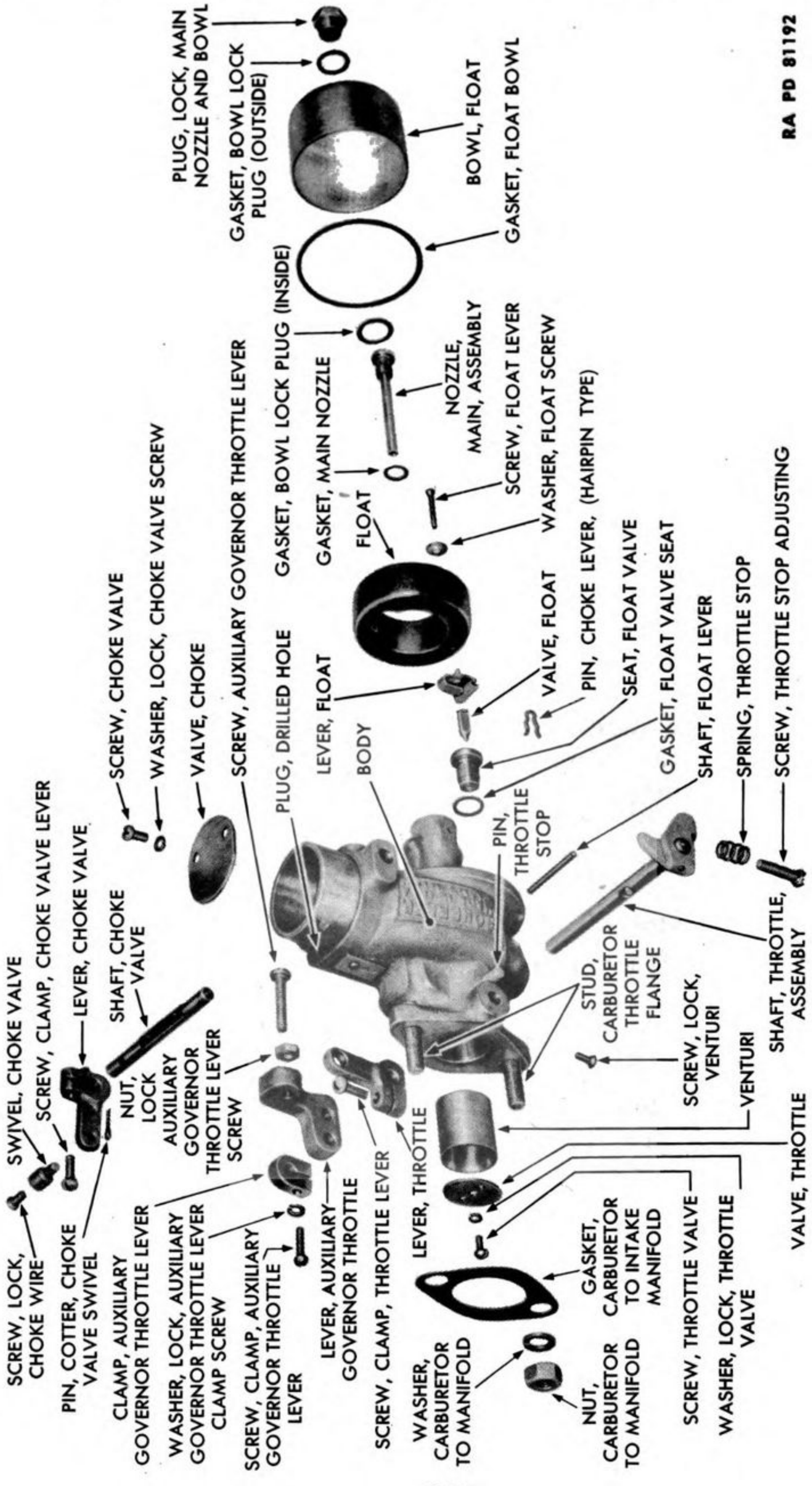


Figure 194 — Carburetor Assembly — Exploded View

(4) Slide choke valve shaft into body so pin groove on shaft is on the side of the body bearing the name "Schebler." Install pin (hairpin type).

(5) Lay choke valve on shaft inside body so screw holes in valve line up with screw holes in shaft. Install screws and lock washers (screwdriver). Check action of valve. If properly installed, it will open and close freely.

(6) Slide choke valve lever on choke valve shaft so lever points up when valve is open. Tighten clamp screw (screwdriver). Assemble choke valve swivel to choke valve lever and secure with cotter pin (pliers) (fig. 194).

(7) Using a new main nozzle gasket, screw main nozzle assembly into body and tighten securely (screwdriver).

(8) Using a new float valve seat gasket, screw float valve seat into body and tighten securely (screwdriver).

(9) Carefully install float valve into float valve seat, pointed end first.

(10) Install float lever to float with screw and washer (screwdriver). Tighten until snug. Do not compress cork.

(11) Place float assembly in position on body, and insert float lever shaft.

(12) Using a new bowl gasket (top end) and a new bowl lock plug gasket (inside), place float bowl in position on body. Using a new bowl lock plug gasket (outside), install main nozzle and bowl lock plug ($^{11}/_{16}$-in. open-end wrench).

142. INSTALLATION OF CARBURETOR.

a. Equipment.

PLIERS
WRENCH, open-end, $^{5}/_{16}$-in.
WRENCH, open-end, $^{7}/_{16}$-in.

b. Procedure.

(1) Using a new carburetor to intake manifold gasket, place carburetor in position on intake and exhaust manifold (fig. 188).

(2) Install throttle flange stud lock washers and nuts ($^{7}/_{16}$-in. open-end wrench) (fig. 188).

(3) Connect auxiliary governor connecting rod to throttle lever ($^{5}/_{16}$-in. open-end wrench) (fig. 188).

(4) Place governor connecting rod in position on throttle lever, and install governor connecting rod cotter pin (pliers) (fig. 188).

(5) Install gasoline strainer (par. 155).

(6) Install air cleaner (par. 136).

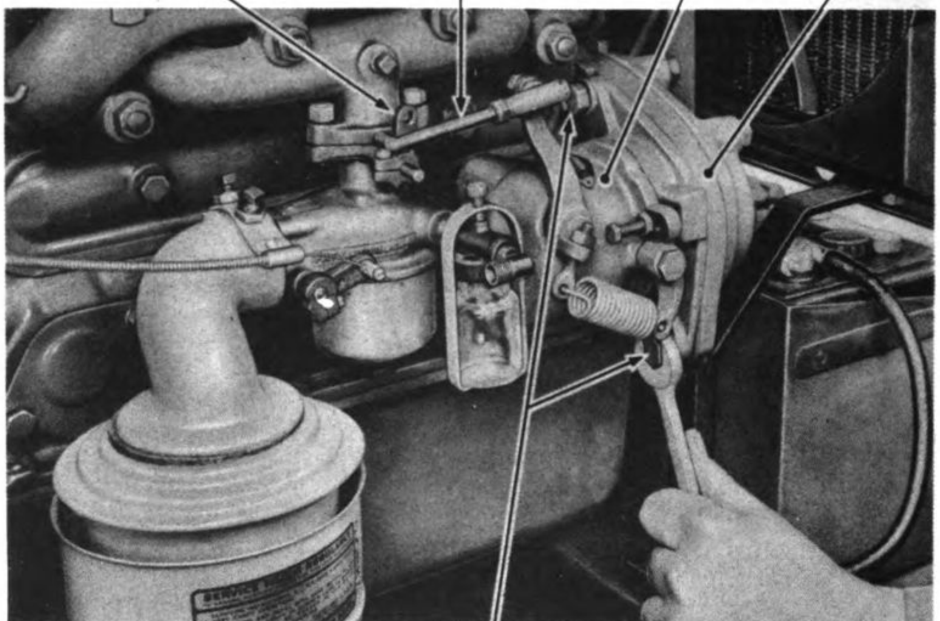


Figure 195 — Removing Governor

143. REMOVAL OF GOVERNOR.

a. Equipment.

PLIERS	WRENCH, open-end, ⅝-in.

b. Procedure (fig. 195).

(1) Remove governor connecting rod cotter pin from governor connecting rod (pliers). Pull rod from throttle lever.

(2) Remove governor attaching screws and lock washers (⅝-in. open-end wrench).

(3) Lift governor from cylinder block. Remove governor attaching gasket from governor or cylinder block.

144. DISASSEMBLY OF GOVERNOR (fig. 200).

a. Equipment.

DRIFT	PUNCH, ⅜-in.
GRINDER	PUNCH, $^{15}/_{32}$-in.
HAMMER	SCREWDRIVER
MALLET	WRENCH, open-end, ⅜-in.
PRESS, arbor	WRENCH, open-end, $^{7}/_{16}$-in.
PUNCH, ⅛-in.	WRENCH, socket, $^{5}/_{16}$-in.

b. Procedure.

(1) Remove surge screw lock nut (Z) and washer (AA), and

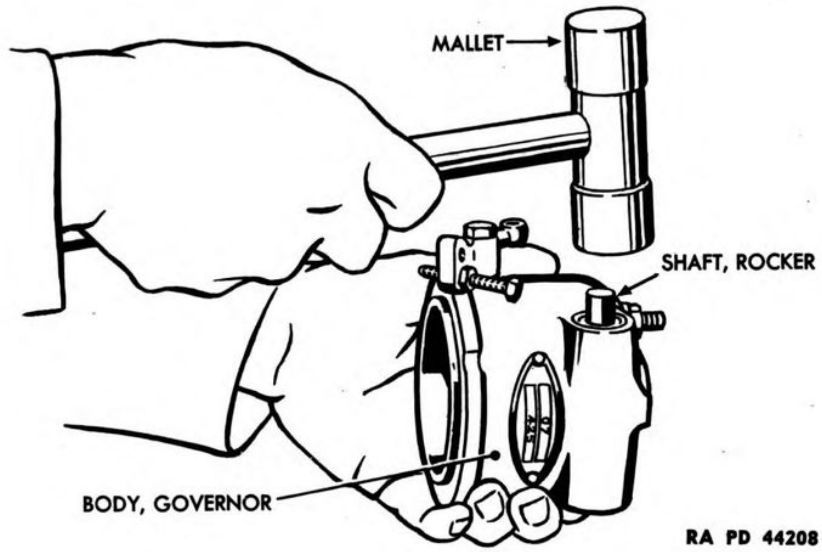


Figure 196 — Driving Rocker Shaft from Governor Body

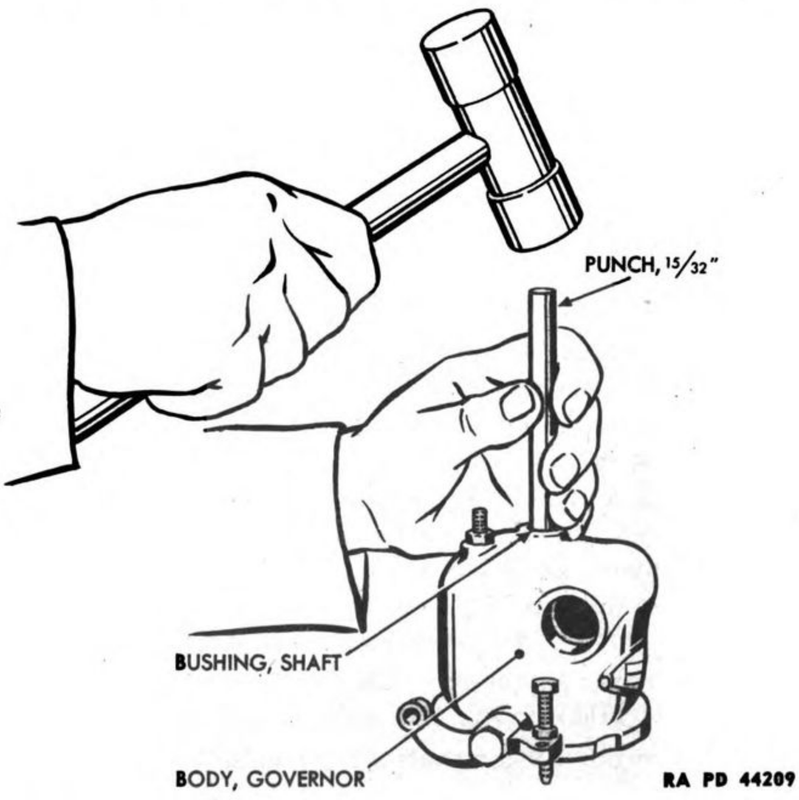


Figure 197 — Driving Shaft Bushing from Governor Body

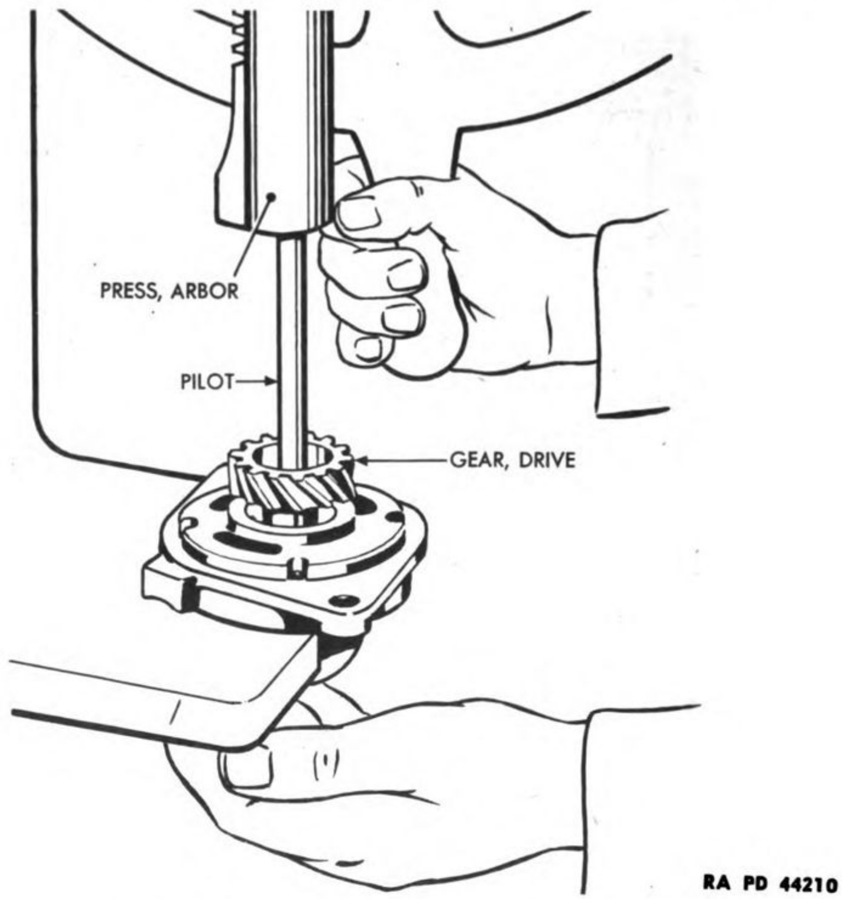


Figure 198 — Pressing Governor Drive Shaft from Drive Gear

unscrew surge adjusting screw (BB) (7/16-in. open-end wrench). Lift off surge adjusting spring (CC).

(2) Unscrew governor adjusting lever pin (A) and remove adjusting lever (W) and spring (V) (7/16-in. open-end wrench).

(3) Remove spring adjusting nut (L) and adjusting screw (N) (3/8-in. open-end wrench).

(4) Remove flange to body screws (AF) and lock washers (AE) from governor, and remove flange (ZZ) from body (FF) (screwdriver). Remove body gasket.

(5) Drive out pin (S) from throttle lever (M) and remove lever from rocker shaft (Y) (1/8-in. punch and hammer).

(6) Remove cap screws (KK) and lock washers (JJ) securing rocker yoke (HH) and lift out yoke (5/16-in. open-end wrench).

(7) Drive out rocker shaft (Y) (mallet) (fig. 196). This operation will automatically remove rocker shaft bearing (R) and expansion plug (GG). Remove bearing from shaft.

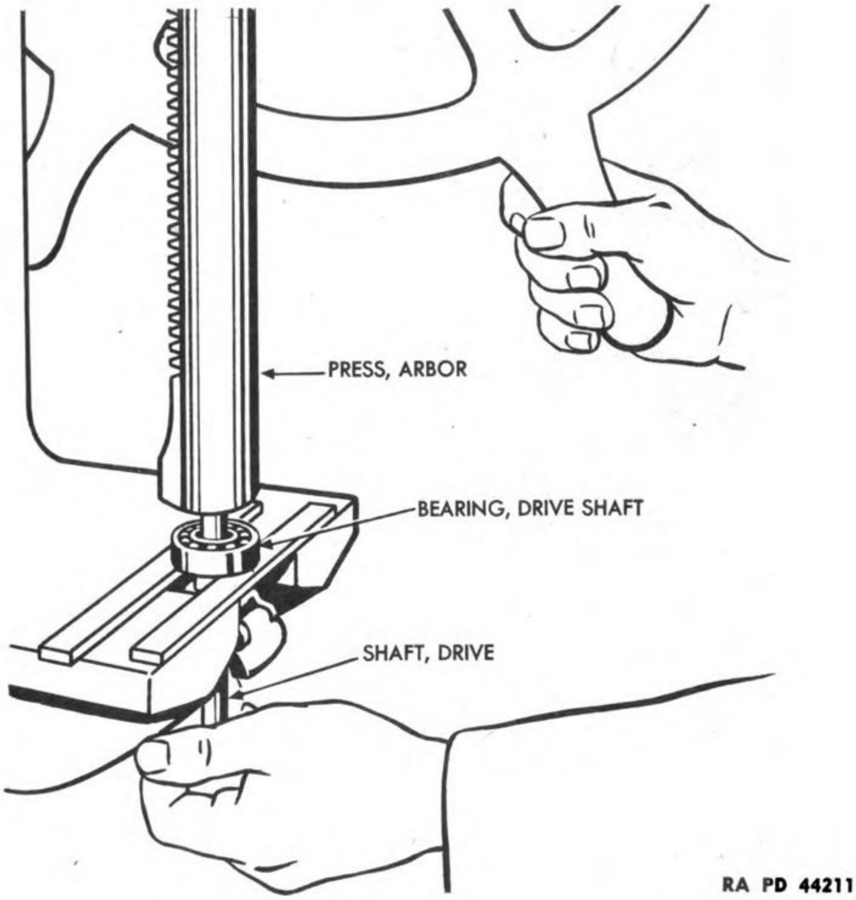


Figure 199 — Pressing Governor Drive Shaft Bearing from Drive Shaft

(8) Reverse the shaft and insert through plug hole in body and into other bearing. Drive out bearing (R), bearing retainer (P), and bearing oil retainer (Q) (mallet).

