[U. S. Dept. of the army]

Technical manual / **TM5-5090**

WAR DEPARTMENT

OPERATOR'S MANUAL AND PARTS CATALOG

GENERATOR SET, PORTABLE, DIESEL ENGINE DRIVEN 30-KW, 127/220-VOLT, 3-PHASE, 60-CYCLE OR 230/400 VOLT, 3-PHASE, 50-CYCLE, BUDA MODEL 6-DTG-317.

THE BUDA CO.
HARVEY, ILL.
SEPT. 27, 1943

TM5-5090

WAR DEPARTMENT

TM5-5090, Maintenance Manual and Parts Catalog, Generator Set, Portable, Diesel Engine Driven, published by The Buda Co., is furnished for the information and guidance of all concerned.

(AG 062.11 (4/26/41) PC (C), June 10, 1941.)

By order of the Secretary of War:

Official:
J. A. ULIO
Major General,
The Adjutant General.

G. E. MARSHALL
Chief of Staff.

BUDA

Model 6-DTG-317

30 KW DIESEL GENERATOR SET

Quick Reference Index

BUDA
ESTABLISHED
1881

LUS
Army

TM5-5090

CONCISE SPECIFICATIONS OF THE
BUDA 6-DTG-317, 30 KW GENERATOR SET

Engine Model - Buda-Lanova Diesel 6-DTG-317

Type - Vertical in-line, overhead valves, four cycle, six cylinder

Power - 76 HP at 1800 R.P.M., laboratory test

Bore and Stroke - Bore 3-5/8", Stroke 5-1/8"

Piston Displacement - 317 cu. in.

Ignition - Compression ignition for starting and running

Fuel - Diesel fuel. See Diesel Fuel Specifications, Chapter 3

Rotation - Clockwise, viewing fan end

Engine Capacities - Crankcase Oil Capacity - 6 quarts
Cooling System Capacity - 24-1/3 quarts

Main Generator and Exciter - Century Electric Type ARC 444, 30 K.W. AC generator, 80% power factor, 3 phase, 50/60 cycle, 127/220 volts at 60 cycle, 230/400 volts at 50 cycle, 13 wire Y connections. Built by Century Electric Company, St. Louis, Missouri. Buda part No. DP-2493.

Generator Control Cabinet - General Electric Company, Buda part No. DP-2523.

Engine Accessories -

Description	Buda Part No.	Manufacturer	Manufacturer's Model No.
1. Air Cleaner	DE-52192	Donaldson Company, Inc. St. Paul, Minn.	B-954
2. Battery	DP-2479	Globe Union, Inc. Milwaukee, Wisconsin	25H97

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Engine Accessories - (Cont'd.)

Description	Buda Part No.	Manufacturer	Manufacturer's Model No.
3. Fan	DE-52272	Service Products Corp. Indianapolis, Ind.	4820-DX
4. Fuel Filter (Primary)	DE-52191	W.G.B. Oil Clarifier, Inc. Kingston, N. Y.	JF-100
5. Fuel Filter (Secondary)	DE-55944	American Bosch Co. Springfield, Mass.	FSP-10A2
6. Fuel Injection Pump	DE-52118	American Bosch Co. Springfield, Mass.	APE6A65P/ 400/S521Eng. 1060ED4
7. Fuel Tank	DP-24788	John Wood Mfg. Co., Inc. Chicago, Ill.	85 Gal. Capacity Tank
8. Generator (Engine Battery)	DE-56516	Electric Auto-Lite Co. Toledo, Ohio	GDB-4804D
9. Governor	DE-52201	Pierce Governor Co. Anderson, Indiana	GC-397
10. Muffler	DP-2557	Maremount Automotive Prod. Chicago, Ill.	EX-1259
11. Nozzles and Nozzle Holders	DE-41466	American Bosch Corp. Springfield, Mass.	ADN 12-SD12
12. Oil Filter	DE-52190	W.G.B. Oil Clarifier, Inc. Kingston, N. Y.	EM-150
13. Radiator	DP-2500	Young Radiator Co. Racine, Wisconsin	3697C
14. Safety Switch	DE-52227	Penn Electric Switch Co., Goshen, Indiana	1501
15. Solenoid Valve	DE-52228	Penn Electric Switch Co., Goshen, Indiana	6500
16. Starter Motor	DE-56518	Electric Auto-Lite Co. Toledo, Ohio	MBR-4003

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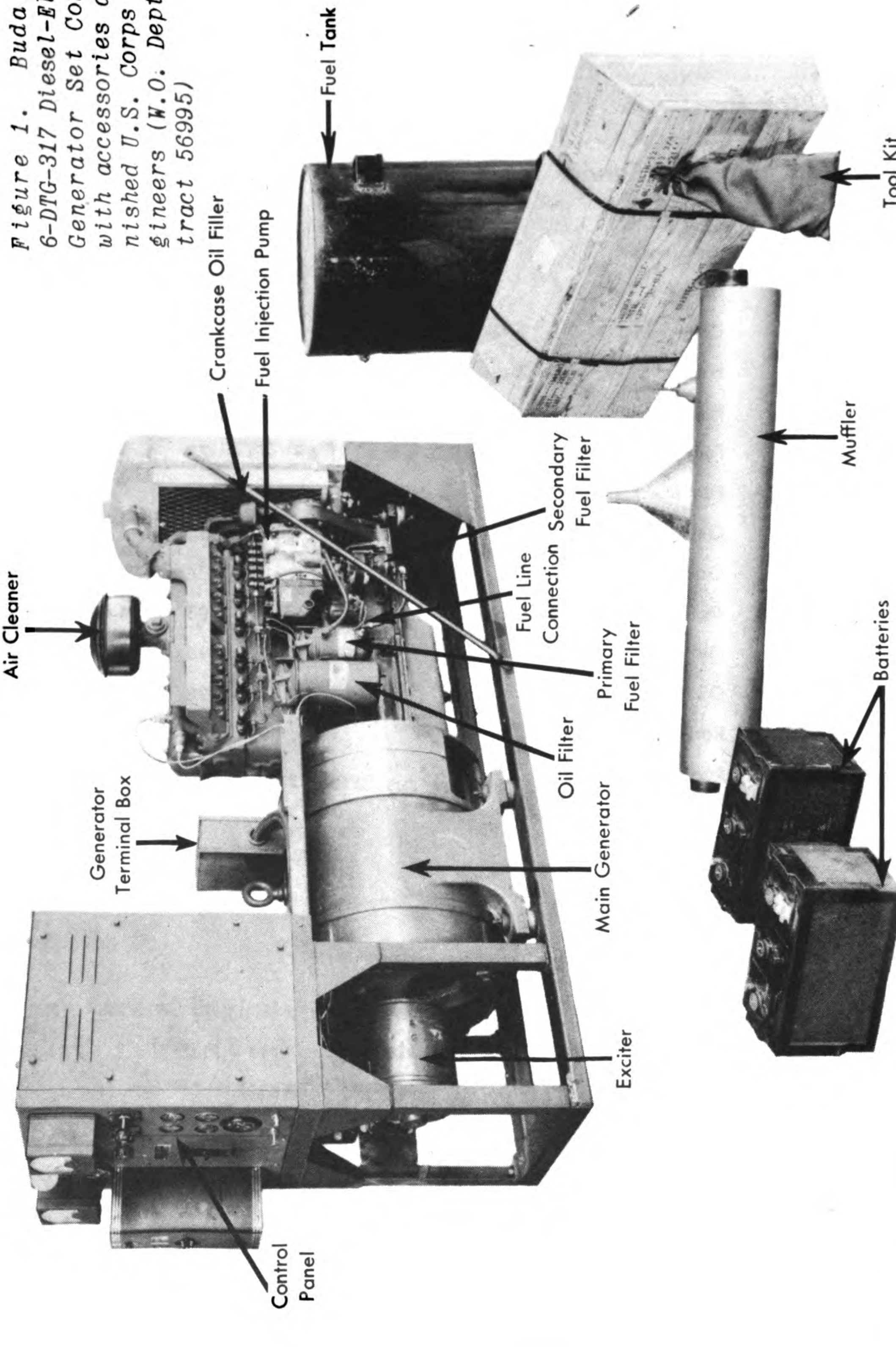


Figure 1. Buda Model 6-DTG-317 Diesel-Electric Generator Set Complete with accessories as furnished U.S. Corps of Engineers (W.O. Dept. Contract 56995)

Chapter I

GENERAL INFORMATION

1. The Buda 6-DTG-317, 30 KW, Diesel-powered AC Generator Sets are designed to operate at 50 and 60 cycles. These units are designed also for parallel operation with another unit of the same type and model. The main generator at 60 cycles (1800 r.p.m.) develops 127/220 volts, 30 KW; at 50 cycles (1500 r.p.m.) develops 230/400 volts, 25 KW. The generator is driven by a Buda-Lanova Diesel industrial type engine. See Figure 1.

The instruments and devices essential to the operation of the engine and the generator are contained in the control unit. See Figure 13 on page 27. The overall length of the Buda 6-DTG-317 generator set is 90 15/16", width 25 1/8", and the net weight is 2995 pounds. See Figure 12 which gives the details for installation and outlined dimensions.

2. DESCRIPTION OF ENGINE

The 6-DTG-317 Buda-Lanova Diesel engine is of the four stroke cycle, full Diesel, solid injection type. The cylinders are numbered from the front end, and the direction of rotation is right hand. The firing order is 1-5-3-6-2-4. The Buda-Lanova Diesel engines have soft and quiet combustion because of the Lanova combustion principle.

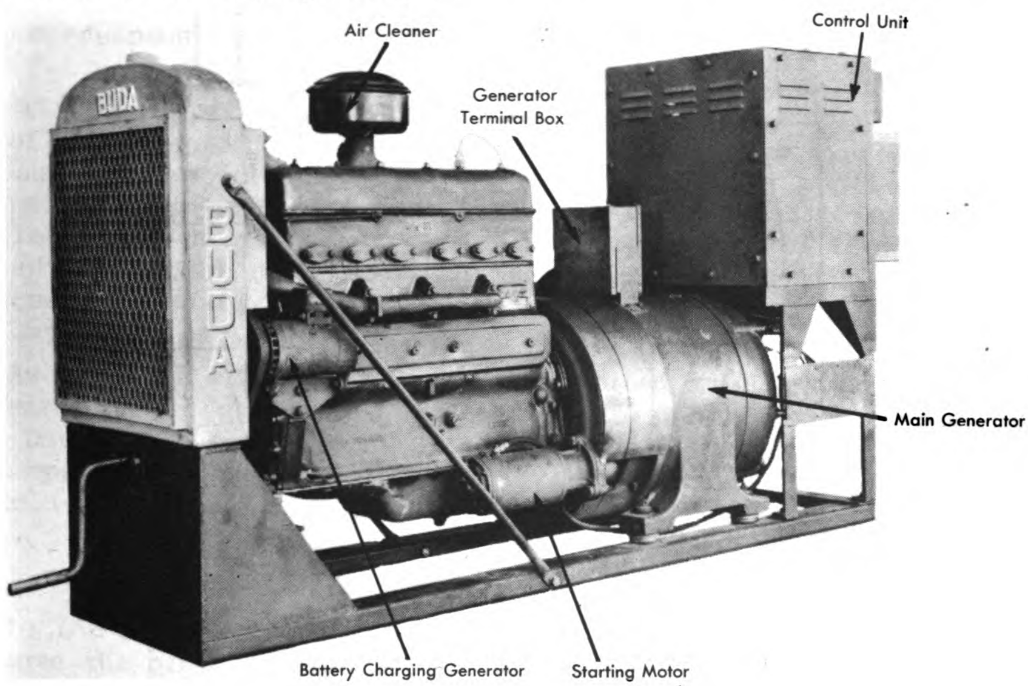


Figure 2. Left side of Buda Model 6-DTG-317, 30KW Generator Set

3. PRINCIPLE OF ENGINE OPERATION

In the four-stroke cycle Buda-Lanova Diesel engine, we have the same series of events taking place as in any four-stroke cycle internal combustion engine, as follows: (See Figure 3.)

a. Inlet stroke.
b. Compression stroke.
c. Expansion or power stroke.
d. Exhaust stroke.

The ignition of the fuel is created by rapidly compressing the air in cylinders into a sufficiently small area to raise the air temperature to a point where it will cause combustion of the injected fuel.

All fuel oil, regardless of gravity, has what is known as a firing point; that is, when the fuel oil is raised to a certain temperature, it will ignite and burn. In the process of burning, energy is liberated.

Referring to Figure 3, we see that when the piston starts downward on the inlet stroke (a), the inlet valve is open, thus admitting a charge of fresh air into the cylinder through the air inlet manifold. After the piston reaches the bottom of the inlet stroke, when the cylinder is filled with air and the piston is returning upward on the compression stroke (b), all the valves

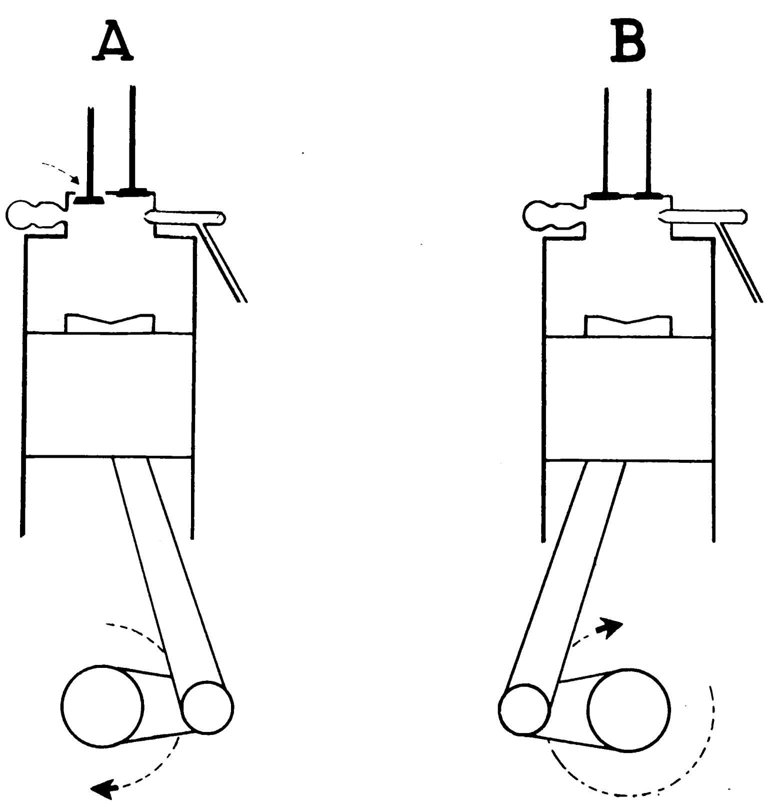
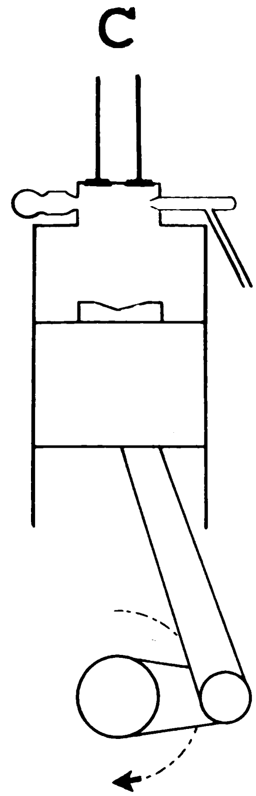


Figure 3a. Inlet Stroke *Figure 3b. Compression Stroke*



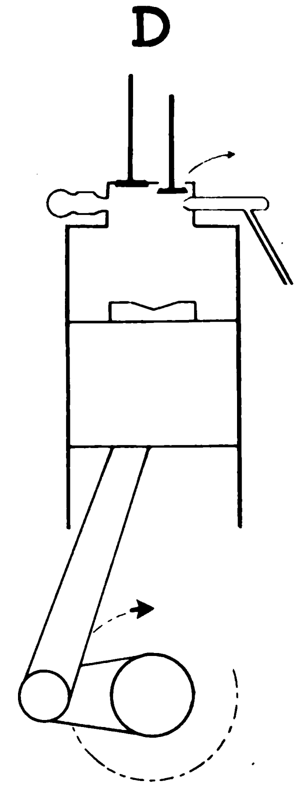


Figure 3c. Power Stroke *Figure 3d. Exhaust Stroke*

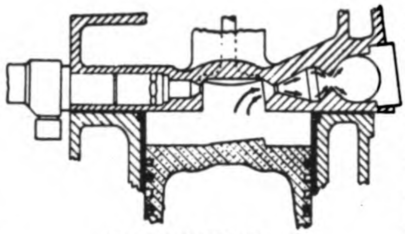
are closed so that the air is rapidly compressed to a final volume at the top of the stroke of approximately 1/12 the initial volume. This decrease in volume causes an increase in pressure and a corresponding increase in temperature to between 900° and 1000° F.

At the proper moment during the compression stroke, the fuel oil is injected into the combustion chamber under a pressure of about 2,000 pounds per square inch. As already mentioned, all fuels have a certain temperature at which they will ignite, and since this point is far below the temperature of the compressed air in the combustion chamber, the fuel in its finely atomized form easily ignites upon coming in contact with this hot compressed air.

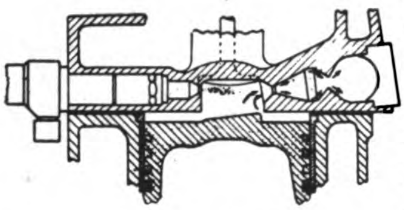
As the fuel oil burns, heat is generated which expands the compressed gases forcing the piston downward on the power stroke (c). During the latter part of this power stroke, the exhaust valve opens and when the piston starts upward on the exhaust stroke (d) it expells the burned gases, thus completing the cycle.

4. HOW THE BUDA-LANOVA LOW PRESSURE COMBUSTION SYSTEM OPERATES

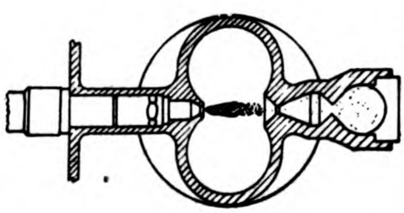
In the Buda-Lanova combustion chamber, the clearance volume above the piston consists of three chambers. The main chamber is in the form of figure eight, which also forms the housing for the intake and exhaust valves. See Figure 4. The two auxiliary chambers, or energy cell, is located directly opposite the injection nozzle.



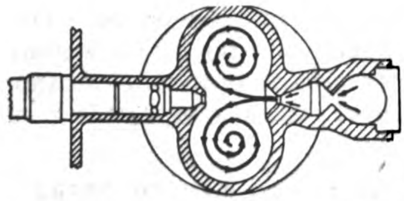
A COMPRESSION



B INJECTION



C IGNITION



D CONTROLLED TURBULENCE

Figure 4. Diagrams Illustrating How the Buda-Lanova Low Pressure Combustion System Operates.

(a) COMPRESSION PERIOD. Referring to Figure 4 (a), which illustrates the compression Period, we see that the air is compressed in the main chamber and also forced into the energy cell during the compression stroke. This energy cell is divided into a major and minor cell. A pre-determined portion of air is forced back into the minor and major energy cells as indicated by the arrows.

(b) INJECTION PERIOD. Just before the piston reaches top-dead-center while the air is being forced at high velocity through the opening which leads into the energy cell, the injection of fuel begins. The atomized fuel passes through the heated air of the main combustion chamber, (note that no fuel strikes the pistons) and a pre-determined portion of fuel enters the energy cell where it is intimately mixed with this inrushing air.

(c) IGNITION PERIOD. Initial ignition takes place in the Main Combustion Chamber where the compression, and consequently the temperature, is slightly higher. The fuel mixture burns very slowly here, as it is not yet thoroughly mixed with the air. This delayed burning eliminates sudden explosion of the fuel and possible shock to piston, rod, bearings, etc., an important feature.

(d) CONTROLLED TURBULENCE PERIOD. In the energy cell where the fuel is well mixed with the air, the burning is rapid, high pressure is developed quickly, and a blast, or back fire, is sent out across the main combustion chamber toward the nozzle. This blast breaks up the cloud of fuel in front of the cell and starts the "Double Swirl" in the main combustion chamber.

This violent swirling, called turbulence, thoroughly mixes the fuel with the air in the main chamber and results in complete combustion and low fuel consumption.

Because the fuel mixture burns very slowly in the main chamber as it is not yet thoroughly mixed with the air, the sudden explosion of the fuel and possible shock to the pistons, rods and bearings are eliminated, by the action of the energy cell. This is an important feature of the Buda-Lanova Diesel engine.

5. MAJOR COMPONENTS OF THE ENGINE

In an internal combustion engine, there are certain components that are necessary to keep the engine running properly. A method of timing must be provided so all necessary action will take place at the right instant, therefore a timing system is necessary. There must be a continuous flow of fuel, hence the fuel system. There must be a lubricating system and also an electrical system which will store energy for starting the engine and operating such automatic controls as the safety engine control switch, and the solenoid or safety shut off valve, which stops the engine if the oil pressure is too low or the engine too hot. Also the engine must not be allowed to overheat, hence there must be a cooling system.

6. TIMING SYSTEM

Timing is obtained by so setting the camshaft gear with the crankshaft to which the pistons are attached that the camshaft opens and closes the valves for each cylinder in their firing order so that each step necessary in a four stroke cycle engine can be performed at the right time. The fuel injection pump is timed with the engine so that it will inject the fuel at the right instant for combustion.

7. FUEL SYSTEM

The fuel system cleans, prepares, and controls the flow of fuel to the engine. The fuel is gravity fed from the fuel tank to the fuel injection pump. The fuel passes first through the primary filter, then to the fuel transfer pump, then to the secondary filter, then through the solenoid, or safety shut off valve, to the fuel injection pump, from which it is injected through the injection lines and finally through the nozzle into the combustion chamber. The fuel return line carries off the excess fuel delivered by the transfer pump, through the check valve at the fuel injection pump, and returns it to the fuel tank. Figure 5 illustrates the flow of the fuel oil. As part of the control of the flow of fuel, a single speed governor automatically regulates the speed of the engine. The governor maintains the rate of operation at an even pace for whatever speed it may be set. Figure 10 shows the position of the governor with respect to the fuel injection pump. It cannot be emphasized too often that extreme care with regard to cleanliness must be exercised in handling the fuel. See the third of the Operator's "Ten Commandments", Chapter II.

8. LUBRICATING SYSTEM

Without a lubricating system, the engine would not run for long. The heat produced by friction would destroy the engine. Oil cushions the moving parts from each other and carries away fine particles of wear. A high velocity oil pump provides full force feed lubrication to the internal working parts of the engine. Figure 6 illustrates the lubricating system. The oil is drawn from the pan through a suction screen to the oil pump. From the pressure side of the pump, it enters a passage drilled in the crankcase casting to the oil pressure relief valve. Here excess oil is bypassed back to the oil pan. The balance of the oil passes on to the main gallery line in the crankcase and to the oil filter. From the main gallery line, side passages are drilled to the main bearings, oil pressure gauge connections, and idler gear stud. From the

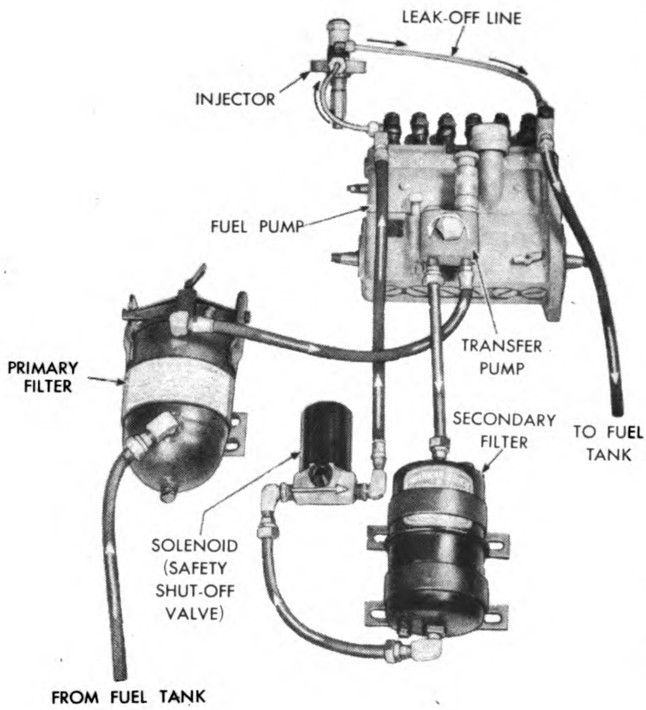


Figure 5. Fuel System Parts Temporary Connected Together to Illustrate Flow of Fuel Oil.

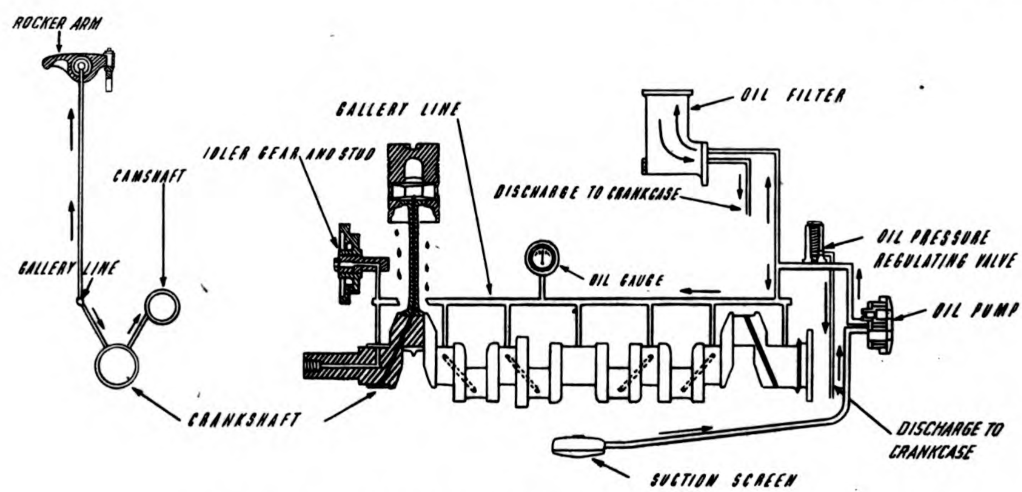


Figure 6. Diagram of Lubrication System

main bearings the oil is delivered to the connecting rod bearings by means of a drilled crankshaft. The piston pins receive their oil through the rifle drilled connecting rods. The cylinders are lubricated by oil thrown from the connecting rod bearings.

From the main bearings, side passages lead to the camshaft bearings. A supply of oil is delivered to the idler gear hub through the drilled idler gear shaft. Oil from the hub of this gear is thrown out through drilled holes and is picked up by a groove in the rim of the gears where it passes through small drilled holes through the gear teeth, spraying the entire gear train. An external connection supplies oil for the lubrication of the rocker arms.

9. ELECTRICAL SYSTEM

As a Diesel engine is a compression ignition engine needing no spark to ignite the combustible gases, the electrical system for a Diesel is primarily to supply energy for cranking the engine and to operate such electrical controls as the safety stop switch and the solenoid (safety shut off) valve. The cranking is done by the means of the starting motor which receives its electrical energy from the storage batteries. These batteries are kept charged by a 12 volt generator in combination with a voltage regulator which automatically decreases or increases the rate of current flowing to the batteries depanding upon the state of charge. See engine wiring diagram, Figure 7.

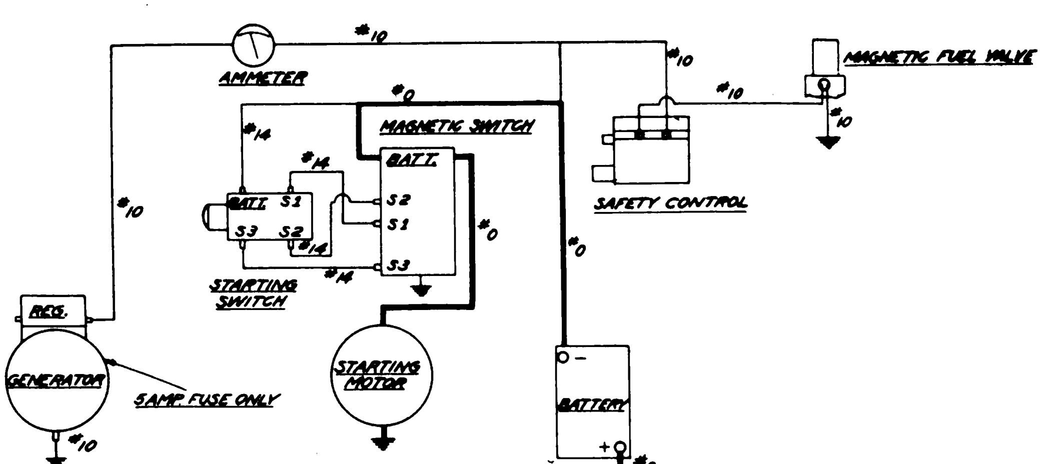


Figure 7. Engine Wiring Diagram

10. COOLING SYSTEM

The cooling system carries off the excess heat from the engine and holds it to a temperature that makes for efficient operation. The thermostat so controls the flow of the water that when the engine is cool, the water re-circulates around the engine water jackets without passing through the radiator. As the engine warms up, the thermostat opens and allows the water to circulate through the radiator. The water is circulated by a centrifugal pump through the water jacket and radiator where the cooling takes place. A fan creates a draft through the radiator to cool the water. A water temperature gauge indicates the temperature of the water. An automatic safety shut off is provided so that if the water temperature goes over 205°, the engine will be automatically stopped.

11. MAIN GENERATOR AND EXCITER

The alternating current generator is of the revolving field, self-excited, single bearing (ball bearing) type, having a direct connected exciter with the back end of the armature shaft arranged for direct connection to the engine flywheel through a flexible safety steel coupling. The generator is a means by which mechanical energy is changed into electrical energy.

The exciter is of the single bearing (ball bearing) type with the drive end of the shaft supported inside a bored hole in the end of the alternator shaft. These two shafts are keyed together with a woodruff key and an internal key way. The exciter is a small D.C. generator, the current of which magnetizes the poles of the main generator fields so that there will be lines of force which can be cut by the armature of the main generator, thereby inducing the alternating current, or the electrical energy necessary for power or light.

The alternator is designed to deliver rated load continuously with a maximum temperature rise of 40° Centigrade. Paragraph 39 tells how the machine can be reconnected to operate at either 50 or 60 cycles by changing the link connections in the generator terminal box.

The calculated average efficiencies are as follows:

Load	Efficiency
1/4	72.8
1/2	83.0
3/4	86.7
4/4	88.3

The alternator and exciter are self-cooled, the exciter by means of a fan attached to the shaft of the armature. A large fan bolted to the drive coupling cools the alternator.

12. DESCRIPTION OF CONTROL UNIT

The control unit contains the instruments and switches necessary to operate the engine and the generator. The control unit consists of a rigid steel frame with a control panel on the front, easily removable sides and back, a fixed top cover, and with an open bottom. The unit is supported at the bottom by shock-proofing cushions to reduce the vibration from the engine. All connections to the external equipment are made through the open bottom. See Figure 13. The Control unit is made by the General Electric Manufacturing Company. For method of operating the control unit, see Chapter IV, Paragraphs 28 and 29.

Chapter II

OPERATOR'S "TEN COMMANDMENTS"

13. The following "Ten Commandments" for the operators of the Buda 6-DTG-317 generator sets, if practiced, will not only lengthen the life of the engine, the generator and control unit, but will free the operator from minor and major troubles which, barring accidents, can be prevented by the simple precautions incorporated in these "Ten Commandments".

I. Know your Buda generator set. Read this operator's manual and follow its simple directions.

II. At all times, keep the engine and its accessories, as well as the main generator and the control unit, clean. An operator who frequently cleans his machine discovers major troubles in the making, caused merely by loose fasteners or loose and leaking connections.

III. Keep the fuel tanks clean. Water and dirt in the fuel oil cause more trouble and service interruptions than any other factor. Handle the fuel with extreme care. Strain the fuel thoroughly to eliminate all water and dirt. Do not depend entirely upon your fuel oil filter. The use of a funnel equipped with 200 mesh wire screen is the most satisfactory insurance against foreign material entering the fuel oil tank. Use only the Diesel fuel of correct specifications as given in paragraph 14.

IV. Keep the radiator filled with clean water or suitable anti-freeze. For continuous load, keep the water temperature at or above 160° F. Never add water to an overheated engine, and never run the engine without water in the cooling system.

V. Use only the oil of recommended viscosity and change the lubricating oil every 64 hours.

VI. Warm up the engine slowly. Never race a cold engine.

VII. Keep the engine within the recommended speed range. Do not overload.

VIII. Because 90% of all engine wear is due to abrasive dust and dirt in the air, wash out and replenish the oil in the air cleaner and crankcase as often as recommended.

IX. Do not over-lubricate the main generator. Most generator trouble is the result of over-lubrication. Lubricate the generator and exciter only as often as is recommended. See paragraph 17.

X. Protect the generator from rain and snow. Moisture plays havoc with the insulation and windings of the generator. When moving the set in from the outdoors for inside operation, do not remove the cover protecting the unit until it has acquired room temperature. Thus condensation is prevented from settling internally or externally on the generator.

LUBRICATION GUIDE

GENERATOR SET, PORTABLE DIESEL
SKID MOUNTED, 30 K.W.
(Buda Model 6-DTG-317)

TABLE OF CAPACITIES AND LUBRICANTS TO BE USED

UNIT	CAPACITY (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		Above +32° F.	+32° F. to 0° F.	Below 0° F.
Crankcase	8 qt. (Includes oil filter capacity)	**OE** SAE 30	**OE** SAE 10	Refer to EFSB L-1000-D

IOTES . . . Additional Lubrication and Service Instructions on Individual Units and Parts

COLD WEATHER:

or Lubrication and Service below 0° F., refer to EFSB L-1000-D.

HIGH TEMPERATURE:

or Lubrication and Service above +90° F., refer to EFSB L-1000-E.

. **HOURS** — The hours indicated are for normal service. For extreme conditions of heat, and dust, change crankcase oil and lubricate more frequently.

. **AIR CLEANER** — Every 8 hours, or every 4 hours in extremely dusty conditions, clean and refill oil cup to circular level mark with OE. Every 8 to 64 hours, depending on operating conditions remove filter assembly and clean, clean air intake pipe, and reassemble. Keep connection tight.

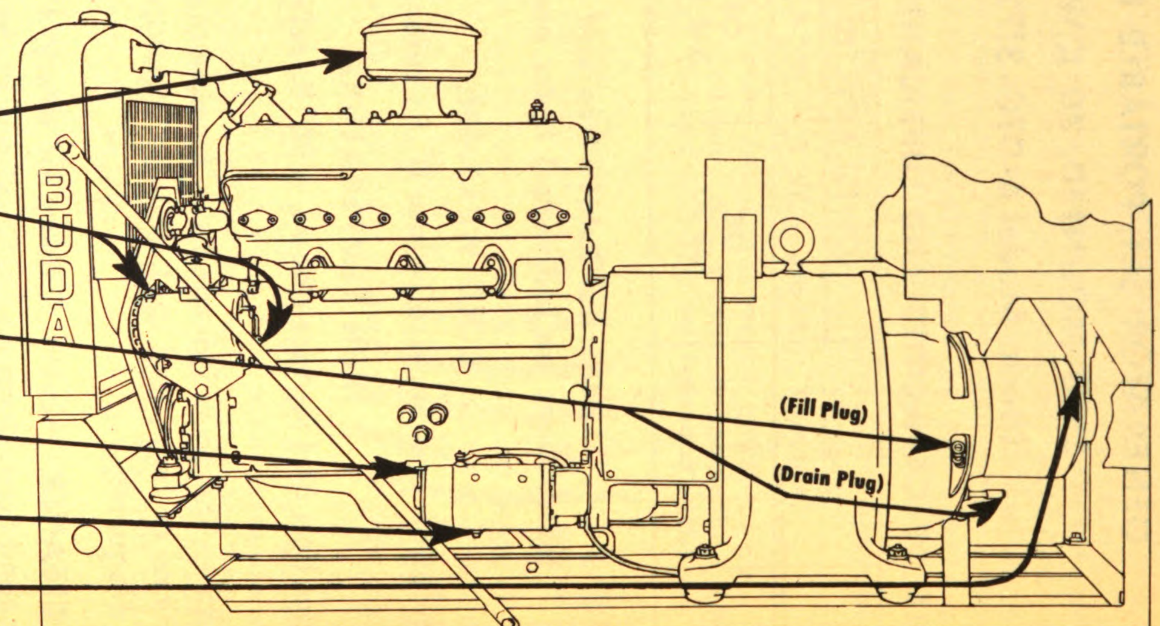
. **CRANKCASE** — Drain only when engine is thoroughly warm. Refill to FULL mark on gage. See Table. **CAUTION**: When running engine, be sure pressure gage indicates oil is circulating. For severe operation above 90° F., SAE 50 may be used. (Crankcase and Fuel Injection Pump Breathers). Every 64 hours, remove breather cap, wash and oil with OE.

When engine pan is removed for engine inspection or repair, remove and clean oil pump screen. **CAUTION:** If oil pressure drops

KEY

Lubricants		
OE—OIL, engine Crankcase grade	WB—GREASE, general purpose No. 2	WB—GREASE, wheel bearing, heavy duty No. 3

	LUBRICANT • HOURS	
Air Cleaner (Note 2)	OE	8
Generator (Sparingly) (Covered oil hole at front; oiler at rear bearing)	OE	64
Main Generator Rear Brg. (Note 7)	WB	
Starter (Sparingly)	OE	64
Crankcase Drain Plug		
Exciter Bearing (Note 8)	WB	



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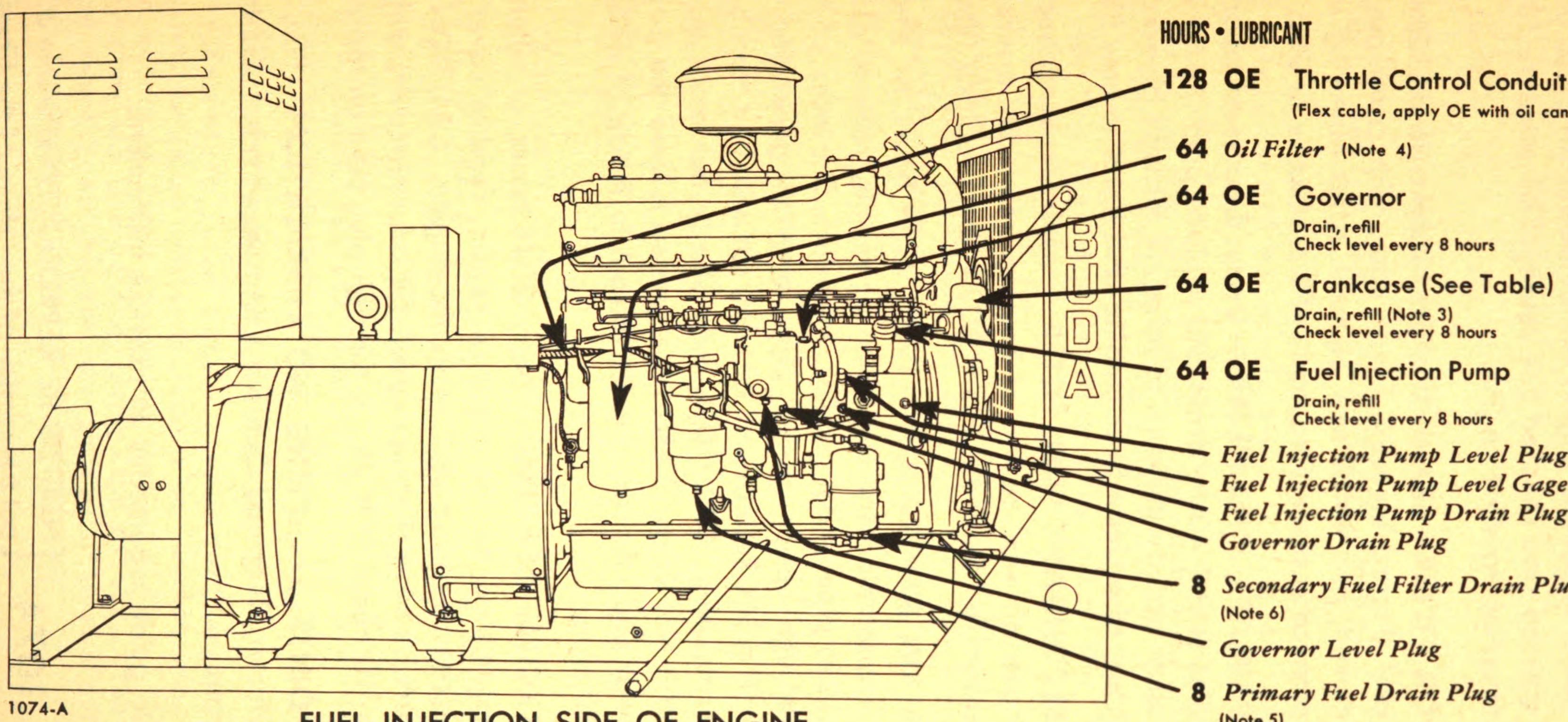
STARTER, GENERATOR SIDE OF ENGINE

KEY

Lubricants		
OE — OIL, engine Crankcase grade	WB — GREASE, general purpose No. 2	WB — GREASE, wheel bearing, heavy duty No. 3



FUEL INJECTION SIDE OF ENGINE

below 7 pounds engine will automatically stop. Unit should be inspected and checked for cause of oil pressure failure before attempting to start engine.

4. **OIL FILTER** — When changing crankcase oil, drain filter, remove and discard element. Clean case, with crankcase drain plug removed, and install new element. After renewing element, replace crankcase drain plug and refill crankcase to FULL mark on gage.

5. **PRIMARY FUEL FILTER** — Every 8 hours of operation, while engine is still warm, drain and replace plug. Remove bleed cock to allow gravity pressure to force air through bleed cock. Every 512 hours also clean filter housing and install a new filter element.

6. **SECONDARY FUEL FILTER** — After draining, replace plug and open air vent on top of housing. Manually operate fuel transfer pump to bleed air. Every 1024 hours replace filter element.

7. **MAIN GENERATOR** — Every 2048 hours, or when generator is disassembled for inspection or repair, remove grease plug from drain pipe under exciter. Introduce 2 ounces of hot OE SAE 10 through upper grease pipe, operate generator a few minutes, and drain. Repeat until all lubricant is flushed from bearing. Replace drain plug. **CAUTION:** Add slowly not more than 3 ounces of WB, No. 2, as if excessive grease is used the bearing will overheat and lubricant will be thrown to inside of generator. Replace fill plug.

8. **EXCITER BEARING** — Every 2048 hours, or when exciter is disassembled for inspection or repair, remove cover enclosing rear exciter bearing and wash thoroughly. **CAUTION:** Do not wash ball bearing. Replace cover. Fill bearing cavity with not more than 4–10 ounce W B, No. 3, through plug hole on top of bearing.

9. **POINTS REQUIRING NO LUBRICATION**—Fan, Water Pump, Starter, Rear and Outboard Bearings, Exciter and Main Generator Fans.

8-26-43

Above guide supersedes all previous instructions.

No. 1074 [NOT TO BE REPRODUCED in whole or in part without permission of the Office of the Chief of Engineers.]

Chapter III

DIESEL FUEL SPECIFICATIONS AND RECOMMENDED LUBRICATION (LUBRICATION CHART)

14. In selecting the fuel for the Buda-Lanova Diesel engine, the following points should be considered: (1) It is important that the fuel selected has a sufficient body to properly lubricate the fuel pump plungers and valves, since these obtain their lubrication from the fuel itself. Improper lubrication will cause rapid wear or sticking plungers and valves. (2) The pour test must be low enough to flow freely at the prevailing temperature. (3) The fuel must be free from water and dirt. Water and dirt cause more Diesel engine trouble than any other one factor.

The fuel selected can be a cracked residual, a blend, or a straight run distillate providing it comes within the scope of the following specifications:

Fuel Oil Specifications

Gravity A.P.I.	.30-35
Viscosity, Saybolt Universal at 100° F.	.35-40
Flash F° Min	.150° F.
Diesel index	.48.5 to 65.5
Cetane number	.46-60
Pour	.0° F.
98% Recovery	.700° F.
Water and sediment	.Trace
Ash max.	.02
Conradson carbon, max.	.03
Sulphur, max	5

Note: It is not alone sufficient to obtain a good grade of fuel, but is of greater importance that every precaution to keep it clean be taken in handling. Be sure that the containers are free from rust, sediment, and water. Filter elements should be cleaned regularly and replaced at given intervals as explained in paragraphs 69 and 70.

15. LUBRICATING OIL RECOMMENDATIONS FOR THE ENGINE

Because lubrication is so vital to efficient engine performance, one of the first concerns should be lubrication. The engine should not be allowed to become anemic either from the lack of oil or from the use of the wrong kind of oil. The following are the specifications for the grades of crankcase oil recommended for the range of temperature indicated.

LUBRICATION

	Capacity (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		Above +32°F.	+32° to 0°F.	Below 0°F.
Crankcase	6 qts.	OE S.A.E.30	OE S.A.E.10	See ¶16 below. Refer to EFSB 1000-D

HIGH TEMPERATURE: Engines operating in high temperatures and under heavy load conditions for long periods of time consume more oil. Hence, crankcase oil level should be checked and crankcase refilled more frequently than normally. If OE (S.A.E. 50) is available it may be used. Always be sure to bring oil level to FULL mark on the gauge. (Refer to EFSB L-1000-E).

NOTE: If unit is operated indoors where the temperature readings will be higher than if operated outdoors where the prevailing temperature is lower, judgment should be used in selecting the oil required for the indoor operation.

16. COLD WEATHER

In temperatures below 0°F, the engine crankcase should be drained at the end of the day's operation. Before the start of the next day's operation, the oil should be heated to 180° before pouring it back into the crankcase. No special preparation need be made for operating the main generator in cold weather. The greases recommended for the main generator are suitable for operation at below zero temperatures. (Refer to EFSB 1000-D).

17. MAIN GENERATOR LUBRICATION

The alternator and the exciter are shipped from the factory with the proper quantity and grade of grease in the bearings to last for a period of approximately 4,096 hours of operation at rated loads and temperatures. At the end of 4,096 hours of operation, the grease should be replaced.

18. RECOMMENDED GREASE FOR ALTERNATOR AND EXCITER

For bearing housing and ball bearings:

Use WB - Grease, general purpose, No. 2.

For labyrinth groove:

Use WB - Grease, wheel bearing, No. 3, heavy duty.

19. MAIN GENERATOR BEARING HOUSING GREASE CAPACITIES

Alternator	Exciter
1/2 full = 3 ounces	4/4 full = .4 ounces
1/3 full = 2 ounces	

NOTE: A column of grease 8" long and 1/8" in diameter will weigh approximately one ounce. This can be used as a guide when regreasing is necessary and when a grease cup of known capacity is not available.

20. HIGH OPERATING TEMPERATURES

NOTE: The recommended greases are on the basis of actual bearing temperatures under 194° F. (90° C.). If operating and climatic conditions are such that the bearing temperatures exceed 194° F. (90° C.), the grease should be changed more frequently. The following is recommended:

195° F. to 225° F., change every 2048 hours.

21. REMOVING OLD GREASE FROM MAIN GENERATOR AND ADDING NEW GREASE

To remove the old alternator bearing and housing grease, introduce hot oil OE (S.A.E. 10, over 2 ounces) in the housing and run the machine for a few minutes to allow the oil to thin out the grease. Remove the drain plug and drain as much as possible. See Figure 8. Replace the drain plug and repeat this operation as often as is necessary to remove all the grease. Let the generator run for a few minutes with the drain pipe open in order to remove any flushing oil that may be trapped. Replace the drain plug and with the machine running, add grease in the quantities given in Paragraph 19. Add grease slowly.