(9) Remove rocker shaft snap rings (X) from rocker shaft (Y).

(10) Knock out drive shaft expansion plug (DD) from end of body (drift and hammer).

(11) Drive shaft bushing (EE) from body ($^{15}/_{32}$-in. punch and hammer).

(12) Remove thrust bearing (LL) and sleeve (MM) from drive shaft (SS).

(13) Drive out pin (AD) securing gear (AC) to drive shaft (SS) ($^{1}/_{8}$-in. punch and hammer).

(14) Remove bearing retainer screws (TT) and lock washers (UU) from flange (ZZ) (screwdriver).

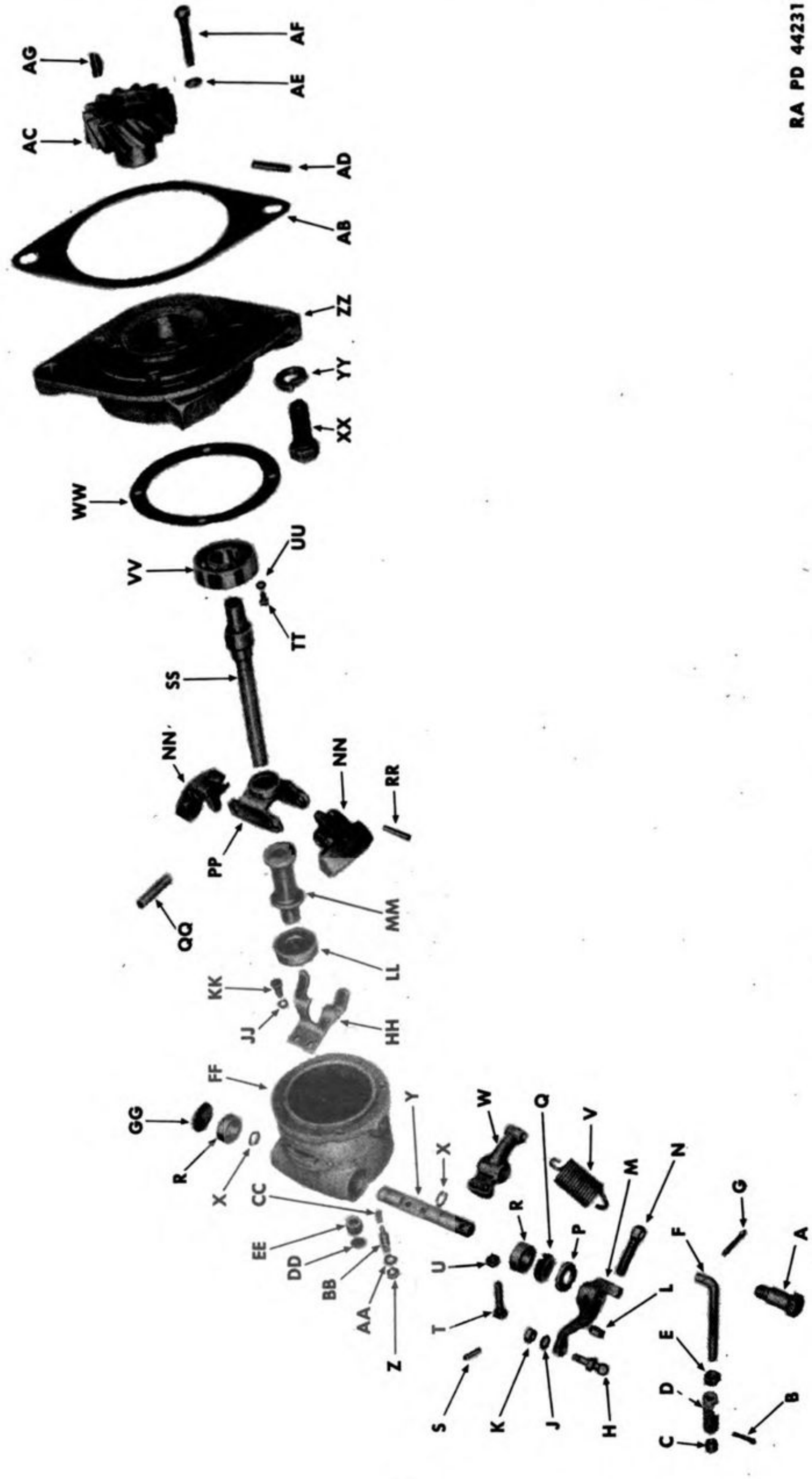


Figure 200 — Governor Assembly — Exploded View

A—PIN, GOVERNOR ADJUSTING LEVER
B—PIN, COTTER, GOVERNOR CONNECTING ROD BALL JOINT PLUG
C—PLUG, GOVERNOR CONNECTING ROD BALL JOINT
D—CASE, GOVERNOR CONNECTING ROD BALL JOINT
E—NUT, LOCK, GOVERNOR CONNECTING ROD
F—ROD, CONNECTING
G—PIN, COTTER, GOVERNOR CONNECTING ROD
H—JOINT, BALL, GOVERNOR CONNECTING ROD
J—WASHER, LOCK, GOVERNOR CONNECTING ROD BALL JOINT
K—NUT, GOVERNOR CONNECTING ROD BALL JOINT
L—NUT, GOVERNOR SPRING ADJUSTING SCREW
M—LEVER, GOVERNOR THROTTLE
N—SCREW, GOVERNOR SPRING ADJUSTING
P—RETAINER, GOVERNOR BEARING
Q—RETAINER, GOVERNOR BEARING OIL
R—BEARING, GOVERNOR ROCKER SHAFT
S—PIN, GOVERNOR YOKE AND LEVER
T—SCREW, GOVERNOR ADJUSTING
U—NUT, GOVERNOR ADJUSTING SCREW
V—SPRING, GOVERNOR
W—LEVER, GOVERNOR ADJUSTING
X—RING, SNAP, GOVERNOR ROCKER SHAFT
Y—SHAFT, GOVERNOR ROCKER
Z—NUT, LOCK, GOVERNOR SURGE ADJUSTING SCREW
AA—WASHER, GOVERNOR SURGE ADJUSTING SCREW
BB—SCREW, GOVERNOR SURGE ADJUSTING
CC—SPRING, GOVERNOR SURGE ADJUSTING
DD—PLUG, EXPANSION, GOVERNOR DRIVE SHAFT
EE—BUSHING, GOVERNOR DRIVE SHAFT
FF—BODY, GOVERNOR
GG—PLUG, EXPANSION, GOVERNOR ROCKER SHAFT
HH—YOKE, ROCKER, GOVERNOR
JJ—WASHER, LOCK, GOVERNOR ROCKER YOKE
KK—SCREW, GOVERNOR ROCKER YOKE
LL—BEARING, THRUST, GOVERNOR
MM—SLEEVE, THRUST, GOVERNOR
NN—WEIGHT, GOVERNOR
PP—SPIDER, GOVERNOR WEIGHT
QQ—PIN, GOVERNOR WEIGHT
RR—PIN, GOVERNOR SPIDER
SS—SHAFT, DRIVE, GOVERNOR
TT—SCREW, GOVERNOR BEARING RETAINER
UU—WASHER, LOCK, GOVERNOR BEARING RETAINER SCREW
VV—BEARING, GOVERNOR DRIVE SHAFT
WW—GASKET, GOVERNOR BODY
XX—SCREW, GOVERNOR ATTACHING
YY—WASHER, LOCK, GOVERNOR ATTACHING SCREW
ZZ—FLANGE, GOVERNOR BODY
AB—GASKET, GOVERNOR TO CYLINDER BLOCK
AC—GEAR, GOVERNOR DRIVE
AD—PIN, GOVERNOR DRIVE GEAR
AE—WASHER, LOCK, GOVERNOR CASE SCREW
AF—SCREW, GOVERNOR CASE
AG—KEY, GOVERNOR DRIVE SHAFT GEAR

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Legend for Figure 200 — Governor Assembly — Exploded View

(15) Press shaft (SS) from gear (AC), catching shaft and weight assembly as they are pressed free, to avoid damaging them (3/8-in. punch and arbor press).

(16) Remove drive shaft gear key (AG) and press bearing (VV) from drive shaft (arbor press) (fig. 199).

(17) Grind off riveted end of weight pins (QQ) and drive pins from weights (NN) and spider (PP) (grinder, 3/8-in. punch, and hammer.)

(18) Drive spider pin (RR) from spider (PP) and shaft (SS), and press spider from shaft (1/8-in. punch, hammer, and arbor press).

145. INSPECTION AND REPAIR OF GOVERNOR.

a. Equipment.

CLOTH, crocus
CLOTH, wiping
COMPRESSED AIR
FILE, 3-cornered
SOLVENT, dry-cleaning
TAP, thread

b. Procedure.

(1) Wash all parts in SOLVENT, dry-cleaning. Dry with compressed air.

(2) Examine all screws, nuts, washers, pins, levers, and connecting rod parts to see if any are broken or have damaged threads. Remove burs with fine, 3-cornered file or thread tap. Replace parts having threads stripped.

(3) Inspect governor spring. If broken, worn, or bent, replace.

(4) Inspect governor body and body flange. Replace if broken.

(5) Examine all bearings to see if any are worn or contain foreign matter. The thrust bearing on the thrust sleeve shows wear by looseness between top thrust surface and opposite race; replace if worn sufficiently to cause looseness. The drive shaft bearing is unsatisfactory for further use if rough spots can be detected when rotating it with the thumb and finger, or if races are loose enough to indicate wear.

(6) Examine governor weights to see if weight noses which bear on the thrust sleeve are worn or flattened. Replace if these conditions exist.

(7) Inspect governor drive shaft bushing to see if it is worn, broken, or scored.

(8) Inspect governor drive shaft to see if it is broken, scored, or worn. If the governor drive shaft is only slightly scored where it revolves in the bushing, polish shaft with CLOTH, crocus. Wipe shaft with CLOTH, wiping. If shaft is more than slightly scored, use a new part.

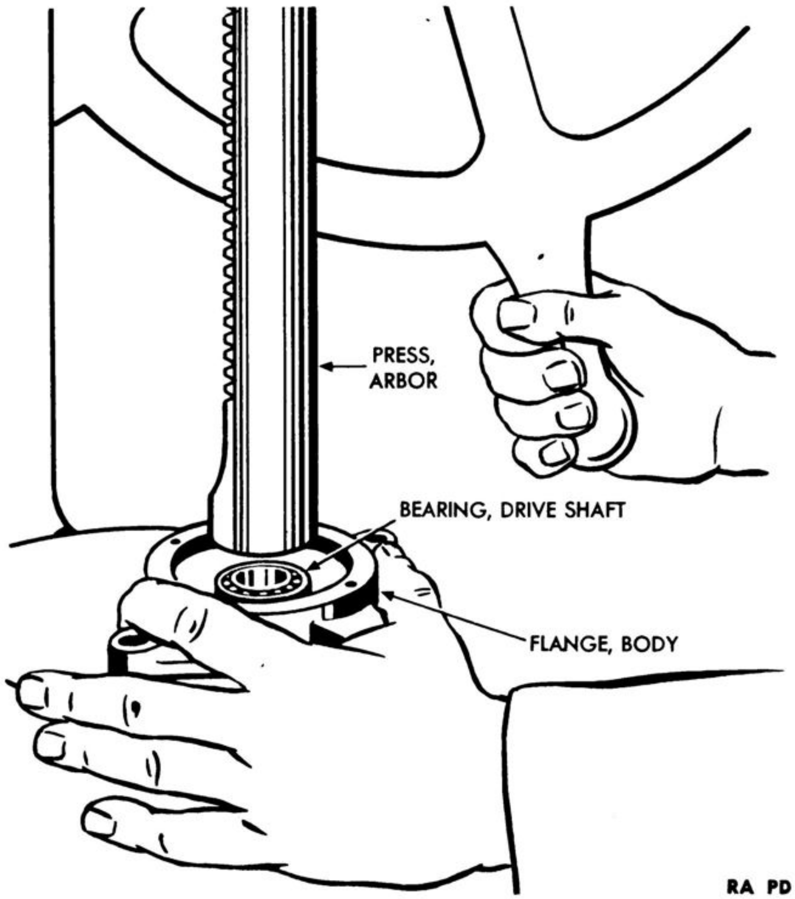


Figure 201 — Pressing Governor Drive Shaft Bearing into Body Flange

146. ASSEMBLY OF GOVERNOR (fig. 200).

a. Equipment.

DRILL, electric ($1/8$-in. bit)	SCALE, spring
DRIVER, special (2)	SCALE, steel
HAMMER	SCREWDRIVER
MALLET	VISE
PLIERS	WRENCH, open-end, $3/8$-in.
PRESS, arbor	WRENCH, open-end, $7/16$-in.
PUNCH, $3/8$-in.	WRENCH, socket, $5/16$-in.
REAMER, taper (No. 1 Morse)	

b. Procedure.

(1) Press weight spider (PP) in position on drive shaft (SS) and secure with spider pin (RR) (arbor press, $1/8$-in. punch, and hammer). NOTE: If new spider and shaft is used, drill through spider and shaft ($1/8$-in. drill).

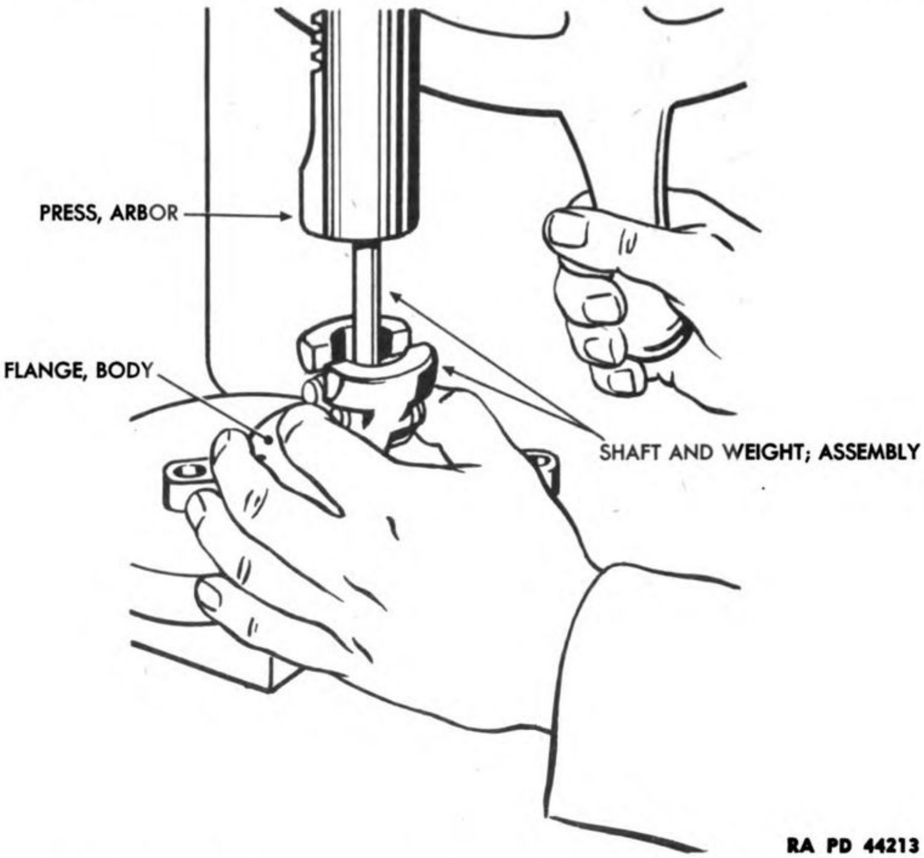


Figure 202 — Pressing Shaft and Weight Assembly into Governor Drive Shaft Bearing

(2) Assemble weights (NN) to spider (PP) and assemble new weight pins (QQ) to weights and spider. Peen over ends of weight pins (hammer).

(3) Press bearing (VV) into body flange (ZZ) (arbor press) (fig. 201), and install bearing retaining screws (TT) and lock washers (UU) (screwdriver).

(4) Press shaft and weight assembly into bearing (VV), using short interrupted strokes with the arbor to aline shaft and bearing (arbor press) (fig. 202). NOTE: Use extreme care during this operation, because if shaft is sprung out of line, it will affect governor operation.

(5) Insert key (AG) in shaft. Line up keyway in gear with key in shaft, and press gear (AC) on shaft (arbor press). Assemble pin (AD) to gear and shaft (3/8-in. punch and hammer).

(6) Assemble thrust sleeve (MM) and thrust bearing (LL) to shaft.

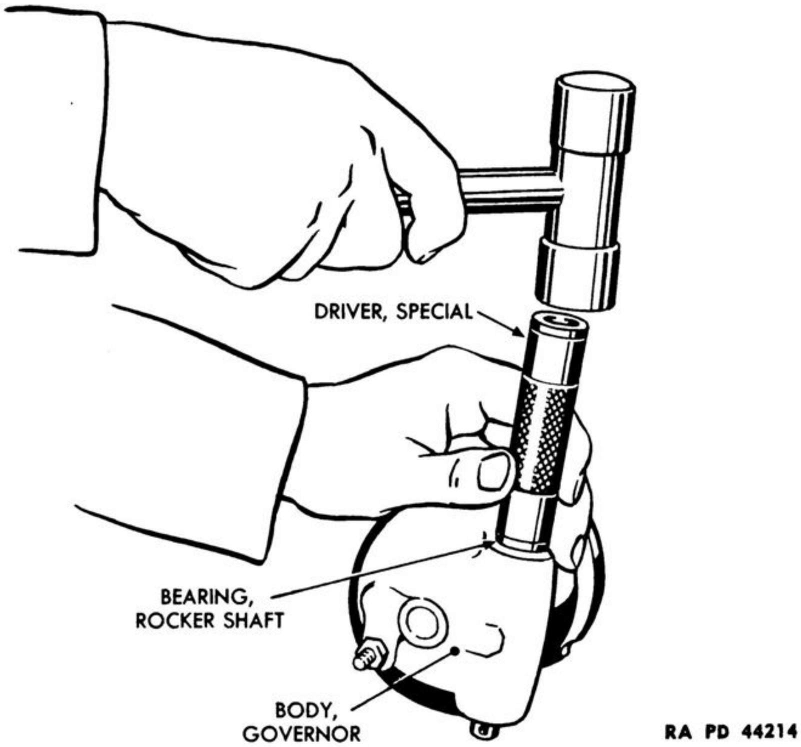


Figure 203 — Installing Governor Rocker Shaft Bearing

(7) Assemble bushing (EE) to body, using special driver (fig. 227). Tap bushing into position with mallet so shoulder of tool is flush with body. NOTE: This bushing must be lined up so it does not bind the drive shaft.

(8) Assemble new drive shaft expansion plug (DD) to body (hammer).