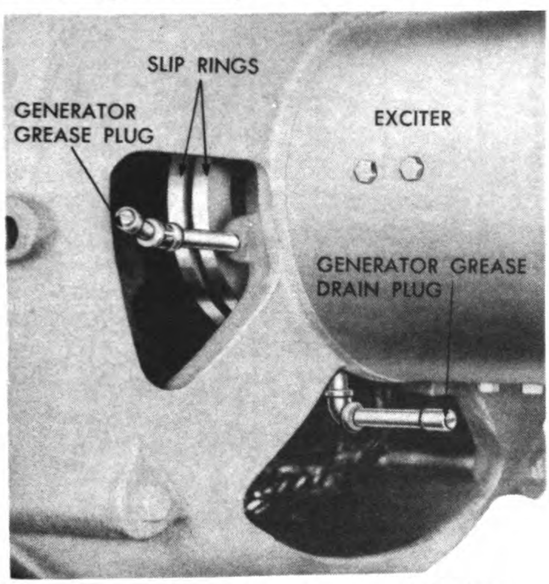


Figure 8. Location of Main Generator Grease Plug

CAUTION: Do not overlubricate and do not allow dirt and grit to enter the bearing housing. Keep grease and greasing equipment clean. If grease is added in excess of the quantities indicated, the bearing will overheat and throw grease inside the generator. Should this excess grease thus thrown find its way to the collector ring or commutator, it will seriously affect the operation of the generator and may even cause complete failure.

The use of high pressure grease guns should be avoided if at all possible since there is no accurate method of determining the amount of grease being introduced into the bearing housing. In the absence of grease cups, it is suggested that a screw type grease gun with a straight nozzle be used. Before using, however, the amount of grease expelled per turn of the grease gun screw should be ascertained. If a grease cup of known capacity is available, this can be screwed into the filler pipe and used instead of a grease gun.

22. REMOVING OLD GREASE FROM EXCITER BEARING HOUSING

The exciter bearing, being of the full sealed type, requires a somewhat different treatment in removing the old grease than that described for the main generator or alternator under Paragraph 21.

The exciter bearing housing has no drain. Therefore, the end bracket should be removed and the grease washed from the bracket and bracket cap with clean unleaded gasoline or kerosene. See Figure 9. Do not wash out the ball bearing. After the bracket is replaced, completely fill the bracket cavity with grease (.4 ounces).

23. LUBRICATION CHART

For all points of the generator set to be lubricated, the lubricants recommended, and periods of lubrication, a complete chart is shown on the next page.

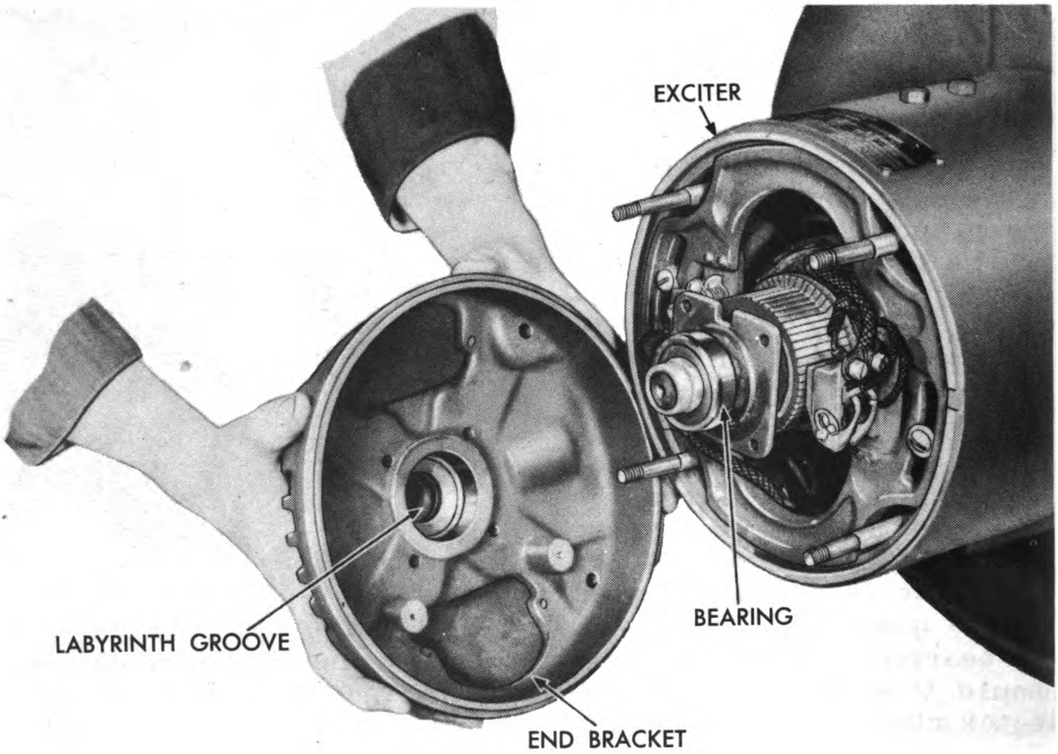


Figure 9. End Bracket of Exciter Removed for Lubricating Bearing every 2,048 hours.

HOW OFTEN	WHAT AND WHERE TO LUBRICATE	LUBRICANT NEEDED
Every 8 operating hours.	Air Cleaner Clean and refill with fresh oil	Engine oil. OE, crankcase grade. See Paragraph 56
Every 64 operating hours.	Crankcase Oil filler and breather (Drain out old oil)	8 quarts of oil of the recommended viscosity. See paragraph 15.
	Fuel Injection Pump Oil filler and breather cap (Drain out old oil)	Engine oil OE, crankcase grade. (When oil flows out of drain cock, level is reached.)
	Generator (Battery Charging) (1 oil cup and 1 oil hole)	5 to 6 drops of OE, crankcase grade.
	Governor Oil plug (Drain out old oil.)	OE, crankcase grade. Fill to oil level
	Lubricating Oil Filter	Renew oil filter cartridge.
	Starting Motor (Oil cup)	Engine oil. OE, crankcase grade
Every 128 operating hours.	Control Cable (Throttle) (To apply, flex cable)	Engine oil. OE (S.A.E. 10)
Every 2,048 operating hours.	Main generator and Exciter	See paragraph 20.
Every 4,096 operating hours.	Main Generator and Exciter	See paragraph 17.

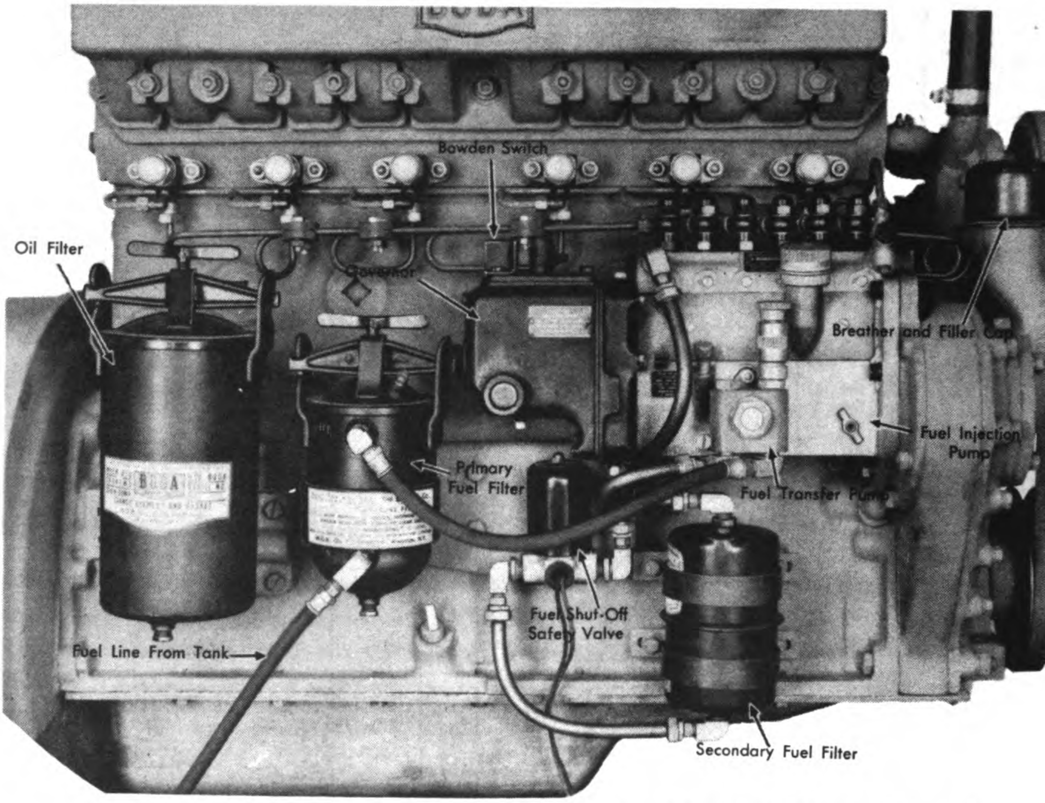


Figure 10. Right Side of Engine Showing Location of Fuel Filters and Injection Pump

CAUTION: This equipment employs high voltages which are dangerous and may be fatal if contacted by the operating personnel. When working on the equipment always ground every part before touching it.

Chapter IV

INSTALLING AND OPERATING THE GENERATOR SET

24. The Buda 6-DTG-317, 30 KW, Diesel-powered generator sets are thoroughly tested and inspected before leaving the factory. The crankcase and radiator are drained for shipment.

Before putting a new generator set into operation, or one that has been stored and drained, certain steps are necessary to discover sabotage or any damage that might have occurred during shipment or storage. See Chapter VII, paragraph 115 for engines that have been stored for any length of time or have been in transit for any prolonged period. Part of the inspection can be made during unpacking.

NOTE: If a generator set is brought from cold surroundings into a warm room, it should be kept covered until its temperature has risen to room temperature so as to prevent condensation on the windings and other parts.

25. UNPACKING GENERATOR SET

The generator set, fuel tank, and battery water are shipped from the factory in three boxes. Each is marked as to contents, weight, etc.

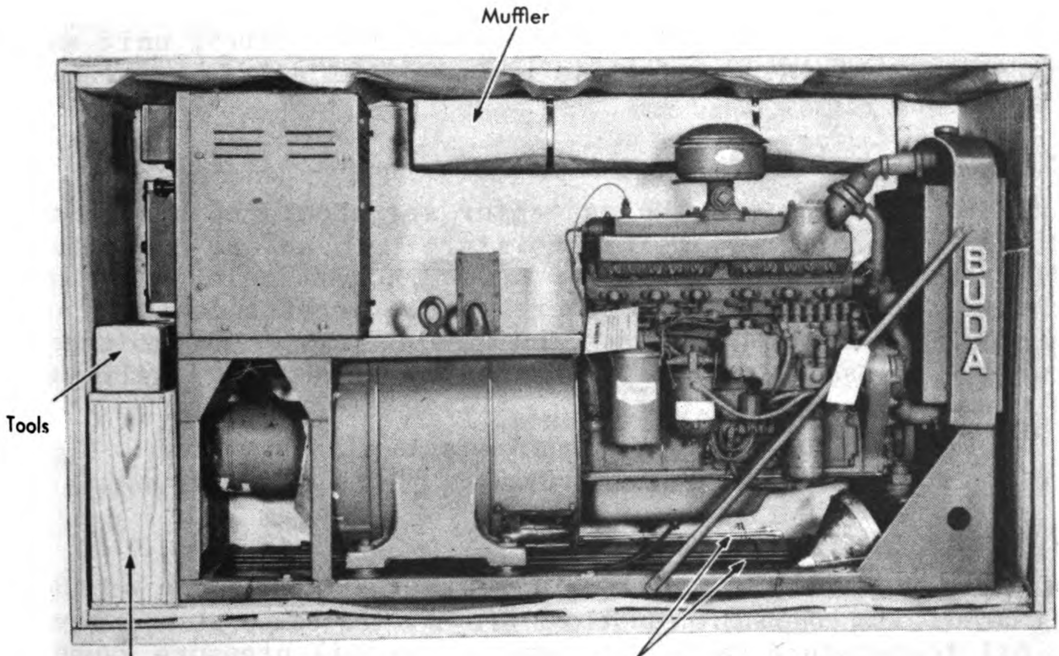


Figure 11. Generator Set Boxed for Shipment with One Side Removed

To unpack the generator set, first remove the three cover bolts, then remove the top. **CAUTION:** The top has the muffler attached to it. See Figure 11. After the top is removed, the ends can be taken off, then the sides. Remove the pipes, funnel, crank, batteries, tool kit, and spare parts which are secured in the same box with the generator set. The generator set is secured to the skid with six carriage bolts. Remove the nuts and lift the generator set off the skids. Remove the water proof paper from the generator.

26. INSPECTION OF GENERATOR SET

1. First make a visual overall inspection of the generator set. Look for broken or loose electrical and hose connections, or loose bolts and capscrews; see that the air cleaner clamp is tight so that no dirt can be sucked in because of the loose connection.

2. Check the fins and passages between the tubes of the radiator to be sure that they are free from any dirt or foreign matter that might restrict the flow of air between the radiator tubes.

3. Remove the cover band around the flywheel housing and coupling to see that there are no loose bolts in the coupling. Also check to see that no foreign objects are inside the generator.

4. Crank the motor by hand to see that it turns freely.

5. Remove the left side panel of the control unit and inspect the wiring connections and see that all fuses are in place. See Figure 17.

27. INSTALLATION OF THE GENERATOR SET

The location of the generator set should be such that it will be protected against moisture both before and after erection. Water or steam from leaking pipes, rain, snow, or condensation from the atmosphere should be excluded. It is particularly important to keep the windings dry, since moisture lowers the insulation resistance and increases the likelihood of a breakdown.

It is important that the machine's location is level. Figure 12 is an outline dimensional drawing of the generator set.

28. PANEL INSTRUMENTS AND CONTROLS

The instruments used to indicate the efficiency of the engine and its component functions are a water temperature gauge, an oil temperature gauge, an ammeter, an oil pressure gauge, and a tachometer. See Figure 13.

a. Water Temperature Gauge

The water temperature gauge indicates the temperature of the cooling liquid, and before operating the engine under a load,

Figure 12.

Figure 12.

Figure 12.

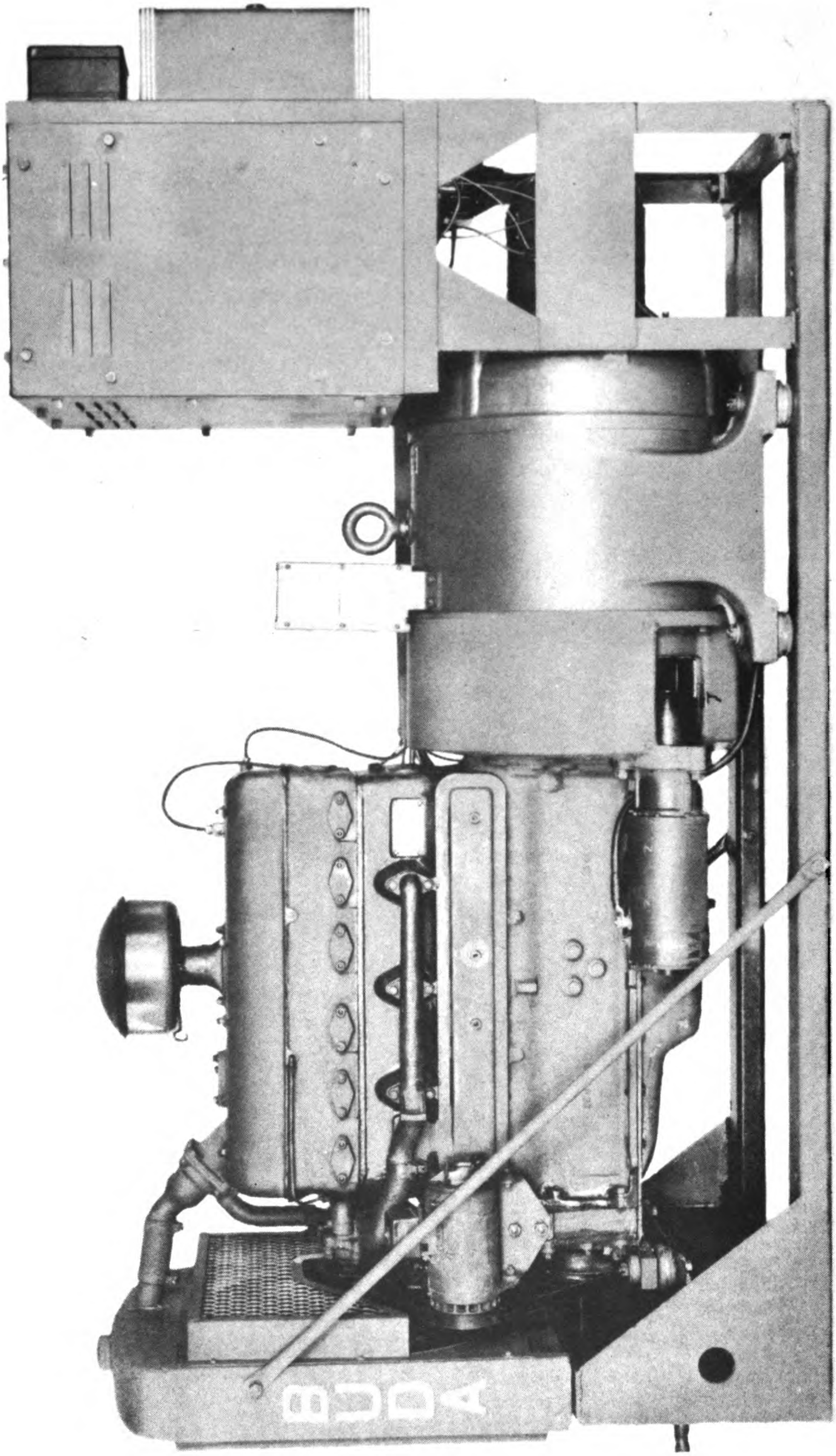


Figure 12A. Left Side View of Generator Set and Control Unit.

the temperature should be between 100° to 120°. For continuous load, the water temperature should not be allowed to go below 165° F. The water temperature should not exceed 200° F. If the water temperature exceeds 205° F., the unit will automatically shut down.

b. Oil Temperature Gauge.

The oil temperature gauge indicates the temperature of the oil. Check unit carefully for proper grade and level of oil as well as engine condition, if temperature exceeds 250 F.

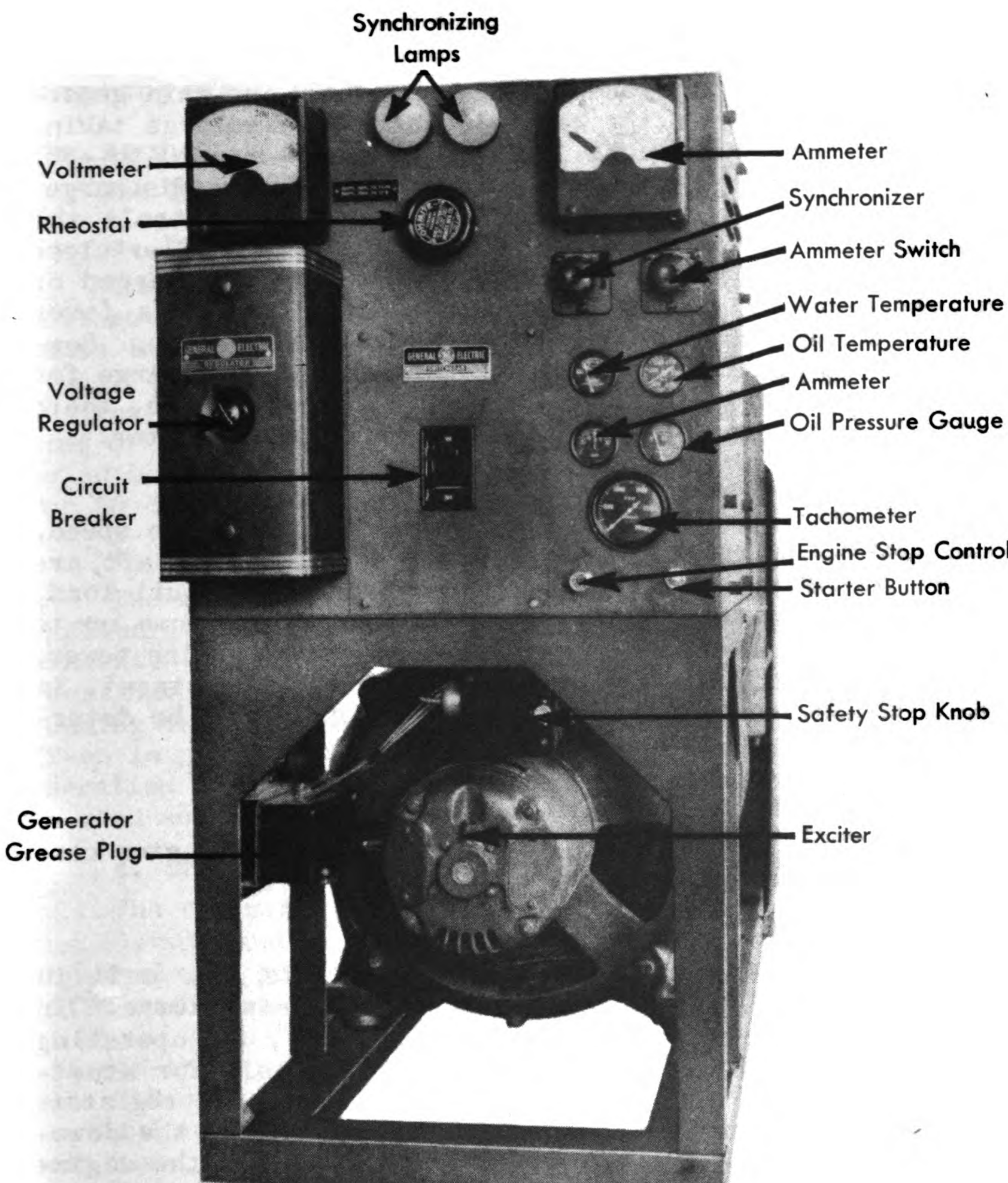


Figure 13. View of Control Panel

c. Oil Pressure Gauge

The oil pressure gauge indicates whether or not the proper amount of oil pressure to lubricate satisfactorily the internal workings of the engine is being delivered. The oil pressure gauge should indicate 25 to 35 pounds under normal operating temperatures with oil of the recommended viscosity.

NOTE: If the oil pressure drops below 7 pounds, the unit will automatically shut down.

NOTE: If the engine stops operating because the oil pressure has dropped below 7 pounds or the water temperature exceeds 205^{o}, determine the cause of the shut down and correct the trouble, check water and oil level, and temperature, before attempting to restart the unit.

d. Ammeter (Battery)

The engine ammeter, as distinguished from the main generator ammeter, indicates the rate of charge or discharge taking place in the battery circuit. The readings are from 0 to +30, which indicates charge, and 0 to -30, which indicates discharge. Because the voltage regulator on the generator controls the rate of charge, it is common for the reading to be at 0 or close thereto. This indicates that the battery is fully charged or in a high state of charge. If high reading continues (over +10) this indicates trouble with the voltage regulator. However, a run-down battery will take a higher rate of charge for a few hours. If the reading shows high on the discharge, there is a short somewhere between the ammeter and the generator.

e. Tachometer

The tachometer is an instrument by which the engine speed, or the revolutions per minute (R.P.M.) of the crankshaft are checked. For instance, at 60 cycle operation under full load, the reading should be 1800 R.P.M. If it fails to come up to 1800 R.P.M., it indicates an overload or a loss of engine power, or it may indicate that the governor is out of adjustment, in which cases the causes for the drop in R.P.M. should be determined and corrected.

29. ENGINE CONTROLS

The controls governing the engine are: safety engine control switch, engine stop control, and starter button.

a. Safety Engine Control Switch

The safety engine control switch protects the unit in the case of low oil pressure or high engine temperature. In order to permit the switch to function properly, the operating knob is turned with the arrow pointing to the left for starting. As soon as the engine starts and the oil pressure registers on the gauge, the knob should turn automatically in the downward position. This will permit the switch to stop the engine in case of failure due to low oil pressure or high water temperature.

b. Stop Control

The stop control is connected directly to the arm of the engine governor. When it is depressed all the way in, it allows the engine to operate at the speed for which the governor is set. When it is pulled all the way back, the flow of fuel through the injection pump is shut off, thus causing the engine to stop. See Chapter VI, Paragraph 73 for further details on how the fuel injection pump operates. When it is necessary to operate the engine at half speed, preliminary to warming up the engine during cold operating temperatures, the stop control can be pulled half way out to operate at about 900 R.P.M.

c. Starter Button

The starter button is used to close the starting motor circuit to crank the engine. As soon as the engine starts running, the starter button should be disengaged.

30. MAIN GENERATOR INSTRUMENTS AND CONTROLS

The instruments and their functions are as follows:

a. Voltmeter

The voltmeter for the main generator indicates the phase voltage on 60 cycles and voltage to neutral on 50 cycles. Because the voltage regulator will automatically adjust the voltage to a value determined by the setting of the voltage adjusting rheostat on the front of the regulator and by the setting of the exciter field rheostat, the generator voltage should be adjusted at no load to 228 volts, 60 cycles, and 238 volts for 50 cycles, as indicated on the voltmeter.

b. Ammeter

The main generator ammeter indicates only as the load is applied and shows the amount of current flowing through the circuit. The synchronizing lamps are necessary when parallel operation is desired between two units. Further details in reading the main generator instruments and adjusting them are given in paragraph 34 as it is necessary that the engine be in operation and the electrical connections properly made in order to read and adjust the generator instruments.

c. Circuit Breaker

The circuit breaker, as its name implies, opens or closes the circuit and also provides for overcurrent protection and undervoltage protection. The circuit breaker should be in "off" position whenever the engine is started and should not be moved into "on" position until after the engine has been started and the necessary electrical connections made to operate. When the generator is to be taken out of operation, it is wise practice to first move the circuit breaker to "off" position. (Always slow down the engine to an idling position by pulling the stop control half way out and allow the engine to idle a few minutes before stopping. This allows the engine to cool off gradually so the temperature of the contracting parts will remain approximately the same.)

NOTE: When it is desired to disconnect one unit from the line that has been operating in parallel with other units, make sure the circuit breaker is first opened before attempting to stop or slow down the engine.

NOTE: A safety interlock is provided on the governor which is engaged by the governor lever when the stop button is pulled all the way out. This provision is made in order to make sure that the breaker is open when the engine is stopped.

d. Voltage Regulator, Rheostat, and Ammeter Switch

The voltage regulator is used for controlling voltage, and the ammeter switch permits reading all phases of the load circuit. The load on any phase should not exceed the name plate reading of the unit. The exciter field rheostat should always be located with the pointer on the mark.

e. Synchronizer

The synchronizer switch is used when it is necessary to synchronize two units for parallel operation. The procedure for operating and using the main generator controls and instruments are given in paragraphs 34 and 35 under Operation of the Generator Set.

31. PREPARING ENGINE FOR OPERATION

1. Fill the oil pan with the recommended grade of lubricating oil, according to operating temperature, to the level indicated on the bayonet gauge, or dip stick. See Lubrication Chart, on Page 22.

2. Fill the radiator with clean soft water or a suitable anti-freeze.

3. Connect the two six volt batteries in series and connect the batteries to the unit. See the Wiring Diagram, Figure 7. Be sure the batteries are filled with electrolyte. The battery positive terminal should be connected to the ground on the engine and the battery negative terminals should be connected to the large post of the magnetic switch mounted under the control panel.

4. Connect the fuel suction line to the first stage filter inlet, see Figure 14, and the suction connection on the fuel tank. (NOTE: The suction connection on the fuel tank is the special plug which has the pipe extending to the bottom of the tank.)

5. Connect the fuel return line, from the fuel injection pump overflow (see Figure 15), to the fuel tank return opening. NOTE: The fuel tank return opening should be connected to the horizontal outlet of the "T" provided in one of the fuel tank connections and vertical outlet of this "T" should be provided with an open extension for vent purposes.

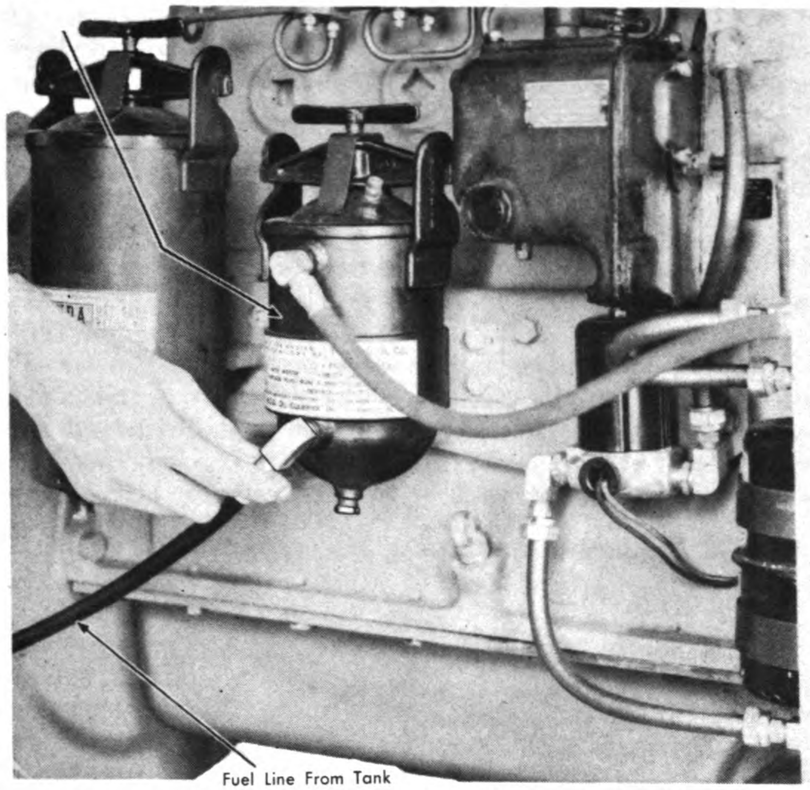


Figure 14. Connections to Primary Fuel Filter

6. Loosen the spring screw of the fuel injection pump to release overflow check valve spring tension so pump housing can be vented. Remove the fuel return connection at the fuel pump overflow (see Figure 15) and work the hand plunger on the fuel transfer pump until the air bubbles cease coming out of the loosened connection and solid fuel appears at every stroke of the pump. NOTE: Hand primer must be unscrewed (turn to the left) before it can be operated. Then replace the fuel return connection and screw down the hand plunger to the locked position. The engine is now ready for starting.

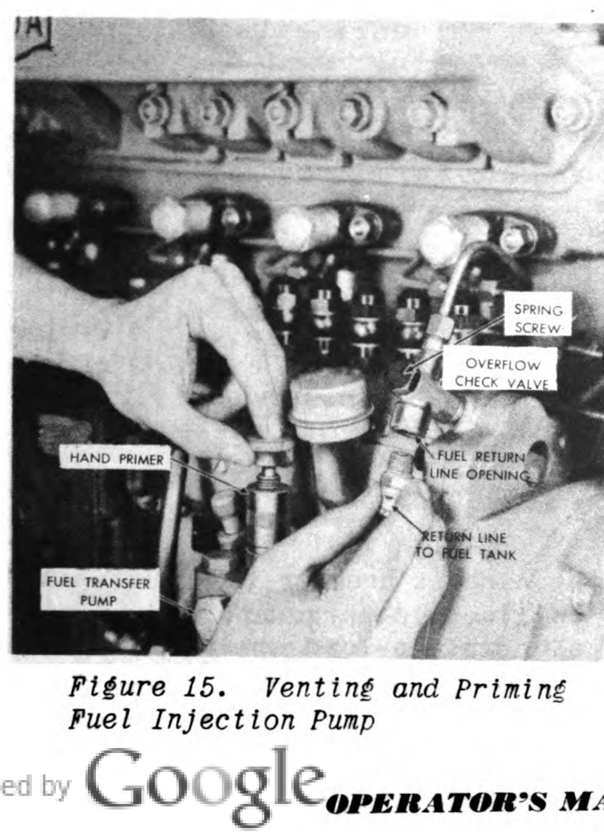


Figure 15. Venting and Priming Fuel Injection Pump

32. STARTING ENGINE

NOTE: Whether or not connections of the load have been made, the circuit breaker must be in off position when starting the engine.

OPERATING GENERATOR SET

1. Turn the safety stop knob to on position, that is, pointed to the left. NOTE: The safety stop control is mounted at the rear of the unit underneath the control panel. See Figure 16.

2. See that the engine control marked "stop" is positioned clear in.

3. Depress the starter button.

4. When the engine fires and continues firing, release the starter button and the engine will automatically come up to full speed of 1800 R.P.M. (60 cycle operation). As soon as the oil pressure registers on the oil pressure gauge, the knob on the safety switch located below the switchboard cabinet should turn automatically in the downward position. This position permits the switch to stop the engine in case of failure due to no oil pressure or high water temperature.

NOTE: If the operating temperature is cold, it will be desirable to run the engine at partial speed, from 1000 to 1200 r.p.m. until the water temperature rises to 100° or 120°. This may be done by holding out the engine stop control button and watching the tachometer to see that this reduced speed is maintained.

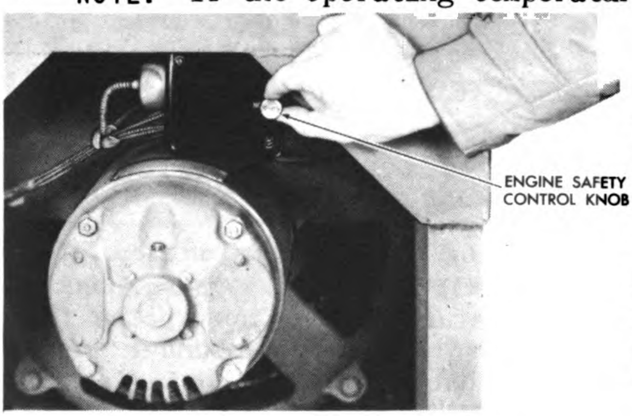


Figure 16. Location of Safety Stop Control

NOTE: After the engine is operated at no load for approximately 15 minutes, stop the engine and make the necessary electrical connections. Do not make connection with generator running.

Units shipped from the factory are connected for 60 cycle operation.

33. MAKING ELECTRICAL CONNECTIONS

In making the electrical connections, refer to the Wiring Diagram. This wiring diagram is attached to the inside of the switchboard cabinet side cover and is also shown in Figure 17 in this manual. Connect the load to terminals marked 1, 2, 3, and "N".

34. OPERATING GENERATOR SET

1. Make certain that the circuit breaker is in off position. Start the engine as outlined in paragraph 32 and permit the engine to warm up to normal no-load speed of approximately 1800 R.P.M., indicated on the tachometer.

Figure 17. Wiring Diagram of Generator Set and Control Panel

2. Adjust the voltage regulator knob for approximately 220 volts no-load, as indicated on the voltmeter.

3. Turn the exciter field rheostat so that the pointer points to the mark on the front of the panel. See Figure 13. The unit is now ready to operate under load. With the load attached, move the breaker into the "on" position.

The generator being now connected to the external circuit, the ammeter will indicate as the load is applied. The ammeter transfer switch may be turned to each of its three positions to read the current in each phase. If single phase loads are connected, the load should be adjusted in order that each phase balances as nearly as possible. This switch should be left in the position indicating the higher current.

NOTE: The generator should not be called upon to deliver more than the rated current on one phase even though the other phases are not fully loaded.

CAUTION: This unit is provided with a safety switch lock located below the switchboard cabinet. This switch protects the unit in case of low oil pressure or high engine temperature. However, in order to permit the switch to function properly, the operating knob is turned with the arrow pointing to the left for starting. As soon as the engine starts and oil pressure registers on the gauge, the knob should be turned in the downward position. This will permit the switch to stop the engine in case of failure due to low oil pressure or high water temperature.

35. PARALLEL OPERATION

These generator sets are designed for parallel operation with another unit of the same type and model. When parallel operation is desired between two generator sets, it is necessary that they be synchronized. For this purpose, each unit has a pair of synchronizing lamps and a synchronizing switch. Load lead terminals on the two units to be paralleled must be connected prior to the parallel operation to the same bus. These connections should tie points 1 to 1, 2 to 2, etc. The first generator set should be started as described in paragraphs 32 and 34 and connected to load. The second generator should then be brought to speed and its voltage adjusted. The first set should then be considered as the running machine and the second as the incoming. Be sure before starting the engine of the incoming unit that the breaker is in "off" position. On the incoming panel, the synchronizing switch should be turned to the on position at which time the synchronizing lamps will be found to flash on and off at a frequency dependent upon the difference of the speed between the units.

Synchronism is determined when the frequency of these flashes diminishes to zero and the lamps are out or dark. When this condition is reached, the two units may be connected by closing the line breaker on the incoming unit, after which the two units are parallel.

From the foregoing, it is evident that the essential necessity for correct synchronizing is the time of the closing of the incoming breaker. If the voltages are slightly apart, small cross currents will flow between the machines with no detriment to the machines and very little voltage variation, if any, in the load circuits. However, if a phase displacement exists at the time of closing the breaker of the incoming machine by reason of closing when partially out of phase, more or less severe jolts will be felt by the generators. With a little experience and care, the operator can so anticipate the breaker closing movement with the slowly oscillating lamp outages that the breaker can be closed when the lamps are dark.

After the total load has been applied, turn the knob on the voltage regulator until each unit shows the same current on the ammeter. Taking ammeter readings, make sure that the phase on each unit registers current on the same phase as indicated by the phase switch. Make sure that the stop button is pushed all the way in after synchronizing has been made.

NOTE: If it becomes necessary to adjust the governor for synchronizing speeds, make certain that all units to be synchronized have the same speeds and voltage at no load. In making this check, permit the generator sets to operate until the temperature of each is approximately the same. Although the tachometer on these units indicates the operation at the speed indicated, this is not always accurate enough for synchronizing. In order to obtain greater accuracy, permit the units to operate at no load with one unit connected to the load bus and the synchronizing light on the other unit in the "on" position. This will permit the lights to blink and indicate the relative speeds of each unit. With each unit operating at no load, the synchronizing lights should blink very slowly. Adjust the governor, if necessary, on one of the units until this condition is obtained. To adjust the governor, loosen the locknut on the adjusting screw at the front of the governor, as shown in Figure 18. Adjust this screw until the desired synchronization is obtained.

36. DISCONNECTING PARALLEL OPERATION

When it is desired to disconnect one unit (generator set) from the line that has been operating parallel with other units, be sure the circuit breaker is first opened before attempting to stop the engine. A safety interlock is provided on the governor which is engaged by the governor lever when the stop button is pulled all the way out. This provision is made in order to make sure that the breaker is open when the engine is stopped.

37. 50 CYCLE OPERATION

If it is desired to operate the generator set on 50 cycles, it will be necessary to remove the 100 A. thermal ele-

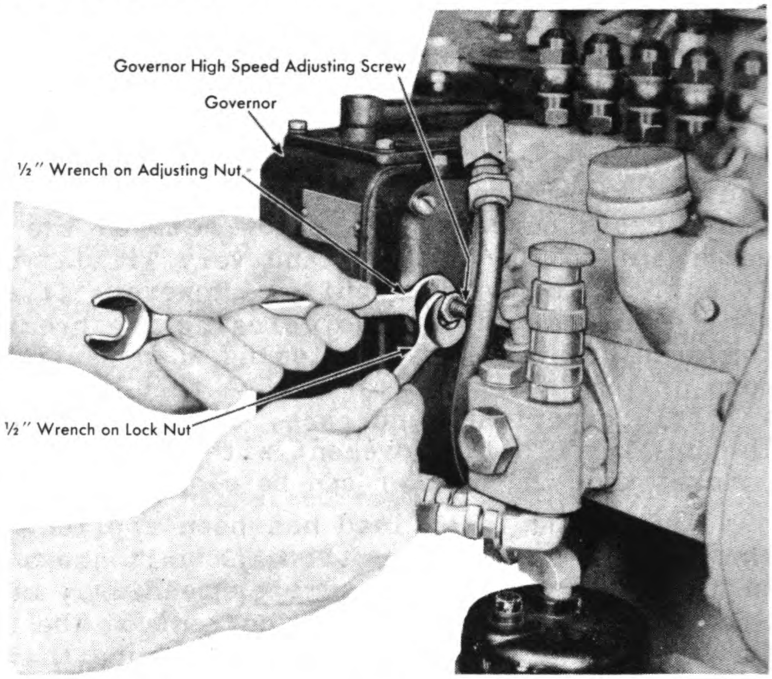


Figure 18. Adjusting Governor for Synchronization

ment in the air circuit breaker and install the spare 50 A. thermal element which is mounted on the right side of the control cover.

38. PROCEDURE FOR REMOVING TRIPPING ELEMENT OF AIR CIRCUIT BREAKER

Remove the steel cover plate on panel. Remove the four holding screws on breaker cover and remove cover. Then remove the undervoltage device by the two holding screws and pass undervoltage device to the right. It will hang by its two external leads outside the breaker. Remove the three lead holding screws of the movable contacts of the breaker. Remove the breaker operating handle. Then raise the trip element slightly so as to disengage the element from the breaker and remove.

The spare element is fastened to a right side cover and, when changing elements, the unused element should be bolted to the cover.

If it is desired to remove the breaker from the unit, leads should be disconnected at the back, the undervoltage leads disconnected and withdrawn from their clips, and the front cover removed after which remove the four rear holding screws which frees the breaker from its supports.

When replacing the removable handle, care should be taken to see that the white "position" line is at the bottom or the letter "T" molded in the handle, is right side up.

The four holding screws of the front cover of the breakers should be equally and lightly tightened to avoid strains. It is important that they be progressively tightened as one would tighten the rim bolts of a car wheel. The steel cover on the panel front should be placed to give an equal clearance between it and the breaker boss before tightening.

39. CHANGEOVER FROM 60 CYCLE TO 50 CYCLE OPERATION

The changeover from the 60 cycle to 50 cycle operation is made as follows:

1. Remove the front cover on the terminal box located on top of the alternator.

2. Change the links on the terminal board in line with the instructions on plate attached to the terminal box, or see Figure 17, wiring diagram.

3. Remove the knob and cover from the voltage regulator. Change the slide wire terminal on the small resistor at the lower left of the regulator to position marked 50 cycles.

4. Remove the side cover from the switchboard cabinet and with the wiring diagram as a guide, reconnect wires marked "A", "B", and "C" to the position as shown in the marginal information. (This information is given at the upper right hand corner of the wiring diagram, Figure 17).

5. Start the engine according to the instructions in paragraph 32, making certain that the circuit breaker is in off position.

6. Loosen the locknut on the adjusting screw at the front of the governor as shown in Figure 18. Loosen this screw until the engine operates at approximately 1500 r.p.m. at no load. The generator set should now be ready to operate on 50 cycles, 230-400 volts. All covers should be replaced and securely fastened.

40. SAFETY MEASURES TO BE OBSERVED DURING OPERATIONS

1. Do not use inflammable cleansing fluid on or around the machine while it is in operation. A spark from the machine may ignite the fluid.

2. Do not attempt to make changes in the connections of the machine while it is in operation. Always stop the generator set before connection changes are to be made.

3. Do not wipe the machine with rags, etc., while it is running. The wiping cloth may become caught in a rotating part resulting in possible injury to the operator and damage to the machine.

4. When it becomes necessary to polish the collector rings and commutator, the machine should first be stopped so that the operator may observe the safest position for the hands or the fingers.

5. Do not attempt to polish both collector rings at once as particles of the metal may become imbedded in the sandpaper, thereby creating a metal bridge across the two collector rings. Polish one ring at a time. See paragraph 91.

41. HAND OPERATION OF CONTROL UNIT

If it is desired to transfer the generator to hand control of voltage from that normally supplied by the voltage regulator and the generator is running, turn the exciter field rheostat in slowly till the voltage begins to fall. The voltage adjusting rheostat then should be turned to increase the resistance after which the regulator is out of circuit and the voltage may be controlled by the exciter field rheostat alone To return to regulator control, turn the voltage adjusting rheostat back slowly to its normal position and move the exciter rheostat in turn slowly back to its normal setting. After this operation the regulator will again operate in its former manner.

42. INSTRUMENT TRANSFORMERS

The three line transformers are single secondary transformers having a 24:1 ratio with 5 Amp. secondary. The compensating transformer has a 24:1 ratio with 5 Amp. mid-tap secondary to permit proper current for compensation at both voltages of operation. Lead A at the terminal board is connected to the full winding on 60 cycle operation and the mid-tap for 50 cycle operation.

Chapter V

CARE OF ENGINE AND GENERATOR

43. To maintain the efficiency of this Buda 6-DTG-317 generator set, it is necessary that the operator inspect, lubricate, and care for the generator set at regular intervals. Regularity in lubrication and other normal maintenance will eliminate the development of serious trouble and unnecessary delays.

Here let it be noted that distinction is made between the maintenance, adjustments, and minor repairs which the operator can and should normally perform, and such major repairs and overhauls which must be performed by the maintenance men or mechanics who have the necessary tools, equipment, and special data. Such information is contained in the maintenance manual for this engine.

The maintenance and minor repairs which is within the scope of the operator is called Operator Maintenance. The maintenance that requires special tools, data, and skill is called maintenance repair.

Because operating conditions may vary, it is somewhat difficult to lay down rigid rules as to the time intervals when lubrication and other maintenance be done. However, the following recommendations of what to do, and when, can be followed under almost all operating conditions.

If it becomes necessary to make adjustments or repairs, detailed instructions for so doing are given in Chapter VI under the particular part of the engine or generator needing such adjustment or repair.

44. TOOLS AND EQUIPMENT NEEDED BY THE OPERATOR

Furnished as a part of the Buda Model 6-DTG-317 generator set is a tool kit containing the following tools:

1 - Brown canvas bag	
1 - Hammer	9" handle
1 - Pliers	6"
1 - Wrench adjust. end	8"
1 - Wrench adjust. end	10"
1 - Pipe wrench - Adjust.	10"
1 - Open end wrench	Sizes 7/16 x 1/2
1 - Open end wrench	Sizes 9/16 x 5/8
1 - Open end wrench	Sizes 3/4 x 13/16
1 - Open end wrench (cyl. head)	Sizes 15/16 x 1"
1 - Screw driver	7-1/2" long
1 - Screw driver	10" long

1 - Punch pin	. . . .	
1 - Cold chisel	. . . .	1/2" x 6" long
1 - Socket wrench handle	. . . . .	15" x 1/2 drive
1 - Socket	. . . .	5/8"
1 - Socket	. . . .	3/4"
1 - Socket	. . . .	13/16"
1 - Drain plug wrench	. . . . . .	8-3/4" long
1 - Oil can	. . . .	
25 - 10 ampere - 250 volt, fuses for switchboard		
25 - 4 ampere fuses 5/8" long for battery charging generator		

In addition, the operator should be provided with the following tools and equipment; #00 sandpaper, canvas or non-linting material, feeler gauge, and a rule.

WHAT TO DO AND WHEN

45. NEW GENERATOR SET AFTER 8 HOURS OF OPERATION

1. Tighten cylinder head nuts and check all the other nuts, clamps, and connections for loose fittings and leaks, paying particular attention to the fuel injection lines.

2. Check tappet clearance - tightening of head changes clearance (.009) (.012). **NOTE:** It will be necessary to remove the rocker arm assembly to tighten cylinder head. If possible, use a torque wrench - tension in foot pounds, 95-105.

46. EVERY 8 HOURS OF OPERATION (DAILY)

1. Make a visual inspection, checking for loose connections, oil, water and fuel line leaks, loose nuts, bolts, and capscrews; check fan belt tension, oil pressure gauge; it should return to "0" if the hand is not sprung.

2. Check the water level. Radiator must be full. Use only clean soft water. If the water is hard, use a commercial water softener. Check the fins and passages between the tubes of the radiator to be sure that they are free from any foreign material that may have been sucked in by the radiator fan.