(9) Install rocker shaft snap rings (X) on rocker shaft (Y) and place shaft in body.

(10) Assemble yoke (HH) to rocker shaft with two cap screws (KK) and lock washers (JJ) ($\frac{5}{16}$-in. socket wrench).

(11) Place rocker shaft bearings (R) on shaft with lettered side toward yoke.

(12) Tap bearings into place with special driver (fig. 228) and mallet (fig. 203).

(13) Assemble oil retainer (Q) and bearing retainer (P) over shaft with convex side out. Set in place with special tool (fig. 228). NOTE: Do not force oil seal on shaft so tight it will cause excessive friction. Rocker shaft must rotate freely.

(14) Install rocker shaft expansion plug (GG) (hammer).

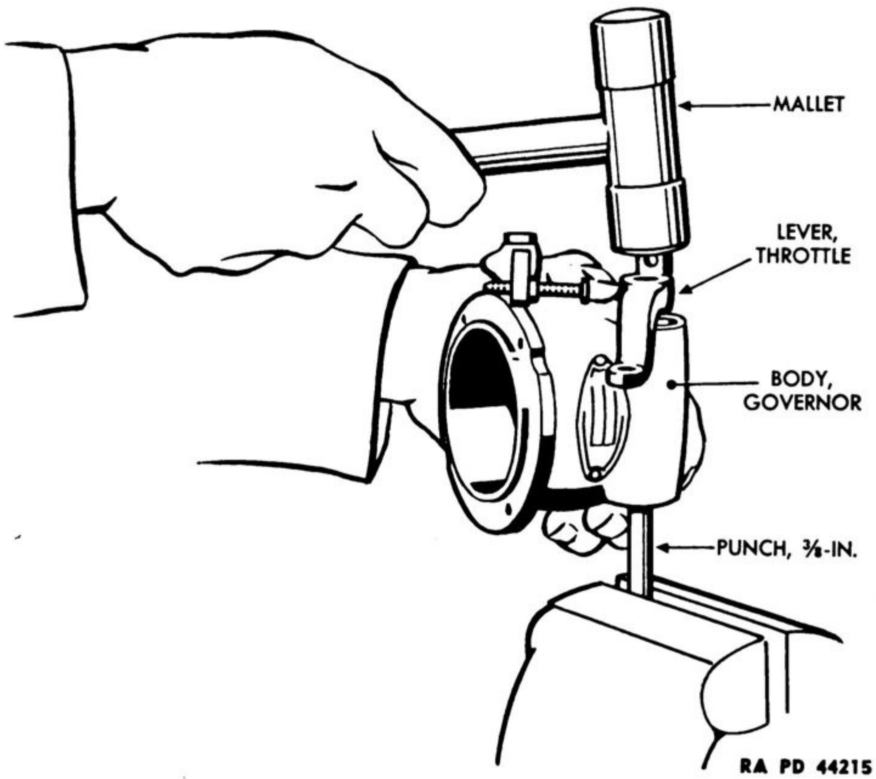


Figure 204 — Installing Governor Throttle Lever

(15) Assemble throttle lever (M) to rocker shaft (X). NOTE: When tapping lever on shaft, back up shaft with a 3/8-inch punch to avoid damage to bearings (vise, 3/8-in. punch, and hammer) (fig. 204).

(16) Check rocker shaft for freedom of operation. Not more than a 3-ounce pull on the end of the lever should be necessary to rotate rocker shaft (spring scale).

(17) Assemble body and flange, using a new gasket (WW), by installing four screws (AF) and lock washers (AE).

(18) Hold governor vertically so weights are closed, and then rotate throttle lever (M) away from gear until yoke contacts thrust bearing inside body.

(19) Advance lever from this position, in the same direction, until center of the lever hole measures 3 7/16 inches from the body flange (steel scale) (fig. 205).

(20) Drill 1/8-inch hole through lever and shaft, and ream for No. 1 taper pin. Install pin (electric drill, 1/8-in. bit, and No. 1 Morse taper reamer).

(21) Assemble spring adjusting screw (N) on throttle lever (M) and lock with spring adjusting screw nut (L) (3/8-in. open-end wrench).

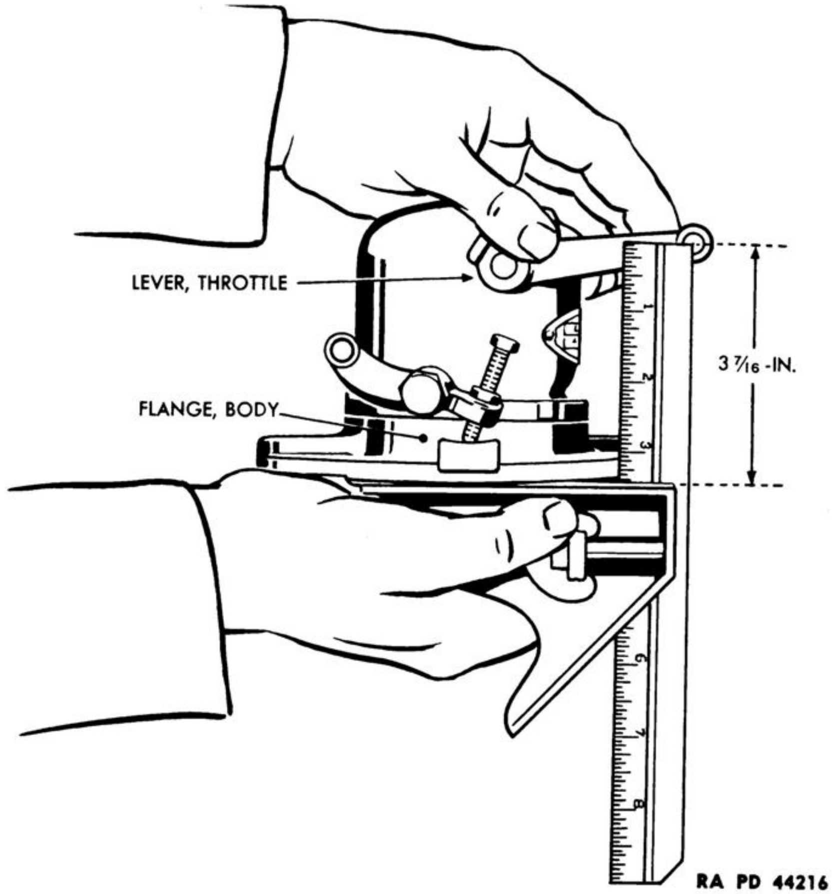


Figure 205 — Setting Governor Throttle Lever

(22) Install adjusting lever in position on governor body with adjusting lever pin (A) (7/16-in. open-wrench). Install spring by hooking one end through eye of adjusting screw (N) and the other end through hole in adjusting lever (W).

(23) Assemble surge spring (CC) and surge adjusting screw (BB) on body, and secure with lock nut (Z) and washer (AA).

147. INSTALLATION OF GOVERNOR.

a. Equipment.

PLIERS — WRENCH, open-end, 5/8-in.

b. Procedure.

(1) Using a new governor attaching gasket, place governor in position on cylinder block (fig. 195).

(2) Install lock washers and cap screws (5/8-in. open-end wrench) (fig. 195).

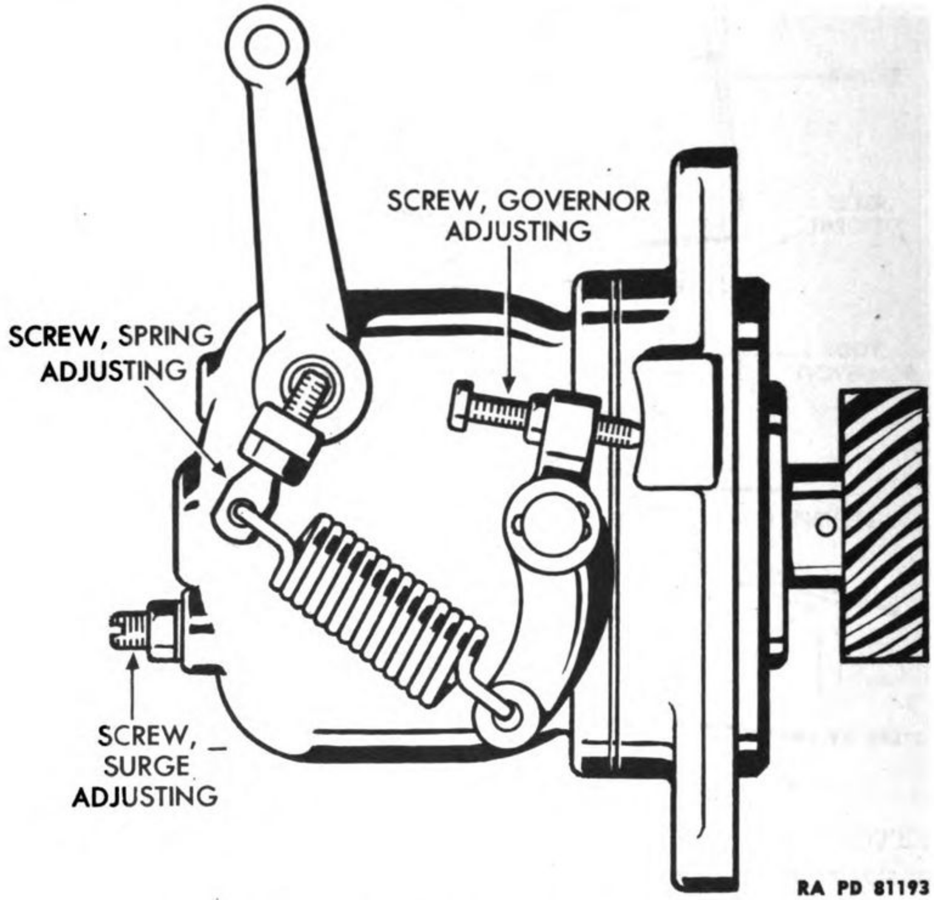


Figure 206 — Governor Adjusting Diagram

(3) Place governor connecting rod in position on throttle lever. Install cotter pin (pliers) (fig. 195).

148. ADJUSTMENT OF GOVERNOR.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, ¼-in.
WRENCH, open-end, ⅜-in.
WRENCH, open-end, $^{7}/_{16}$-in.

b. Procedure (fig. 206).

(1) Loosen surge adjusting screw lock nut ($^{7}/_{16}$-in. open-end wrench).

(2) Back surge adjusting screw from governor until only a few threads are engaged (screwdriver).

(3) Tighten surge adjusting screw lock nut ($^{7}/_{16}$-in. open-end wrench).

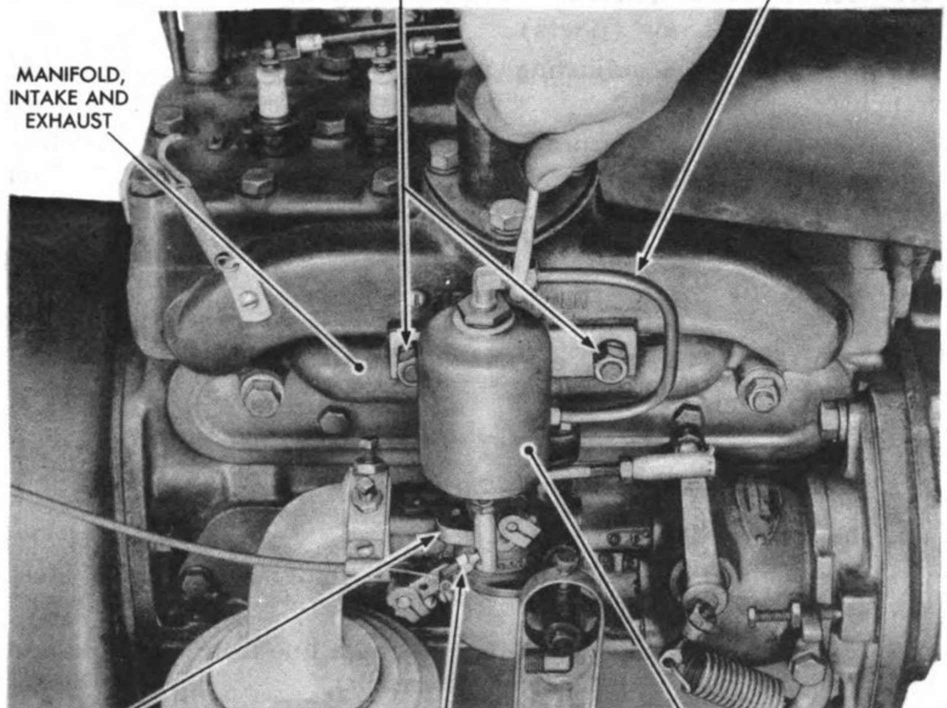


Figure 207 — Removing Auxiliary Governor

(4) Loosen governor adjusting screw lock nut (7/16-in. open-end wrench).

(5) Start engine and adjust engine speed by turning governor adjusting screw in or out (3/8-in. open-end wrench). Turning screw clockwise increases engine speed. Turning screw counterclockwise decreases engine speed. Engine speed is correct when frequency meter shows 50 or 60 cycles, depending on change-over panel adjustment. Stop engine.

(6) Adjust governor sensitivity, if necessary, as follows:

(a) Remove governor spring from governor spring adjusting screw (pliers).

(b) Loosen governor spring adjusting screw lock nut (7/16-in. open-end wrench).

(c) Turn governor spring adjusting screw in or out (1/4-in. open-end wrench). Moving spring hook closer to the rocker shaft, decreasing effective length of screw, increases governor sensitivity. Moving spring away from shaft broadens sensitivity. Use shortest screw length possible without causing surging of the governor.

(d) Tighten governor spring adjusting screw lock nut (7/16-in. open-end wrench).

(e) Hook end of governor spring into spring hook on governor spring adjusting screw (pliers).

(7) Loosen surge adjusting screw lock nut ($^7/_{16}$-in. open-end wrench).

(8) Start engine and turn surge adjusting screw clockwise until no-load surge is dampened out (screwdriver). CAUTION: Do not turn it far enough to increase no-load engine speed.

(9) Tighten surge adjusting screw lock nut ($^7/_{16}$-in. open-end wrench).

149. REMOVAL OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

PLIERS	WRENCH, open-end, $^9/_{16}$-in.
WRENCH, open-end, $^1/_2$-in.	

b. Procedure (fig. 207).

(1) Disconnect auxiliary governor ball joint from throttle lever (pliers).

(2) Disconnect auxiliary governor vacuum line from manifold and auxiliary governor ($^1/_2$-in. open-end wrench).

(3) Remove center manifold stud nuts ($^9/_{16}$-in. open-end wrench).

(4) Lift auxiliary governor from intake and exhaust manifold.

150. DISASSEMBLY OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

PLIERS	WRENCH, open-end, $^3/_8$-in.
SCREWDRIVER	WRENCH, open-end, $^{11}/_{16}$-in.

b. Procedure (fig. 208).

(1) Screw vacuum line elbow (A) from bellows housing orifice (B) ($^3/_8$-in. open-end wrench) (fig. 208).

(2) Screw bellows housing orifice (B) from bellows housing (D) ($^{11}/_{16}$-in. open-end wrench) (fig. 208).

(3) Remove support-plate-to-bellows-housing screws (F) (screwdriver). Lift support plate (E) from bellows housing (D) (fig. 208).

(4) Remove base-to-bellows-housing screws (K) and lock washers (J) (screwdriver). Lift bellows and base (H) and gasket (G) from bellows housing (D) (fig. 208).

(5) Loosen ball joint case lock nut (L) ($^3/_8$-in. open-end wrench). Remove ball joint case (M) and lock nut (L) from plunger (fig. 208).

(6) Remove ball joint cotter pin (P) from ball joint case (M) (pliers). Screw ball joint plug (R) from ball joint case (M) (screwdriver). Lift ball joint (N) from ball joint case (M) (fig. 208).

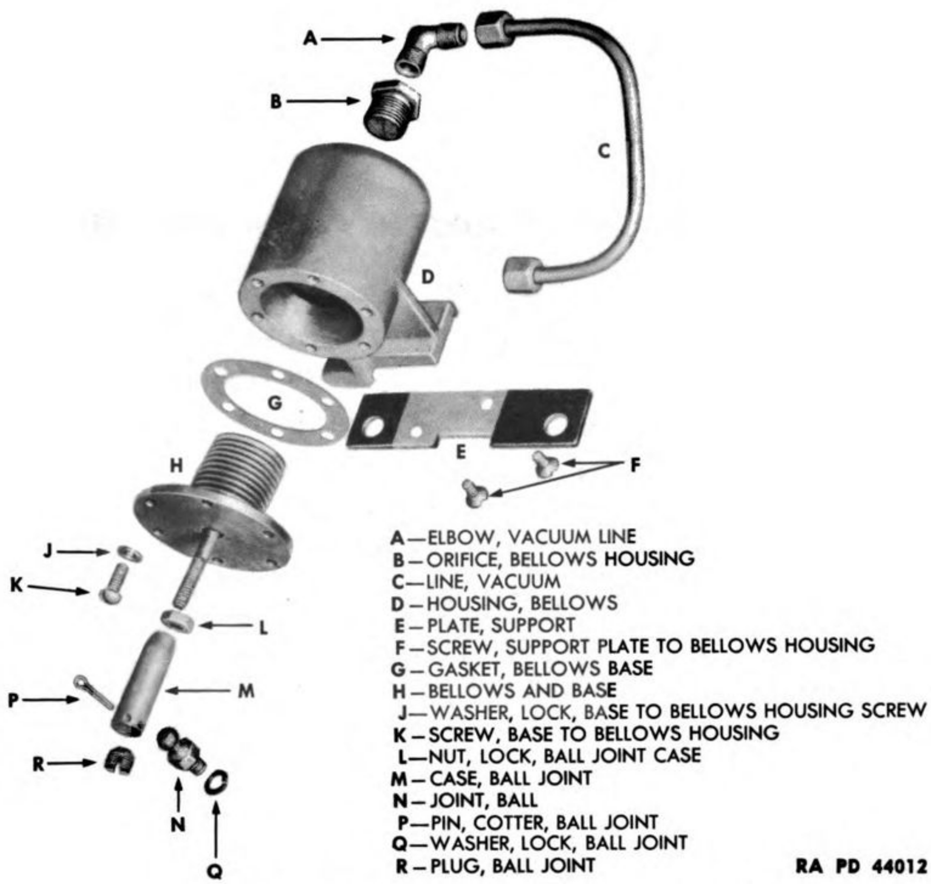


Figure 208 — Auxiliary Governor Assembly Unit M6 — Exploded View

151. INSPECTION AND REPAIR OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

COMPRESSED AIR SOLVENT, dry-cleaning

b. Procedure.

(1) Clean all parts in SOLVENT, dry-cleaning. Blow dry with compressed air.

(2) Examine vacuum line, elbow, and bellows housing orifice to see if broken, or if threads are damaged. Blow through each to be sure passage is clear. Replace damaged parts.

(3) Inspect bellows housing, base, and support plate to see if cracked or broken. Observe condition of the threads tapped in base-to-bellows-housing screw holes. Replace cracked or broken parts and repair damaged threads. Always replace base gasket when governor is disassembled.

(4) Examine parts of ball joint for breakage or damaged threads. Replace if damaged.

(5) Inspect bellows for breakage. Place bellows to the mouth. With lips against base, attempt to blow and suck through bellows. Replace if leaking.

152. ASSEMBLY OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

LEAD, red	VARNISH, shellac
PLIERS	WRENCH, open-end, 3/8-in.
SCREWDRIVER	WRENCH, open-end, 11/16-in.

b. Procedure (fig. 208).

(1) Place ball joint (N) in position in ball joint case (M). Screw ball joint plug (R) into case (M) far enough to stop all side play of ball joint (N) (screwdriver). Do not tighten so ball joint (N) binds in case (M). Install cotter pin (P) through ball joint case (M) and plug (R) (pliers) (fig. 208).

(2) Screw ball joint lock nut (L) about halfway up on threads of bellows plunger. Screw ball joint case (M) up to lock nut (L) on plunger. Tighten lock nut (L) against case (M) (3/8-in. open-end wrench) (fig. 208).

(3) Shellac a new bellows base gasket (G) to bottom of bellows housing (D). Insert bellows (H) into housing (D). Install base-to-bellows-housing screws (K) and lock washers (J) (screwdriver) (fig. 208).

(4) Put a little LEAD, red, on male thread of bellows housing orifice (B). Screw orifice (B) in top of bellows housing (D) (11/16-in. open-end wrench). Screw vacuum line elbow (A) in bellows housing orifice (B) (3/8-in. open-end wrench) (fig. 208). Tighten securely, and have elbow pointing to front of auxiliary governor (fig. 216).

(5) Place support plate (E) in position on bellows housing (D), slotted side down. Install screws (F) (screwdriver) (fig. 208).

153. INSTALLATION OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

WRENCH, open,-end, 1/2-in.	WRENCH, open-end, 5/8-in.
WRENCH, open-end, 9/16-in.	

b. Procedure.

(1) Place auxiliary governor in position on manifold studs (fig. 207).

(2) Install manifold stud nuts (9/16-in. open-end wrench) (fig. 207).

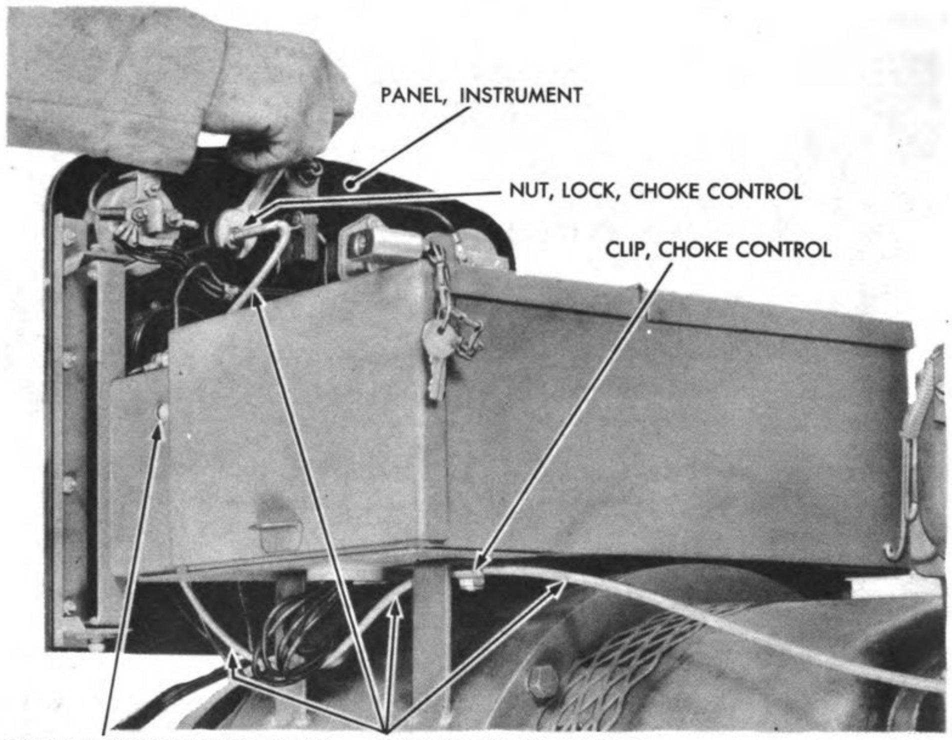


Figure 209 — Removing Choke Control

(3) Connect auxiliary governor vacuum line securely to manifold, and to auxiliary governor (½-in. open-end wrench) (fig. 207).

(4) Connect auxiliary governor ball joint to throttle lever (⅝-in. open-end wrench) (fig. 207).

154. CHOKE CONTROL.

a. Removal.

SCREWDRIVER — WRENCH, open-end, ⅝-in.
WRENCH, open-end, ½-in.

(1) Remove housing (par. 14).

(2) Screw choke control lock nut completely off threads behind switchboard panel (⅝-in. open-end wrench) (fig. 209).

(3) Loosen top switchboard bracket screw (screwdriver), and pull choke control conduit from clamp held by top switchboard bracket screw nut (fig. 209).

(4) Loosen nut beneath change-over panel box, and pull choke control conduit from clip held by nut (½-in. open-end wrench).

(5) Loosen screw which secures choke control conduit to clamp on air cleaner (screwdriver) (fig. 186).

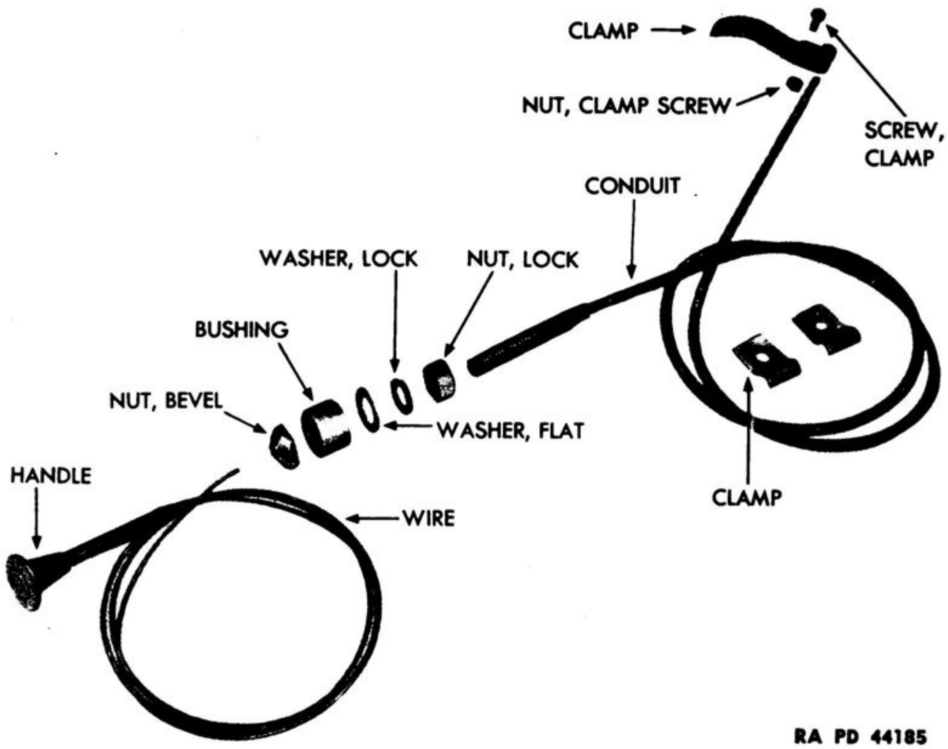


Figure 210 — Choke Control Assembly — Exploded View

(6) Disconnect choke control wire from choke valve lever on carburetor (screwdriver) (fig. 186).

(7) Remove lock nut, lock washer, and flat washer from choke control conduit. Pull choke control assembly out through switchboard panel.

b. Inspection and Repair.

COMPRESSED AIR
GREASE, general purpose, No. 0
SOLVENT, dry-cleaning

(1) Clean all parts of choke control with SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect bevel nut, bushing, flat washer, lock washer, lock nut, clips, and bracket. Replace any broken part.

(3) Grasp handle with one hand and conduit with the other. Pull wire from conduit. Inspect handle, wire, and conduit. Replace any broken part. Grease wire and insert it in conduit assembly (GREASE, general purpose, No. 0).

c. Installation.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.

FUEL SYSTEM

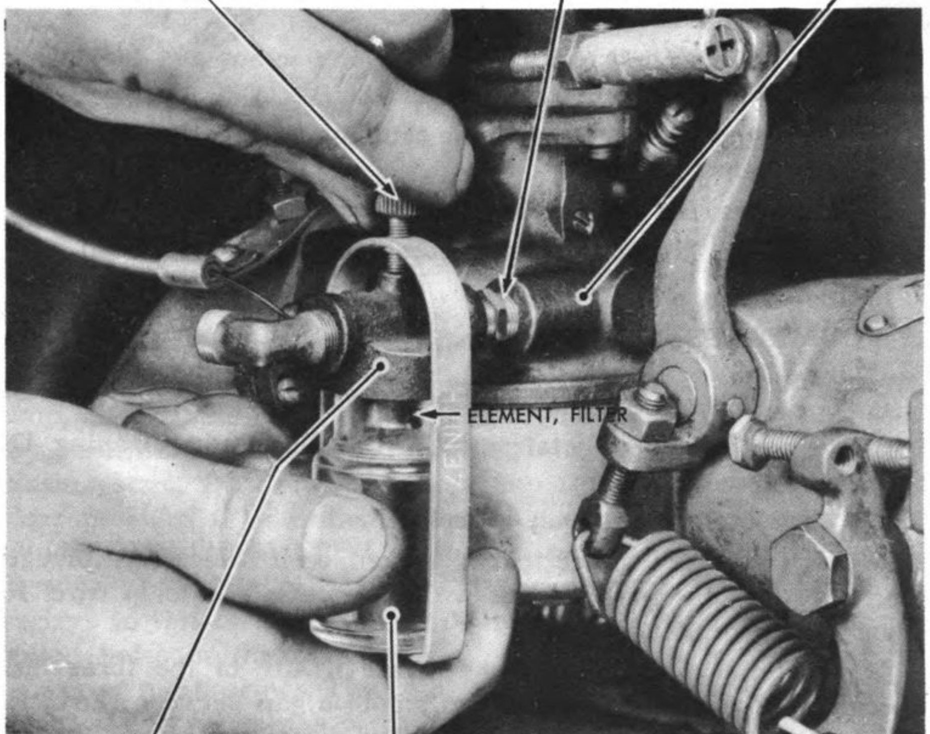


Figure 211 — Removing Gasoline Strainer

(1) Thread carburetor end of choke control through switchboard panel from rear of unit (fig. 209).

(2) Place flat washer, lock washer, and lock nut on choke control behind switchboard panel (fig. 209).

(3) Work choke control into place, and tighten lock nut (5/8-in. open-end wrench) (fig. 209).

(4) Attach choke control wire to choke lever (screwdriver) (fig. 186).

(5) Tighten screw which secures choke control conduit to clamp on air cleaner (screwdriver) (fig. 186).

(6) Place conduit under clip on nut beneath change-over panel box. Tighten nut (1/2-in. open-end wrench).

(7) Place conduit under clamp on top switchboard panel bracket screw. Tighten screw (screwdriver) (fig. 209).

(8) Install housing (par. 19).

155. GASOLINE STRAINER.

a. Removal (fig. 211).

WRENCH, open-end, 7/16-in. WRENCH, open-end, 1/2-in.

(1) Remove gasoline line from gasoline strainer head (½-in. open-end wrench).

(2) Loosen gasoline strainer bowl thumb screw, and lift gasoline strainer bowl from gasoline strainer head.

(3) Screw gasoline strainer male coupling from carburetor (7/16-in. open-end wrench).

(4) Lift gasoline strainer head from carburetor.

(5) Unscrew filtering element from gasoline strainer head.

b. Inspection and Repair.

COMPRESSED AIR	HAMMER
DOLLY	SOLVENT, dry-cleaning
FILE, 3-cornered (fine)	WIRE

(1) Wash bowl and metal parts in SOLVENT, dry-cleaning. Dry with compressed air.

(2) Inspect bowl. Replace if broken.

(3) Inspect head to see if it is broken, or if orifices are plugged. Clean obstructions from orifices with compressed air or a wire. Replace head if broken.

(4) Examine filtering element to see if any of the three disks which compose it are bent so as to create a gap between them. Replace filtering element if it has any bent disks.

(5) Inspect coupling and elbow to see if either is broken or has damaged threads. Clean burs from threads (fine 3-cornered file). Replace part if broken, or if threads are damaged beyond repair.

(6) Examine bowl gasket. Replace if crushed or torn.

(7) Examine bowl bail and thumb screw. Straighten bail if bent (hammer and dolly). Replace assembly if screw threads are stripped.

c. Installation.

WRENCH, open-end, 7/16-in.	WRENCH, open-end, ½-in.

(1) Screw filtering element into gasoline strainer head.

(2) Screw gasoline strainer male coupling, with attached gasoline strainer head, into carburetor (7/16-in. open-end wrench) (fig. 211).

(3) Place gasoline strainer bowl in position and tighten thumb screw.

(4) Connect gasoline line to gasoline strainer head (½-in. open-end wrench).

Section XIX

LUBRICATION: ENGINE LUBRICATION SYSTEM

156. DESCRIPTION.

a. The engine lubrication oil system consists of the oil pan, oil pump, oil pressure gage, oil pressure regulator, oil filter, and necessary connecting parts. It is known as a combination pressure and splash system. Oil drawn by the pump from the oil pan is forced under pressure to a drilled passage on the accessory side of the cylinder block. This drilled passage is plugged on both ends with threaded plugs. Radial holes are drilled from the crankshaft main bearings to this oil gallery which supplies oil to the main bearings. Drilled holes in the crankshaft supply oil under pressure to the connecting rod bearings. The cylinder bores, tappets, and valve stems are lubricated by means of the mist of oil thrown off by the connecting rods and main bearings. The camshaft bearings receive their lubrication from oilholes leading from the valve tappet compartment which is filled by splash. The oil pressure regulator is mounted on the front end of the engine on the accessory drive side. It automatically regulates the oil pressure by means of a piston and spring. The tension of the spring is adjustable, and by this means proper oil pressure can be maintained at all times.

b. The oil filter is mounted on a bracket at the top of the cylinder head, under the canopy engine door. The inlet line is attached to the oil pressure gage line "T". This "T" taps the oil gallery which extends the full length of the cylinder block. The return line is attached to the side of the cylinder block. Unfiltered oil from the crankcase enters the filter through the inlet line, and flows through drilled holes in the inlet line to holes in the center of the oil filter element. The oil is forced through the filter element. The filtered oil is then returned to the crankcase through the outlet line.

c. The oil pump is of the positive spur gear type. It consists of two spur gears enclosed in a 1-piece cast iron housing. It is gear driven from the camshaft. In operation, oil is drawn from the oil pan, through the pump, and to the main oil gallery in the cylinder block.

157. SPECIFICATIONS.

a. Engine.

Make	Hercules Motor
Type	Combination pressure and splash
Capacity, crankcase	4 qt
Oil pressure	15 lb at 1,000 rpm

b. Oil Filter.

Make	Purolator
Type	N-1503
Element	Replaceable
Element type	N-15

158. TROUBLE SHOOTING.

a. Lubrication System Troubles and Remedies.

(1) LOW OIL PRESSURE.

Possible Cause	Possible Remedy
Improper oil level.	Check oil level and fill to proper level.
Improper grade and viscosity of oil.	Drain system and refill with proper grade.
Oil pressure gage defective.	Replace gage (par. 33).
Oil pressure regulating piston stuck open.	Remove oil pressure regulating piston and check action (par. 161).
Oil pan screen clogged.	Remove oil pan and clean screen (par. 116).
Excessive main and connecting rod bearing clearance.	Adjust or replace bearings (par. 129).
Oil pump worn excessively.	Repair oil pump (par. 160).
Oil pump inoperative.	Remove pump and overhaul (par. 160).

(2) HIGH OIL PRESSURE.

Possible Cause	Possible Remedy
Oil pump regulator not properly adjusted.	Adjust oil pump regulating piston (par. 161).
Oil pump regulating piston stuck closed.	Remove oil pressure regulating piston and check action (par. 161).
Oil pressure gage defective.	Replace oil pressure gage (par. 33).

159. OIL FILTER.

a. Removal.

WRENCH, open-end, ½-in. (2)

WRENCH, open-end, 9/16-in.