3. Check the oil level with the bayonet gauge, or dip stick, in the crankcase, and also check the oil level in the fuel pump.

4. Clean the air cleaner cup and refill with fresh crankcase oil to level indicated inside of air cleaner oil cup. See Fig.19. **CAUTION:** Inspect the clamp between the air cleaner and the intake manifold to be sure this joint is air tight so that no dirt can be sucked in through a loose joint.

5. The alternator or main generator and exciter should be wiped with a rag slightly dampened with gasoline or kerosene. **CAUTION:** See paragraph 87 for correct procedure. Be sure that all parts that are cleaned internally and externally are dried before operating the machine. Do not use gasoline or kerosene in or around the machine when it is in operation.

6. Keep the windings of the alternator and exciter clean by blowing with dry compressed air. Make sure that no moisture is in the compressed air line. Do not use air pressure in excess of 25 pounds. See instructions under Main Generator and Exciter, paragraph 89.

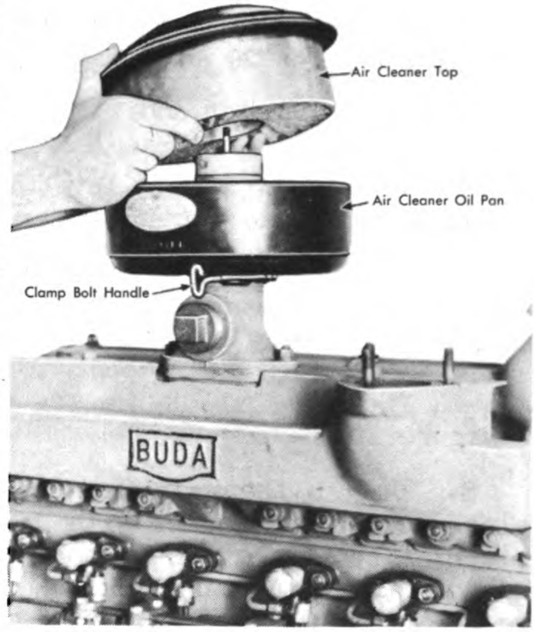


Figure 19. Removing Air Cleaner Cup

47. EVERY 64 HOURS OF OPERATION

1. Repeat the 8 hour, daily, maintenance recommendations.

2. Change the oil in the crankcase with the recommended oil. **NOTE:** Drain the old oil out of the crankcase while the engine is hot.

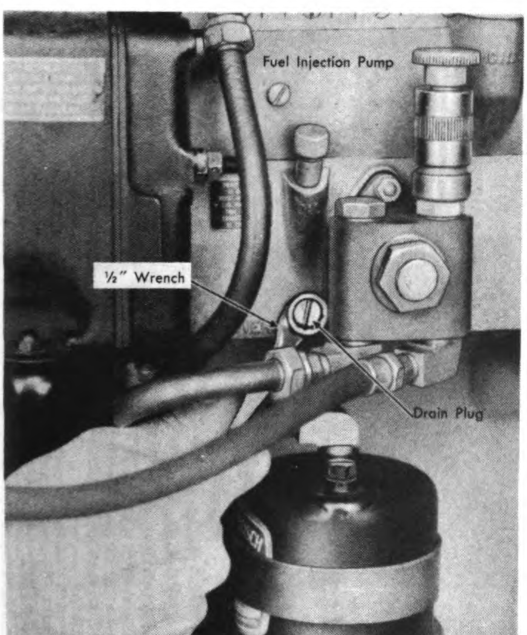


Figure 20. Draining oil in Fuel Pump.

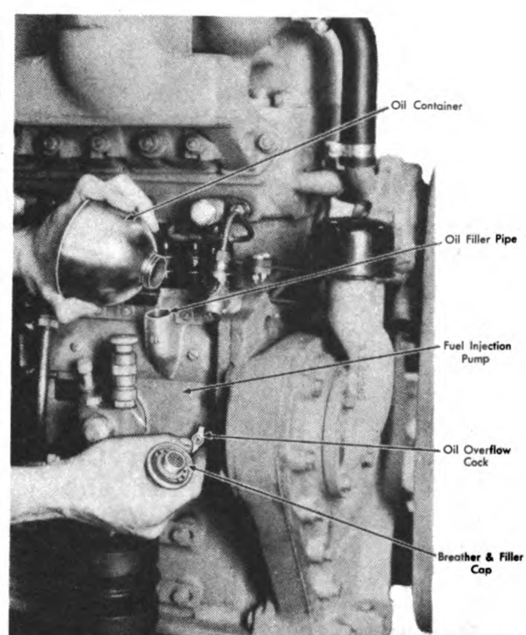


Figure 21. Refilling Fuel Injection Pump with Oil

3. Install new oil filter element. See Figure 48.

4. Change the oil in the governor and in the fuel injection pump. See Figures 20 and 21.

5. Oil generator and the starting motor with a few drops of engine oil. Do not oil excessively.

6. Check the water level of the batteries. **NOTE:** In freezing weather, do not add water after shutting down operation. Add the water at the start of operations to avoid freezing.

7. Check the control wires and cables leading to the instrument panels. Apply a few drops of oil along the surface of the flexible tube for the stop control and with your fingers, flex the tubing a little to allow the oil to penetrate through the wire. See Figure 22.

8. Polish the Main Generator exciter commutator with a piece of canvas or non-linting material. Do not use vaseline or oil on the commutator.

9. Before attempting to polish the slip rings of the alternator the brushes should be raised. Polish the slip rings with a piece of canvas or non-linting material. Do not use oil or vaseline. **NOTE:** The machine should be run at its highest speed.

48. EVERY 128 HOURS OF OPERATION

Repeat the 64 hours of operation instructions.

1. Check the valve tappets with a feeler gauge of the right thicknesses. It is necessary to remove the rocker arm cover. The recommended clearances between the rocker arm and the valve stem for a hot engine are as follows: For the intake valve, .009"; for the exhaust valve, .012", See Figure 23.

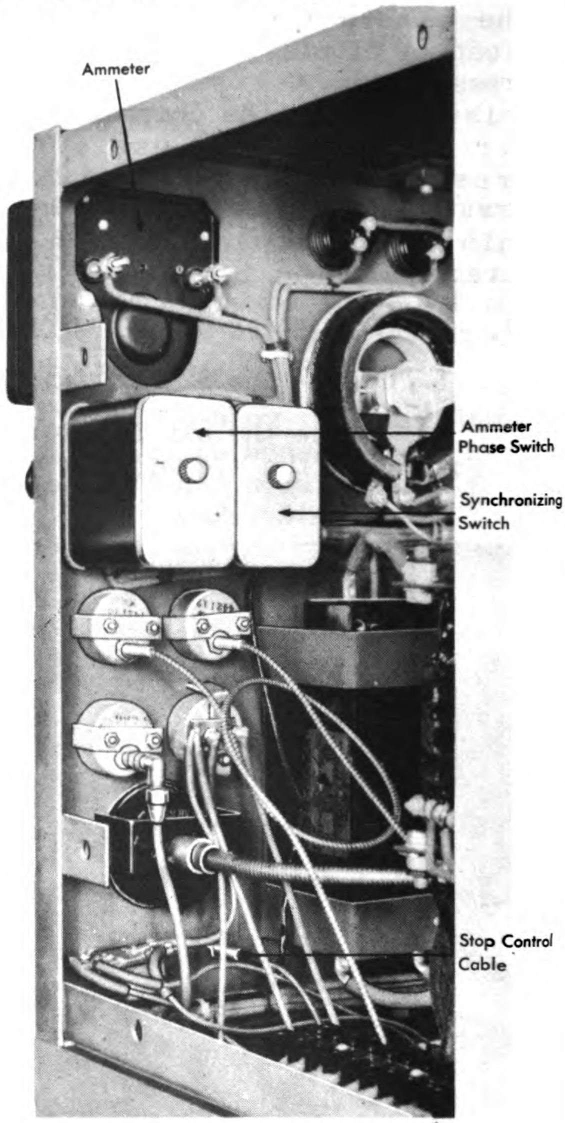


Figure 22. Rear View of Section of Control Panel

2. Inspect the commutator and brushes of both the battery charging generator and the starter motor. If commutator is dirty,

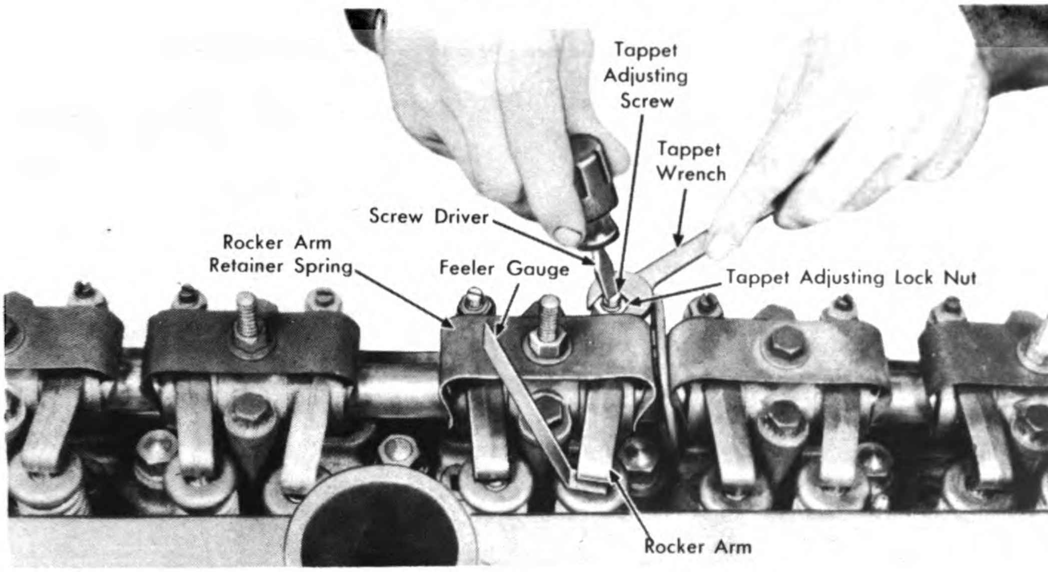


Figure 23. Adjusting the Valve Tappets for Correct Clearances

clean with #00 sandpaper. Do not use emery cloth. If brushes are worn or under improper tension, replace and adjust. Blow out dust with dry compressed air or with hand bellows to prevent short circuits, grounding, and sticking brushes. See Figure 24.

3. Check the specific gravity of each battery cell with a hydrometer. A reading of 1.250 to 1.285 indicates approximately fully charged; 1.230, half charged; and 1.150, dead. Never take a reading shortly after adding water.

4. Remove the crankcase breather and filler cover and wash in gasoline. Dip the breather in light engine oil OE, (S.A.E. 10) and let it drain before installing it on the engine.

5. Check the fan belt tension. It should be possible to pull the long side of the belt triangle out of line about 3/4". See Figure 25.

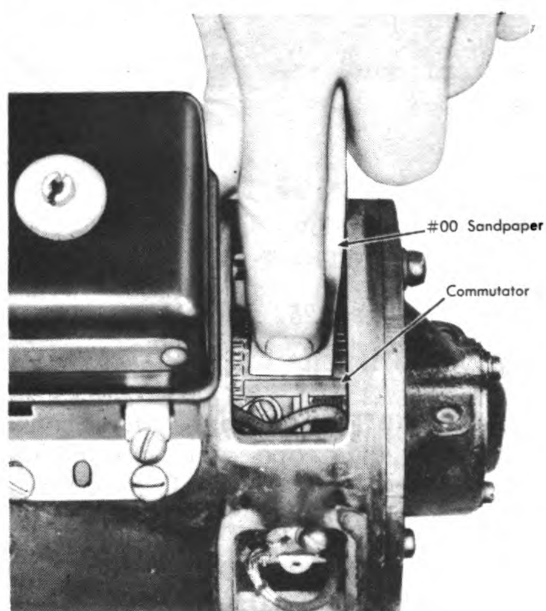


Figure 24. Cleaning Commutator with #00 Sandpaper

49. EVERY 512 HOURS OF OPERATION

1. Repeat the 128 hours of operation maintenance.

2. The injectors should be removed, inspected, cleaned, and checked, this servicing to be done by the maintenance repair per-

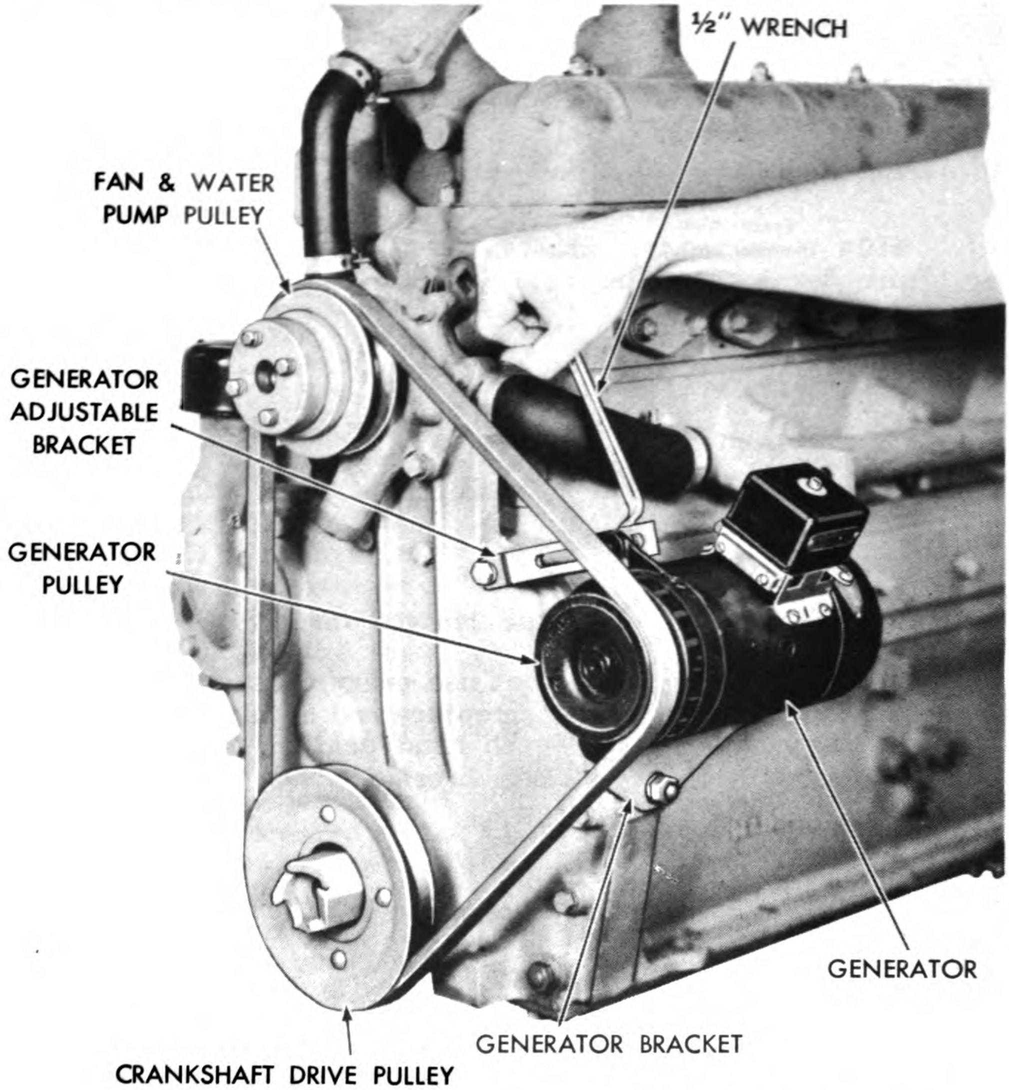


Figure 25. Adjusting Tension of Fan Belt by Shifting Generator on Bracket

sonnel. **NOTE:** As spare injectors should be a part of the regular equipment, the operator can remove the injectors to be serviced and replace with ones already so serviced. Methods for such servicing are given in the maintenance manual for this engine.

3. Inspect the alternator rings, exciter commutator, and brushes of the main generator. The brushes should be inspected for wear, proper spring pressure, and freedom in the holders. The exciter commutator should be inspected for dirt and oil on brush contact surfaces, high or low bars, carbon deposits in the undercutting grooves. A commutator in good condition will have a highly glazed appearance and show a light brown color. See paragraph 88. The alternator rings, or collector rings, should be inspected for roughness or a pitted condition.

4. Replace the primary and secondary fuel filters.

50. EVERY 1,024 HOURS OF OPERATION

1. Repeat the 512 hours of operation maintenance.

2. Clean the outside of the engine by washing with kerosene, distillate or a grease solvent. If the dirt is thick, allow to soak for ten minutes, then wash off the dirt with hose and water.

3. Remove the oil pan, wash out any sludge and clean the oil pump suction screen. Inspect the inside of the engine, checking the cotter pins and locks in the connecting rods and main bearings. Make sure that all connecting rod bolts, nuts, and main bearing capscrews are tight. Check the oil suction screen float bracket for tightness. Replace the oil pan gasket.

4. Flush the radiator with standard flushing compound.

5. Inspect the battery cables and all electric wiring. Replace frayed, worn, or oil soaked wires with new ones of the same dimensions.

51. EVERY 2,048 HOURS OF OPERATION

1. The engine and its accessories should be completely overhauled by the maintenance repair.

2. While the engine and engine accessories are undergoing overhaul, the main generator and exciter should be inspected.

3. If operating and climatic conditions are such that the bearing temperature exceeds 194°F. (90°C.) the grease should be changed. See Paragraphs 18, 19, 21, and 22.

NOTE: The instructions for the overhaul of the engine and its accessories, the main generator, and the control unit are given in the Maintenance Manual, Section II.

52. EVERY 4,096 HOURS OF OPERATION

The main generator and exciter should be lubricated according to the instructions given in Paragraphs 18, 19, 21 and 22.

Chapter VI

OPERATOR'S SERVICE ADJUSTMENTS AND REPAIRS

53. As indicated in Chapter V, there are certain adjustments and repairs which the operator must perform. These servicings are part of the normal maintenance. This chapter gives the necessary detailed instructions for carrying out these servicings and includes a functional description of the units. However, only the instructions for those servicings which come within the scope of the operator are given. Complete engine maintenance and repair instructions are given in the Maintenance Manual, Section II.

For convenience the items the operator may have to check, adjust, or repair are listed alphabetically.

A list of tools needed to make minor adjustments and repairs is given in paragraph 44 of the previous chapter.

AIR CLEANER

54. FUNCTIONAL DESCRIPTION

It is the function of the air cleaner to prevent abrasive dust, which is the chief cause of engine wear, from entering the engine. The air cleaner is of the oil bath type. The air is drawn through the filter element before it enters the combustion chamber of the engine. In order to remove the dirt efficiently, the air cleaner must be properly serviced.

55. CHECKING THE CLAMP CONNECTION

The connection between the air cleaner and the intake manifold must be kept air tight at all times. Because of normal engine vibration, the clamp should be checked daily or every 8 to 10 hours of operation.

56. TO CLEAN THE OIL CUP

The oil cup should be emptied and cleaned, and refilled with oil to the oil level bead with engine oil daily, every 8 hours of operation. See Figure 19 on Page 41. If dust conditions are exceptionally bad, it may be wise to clean the cup and refill with fresh oil every 4 hours. Check the felt gasket sealing the oil cup to the intake manifold adaptor every time the cup is removed for cleaning.

57. CLEANING FILTER ELEMENT

The air filter element and assembly should be soaked in gasoline and blown dry with an air compressor every 64 operating hours. If dirt conditions are exceptionally bad, this servicing should be done every 8 hours, or oftener if indicated as necessary.

BATTERY

58. The battery stores the electrical energy used to operate the starting motor and supply current to the panel light. The battery is charged by the engine charging generator.

59. CHECKING AND SERVICING THE BATTERY

Do not allow the level of the electrolyte to get below the top of the separators. Use only clean distilled water for the battery. Do not fill higher than just below the bottom of the filling tube, otherwise gassing will cause the electrolyte to spill over. Never add acid to the water as this will give a false reading as to the condition of the battery. Keep the terminals tight and clean. If they show a tendency to corrode, clean them and apply a thin coat of vaseline to protect them from the acid action. The outside of the battery must be kept clean. Neutralize any electrolyte that may be on the metal surfaces, with a cloth saturated with ammonia or a bicarbonate of soda solution (one pound of baking soda to one gallon of water) then wash off with water and dry thoroughly.

Test the specific gravity of each cell with a hydrometer. A reading of 1.270 to 1.285 indicates approximately fully charged, 1.230 indicates half charged, and 1.150 indicates dead. Never take a reading just after adding water for the reading will not be true.

If the battery is in good condition, this gassing is most likely due to overcharging. Therefore, the voltage regulator should be checked by the maintenance repair crew for faulty adjustment, as outlined in the Maintenance Manual. If one or more cells continually require more water than others, it is an indication of a damaged cell which should be checked by maintenance repair. **CAUTION:** Do not allow the battery to stand in a discharged state. It will become ruined by sulphation.

60. COLD WEATHER CARE

It is especially important in cold weather to test the specific gravity. A battery freezes between the temperatures of 20^{o} above zero and 50^{o} below zero, depending on the state of its charge. Do not add water after shutting down for the night, otherwise it will freeze quickly. Always see that it gets a charge after adding water.

CONTROL UNIT (INSTRUMENT PANEL)

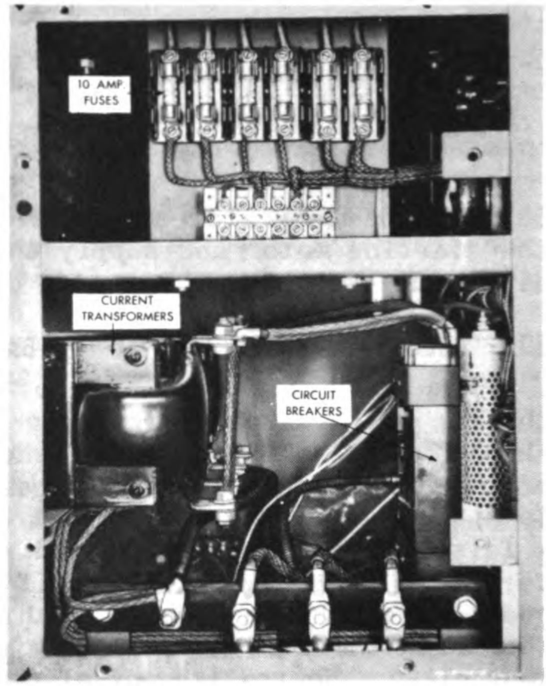


Figure 26. Back Side View of Control Unit with Left Panel Removed

61. The control unit contains the devices essential to the operation of the engine and the generator. All connections to the external equipment are made through the open bottom. See Figure 26.

62. GENERAL DESCRIPTION OF PANEL EQUIPMENT

The panel equipment consists of a voltmeter and ammeter, a generator voltage regulator, an automatic air circuit breaker, synchronizing lamp equipment, a synchronizing switch, and an ammeter transfer switch, all of which control the generator. See Figure 13 on Page 27. The engine controls and instruments are water temperature gauge, oil temperature gauge, ammeter, oil pressure gauge, tachometer, engine stop control, starter button, and safety stop switch.

63. GENERAL DESCRIPTION OF THE INTERIOR EQUIPMENT

Within the unit are three current transformers for the line ammeter and one current transformer for the voltage regulator compensation, terminal boards for the main and secondary leads, and protective fuses. See Figure 26. The spare 50 Ampere tripping element for the circuit breaker is mounted on the right side cover. This element is used for 50 cycle operations. The wiring diagram for the unit is located on the left side cover as well as in this manual, Figure 17.