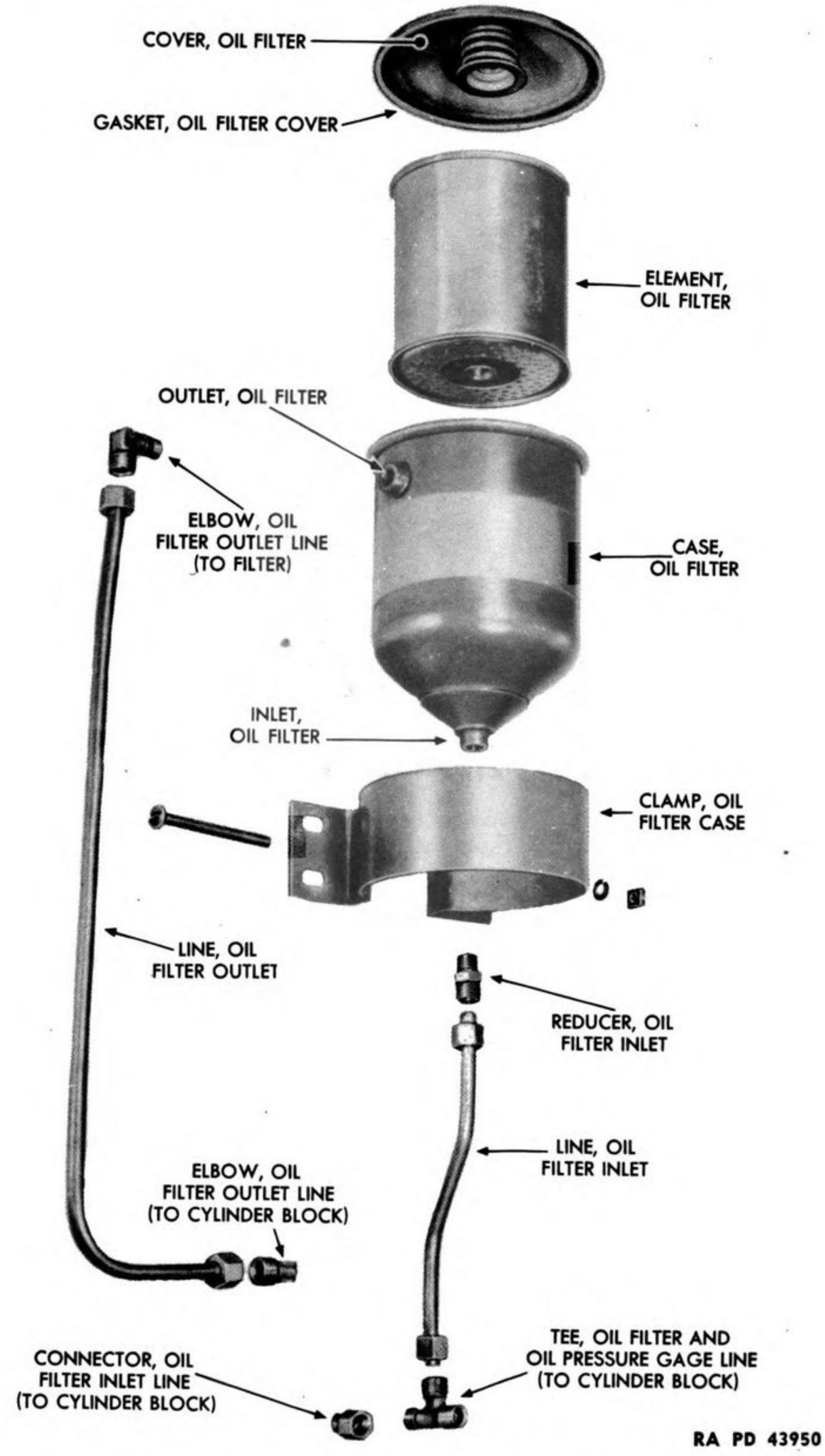


Figure 212 — Oil Filter Assembly — Exploded View

Figure 213 — Removing Oil Filter

(1) Disconnect oil lines at oil filter (9⁄16-in. open-end wrench) (fig. 213).

(2) Remove oil filter to bracket bolts, lock washers, and nuts (two ½-in. open-end wrenches) (fig. 213).

(3) Lift oil filter from bracket (fig. 213).

b. Disassembly (fig. 212).

SCREWDRIVER	WRENCH, open-end, 9⁄16-in.
WRENCH, open-end, ½-in.	WRENCH, open-end, 1-in.

(1) Remove oil filter inlet line (9⁄16-in. open-end wrench).

(2) Remove oil filter inlet reducer (½-in open-end wrench).

(3) Remove oil filter outlet line (9⁄16-in. open-end wrench).

(4) Remove oil filter outlet line elbow (½-in. open-end wrench).

(5) Remove oil filter cover (1-in. open-end wrench).

(6) Remove oil filter element.

(7) Drain oil from oil filter case.

(8) Remove oil filter case clamp bolt, nut, and lock washers (screwdriver).

(9) Lift oil filter clamp from case.

c. Inspection and Repair.

COMPRESSED AIR   SOLVENT, dry-cleaning

(1) Wash all parts thoroughly in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Check to see that oil filter element retainer spring is not broken.

(3) Inspect oil filter inlet line to see that holes are not plugged.

(4) Check oil filter inlet reducer to make sure hole is not plugged.

(5) Check oil filter cover gasket to be sure it is in good condition. Replace if necessary.

d. Servicing Oil Filter.

COMPRESSED AIR   WRENCH, open-end, 1-in.
SOLVENT, dry-cleaning

(1) REPLACING OIL FILTER ELEMENT.

WRENCH, open-end, 1-in.

(a) Every 300 hours, or when oil gage rod shows oil is dark, replace oil filter element.

(b) Remove cover (1-in. open-end wrench) and lift oil filter element from case (fig. 212).

(c) Replace oil filter cover gasket, and install new oil filter element.

(d) Assemble cover (1-in. open-end wrench) to oil filter case.

(2) CLEANING OIL FILTER CASE.

COMPRESSED AIR   SOLVENT, dry-cleaning

Examine inside of oil filter case, and if there is any trace of foreign matter, remove oil filter from bracket, drain oil, disassemble, thoroughly wash in SOLVENT, dry-cleaning, and dry with compressed air. Reassemble and remount oil filter.

e. Assembly (fig. 212).

SCREWDRIVER   WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{1}{2}$-in.   WRENCH, open-end, 1-in.

(1) Assemble clamp to oil filter case, with opening at opposite side of outlet hole. Attach with bolt, lock washer, and nut (screwdriver).

(2) Assemble a new oil filter element over oil pump case inlet pipe.

(3) Assemble oil filter cover to case (1-in. open-end wrench).

(4) Assemble oil filter inlet reducer ($\frac{1}{2}$-in. open-end wrench).

(5) Assemble oil filter inlet line to reducer ($\frac{9}{16}$-in. open-end wrench).

(6) Assemble oil filter outlet line elbow ($\frac{1}{2}$-in. open-end wrench), and assemble oil filter outlet line to "T" ($\frac{9}{16}$-in. open-end wrench).

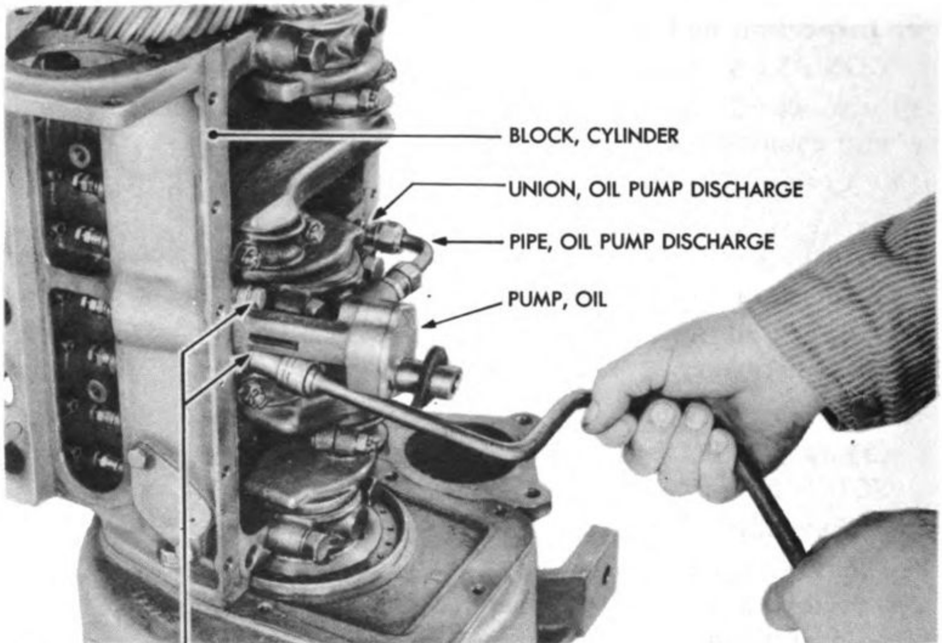


Figure 214 — Removing Oil Pump

f. Installation.

WRENCH, open-end, ½-in. (2) WRENCH, open-end, 9/16-in.

(1) Place oil filter in position on bracket (fig. 213).

(2) Install oil filter to bracket bolts, lock washers, and nuts (two ½-in. open-end wrenches) (fig. 213).

(3) Connect oil lines to oil filter (9/16-in. open-end wrench) (fig. 213).

160. OIL PUMP.

a. Removal.

WRENCH, open-end, ¾-in. WRENCH, socket, ½-in.

(1) Remove engine from unit (par. 114).

(2) Remove oil pan (par. 116).

(3) Disconnect oil pump discharge pipe from oil pump discharge union (¾-in. open-end wrench) (fig. 214).

(4) Remove the oil-pump-to-cylinder-block cap screws and lock washers (½-in. socket wrench) (fig. 214).

(5) Lift oil pump from cylinder block (fig. 214).

LUBRICATION: ENGINE LUBRICATION SYSTEM

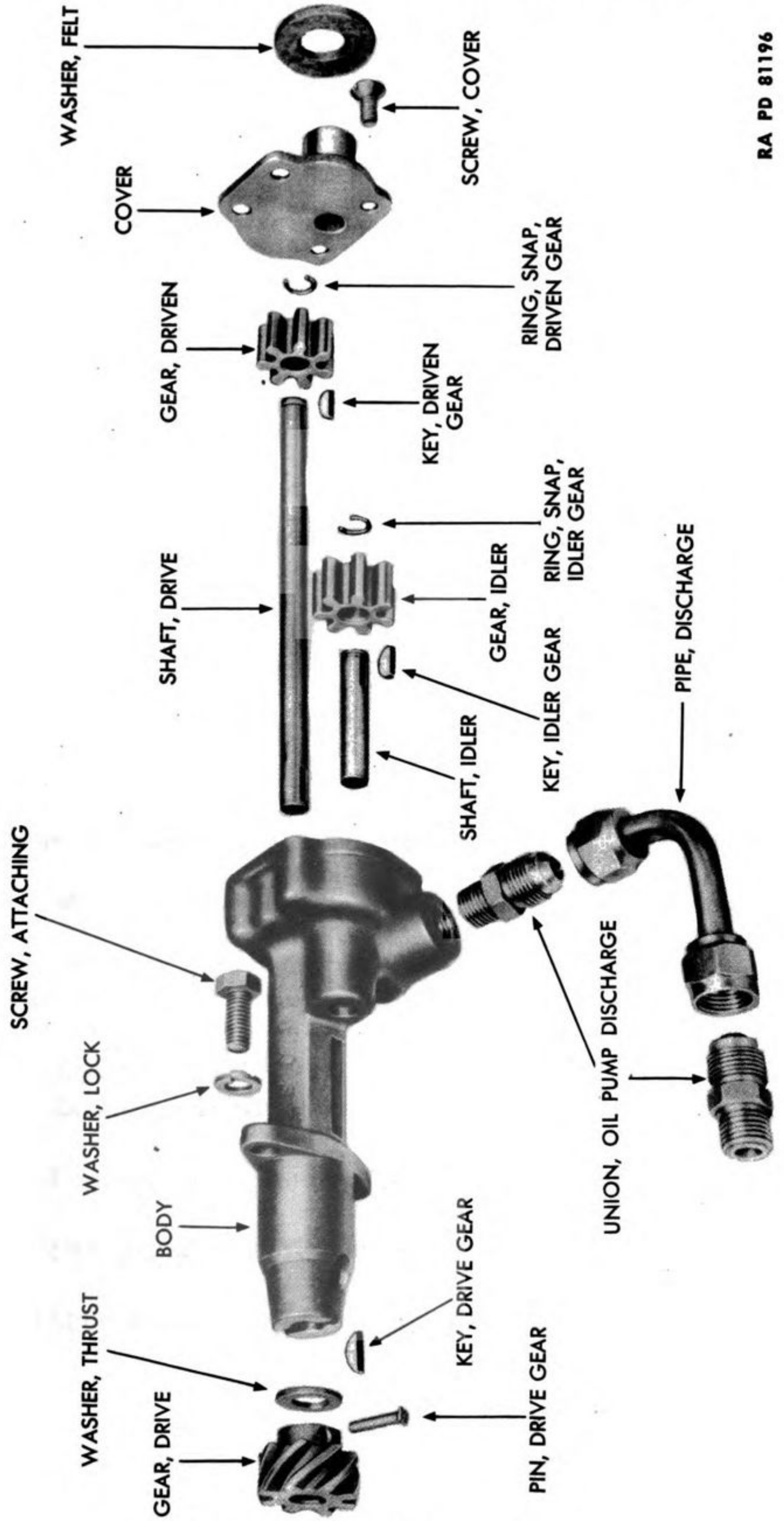


Figure 215 — Oil Pump Assembly — Exploded View

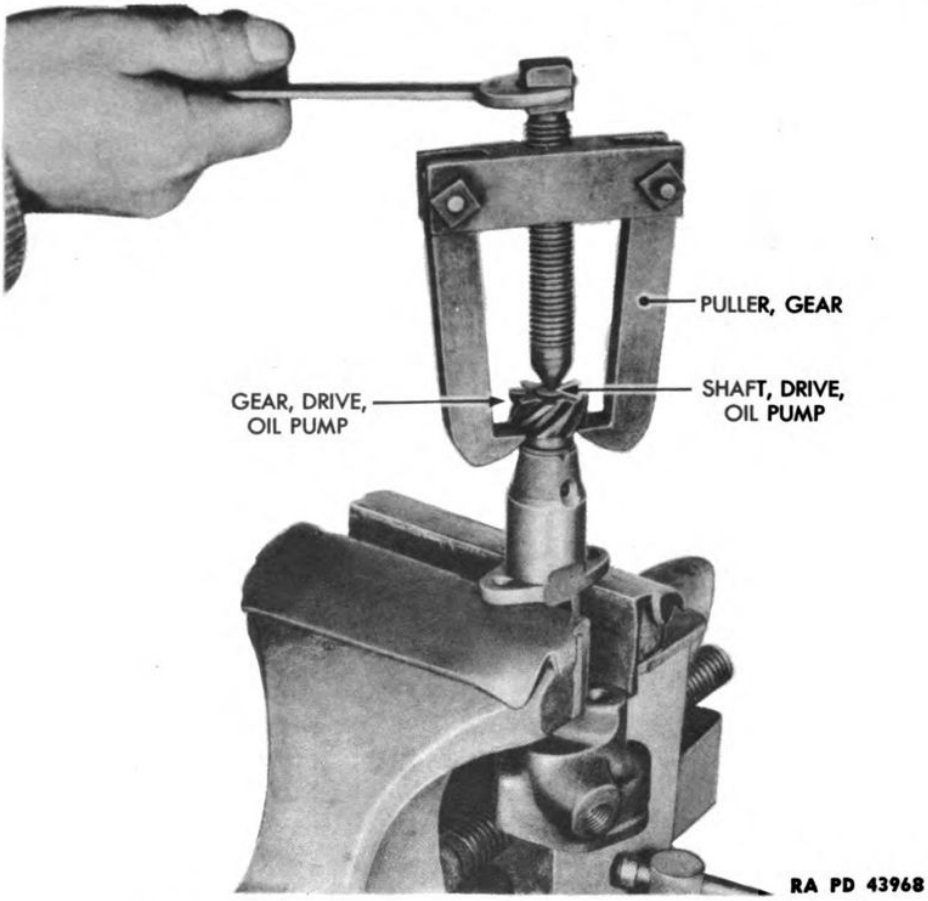


Figure 216 — Removing Oil Pump Drive Gear from Oil Pump Drive Shaft

b. Disassembly (fig. 215).

HAMMER	SCREWDRIVER
PRESS, arbor	WRENCH, open-end, ⅝-in.
PULLER, gear	WRENCH, open-end, ¾-in.
PUNCH	

(1) Remove oil pump discharge pipe from oil pump discharge union (¾-in. open-end wrench).

(2) Remove oil pump discharge union from oil pump body (⅝-in. open-end wrench).

(3) Remove four oil pump cover screws (screwdriver), and remove oil pump cover from pump assembly.

(4) Remove oil pump idler shaft and gear assembly from oil pump body (punch and hammer).

(5) Drive oil pump drive gear pin from oil pump drive gear and drive shaft (hammer and punch) (fig. 215).

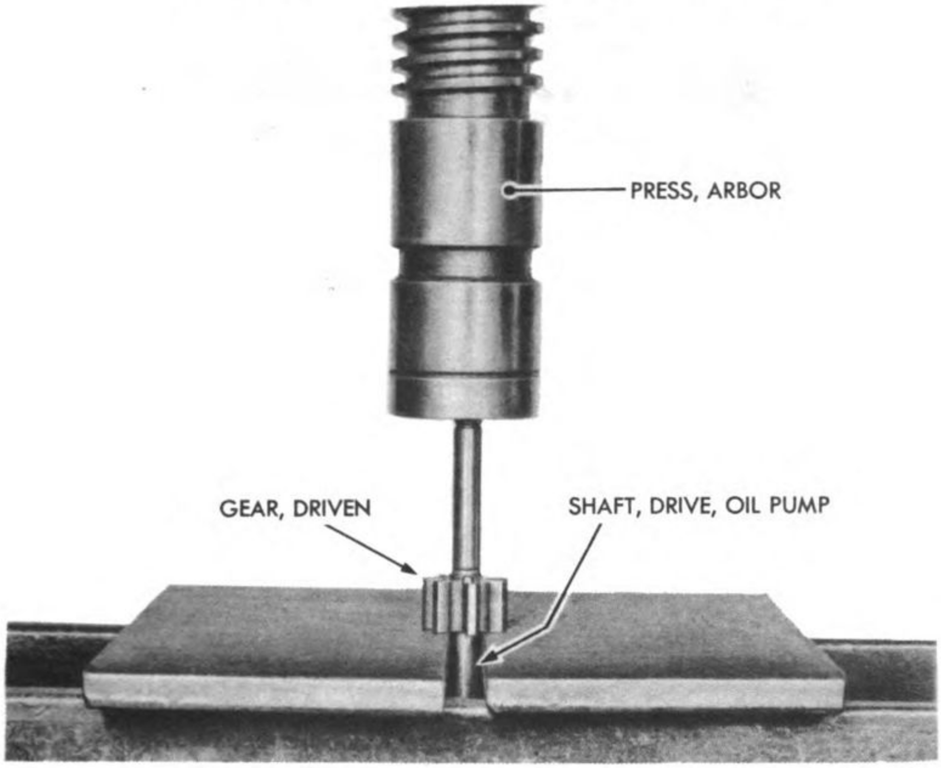


Figure 217 — Pressing Oil Pump Driven Gear on Oil Pump Drive Shaft (First Operation)

(6) Pull oil pump drive gear from drive shaft (gear puller) (fig. 216). CAUTION: Remove oil pump drive gear from shaft. Do not attempt to drive or press oil pump drive shaft from oil pump drive gear, as the oil pump drive gear key will damage washer and oil pump body.

(7) Remove oil pump drive gear washer from shaft.

(8) Remove oil pump drive shaft and driven gear from body (fig. 215).

(9) Press oil pump driven gear from shaft by pressing gear about three-eighth inch up on shaft, and remove snap ring from drive shaft. Press shaft from gear (arbor press) (fig. 218).

(10) Tap oil pump driven gear key from shaft (hammer) (fig. 215).

(11) Press oil pump idler gear from idler shaft (arbor press).

(12) Tap oil pump idler gear key from shaft (hammer) (fig. 215).

c. Inspection and Repair.

(1) Check oil pump drive shaft for wear and damage. Replace if necessary.

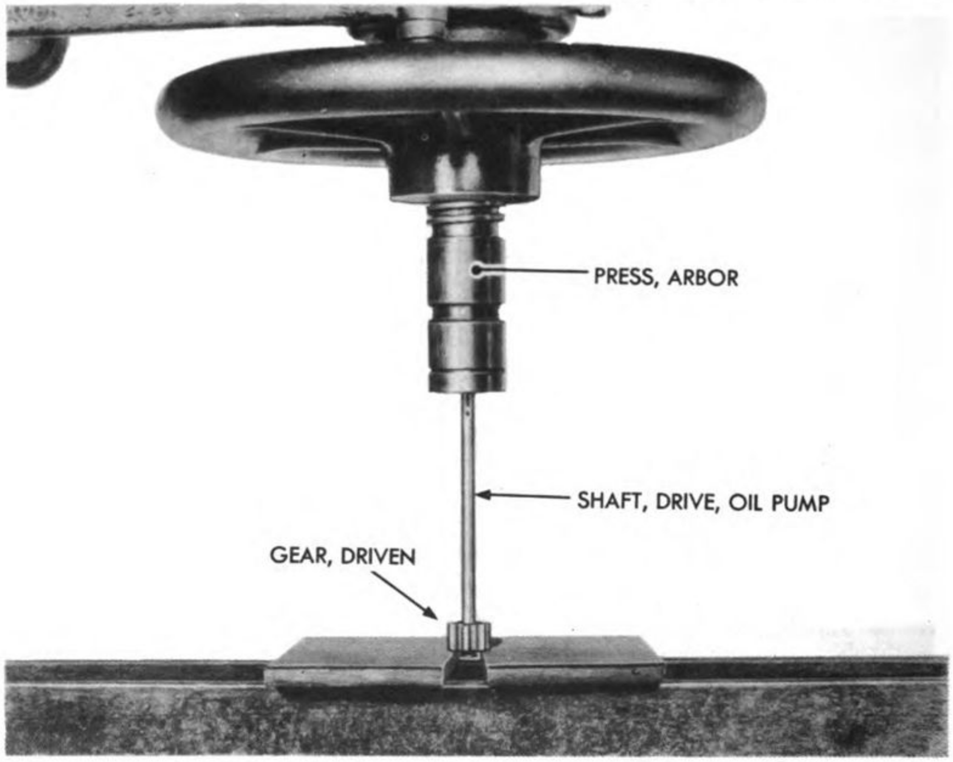


Figure 218 — Pressing Oil Pump Driven Gear on Oil Pump Drive Shaft (Second Operation)

(2) Try fit of oil pump drive shaft in body. It should be a free running fit without side play. Replace oil pump drive shaft or body if worn.

(3) Inspect condition of all oil pump gears. Replace damaged gears.

(4) Inspect condition of oil pump gear keys. Replace damaged keys.

d. Assembly.

HAMMER	SCREWDRIVER
PRESS, arbor	WRENCH, open-end, ⅝-in.
PUNCH	WRENCH, open-end, ¾-in.

(1) Press oil pump drive shaft into oil pump driven gear so end of shaft extends down past gear about three-eighths inch (arbor press) (fig. 217).

(2) Assemble oil pump snap ring to shaft. Place oil pump key in position in shaft, and press shaft down into gear until snap ring is flush with recess in gear (arbor press) (fig. 218).

(3) Assemble oil pump idler gear to idler gear shaft (arbor press).

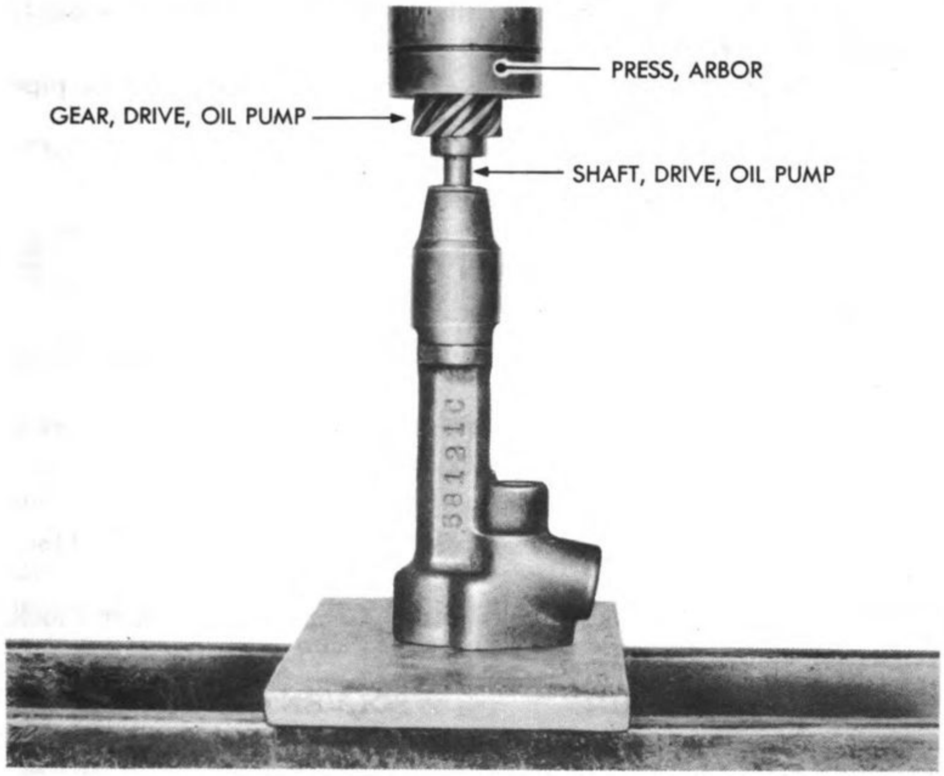


Figure 219 — Pressing Oil Pump Drive Gear on Oil Pump Drive Shaft

(4) Insert oil pump drive shaft and driven gear assembly in oil pump body.

(5) Assemble oil pump drive gear washer over shaft, and place oil pump gear key in position in shaft (fig. 215).

(6) Press oil pump drive gear on shaft, making sure gear pin holes line up with hole in shaft (arbor press) (fig. 219).

(7) Drive new pin in oil pump drive gear and shaft (hammer).

(8) Assemble oil pump idler gear and shaft assembly to oil pump body.

(9) Place oil pump cover in position and assemble four oil pump cover screws (screwdriver) and stake in place (punch and hammer).

(10) Assemble oil pump union (5/8-in. open-end wrench), and assemble oil pump discharge pipe (3/4-in. open-end wrench) to oil pump union.

e. Installation (fig. 214).

WRENCH, open-end, 3/4-in. WRENCH, socket, 1/2-in.

(1) Place oil pump in position in cylinder block.

(2) Install oil pump to cylinder block cap screws and lock washers (½-in. socket wrench).

(3) Connect oil pump discharge pipe to oil pump discharge pipe union in cylinder block (¾-in. open-end wrench).

(4) Install oil pan (par. 129).

(5) Install engine in unit (par. 131).

161. OIL PRESSURE REGULATOR.

a. **Removal** (fig. 220).

SCREWDRIVER
WRENCH, open-end, 1-in.
WRENCH, open-end, 1¼-in.

(1) Remove regulator acorn nut from adjusting screw (1-in. open-end wrench).

(2) Lift acorn nut gasket from adjusting screw.

(3) Remove adjusting screw and lock nut from cylinder block (1¼-in. open-end wrench and screwdriver).

(4) Lift lock nut gasket, spring, and piston from cylinder block.

b. **Inspection and Repair.**

COMPRESSED AIR
SOLVENT, dry-cleaning

(1) Clean all metal parts with SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect metal parts to see if any are broken, worn, scored, or have damaged threads. Replace all damaged parts. Replace gasket every time oil pressure regulator is disassembled.

c. **Assembly** (fig. 220).

SCREWDRIVER
WRENCH, open-end, 1-in.
WRENCH, open-end, 1¼-in.

(1) Assemble piston and spring to cylinder block.

(2) Assemble lock nut and lock nut gasket to adjusting screw.

(3) Install adjusting screw and lock nut in cylinder block.

(4) Start engine and turn adjusting screw to right or left until oil pressure gage on switchboard panel shows 15 pounds pressure (fig. 221) (screwdriver).

(5) Tighten lock nut (1¼-in. open-end wrench).

(6) Assemble acorn nut gasket and acorn nut to adjusting screw (1-in. open-end wrench) (fig. 220).

d. **Adjustment.**

SCREWDRIVER
WRENCH, open-end, 1-in.
WRENCH, open-end, 1¼-in.

(1) Remove acorn nut from adjusting screw (1-in. open-end wrench) (fig. 220).

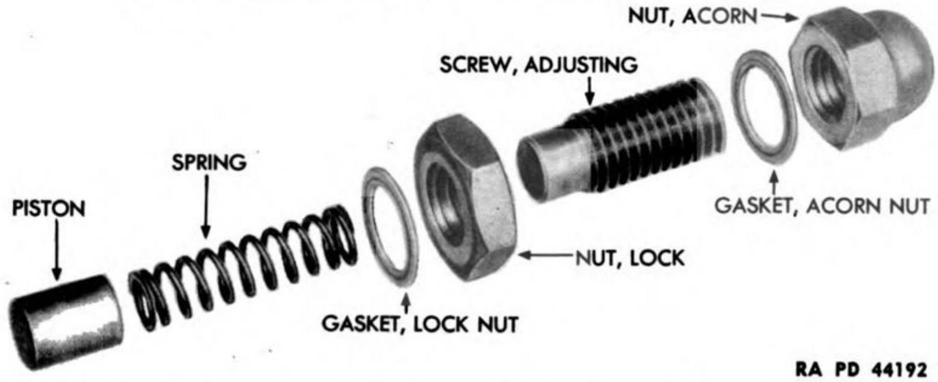


Figure 220 — Oil Pressure Regulator — Exploded View

(2) Remove acorn nut gasket from adjusting screw (fig. 220).

(3) Loosen adjusting screw lock nut (1¼-in. open-end wrench and screwdriver) (fig. 220).

(4) With engine running, turn adjusting screw to right or left until oil pressure gage on switchboard panel shows 15 pounds pressure (screwdriver) (fig. 221).

(5) Tighten lock nut (1¼-in. open-end wrench).

(6) Install acorn nut gasket and nut (1-in. open-end wrench) (fig. 220).

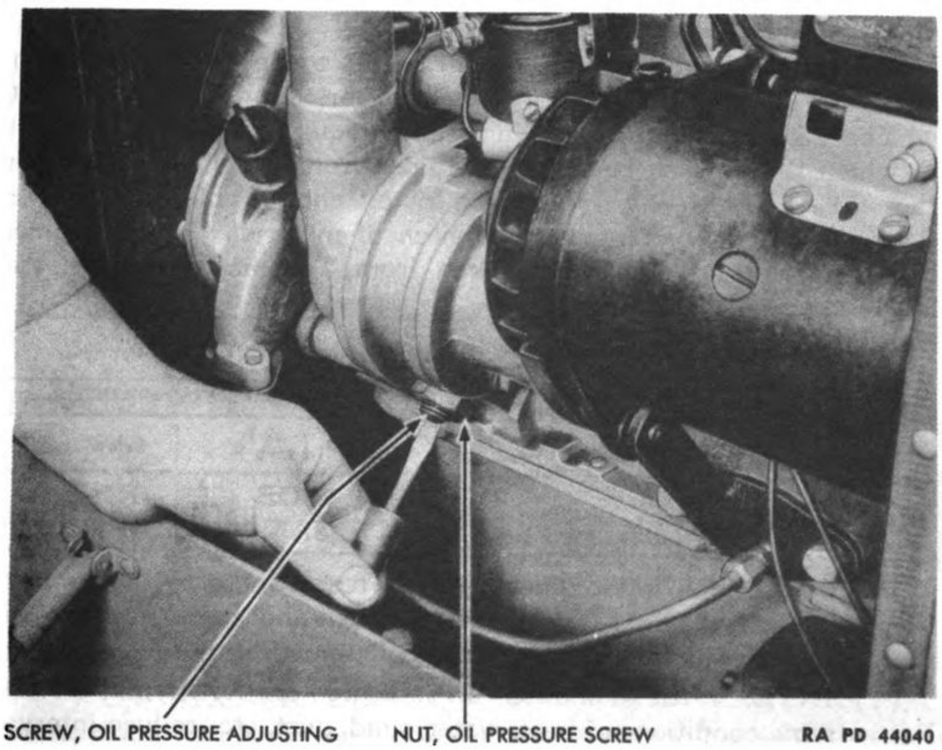


Figure 221 — Adjusting Oil Pressure Regulator

Section XX

LUBRICATION INSTRUCTIONS FOR GENERATING UNITS M5 AND M6

162. GENERAL.

a. The following lubrication instructions for generating Units M5 and M6 are published for the information and guidance of all concerned, and supersede all previous instructions.

(1) REFERENCES. Materiel must be lubricated in accordance with the latest instructions contained in Technical Manuals and/or Ordnance Field Service Bulletins. Reference is made to OFSB 6-4, Artillery Lubrication, General, for additional lubrication information, and to OFSB 6-2, Product Guide, for latest approved lubricants.

163. LUBRICATION GUIDE.

a. Lubrication instructions for all points to be serviced by using arms are shown in War Department Lubrication Guide No. 120, which specifies the types of lubricants required and the intervals at which they are to be applied. Guides from which information is reproduced are 10- by 15-inch laminated charts which are part of the accessory equipment of each piece of materiel. Data contained in the lubrication guides are taken from Technical Manuals, and are binding on using troops.

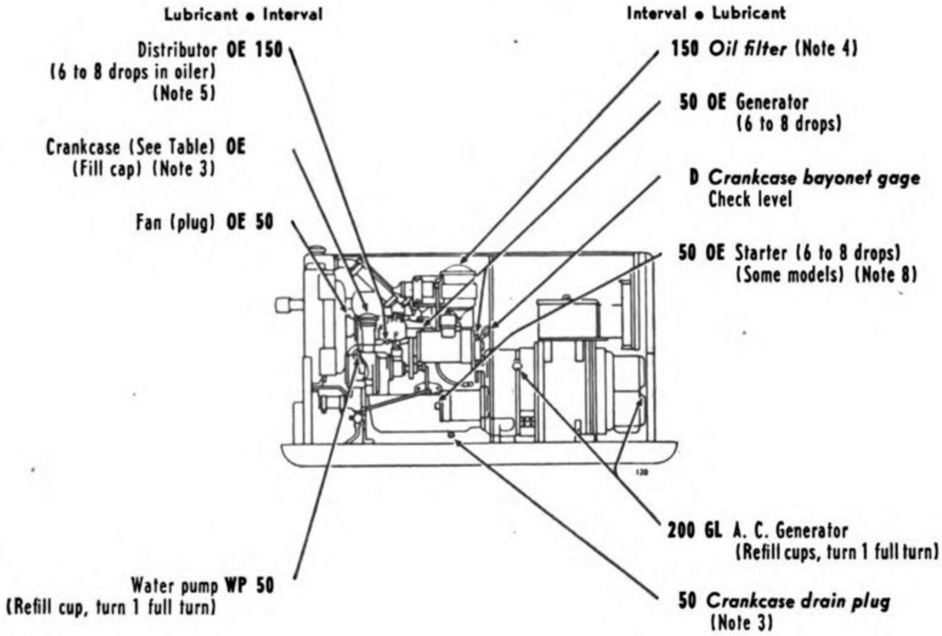
TABLE OF CAPACITIES AND LUBRICANTS TO BE USED

UNIT	CAPACITY (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		+32 F and above	+32 F to zero F	Below zero F
Crankcase	4 qt	OE SAE 30	OE SAE 10	Refer to OFSB 6-5

b. Lubrication Notes. The following notes apply to the lubrication guide (fig. 222). All note references in the guide itself are to the subparagraphs below having the corresponding numbers:

(1) INTERVALS. The intervals indicated are for normal service. For extreme conditions of heat, water, sand, dust, etc., reduce interval by a third or a half, or more if conditions warrant.

LUBRICATION INSTRUCTIONS FOR GENERATING UNITS M5 AND M6



KEY

LUBRICANTS	
OE—OIL, engine Crankcase grade	WP—GREASE, water pump
CG—GREASE, general purpose No. 1 (above +32° F.) No. 0 (below + 32° F.)	GL—GREASE, lubricating, special

INTERVALS
D—DAILY 50—50 HOURS 150—150 HOURS 200—200 HOURS
CHECK DAILY Crankcase Air cleaner

RA PD 81199

Figure 222 — Lubrication Guide — Generating Units M5 and M6

(2) AIR CLEANER. The air cleaner is located on the right side of the engine. Daily, check level and refill oil reservoir to bead level with used crankcase oil or OIL, engine (crankcase grade). Every 100 hours, or daily when operating in extreme dust conditions, remove air cleaner and wash all parts. Proper maintenance of air cleaners is essential to prolonged engine life.

(3) CRANKCASE. Drain only when engine is hot. Every 50 hours, drain and refill to "FULL" mark on gage. Run engine a few minutes and recheck oil level. CAUTION: Be sure pressure gage indicates that oil is circulating.

(4) OIL FILTER. Every 150 hours, or more often if filter becomes clogged, renew filter element. After renewing element, refill crankcase to "FULL" mark on gage. Run engine a few minutes, recheck level, and add oil to "FULL" mark.

(5) DISTRIBUTOR. Every 50 hours wipe distributor breaker cam lightly with GREASE, general purpose (seasonal grade), and apply 1 or 2 drops of OIL, engine (crankcase grade), to wick under rotor. Lubricate breaker arm pivot with 1 or 2 drops of OIL, engine (crankcase grade). Every 150 hours apply 6 to 8 drops of OIL, engine (crankcase grade) to distributor shaft oiler.

(6) FUEL STRAINER. The fuel strainer is located on the right side of the engine. Check fuel strainer bowl daily. When necessary, remove and wash bowl.

(7) OILCAN POINTS. Every 50 hours lubricate throttle connections and governor linkage with OIL, engine (crankcase grade).

(8) COLD WEATHER. For lubrication and service below zero F, refer to OFSB 6-5.

164. POINTS TO BE SERVICED AND/OR LUBRICATED BY ORDNANCE MAINTENANCE PERSONNEL.

a. Starter (some models). Once each year disassemble, clean, and repack armature bearings with GREASE, general purpose No. 2. Wash over-running clutch and pinion in SOLVENT, dry-cleaning, coat lightly with OIL, engine (crankcase grade), and reassemble.

165. REPORTS AND RECORDS.

a. Reports. If lubrication instructions are closely followed, proper lubricants used, and satisfactory results are not obtained, a report will be made to the ordnance officer responsible for the maintenance of the materiel.

b. Records. A complete record of lubrication servicing will be kept.