64. GENERAL DESCRIPTION

The generator control unit is designed to control the three phase, four wire, generator which may be operated at either of two ratings, as follows:

37.5 KVA,60 cycle, 1800 RPM., 127/220V
31.3 KVA,50 cycle, 1500 RPM., 230/400V

The change in generator voltage is made by moving connection links on the terminal board of the generator and on the terminal board within the unit, and by changing the position of the slider on the resistor mounted inside the voltage regulator case. The engine speed must be adjusted separately to correspond with the desired operation. In addition, the 100 Ampere tripping element installed in the circuit breaker for 60 cycle operation must be changed to the spare 50 Ampere tripping element when 50 cycle operation is desired. The procedure of operation, either for 60 cycle or 50 cycle or for parallel operation, is given in paragraphs 39, 38, and 35.

FAN BELT

65. FUNCTIONAL DESCRIPTION

The fan belt drives the fan, water pump, and the generator from the pulley on the crankshaft. There should be approximately 3/4" slack in the vee belt at its freest position.

66. ADJUSTING FAN BELT TENSION

The tension of the fan belt can be adjusted by moving the generator in or out. Loosen the locknut on the adjustable bracket of the generator and move the generator in the direction that is desired; when the proper tension is obtained, tighten the locknut. See Figure 25 on Page 44.

67. INSTALLING FAN BELT

Whenever installing a new fan belt, always loosen the fan belt adjustment so as to allow the belt to be slipped in place without forcing. This will avoid any internal damage to the belt.

FUEL FILTERS

68. FUNCTIONAL DESCRIPTION

The Buda-Lanova 6-DTG-317 engine is equipped with two fuel filters, a primary fuel filter, and a secondary fuel filter. See Figure 10 on Page 21. Because fuel oils are less fine than gasoline, they contain more gum, fine abrasives, and water. To prevent these from entering the engine and there cause trouble, a primary and secondary stage of fuel oil filtration is used. Not only should these filters be serviced as recommended, but the fuel line connections should be inspected and replaced if there is any evidence that the fuel line is breaking down internally, either from age or accident. This internal breakdown would release fine particles into the fuel stream.

69. SERVICING PRIMARY FUEL FILTER

Every 8 hours of operation, while the engine is still warm, drain the water and sediment from the bottom of the filter and replace the plug. See Figure 27. Then remove the bleed cock, (air vent) on the primary filter and allow the gravity pressure to force the air out of the primary fuel oil filter. After every 512 hours of operation, drain and clean out the primary filter housing and install a new filter element. See Figure 28.

Figure 27. Removing the Air Vent in the Primary Fuel Filter

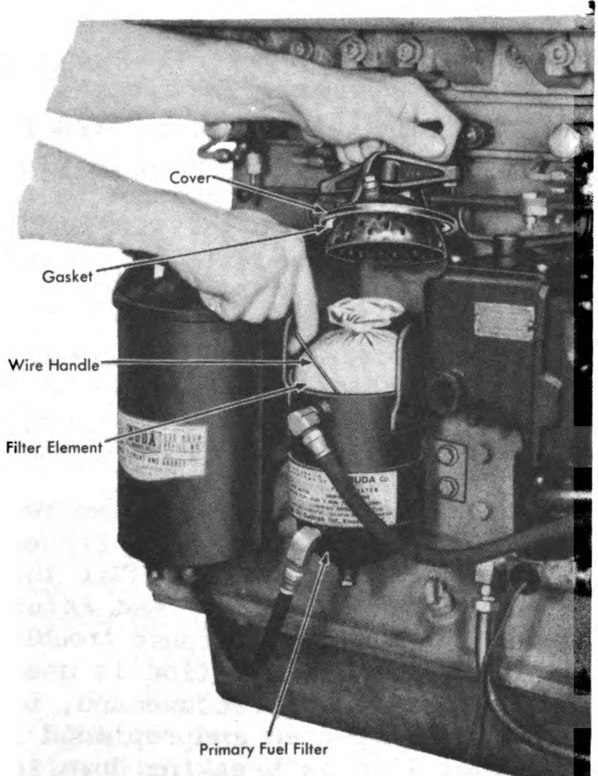


Figure 28. Removing Primary Filter Element

70. SERVICING SECONDARY FUEL FILTER

The secondary fuel oil filter is a sealed fuel oil filter. Every 8 hours of operation, unscrew the plug at the bottom to drain out sludge and water. Replace the plug and unscrew the plug at the top and operate the fuel transfer pump to bleed the air until fuel oil flows. See Figure 29.

Every 1024 hours of operation, replace the secondary sealed fuel oil filter.

FUEL INJECTOR (NOZZLES)

71. FUNCTIONAL DESCRIPTION

The function of the injector is to direct a metered quantity of fuel from the injection pump into the engine combustion chamber in a definite spray pattern and in such a manner as to produce the most efficient performance. The injector is made up of the nozzle and the nozzle holder which holds the nozzle in its correct position in the engine cylinder and also provides the means of conducting the fuel oil to the nozzle. The holder also contains the necessary spring and means of pressure adjustment to provide action of the nozzle valve. See Figure 30.

Because the nozzle and nozzle holder are manufactured to precision accuracy, the operator is cautioned against making any adjustments or other servicings. Such adjustments and servicings which are necessary should be made by maintenance repair, equipped with the proper tools, as outlined in the Maintenance Manual. However, the operator can remove the injector to be sent to maintenance repair for servicing and install the injector after such servicings, only after he has taken neces-

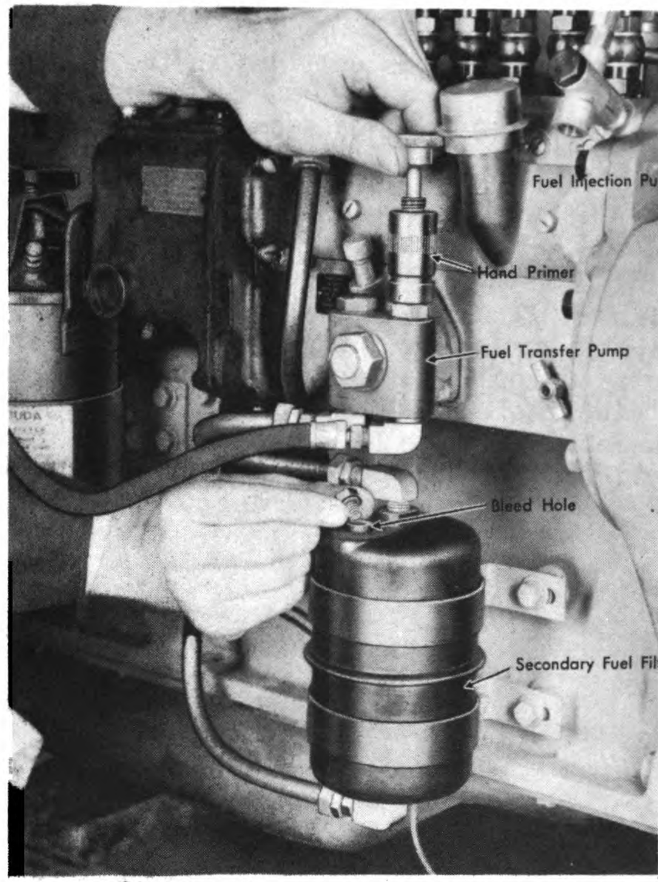


Figure 29. Venting Secondary Fuel Filter

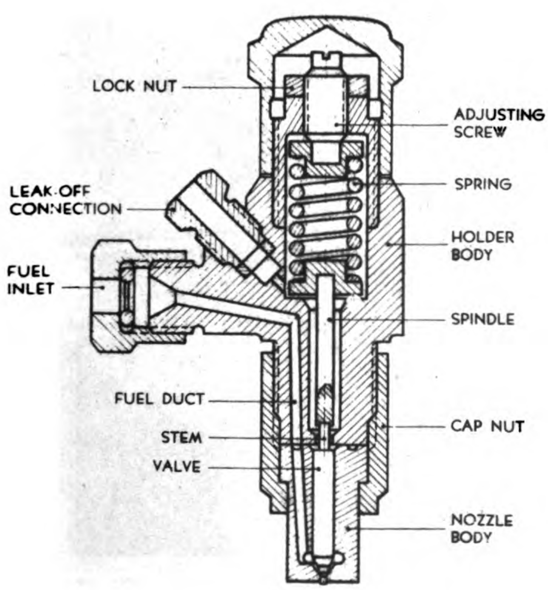


Figure 30. Diagram of Injector

sary precautions as outlined in the following steps:

72. REMOVING INJECTOR FROM ENGINE

CAUTION: Before loosening any lines, apply kerosene or fuel oil freely to all connections in order that dirt and grease may be removed.

Detach the high pressure tubing and leak-off lines (See Figure 31) and be sure to cover their open ends with cloth or caps to protect against the entrance of dirt. Remove the holding nuts and pull the assembly from the engine. Be careful not to strike the end of the nozzle against any hard surface. If the assembly seems to be stuck because of carbon deposits within the cylinder recess, the injector can be removed as shown in Figure 32. Cap the injector opening to prevent dirt from entering.

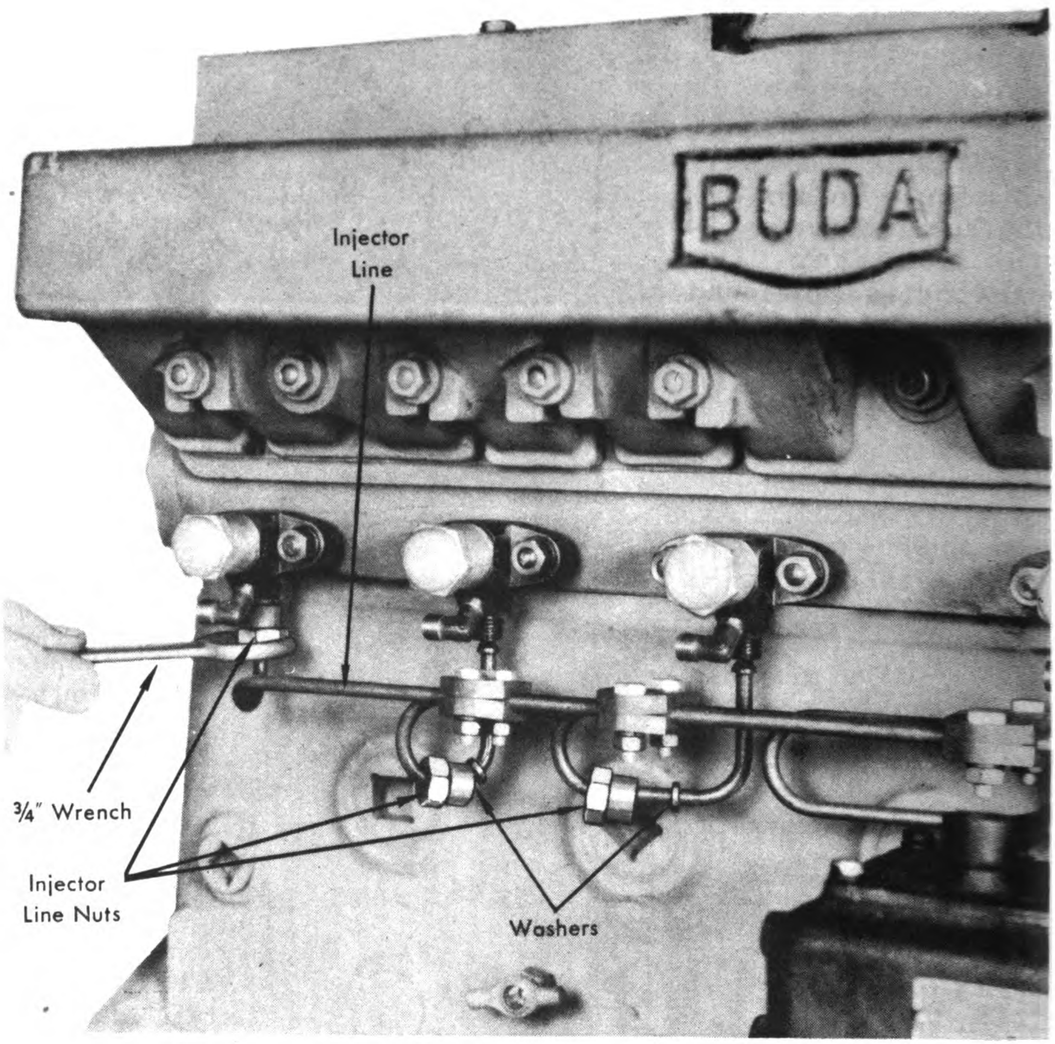


Figure 31. Removing Injector Lines

FUEL INJECTION PUMP

73. FUNCTIONAL DESCRIPTION

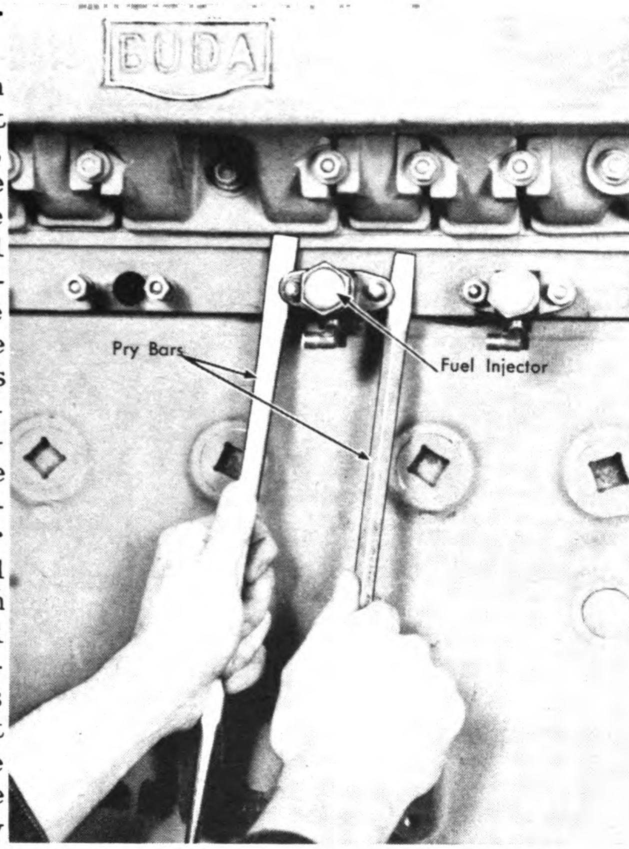


Figure 32. Removing Injector Nozzle Assembly

The fuel injection pump is of the constant stroke, cam actuated, high pressure type. See Figure 33. Its purpose is to meter the fuel accurately and to deliver it at a definite time under high pressure to the spray nozzles through which it is injected into the respective cylinders of the engine. In Diesel engines, speed and power output are controlled solely by a variation of the amount of fuel injected into the combustion chamber. This variation of the amount of fuel delivered by the injection pump to the nozzle is regulated by the simple and foolproof action of the helixon on the plunger. The external control of this action is by means of a control rod connected to the governor. In order to obtain continued long-time service which is built into the fuel injection pump, intelligent care must be taken of this fine mechanism. The operator, because he has not the proper tools and equipment and necessary experience, should not attempt to service the fuel injection pump.

He should perform those services of which he is capable, and here outlined. Suspected fuel injection pump difficulties should be turned over to maintenance repair as outlined in the Maintenance Manual, (Section II).

It is again called to the operator's attention that the most outstanding factor contributing to long and trouble-free performance of the injection pump is proper filtration of the fuel oil. Therefore, the operator should follow to the letter the instructions given for servicing the primary and secondary fuel oil filters in paragraphs 68 to 70.

74. LUBRICATION OF THE INJECTION PUMP

The lower part of the injection pump housing (camshaft compartment) should always be filled with a good grade of en-

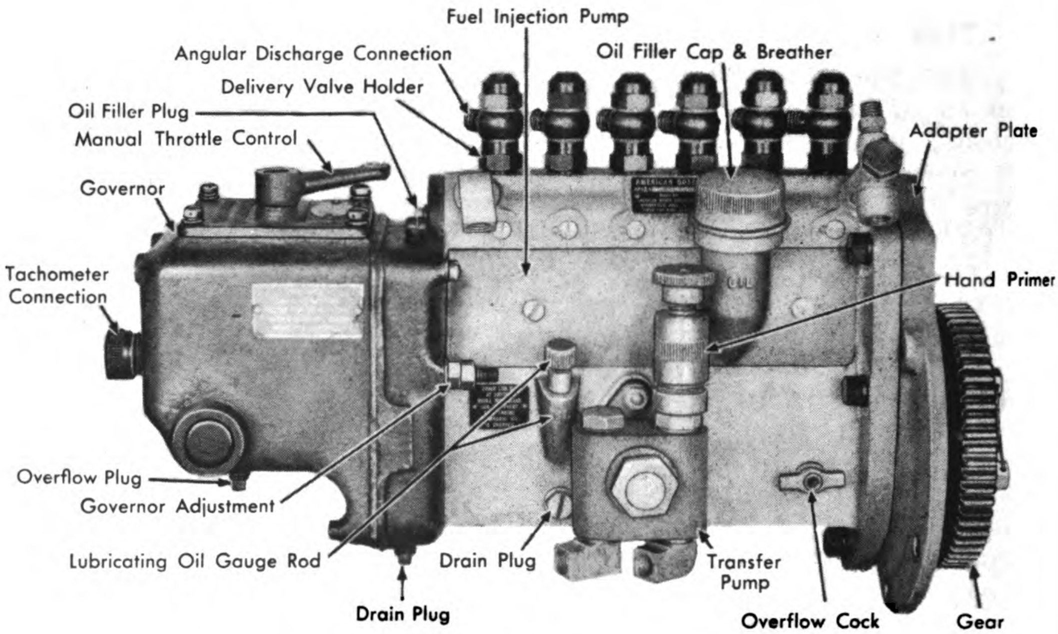


Figure 33. Fuel Injection Pump and Governor

gine lubricating oil, the proper level of which can be determined by means of the oil gauge rod. The pump plungers do not require any lubrication since this is inherently contained in the fuel oil. See Figure 33. The oil gauge rod is provided with a line mark indicating the highest permissable level of lubricant. The lowest level is represented by the end of the oil gauge rod so that if no oil shows upon its withdrawal from the pump housing, the level is too low and must be brought up until the high mark is again reached. The oil is filled into the pump housing through the oil filler and breather, as shown in Figure 21.

It is advisable to change the lubricating oil in the pump housing whenever the engine oil is changed-at every 64 hours of operation. To facilitate this, remove the drain plug which is shown in Figure 20.

75. BLEEDING OF INJECTION PUMP

Before the engine is first started, the injection pump fuel gallery should be bled of air by loosening the fuel return line to the tank on top of the housing as shown in Figure 15.

76. TIMING THE FUEL INJECTION PUMP

To time the fuel injection pump with the engine, the following steps are necessary:

NOTE: It requires two men to time the fuel injection pump with the engine.

1. Crank the engine until the timing mark No. 1, F.P.I. (No. 1 fuel pump injects) is in the center of the timing hole of the flywheel housing. See Figure 34. **NOTE:** The No. 1 piston must be on the compression stroke when centering this timing mark in the timing hole of the flywheel housing. This can be checked by noting that both the intake and exhaust valves of No. 1 cylinder are completely closed and have clearance between the stems and rocker arms.

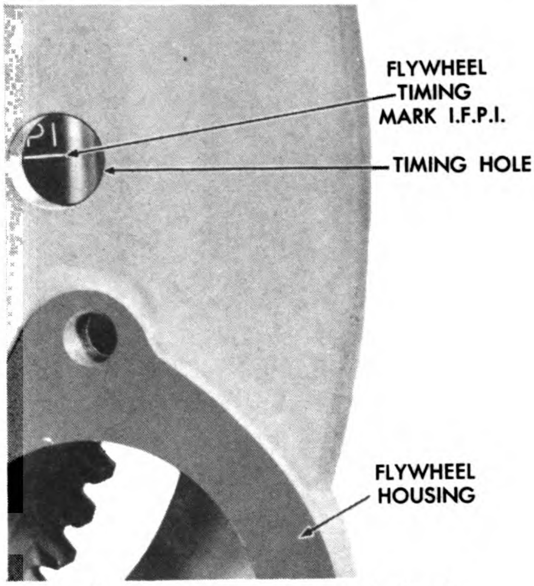


Figure 34. Timing Mark in Center of Hole

2. Drain and remove the radiator. Remove the oil filler pipe. See Figure 35.

3. Remove the wire locks from the capscrews of the fuel pump gear. Slightly loosen the three capscrews so that the gear hub is free to turn. See Figure 36.

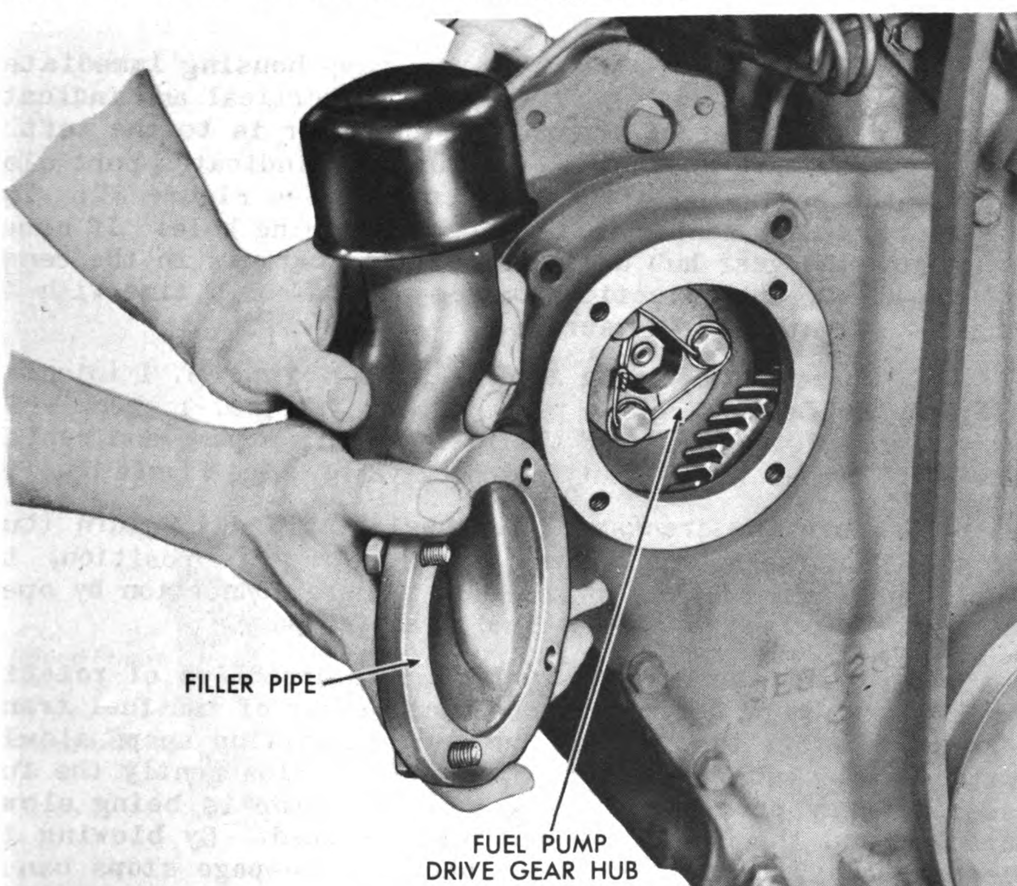


Figure 35. Removing Oil Filler Pipe

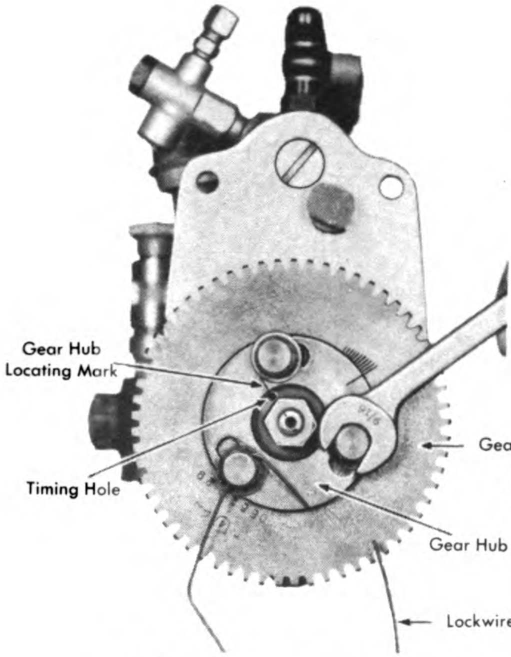


Figure 36. Loosening Capscrew so Gear Hub is Free to Turn

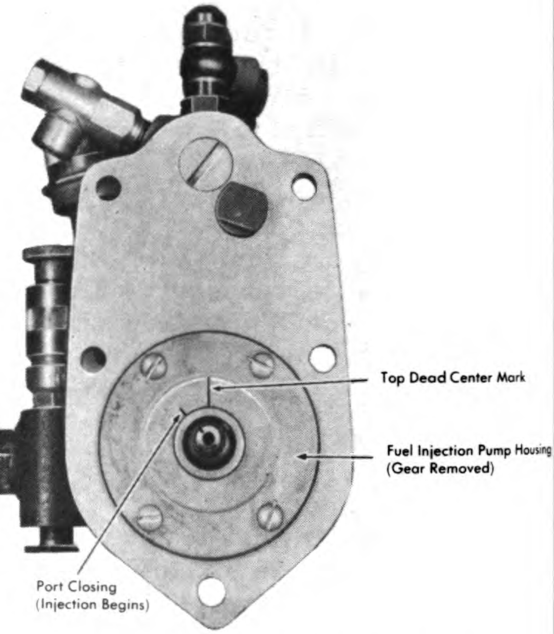


Figure 37. Pump Housing Timing Marks

4. There are two marks on the pump housing immediately in the back of the gear hub. The one is vertical and indicates the top dead center of the pump. The other is to the left of the vertical mark about 1/8 of a turn and indicates port closing or the beginning of the injection. See Figure 37. This latter mark must center in the gear hub timing hole. If necessary turn the gear hub until this timing mark is in the center of the hole. The injection pump is now in rough time with the engine. Tighten the capscrews.

5. To make the timing accurate, remove the No. 1 injection line at the fuel injection pump. Remove the No. 1 check valve at the angle connection of the fuel injection pump and replace the angle connection without the check valve. See Figure 38.

6. Turn the crankshaft flywheel backward 1/2 turn (turn to the left facing the timing gears). At this position, the fuel should run freely from the No. 1 angle connection by operating the hand primer of the fuel transfer pump.

7. Crank the engine slowly in the direction of rotation (while continuing to operate the hand primer of the fuel transfer pump) until the fuel at the open connection seeps slowly. With a small tube, as shown in Figure 39, blow gently the fuel seepage away from the opening as the engine is being slowly cranked and the hand primer being operated. By blowing the seepage away, the exact moment when the seepage stops can be observed. At the instant the fuel seepage stops, the cranking should be stopped and the timing mark No. 1 F.P.I. observed

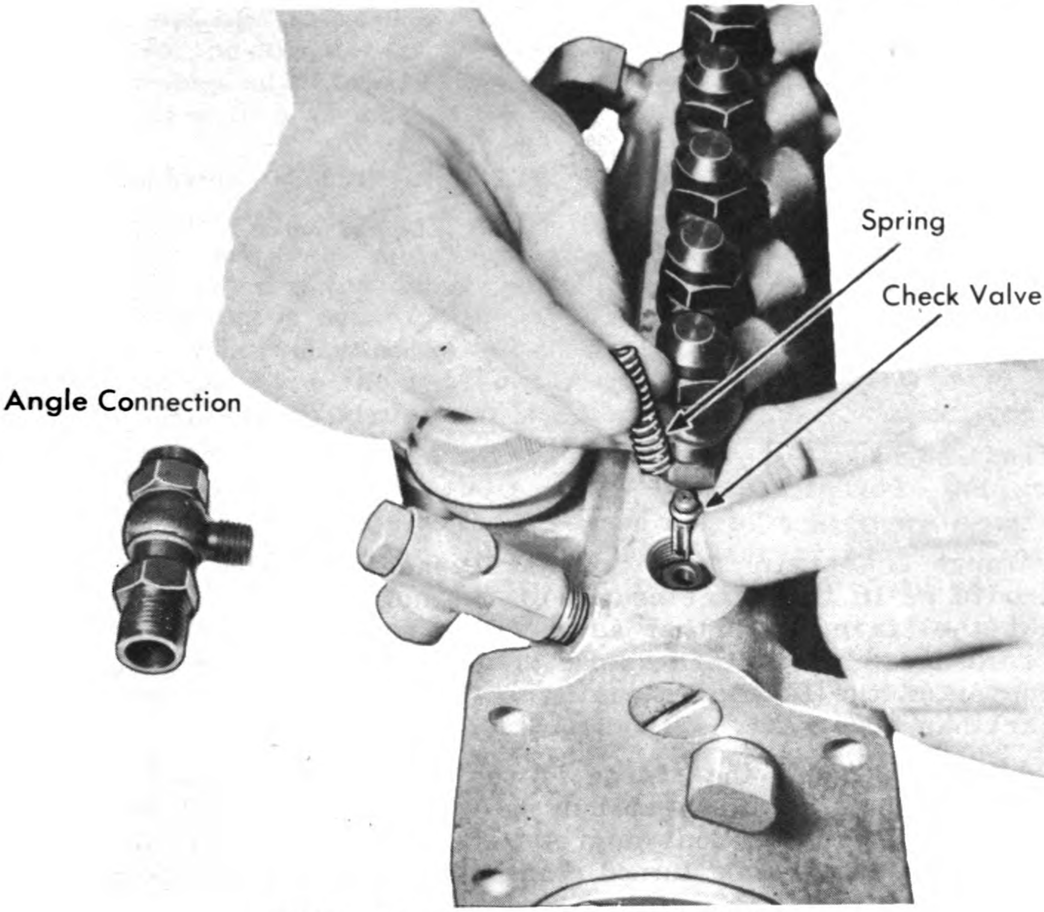


Figure 38. Removing Check Valve

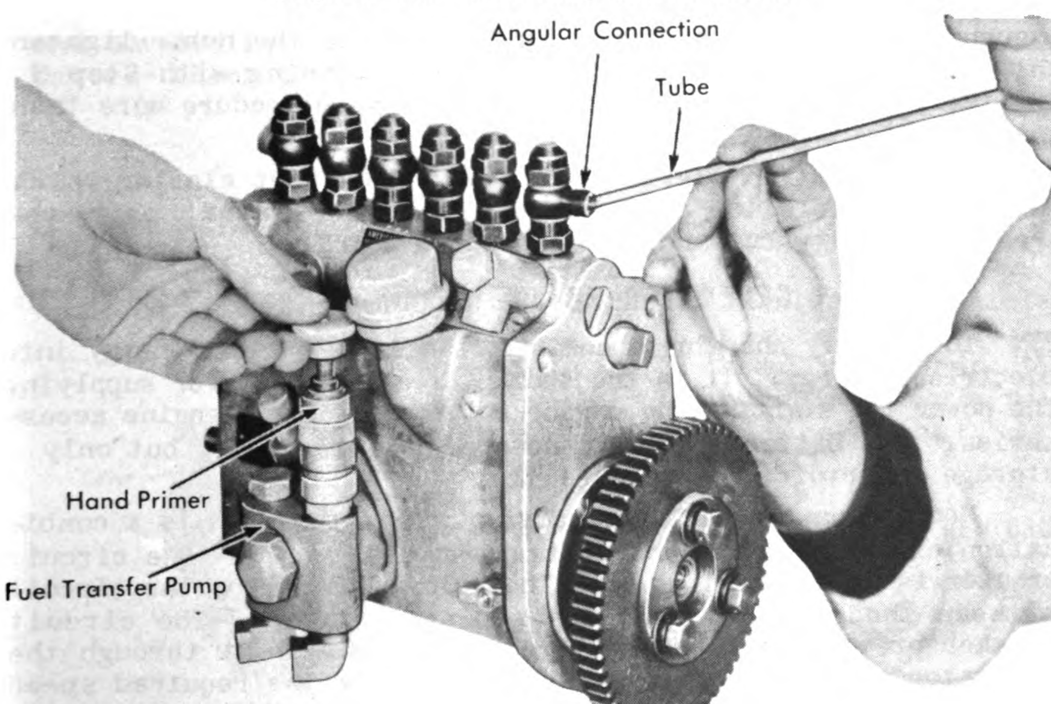


Figure 39. Blowing Seepage Away (Timing Injection Pump)

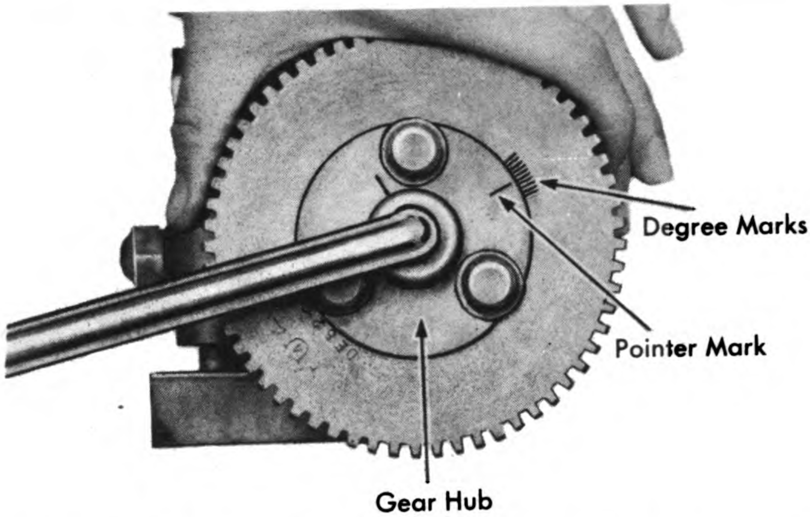


Figure 40. Adjusting Gear Hub

through the timing hole in the flywheel housing. This mark should be in the exact center of the hole. See Figure 34. If not the timing is either advanced or retarded. If the timing is advanced, the timing mark No. 1 F.P.I. is approaching the center of the flywheel housing timing hole. If retarded, the mark has gone past.

8. To reset the timing if the timing is retarded, loosen the capscrews on the gear hub and turn the hub clockwise (as shown in Figure 40) one degree mark. If timing is advanced, the gear hub should be turned counter-clockwise one degree mark.

NOTE: When turning the hub counter-clockwise, as shown in Figure 40, do not loosen the hub retaining nut. Exert just enough pressure on the wrench handle to move the hub. Tighten the capscrews and recheck the timing beginning with Step 6. It may be necessary to repeat the foregoing procedure more than once to obtain exact timing.

Fuel injection starts immediately upon port closing which occurs 32° before top dead center of No. 1 cylinder, as measured on the flywheel and marked No. 1 F.P.I.

GENERATOR (Battery Charging)

77. The battery charging generator changes mechanical energy into electrical energy. It is the source of electricity for supplying the power for starting the engine and for the other engine accessories. The battery is not a source of electricity, but only a storage reservoir. See Figure 41.

Mounted on the battery charging generator frame is a combination circuit breaker and voltage regulator unit. The circuit breaker is an automatic switch that closes and opens the circuit between the generator and the storage battery. The circuit breaker prevents the battery from discharging back through the generator when the engine speed falls below the required speed necessary for charging the battery. The voltage regulator reduces the generator output when the maximum is not needed, thus preventing overcharged batteries. The operator is cautioned not to attempt to make any adjustments to the voltage regulator unit, for he has neither the equipment nor the necessary data to make any adjustments or servicings other than cleaning the contacts with a crocus cloth. See Figure 42.

78. CHECKING THE COMMUTATOR AND BRUSHES

Remove the cover to inspect the commutator and brushes for dirt and wear, and also check for high mica (insulation material between the copper bars of the commutator) or for the commutator being out of round. Visually inspect all the wiring from the generator to the regulator, from the regulator to the battery, and from the battery to the ground for worn or frayed insulation, broken wires, and for loose or corroded connections.

If the commutator is dirty or discolored, it can be cleaned by holding a piece of No. 00 sandpaper against it while the armature is turning slowly. Blow the sand out of the generator after cleaning the commutator. If the commutator is rough or worn, the generator should be removed and completely overhauled. See Figure 24.

The brushes should slide freely in their holders and should be perfectly in line with the commutator segments. If the brushes do not slide freely, are out of alignment, oil soaked or worn to less than one-half their original length, which is 7/8", the brushes should be replaced.

79. REMOVING THE BRUSHES

To replace oil soaked or worn brushes, lift the brush arm and disconnect the brush lead as illustrated, and install the new brush or brushes. Make certain that the brush is put in so that the beveled face of the brush matches the curve of the commutator. Check the alignment to be sure that the brush edge is parallel with the commutator segments. If the alignment is off or if new brushes do not slide freely, the generator should be turned over to maintenance repair for disassembly and inspection as outlined in the Maintenance Manual, Section II.

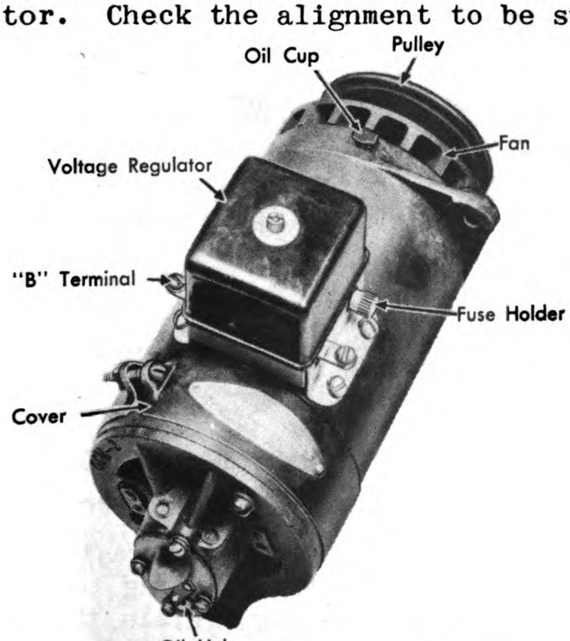


Figure 41. Battery Charging Governor and Voltage Regulator

80. SEATING A NEW BRUSH

After new brushes are installed, they should be sanded to make sure of the proper fit on the commutator. To sand the brushes, cut a strip of No.00 sand-

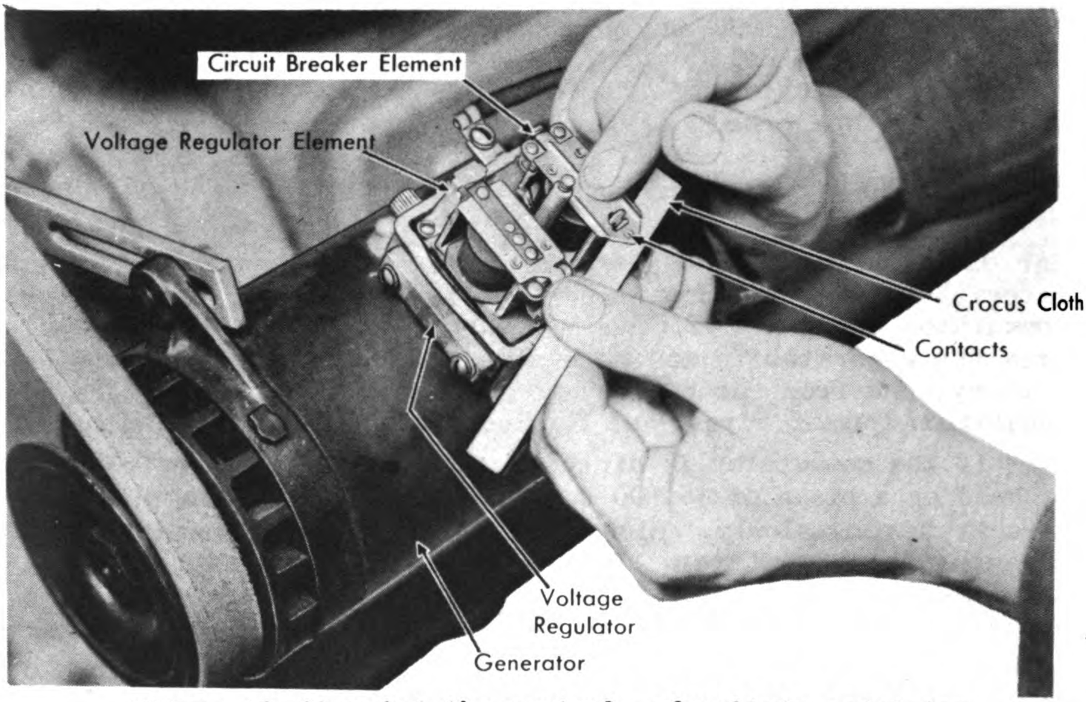


Figure 42. Cleaning the controls of voltage regulator with crocus cloth.

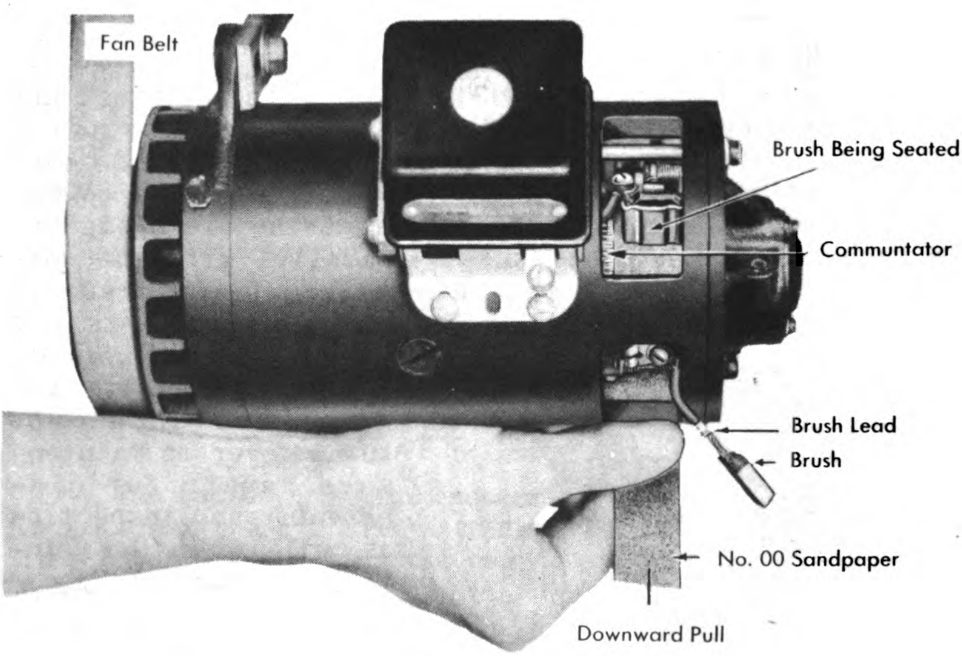


Figure 43. Seating a brush using No. 00 sandpaper.

paper, the exact width of the commutator. With the abrasive side against the brush and the brush at its proper spring tension, draw the sandpaper upward or downward, making certain that the entire face of the brush is being sanded. Do not sand excessively and be careful not to break the edge of the brush. See Figure 43.

81. CHECKING BRUSH SPRING TENSION

Hook a spring scale under the third brush arm near the end and pull on a line parallel to the face of the brush. Take the reading just as the arm leaves the brush. The third brush spring tension should be 50 to 60 ounces. With the main brushes, hook a spring scale in the hole in the lip of the main brush arm and pull on a line parallel to the face of the brush! The main brush spring tension should be 53 ounces maximum.

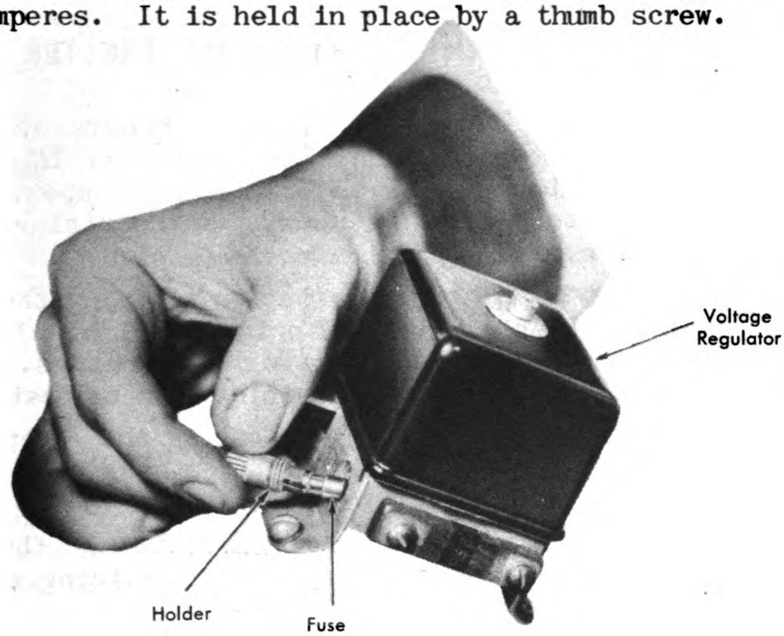
82. LUBRICATING GENERATOR

The drive end ball bearing should be given three to five drops of engine oil through the oiler in the top of the end plate. Also fill the commutator end oil pocket with engine oil through the combination oil and overflow hole in the commutator end cap cover. See Figure 41.

83. REPLACING GENERATOR FUSE

The generator fuse is located in the base of the voltage regulator, as shown in Figure 44. It is a five ampere fuse and if necessary to replace, it should be replaced by one of the same type - 5 amperes. It is held in place by a thumb screw.

Figure 44. Replacing Generator Fuse



GOVERNOR

84. FUNCTIONAL DESCRIPTION

The prime purpose of the governor is to maintain within a close regulation any desired engine speed with the normal idling and nominal maximum speed range, irrespective of the engine load. In addition, the governor controls the engine idling speed to prevent stalling and the maximum speed to prevent racing. The governor is a fully enclosed unit, rigidly mounted to one end of the fuel injection pump. The governor is internally connected to the injection pump control rod. See Figure 33.

OPERATOR SERVICE ADJUSTMENTS

85. LUBRICATION OF GOVERNOR

The governor housing should be filled with engine oil up to the level plug in the body casting. See Figure 33. The oil should be changed every 64 operating hours when the fuel injection pump and crankcase oil is changed.

86. ADJUSTING ENGINE SPEED

Load the engine to 30 K.W. Set the governor to 1800 R.P.M. by adjusting the speed adjusting screw shown in Figure 18 on page 36. Remove the load by moving circuit breaker to "Off" position. The no-load speed indicated on the tachometer should be 1845 R.P.M. If not, remove the lid assembly and turn the surge adjusting screw 1-1/2 turns to the right (in) if the speed is over 1845 - and turn out (left) if speed is under 1845. Again apply load and set the speed to 1800 R.P.M. as shown in Figure 18 on Page 36. Again disconnect load and check tachometer for 1845 R.P.M. NOTE: It may be necessary to repeat the foregoing procedure several times to obtain exact speed which is necessary for parallel operation. Install the lid.

MAIN GENERATOR AND EXCITER

87. Instructions for operating the generator, the necessary controls, and the electrical connections for loading the generator, and such description as will aid the operator are already given in Chapter IV. The periods of servicings for which the operator is responsible are given in Chapter V.

Such servicings are lubrication, keeping the exciter commutator clean, checking brush spring tension, cleaning the slip rings, and replacing and seating new brushes. The following instructions tell how these servicings can be best accomplished.

Because the method for lubricating the generator is already included in Chapter III on lubrication, paragraph 17, the method of lubrication will be omitted here.

CAUTION: It is again pointed out that there are certain safety measures to be observed while servicing the main generator and exciter; they are as follows:

1. Do not use inflammable cleansing fluids, while set is operating.

2. Do not wipe the machine while it is running. To polish the collector rings and commutator, the machine should be first stopped, so that the operator may observe the safest position for the hands or fingers.

3. Do not attempt to polish both collector rings at once, as particles of metal may become imbedded in the sandpaper, thereby creating a metal bridge across the two collector rings. POLISH ONE AT A TIME.