Section XXI

CONSOLIDATED SERVICE DATA

166. FITS AND CLEARANCES.

a. Clearance Between:

	Minimum	Maximum
Valve tappet and valve stem, intake (hot)	0.006 in.	
Valve tappet and valve stem, intake (cold)	0.008 in.	
Valve stem and valve guide, intake	0.001 in.	0.0015 in.
Valve stem and valve guide, exhaust	0.001 in.	0.0015 in.
Valve tappet and valve tappet guide	0.00075 in.	0.001 in.
Idler bearing and idler gear shaft	0.001 in.	0.0015 in.
Camshaft bearing and camshaft	0.0015 in.	0.0025 in.
Cylinder main bearing and crankshaft	0.002 in.	0.0025 in.
Bell housing and chamfer on crankshaft	0.012 in.	0.025 in.
Connecting rod bearing and crankshaft	0.001 in.	0.0015 in.
Connecting rod bearing and crankshaft (end play)	0.005 in.	0.010 in.
Accessory drive bearing and accessory drive shaft	0.0015 in.	0.002 in.
Accessory drive bearing and accessory drive thrust washer (end play)	0.001 in.	0.002 in.
Gear cover and crankshaft	0.008 in.	0.015 in.
Oil pan and crankshaft	0.008 in.	0.015 in.
Piston and cylinder wall	0.002 in.	0.0025 in.
Piston ring and groove in piston	0.001 in.	0.0025 in.
Piston pin and piston	0.0005 in.	

b. Gear Backlash:

Accessory drive gear	0.002 in.	0.003 in.
Crankshaft gear	0.000 in.	0.002 in.
Idler gear	0.001 in.	0.002 in.
Oil pump gear	0.008 in.	0.010 in.

c. Gap Settings:

Piston ring end gap	0.015 in.	0.020 in.
Spark plug electrodes	0.025 in.	
Distributor breaker points	0.018 in.	

d. End Thrust:

Crankshaft	0.002 in.	0.004 in.
Connecting rod bearing	0.005 in.	0.010 in.
Accessory drive bearing	0.001 in.	0.002 in.

e. Dimensions:

	Minimum	Maximum
Main generator driving flange stud top to face of flywheel		2 1/64 in.
Valve guide top to machined face of cylinder block		19/32 in.
Undercut mica, exciter commutator		
Width		0.030 in.
Depth	0.020 in.	0.025 in.

f. Spring Tensions:

	Minimum	Maximum
Main generator commutator brush arm		12 oz
Main generator slip ring brush arm		8 oz

167. WRENCH TENSIONS.

	Inch-pounds	Foot-pounds
Cylinder head	504	42
Connecting rod	276	23
Cylinder main bearing	924	77

Section XXII

PREPARATION FOR USE IN COLD CLIMATE

168. GENERAL.

a. Operation and maintenance of the unit at low temperatures involve factors not found at normal operating temperatures, and operators must devote more time to protective maintenance. Failure to provide extra service will result in actual damage, unnecessary and unwarranted expense, and failure to start.

b. Low temperatures have been divided into two ranges: zero F to —20 F, and below —20 F. Engines and lubricants undergo changes in their physical properties below —20 F. In many cases, accessory equipment for supplying heat to engine, fuel, oil, and intake air is required.

169. GASOLINE FOR LOW TEMPERATURES.

a. Selection. Use the winter class of motor fuel procured under U. S. Army Specification 2-103, latest issue.

b. The formation of ice crystals from small quantities of water in the fuel sometimes causes considerable trouble. To keep water out of the fuel tank, observe the following precautions:

(1) Strain the gasoline through a suitable strainer. CAUTION: Be sure to provide a positive metallic contact between fuel container and gasoline tank, unless both fuel tank and container are independently grounded.

(2) Insofar as possible, always keep the fuel tanks full. This will reduce condensation of water from the free air space above the fuel.

(3) Add one-eighth pint of ALCOHOL, denatured, to a tank of gasoline. The alcohol will absorb the water and prevent it from freezing.

(4) Do not store fuel in old drums unless they have been thoroughly cleaned.

(5) Never pump fuel drums dry when filling vehicle fuel tanks; allow about 4 inches of fuel to remain. This residue can later be

transferred to a settling tank. If time is not an urgent factor, do not pump fuel from drum to unit until it has settled for 16 hours after filling or moving the drum. Keep portable fuel pumps clean and protected from snow and frost.

(6) When a drum has been opened, be sure to cover the opening or replace the bung to keep out snow, frost, or other foreign matter. Store drums in a covered building, or cover with a tarpaulin.

170. ENGINE LUBRICATION.

a. Engine lubrication at temperatures above zero F is covered in the Lubrication Guide. The following instructions supplement this information, and apply only to instances where the temperature falls below zero F for long periods.

b. Several methods of keeping engine oil sufficiently fluid for proper lubrication at temperatures below —10 F are listed below. Give preference to these methods in the order listed according to available facilities.

(1) Keep the unit in heated enclosure when not in operation.

(2) When engine is stopped, drain crankcase oil while it is hot, and store in a warm place until unit is to be operated again. If warm storage is not available, heat the oil before reinstalling. Avoid overheating the oil; heat only to the point where the bare hand can be inserted without burning. *Tag the unit in a conspicuous place to warn personnel that crankcase is empty.* Close shut-off valves to prevent flooding of the carburetor and crankcase dilution, because of the accumulation of gasoline vapor pressure in the gasoline tanks.

(3) If unit is to be kept outdoors and if the oil cannot be drained, cover the engine with a tarpaulin. About 3 hours before engine is to be started, place fire pots under the tarpaulin. Use the Van Prag, Primus type, or other type blowtorch, or ordinary kerosene lanterns.

(4) Dilute the crankcase oil with gasoline. For satisfactory starting in temperatures below zero F, use four-fifths quart of gasoline to each 4 quarts of the engine oil prescribed on the Lubrication Guide for use at zero F.

171. COOLING SYSTEM PROTECTION.

a. Antifreeze Solutions.

(1) In freezing weather, protect the cooling system by addition of an antifreeze solution, employing COMPOUND, antifreeze (ETHYLENE GLYCOL type).

(2) The following table gives the approximate quantity of antifreeze necessary for various temperature conditions; check, however, with an antifreeze solution hydrometer.

PREPARATION FOR USE IN COLD CLIMATE

ANTIFREEZE CHART

Antifreeze	Water	Compound Antifreeze	
Qt	Qt	Degrees F	Gravity
0	5	32	1.000
½	4½	26	1.016
1	4	16	1.031
1½	3½	3	1.045
2	3	—11	1.058
2½	2½	—31	1.070

b. Precautions.

(1) Do not mix antifreeze solutions.

(2) Before installing antifreeze solution:

(a) Thoroughly flush the cooling system.

(b) Check system for leaks; tighten hose connections and replace if necessary; and check thermostat and water pump. Make sure that the pump is properly lubricated.

(c) Check fan belt for adjustment or weakness. Do not use rubber fan belts at temperatures below —20 F. Use leather, fiber, or synthetic rubber fan belts.

172. ELECTRICAL SYSTEM PROTECTION.

a. Generator and Starter. Inspect brushes, commutators, and bearings. See that the commutators are clean. Large surges of current which occur when starting a cold motor require good contact between brushes and commutators.

b. Wiring. Inspect and clean all connections, especially the battery terminals. Take care that no short circuits are present and that there is no ice on the spark plugs, wiring, or other electrical equipment.

c. Coil. Check coil for proper functioning.

d. Distributor. Clean thoroughly, and clean or replace points. Check the points frequently. In cold weather when the current is heavier, the points may pit and burn more than usually.

e. Spark Plugs. Clean, test, and replace if necessary. If it is difficult to make engine fire, reduce gap 0.005 inch more than specified for normal operation. This will make sparking easier at the reduced voltages likely to prevail.

f. Timing. Check carefully. Take care that the spark is not unduly advanced or retarded.

g. Batteries.

(1) The efficiency of batteries decreases sharply with decreasing temperatures and becomes practically nil at —40 F. Do not attempt

to start the engine with the battery when it has been exposed to temperatures below —30 F, until the battery has been warmed.

(2) A fully charged battery will not freeze even at temperatures likely to be found in arctic climates, while a fully discharged battery will freeze and rupture at approximately 18 F. See that the battery is always fully charged with hydrometer reading between 1.275 and 1.300. If a hydrometer is not available, use ammeter and voltmeter to determine battery condition.

(a) Due to the action of the generator regulator, the ammeter reading at constant engine speed will be low when the battery is fully charged, and high when the battery is weak or discharged. To obtain an indication of battery condition, frequently check ammeter readings at approximately equal engine speeds.

(b) Voltmeter readings, taken at intervals, with the same load on the battery, will provide a clue to potential battery performance.

(3) Maintain electrolyte level three-eighths inch above top of plates. If necessary to add distilled water, wait until the engine and battery have warmed up. Keep ventholes in filler plugs open. Keep terminals tight and clean. At regular intervals, apply a coating of GREASE, general purpose, No. 0, or COMPOUND, rust-preventive, light.

173. GENERAL CONDITIONS.

a. Make sure that no heavy grease or dirt has been left on the starter throw-out mechanism. Heavy grease or dirt may keep the gears from being meshed, or cause them to remain in mesh after the engine starts and thus ruin the starter.

b. Pull the choke control all the way out to secure the air-fuel ratio required for cold weather starting. Make sure the butterfly valve in the carburetor closes all the way and otherwise functions properly.

c. Carburetors which give no appreciable trouble at normal temperatures may not operate satisfactorily at low temperatures. A fuel pump which will deliver enough gasoline at normal starting speeds of 400 revolutions per minute may have leaky valves or a diaphragm which will prevent it from delivering a sufficient quantity of fuel at cranking speeds of 30 to 60 revolutions per minute. Another source of trouble is the float needle valve which, although a close fit, must move freely. Different expansions of the metals used in the needle valve parts may cause the needle valve to stick at extremely low temperatures.

d. At temperatures below zero F, do not use oil in air cleaners. The oil will congeal and prevent easy flow of air. At temperatures below —30 F, remove the air cleaners. Ice and frost formations on the air cleaner screens may cause an abnormally high intake vacuum and an overrich mixture.

e. Inspect the unit frequently. Shock resistance of metals, or resistance against breaking, is greatly reduced at extremely low temperatures. Movement of units on hard, frozen ground causes strain and jolting which will loosen or break bolts and nuts.

f. Remove or bypass oil filters at temperatures below —30 F, because the viscous oil will not flow freely through them.

g. Remove and clean gasoline strainer at frequent intervals.

174. STARTING AND OPERATION.

a. Temperatures from Zero F to —30 F.

(1) It is possible to start gasoline engines with batteries at temperatures as low as —30 F, if the engines are properly lubricated and in good mechanical condition.

(2) To ensure that the engine will start on the first attempt, proper preparation of the engine is very important. Should the engine fire a few times and stop, water vapor which is a product of combustion, may form frost in the combustion chamber, and make it impossible to start without heating the engine to above 32 F. Prolonged starting efforts wear down the battery.

(3) Pull the choke lever all the way out for starting, and keep it partially pulled out until the engine has warmed up. Since only the lightest components of the gasoline vaporize in a cold engine, a very rich mixture is necessary.

(4) When attempting to start, turn the engine over as rapidly as possible. All engines have a critical cranking speed; i.e., the engine must be turned over at a certain rate of speed before any start at all is possible. For engines in good mechanical condition, this critical rate of speed may vary from 40 to 70 revolutions per minute.

(5) After the engine has been started, idle it at 800 to 1,000 revolutions per minute until it has warmed up enough to run smoothly. Do not place the unit in operation until its operating temperature of 160 F has been reached.

b. Temperatures Below —30 F.

(1) Cover engine with tarpaulin, tent, or portable shed. Place oil stoves, fire pots, or four or five ordinary kerosene lanterns under the covering about 3 hours prior to starting time.

(2) Keep unit in sheltered areas shielded from wind. Cold winds increase starting difficulties.

175. COLD WEATHER ACCESSORIES.

a. A number of the most commonly used accessories have been mentioned in the preceding sections. These, together with other accessories and attachments used successfully in northern climates, are listed below. The use of these accessories is not mandatory. They are given only as suggestions and are to be used at the discretion of officers in charge of the materiel.

(1) Tarpaulins, tents, or collapsible sheds are useful for covering units, particularly for the engines.

(2) Fire pots (Primus type) or Van Prag blowtorches, ordinary blowtorches, oil stoves, or kerosene lanterns can be used for heating unit.

(3) Extra batteries and facilities for changing batteries quickly help in starting.

(4) Steel drums and suitable metal stands are useful in heating crankcase oil.

(5) Insulation for the fuel line helps prevent ice formation inside the line.

(6) Radiator covers, improvised locally, help keep the engine running at normal temperatures.

Section XXIII

SPECIAL TOOLS AND EQUIPMENT

176. TOOLS FURNISHED WITH UNIT.

a. Each Unit M5 and each Unit M6 is equipped with a set of tools which is housed in the tool box. Included are a trouble light, screwdriver, pliers, spark plug wrench, valve lifter, adjustable wrench, a set of six open-end wrenches, and a cloth case for the open-end wrenches (fig. 223). A gasoline funnel and crank are attached to the inside of the canopy (fig. 223). The funnel and crank are reached by opening the right-hand engine door.

177. SPARE PARTS FURNISHED WITH UNIT.

a. Bolted to the under side of the right-hand engine door of the housing are four extra cylinder head gaskets (fig. 224). Within the tool box are two manifold gaskets, two lengths of radiator hose, four hose clamps, a fan belt, a battery charging generator drive belt (fig. 224), four valve springs, two intake valves, four exhaust valves, four main generator commutator brushes, four main generator slip ring brushes, eight valve spring seat pins, two gasoline strainer pads, three 25-ampere main generator fuses, two sets of distributor breaker points, four spark plugs, two cotter pins, and an assortment of screws, nuts, and washers (fig. 225). With the Unit M6, an extra fixed resistor and an extra variable resistor are also furnished (fig. 225).

178. SPECIAL TOOLS.

a. **General.** Simplicity of design of the generating unit makes it possible to do nearly all repair operations with standard automotive equipment. Only three special tools are required: a pilot for removing the accessory drive bushing from the accessory drive housing (fig. 226), and two bearing drivers for installing bearings in the governor (figs. 227 and 228).

b. **Accessory Drive Bushing Pilot.** In use, the disk with the flattened side is inserted through the large opening of the housing, through the bushing. The disk is then maneuvered so that it lies flat on top of the bushing. The rod is then inserted through the small opening on top of the housing. With the rod against the disk, the bushing is driven out by hammering the end of the rod projecting from the housing. This tool is easily constructed from stock steel or scrap parts. Build it to the dimensions shown (fig. 226).

c. **Governor Bearing Drivers.** Construct two bearing driving tools to dimensions shown in illustrations (figs. 227 and 228) from stock steel.

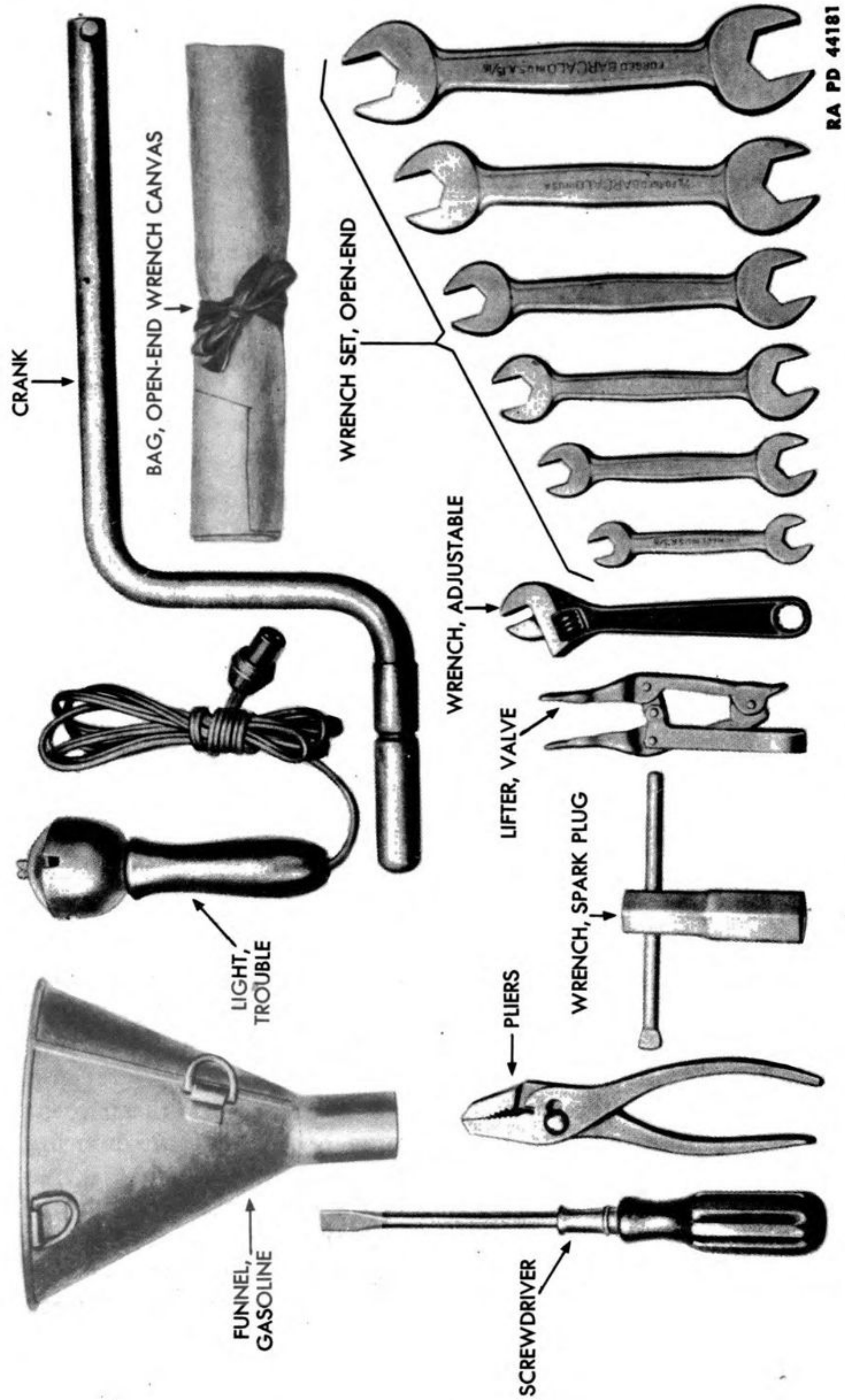


Figure 223 — Tools

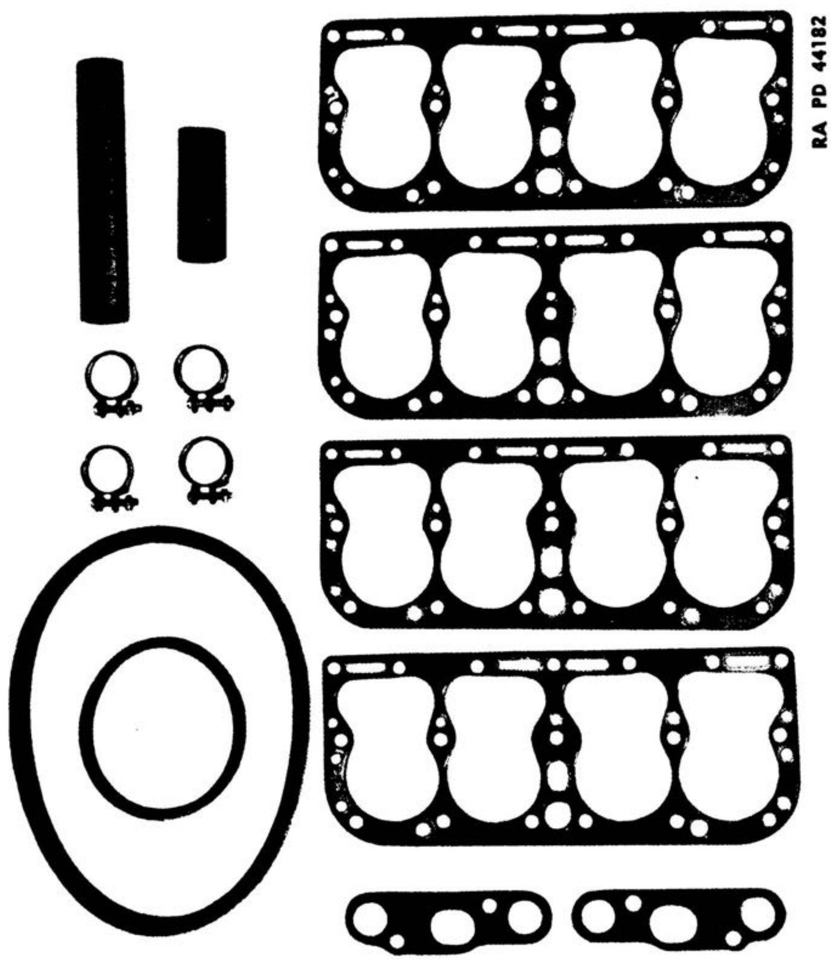
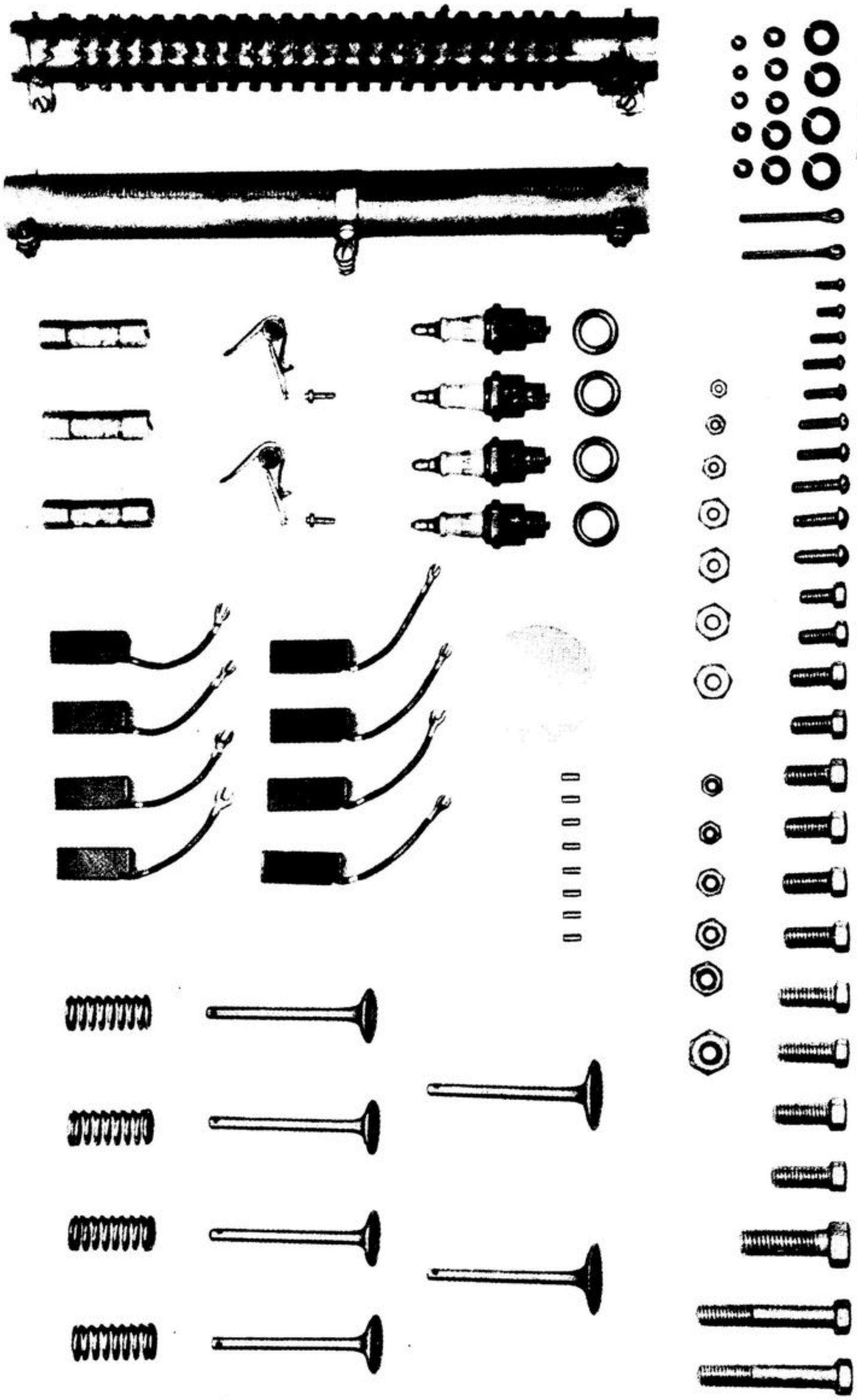


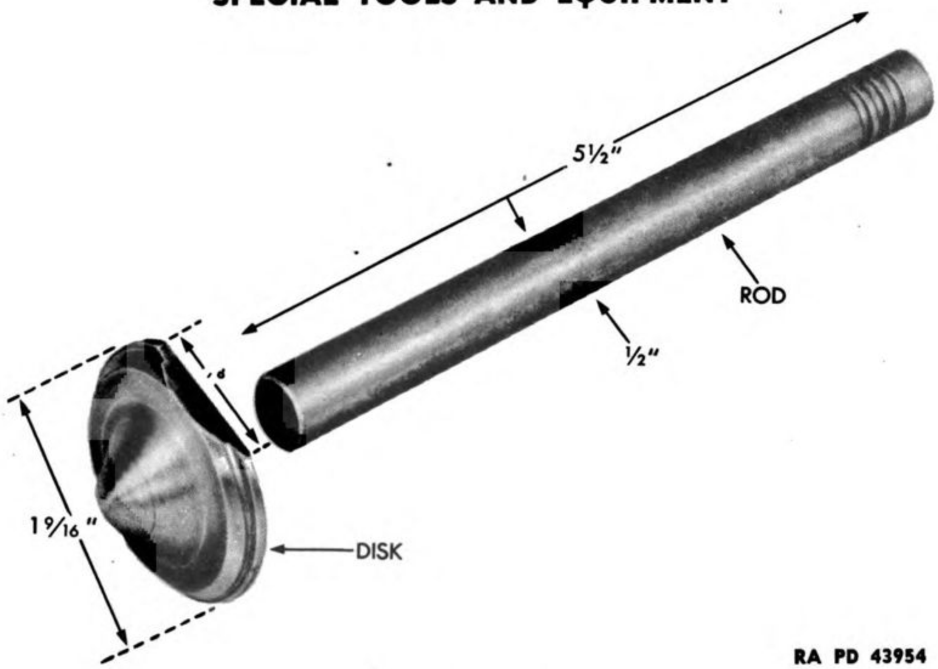
Figure 224 — Equipment — Gaskets, Hose, and Belts



RA PD 44183

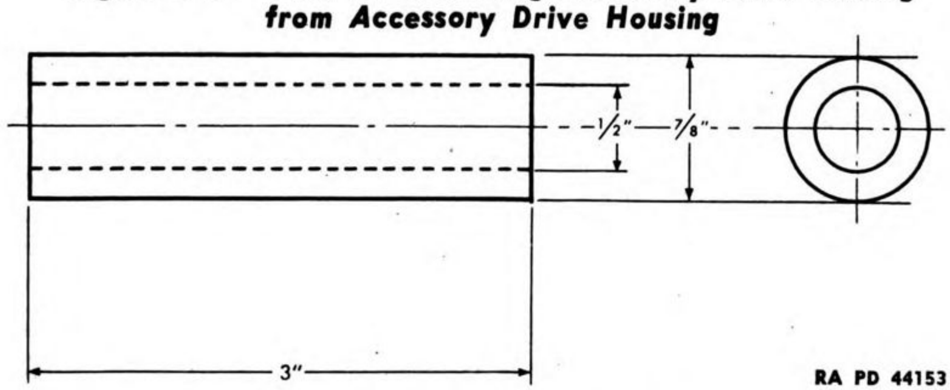
Figure 225 — Equipment — Small Parts

SPECIAL TOOLS AND EQUIPMENT



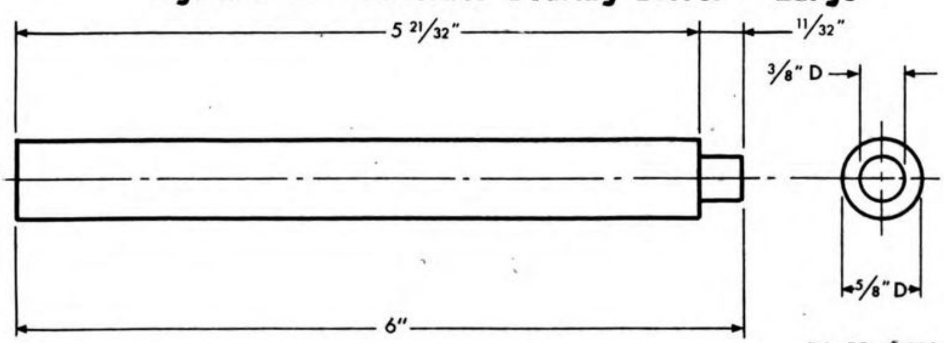
RA PD 43954

Figure 226 — Pilot for Removing Accessory Drive Bushing from Accessory Drive Housing



RA PD 44153

Figure 227 — Governor Bearing Driver — Large



RA PD 44152

Figure 228 — Governor Bearing Driver — Small

Section XXIV

PAINTING

179. GENERAL.

a. Ordnance materiel is painted before issue to the using arms, and one maintenance coat per year will ordinarily be ample for protection. With but few exceptions, this materiel will be painted with ENAMEL, synthetic, olive-drab, lusterless. The enamel may be applied over old coats of oil enamel and oil paint previously issued by the Ordnance Department, if the old coat is in satisfactory condition for repainting.

b. Paints and enamels are usually issued ready for use and are applied by brush or spray. They may be brushed on satisfactorily when used unthinned in the original package consistency, or when thinned no more than 5 percent by volume with THINNER, synthetic. The enamel will spray satisfactorily when thinned with 15 percent by volume of thinner. (Linseed oil must not be used as a thinner since it will impart a lustre not desired in this enamel.) If sprayed, it dries hard enough for repainting within one-half hour, and dries hard in 16 hours.

c. Certain exceptions to the regulations concerning painting exist. Fire-control instruments, sighting equipment, and other items which require a crystalline finish will not be painted with ENAMEL, synthetic, olive-drab, lusterless.

d. In no case should an oil or kerosene mixture be used to impart a polished surface.

180. PREPARING FOR PAINTING.

a. If the base coat on the materiel is in poor condition, it is more desirable to strip the old paint from the surface than to use sanding and touch-up methods. After stripping, it will then be necessary to apply a primer coat.

b. PRIMER, synthetic, refinishing, should be used on wood as a base coat for synthetic enamel. It may be applied either by brushing or spraying. It will brush satisfactorily as received, or after the addition of not more than 5 percent by volume of thinner. It will be dry to touch in 30 minutes, and hard in from 5 to 7 hours. For spraying, it may be thinned with not more than 15 percent by volume of thinner. Lacquers must not be applied to the primer within less than 48 hours.

c. PRIMER, synthetic, rust-inhibiting, for bare metal, should be used on metal as a base coat. Its use and application is similar to that outlined in subparagraph b above.

d. The success of a job of painting depends partly on the selection of a suitable paint, but also largely upon the care used in preparing the surface prior to painting. All parts to be painted should be free from rust, dirt, grease, kerosene, oil, and alkali, and must be dry.

181. PAINTING METAL SURFACES.

a. If metal parts are in need of cleaning, they should be washed in a liquid solution consisting of one-half pound of SODA ASH in 8 quarts of warm water, or an equivalent solution, and then rinsed in clear water and wiped thoroughly dry. Wooden parts in need of cleaning should be treated in the same manner, but the alkaline solution must not be left on for more than a few minutes, and the surfaces should be wiped dry as soon as they are washed clean. When artillery or automotive equipment is in fair condition and marred only in spots, the bad places should be touched with ENAMEL, synthetic, olive-drab, lusterless, and permitted to dry. The whole surface will then be sandpapered with PAPER, flint, class B, No. 1, and a finish coat of ENAMEL, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the materiel is used. If the equipment is in bad condition, all parts should be thoroughly sanded with PAPER, flint, class B, No. 2, or equivalent, given a coat of PRIMER, synthetic, rust-inhibiting, and permitted to dry for at least 16 hours. They will then be sandpapered with PAPER, flint, class B, No. 00, wiped free from dust and dirt, and a final coat of ENAMEL, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the materiel is used.

182. PAINT AS A CAMOUFLAGE.

a. Camouflage is now a major consideration in painting ordnance vehicles, with rust prevention secondary. The camouflage plan at present employed utilizes three factors: color, gloss, and stenciling.

(1) COLOR. Vehicles are painted with ENAMEL, synthetic, olive-drab, lusterless, which was chosen to blend in reasonably well with the average landscape.

(2) GLOSS. The new lusterless enamel makes a vehicle difficult to see from the air, or from relatively great distances over land. A vehicle painted with ordinary glossy paint can be detected more easily and at greater distances.

(3) STENCILING. ENAMEL, synthetic, stenciling, lusterless, blue-drab, which does not photograph well, is used. The numbers are illegible at distances exceeding 75 feet.

b. Preserving Camouflage.

(1) Continued friction or rubbing must be avoided, as it will smooth the surface and produce a gloss. The vehicle should not be washed more than once a week. Care should be taken to see that the washing is done entirely with a sponge or a soft rag. High-pressure water and fender brushes must be used to clean chassis and suspension. The surface should never be rubbed or wiped, except while wet, or a gloss will develop.

(2) It is not desirable that vehicles painted with lusterless enamel be kept as clean as vehicles were kept when glossy paint was used. A small amount of dust increases the camouflage value. Grease spots should be removed with SOLVENT, dry-cleaning. Whatever portion of the spot cannot be so removed should be allowed to remain.

(3) Continued friction of wax-treated tarpaulins on the sides of a vehicle will also produce a gloss, which should be removed with SOLVENT, dry-cleaning.

(4) Tests indicate that repainting with ENAMEL, synthetic, olive-drab, lusterless, will be necessary once yearly, and with ENAMEL, synthetic, stenciling, lusterless, blue-drab, twice yearly.

183. REMOVING PAINT.

a. After repeated paintings, the paint may become so thick as to crack and scale off in places, presenting an unsightly appearance. If such is the case, remove the old paint by use of REMOVER, paint and varnish. It is important that every trace of paint remover be completely rinsed off and that the equipment be perfectly dry before repainting is attempted. Crevices or cracks in wood should be filled with putty and the wood sandpapered before refinishing. The surfaces thus prepared should be painted according to directions in paragraph 181.

184. PAINTING LUBRICATING DEVICES.

a. Oil cups, pressure fittings, oilholes, and similar lubricating devices, as well as a circle about three-quarters inch in diameter at each point of lubrication, will be painted with ENAMEL, synthetic, gloss-red, in order that they may be readily located. Do not paint openings in fittings through which lubricant passes.

Section XXV

REFERENCES

185. STANDARD NOMENCLATURE LISTS.

a. Unit, generating, M5 (for directors M5 and M5A1 and for seacoast uses) .... SNL F-227

Unit, generating, M6 (for directors M4 and M7 with data transmission system and for seacoast uses .... SNL F-227

Current Standard Nomenclature lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" .... OPSI

186. EXPLANATORY PUBLICATIONS.

a. Maintenance and Inspection.

Cleaning, preserving, lubricating, and welding materials and similar items issued by the Ordnance Department .... TM 9-850

Detailed lubrication instructions for ordnance materiel .... OFSB 6-series

Echelon system of maintenance .... TM 10-525

Field inspection of ordnance materiel by service command inspectors in continental U. S. .... TB 1100-1

Fire prevention, safety precautions, accidents .... TM 10-360

Hand measuring, and power tools .... TM 10-590

Instruction guide: Generating unit M5 .... TM 9-2616

Instruction guide: Generating unit M6 .... TM 9-2617

Instruction guide: The instrument repairman .... TM 9-2602

Maintenance and repair .... TM 10-520

Ordnance maintenance: Remote control systems M1 and M5 .... TM 9-1643

Tune-up and adjustment .... TM 10-530

37-mm A.A. gun materiel .... TM 9-235

40-mm automatic gun M1 and 40-mm antiaircraft gun carriage M2 .... TM 9-252

b. Miscellaneous.

Camouflage	FM 5-20
Chemical decontamination materials and equipment	TM 3-220
Defense against chemical attack	FM 21-40
Fuels and carburetion	TM 10-550
List of publications for training	FM 21-6
Ordnance storage and shipment chart — Group F —major items	OSSC F
The internal combustion engine	TM 10-570
Welding, theory and application	TM 9-2852

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[A.G. 062.11 (8 May 43)
O.O. 461/40267 O.O. (2 Aug 43)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

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

DISTRIBUTION: R 9(4); Bn 9(2); C 9(8)

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

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