88. INSPECTING THE ALTERNATOR RINGS, EXCITER COMMUTATOR, AND BRUSHES

The brushes should be inspected for wear, proper spring pressure, and freedom in the holders. If the brushes are stuck with dirt or other foreign substances, they should be removed and cleaned. Brush holders and insulating supports should be carefully cleaned. Brush pigtail connections should always be

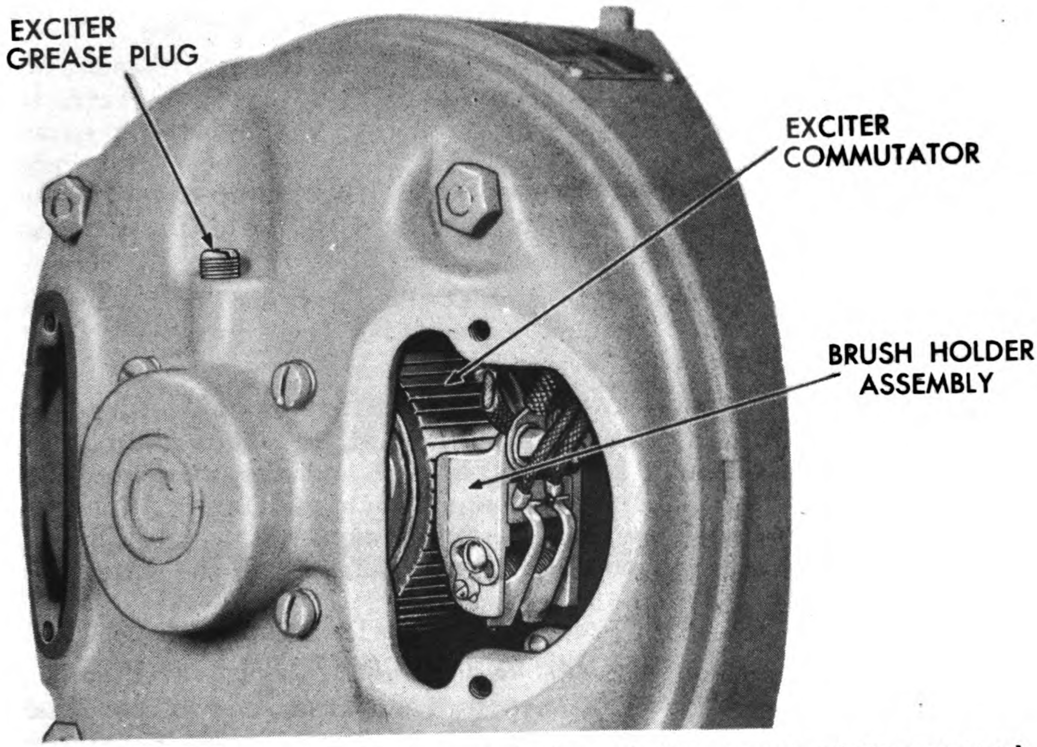


Figure 45. View of Exciter with Commutator cover plate removed.

kept tight. Collector rings should be inspected for roughness or a pitted condition. They should be smoothed in accordance with the instructions given in paragraph 91. Badly roughened or grooved rings should be trued in a lathe. This becomes an operation for the maintenance repair as outlined in the Maintenance Manual, Section II.

The commutator should be inspected for dirt and oil on the brush contact surfaces, high or low bars, carbon deposits in the undercutting grooves. See Figure 45. A commutator in good condition will have a highly glazed appearance and show a light brown color. This condition is conducive to long commutator and brush life and should not be disturbed other than to clean with a piece of canvas or non-linting cloth. If commutator is rough, blackened, or pitted, it should be polished with #00 sandpaper. See paragraph 90. The remedy for high or low bars is to true up the commutator in a lathe. This is an operation for maintenance repair as outlined in the Maintenance Manual, Section II.

89. CLEANING THE MAIN GENERATOR AND EXCITER

The alternator and the exciter should be kept as clean as possible, both internally and externally. Accumulations of oil or dirt should be removed with a rag slightly dampened with gasoline or kerosene. Be sure all parts are cleaned and dried before operating machine, to avoid danger of fire. Again it is emphasized, do not use gasoline or kerosene in or around the machine when it is in operation, since a spark from the collector rings or commutator may ignite the cleansing fluid.

Keep the windings of the alternator and exciter clean, preferably by blowing with dry compressed air. Make certain that no moisture is in the compressed air lines. Also air of extreme pressure should not be used for this purpose, since there would be danger of lifting the insulation and damaging the windings. Air pressure in excess of 25 pounds should not be used in blowing out the machine.

NOTE: If the machine is operated in extremely dirty atmosphere, cleaning should be done more often than indicated in the periods of maintenance.

If the exciter or alternator windings become caked with grease or other substances, that can not be removed with air, then the machine should be disassembled and the windings thoroughly cleaned with a cloth dampened with gasoline. The windings should be thoroughly dried before reassembly. This becomes an operation for maintenance repair as outlined in the Maintenance Manual, Section II.

90. CLEANING AND SMOOTHING THE EXCITER COMMUTATOR

The commutator should always be kept clean and well-polished with a piece of canvas or non-linting material. No vaseline or oil of any description should be used on the commutator.

If the commutator becomes rough, the roughness may be removed by polishing the commutator with a piece of sandstone from which a segment piece has been cut having the same radius as the commutator. If the sandstone is not easily obtainable, #00 sandpaper may be used by pressing it against the surface of the commutator, with a block shaped like the sandstone. In both cases, the commutator should be run at the highest engine speed during the polishing. When removing the roughness, the sandstone or sandpaper should be moved back and forth along the surface parallel to the shaft, with the engine running at its highest engine speed. **NOTE:** Be sure that the brushes are raised from the commutator during this operation to avoid unnecessary brush wear and particles of the abrasive becoming imbedded in the surface of the brush.

Carbon deposits can be removed from the undercutting grooves by using a small piece of hard wood shaped to the width of the grooves and used as a scraper. Also suitable for this operation is a piece of hacksaw blade from which the set has been ground off. When using the hacksaw blade, however, exercise care to avoid scratching the commutator. After the commutator has been

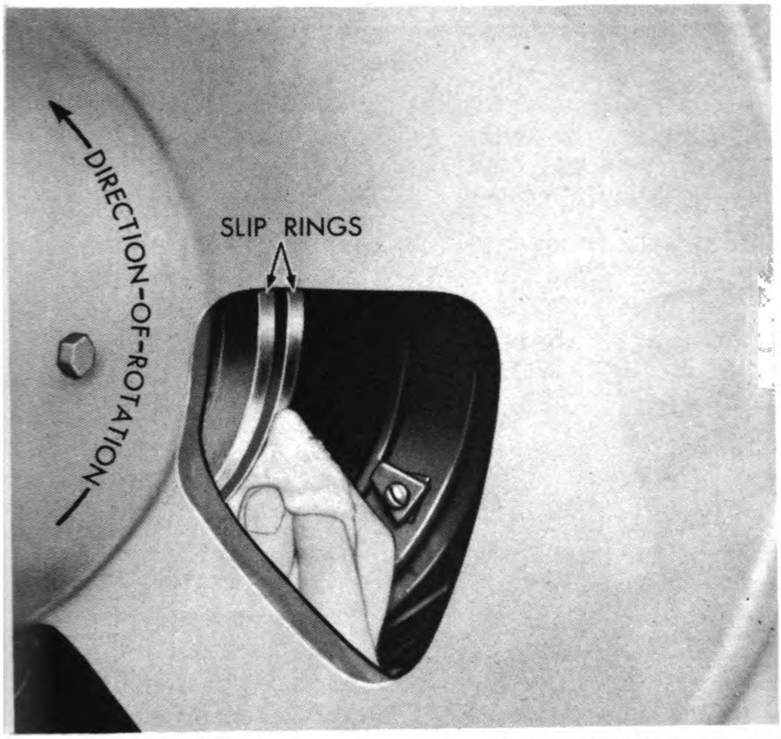


Figure 46. Cleaning the slip rings with a piece of canvas.

smoothed, the commutator and brush faces should be carefully cleaned to remove any grit which might cut or scratch the commutator. **NOTE: EMERY CLOTH SHOULD NEVER BE USED ON A COMMUTATOR OR BRUSH.**

91. CLEANING THE SLIP RINGS

Before attempting to polish the rings, all the brushes should be raised to avoid unnecessary brush wear and to prevent the particles of abrasive becoming imbedded in the surfaces of the brushes.

The slip rings should always be kept clean and well polished with a piece of canvas or non-linting material. See Figure 46. No vaseline or oil of any description should be used on the rings or brushes. If the slip rings become rough or pitted, the rings should be smoothed by polishing with a piece of sandstone from which a segment piece has been cut having the same radius as the ring. If sandstone is not available, then sandpaper may be used by pressing against the surface of the slip rings with a block of wood shaped like the sandstone mentioned previously. See Figure 47. In either case, the machine should be run at its highest speed during the polishing process. If the rings are badly roughened or pitted, coarse sandpaper or sandstone should be used first, then followed up with a finer grade of sandpaper for the final polishing. After this is done, the rings and brush holders should be carefully cleaned in order to remove any grit or abrasive which might cut or scratch the slip rings.

92. CHECKING BRUSH SPRING TENSION

The alternator brush holder springs are designed to give a pressure of 7 to 9 ounces. This pressure is not critical on the

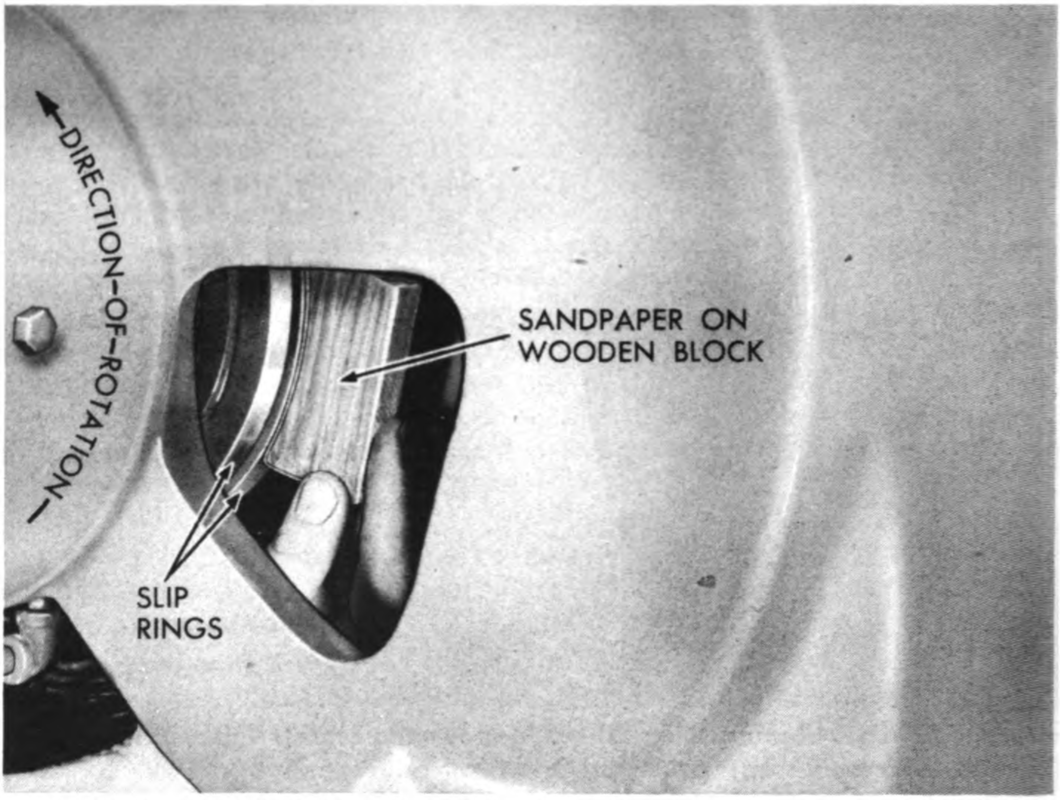


Figure 47. Cleaning the slip rings with a piece of sandpaper wrapped around a block of wood.

slip rings and the spring pressure will be maintained indefinitely unless the brush pigtail circuit opens and permits the brush holder spring to carry the current. If this occurs, then the spring will lose its temper and should be replaced. The exciter brush holder spring is designed to give a pressure of 10 to 13 ounces. This spring, like the alternator brush holder spring, will maintain the correct tension indefinitely unless the brush pigtail circuit opens and permits the brush holder spring to carry the current. If this occurs and the spring pressure falls below 10 ounces, the springs should be replaced.

To check the spring pressure, hook a small spring scale having a capacity of approximately 1 to 2 pounds under the brush holder finger at a point where it bears on the brush. Pull the spring in a direct line in the direction of the brush travel in the brush holder, and when the finger is just lifted off the brush, the reading should be made.

93. REPLACING AND SEATING BRUSHES

If the brushes of either the exciter or alternator are worn to less than half their original length, they should be replaced. In fitting, or seating, the new brushes, the brush should be in the brush holder under normal brush spring tension. Draw a strip of #1 or #2 sandpaper, with the sanded side against the brush, in the direction of rotation following the contour of the exciter commutator or the alternator slip ring.

CAUTION: Do not use emery cloth on the slip rings, the commutator, or the brushes.

The final finish should be done with #0 or #00 sandpaper. Run the machine for a few minutes and inspect the brush contact surfaces for perfect seating. If not perfectly seated, repeat the foregoing operation with #0 or #00 sandpaper.

CAUTION: It is extremely important that the brushes of both the alternator and exciter be replaced with the same type and grade recommended by the manufacturer.

OIL FILTER

94. FUNCTIONAL DESCRIPTION

The oil filter removes the metallic and carbon particles that scratch bearing and piston surfaces, and removes the sludge and water which is the result of condensation, and by filtering out the water which combines with crankcase gases, the filter reduces acid erosion. In operation, from 5% to 10% of the oil pump capacity is fed to the oil filter, through its built-in metering hole. This oil swirls into a filter base where water, sludge, and heavy solid particles settle out. From here, it is forced through the porous filtering cartridge where the cotton fibres strain out large particles and absorb fine foreign particles. Finally the oil reaches the top outlet and is sent back to

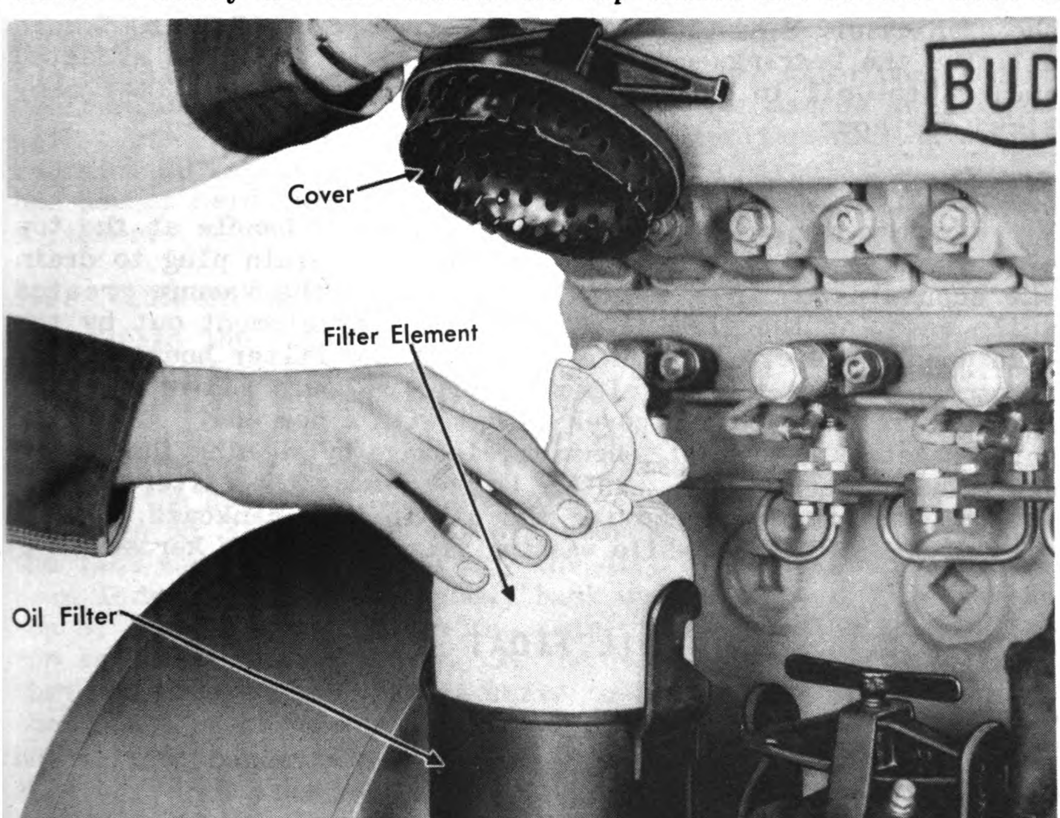


Figure 48. Removing the Oil Filter Element.

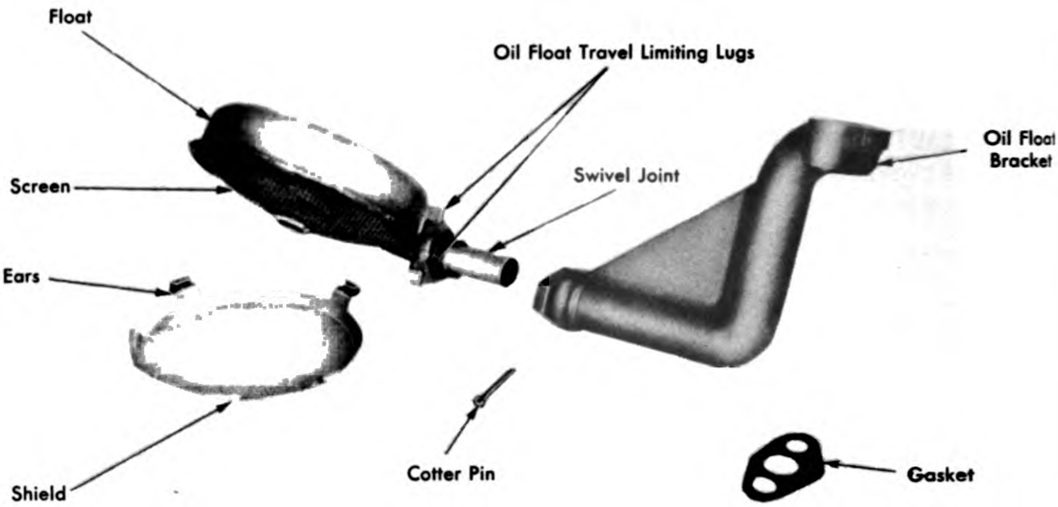


Figure 49. Exploded View of Oil Float Assembly.

the crankcase. Since the oil pump delivers from 50 to 100% more oil than the bearings can take, the pressure is seldom affected and all the oil in the engine travels through the filter many times per hour.

95. REMOVING THE FILTER ELEMENT

Unscrew the cover assembly by turning the handle at the top of the filter counter-clockwise. Remove the drain plug to drain the accumulation in the sump and to break the vacuum created while removing the element. Pull the dirty element out by the wire handle. See Figure 48. Flush out the filter housing with kerosene. Insert the new element every 128 hours and replace the drain plug. Replace the cover gasket with a new one. With filter completely assembled, check for leakage by running the engine until the filter is warm. **NOTE:** Do not remove the filter element without draining and removing the oil in the crankcase. Leave oil pan drain plug out while washing filter body with kerosene.

OIL FLOAT

96. FUNCTIONAL DESCRIPTION

The oil float is a floating oil screen arranged to rise and fall with the oil level in the crankcase so that only the best oil is taken for the bearings-thus avoiding the sludge and foam either of which would cause bearing damage. See Figure 49.

97. CHECKING THE FLOAT

When the oil pan is removed, check the joint about which the body of the float swings. It must be free of any binding. A damaged tube of the float or a damaged casting in which the float tube seats can cause binding at that point. The damaged parts should be replaced. Since the tube cannot be removed from the float body assembly, the entire unit must be replaced if the tube is at all damaged.

98. CLEANING THE FLOAT SCREEN

When the oil pan is removed, examine the screen and, if necessary, clean it by removing the float and washing it in gasoline or a good cleaner. Blow the compressed air through the screen. If the stoppage is particularly bad, bend out the ears and remove the shield, paying particular attention to the position on the float. The screen can then be thoroughly cleaned with a wire brush. The shield should be carefully positioned and the ears turned back over the body flange. Clinch the ears with pliers, not a hammer.

RADIATOR

99. FUNCTIONAL DESCRIPTION

The air forced between the radiator tubes by the fan cools the water which is circulating through the tubes. The hot water moves in through the top, cooling as it goes downward, and leaves the radiator at the bottom outlet, to enter the water pump and be recirculated through the engine. **NOTE:** The use of hard water will cause scale to form in the engine water jackets and in the radiator tubes, thereby tending to clog the circulation. Where the use of hard water cannot be avoided, use a commercial water softener.

100. FLUSHING THE RADIATOR

Drain the radiator and refill and flush it. Examine the hose connections for disintegration. Some anti-freeze solutions have a tendency to cause the rubber hose connections to deteriorate; thus, particles of rubber pass into the system and obstruct the water passages. If the system is clogged, attach a hose to the bottom of the radiator at the water outlet connection and turn on 20 to 30 pounds of water pressure. This reverses the flow and will tend to carry the dirt or particles which have been lodged down in the tubes, back upward and out through the top of the radiator. Allow the radiator to overflow through the top as long as is necessary. If the radiator is so badly clogged that this procedure does not serve to free the circulation, then the following steps must be taken:

101. CLEANING THE RADIATOR

With a solution of one part of muriatic acid to three parts of water in sufficient quantity to fill the radiator, or a solution made up of three or four pounds of commercial lye added to a sufficient quantity of water to fill the cooling system, allow either of these solutions to stand in the system for three or four hours. Drain the radiator and thoroughly flush the cooling system with clean water.

102. REPAIRING RADIATOR

CAUTION: Do not use liquid solder or radiator compounds to stop leaks as these tend to clog the radiator tubes. A leaky radiator should be repaired by soldering in the regular manner. This is a job for maintenance repair.

ROCKER ARMS

103. FUNCTIONAL DESCRIPTION

The camshaft operates the push rods, which in turn operate the rocker arms, and they, bearing directly on the ends of the valve stems, cause the valves to open and close. The rocker arms also provided with a means of adjusting the valves so that they will seat and open correctly.

104. CHECKING ROCKER ARM CLEARANCE

It is of utmost importance that, at all times, there is the correct amount of clearance between the rocker arms and valve stems.

NOTE: The engine should be operating very slowly but at normal temperatures when the check is made. The intake clearance should be .009" and the exhaust .012". Insert the correct feeler gauge between the rocker arm and the valve stem. See Figure 23. Slowly move the feeler gauge back and forth. If the clearance is correct, the operator will note that there is just a slight drag followed by tightness which momentarily prevents him from moving the feeler gauge. If the clearance is not correct, this will be indicated by tightness which will not permit the feeler gauge to move without a considerable drag. On the other hand, if the feeler gauge moves without any binding, the clearance is incorrect.

105. ADJUSTING ROCKER ARM (TAPPET) CLEARANCE

With a tappet wrench, as shown in Figure 23 on page 43, loosen the locknut and turn the adjusting screw in either direction depending upon the adjustment that is needed. Tighten the locknut and again check with the feeler gauge as outlined in the foregoing paragraph. If necessary, repeat the adjusting operation until the proper adjustment is made.

106. CHECKING ROCKER ARM LUBRICATION AND WEAR

While checking the tappet clearance, check the rocker arms for adequate lubrication. There should be a seepage of oil around each of the rocker arms. Also check the wear on the rocker arm where it contacts the valve stems. If unduly worn, should be reported to the maintenance repair who should replace the worn part.

SAFETY ENGINE CONTROL

107. The safety engine control is designed for use with Diesel engines to protect such engines against oil pressure failure or overheated cooling water. See Figure 16 on Page 32. The control valve is electrically connected to the solenoid fuel line shut-off valve shown in Figure 10, which closes the fuel line valve and thus stops the engine in case of low oil pressure or high cooling water temperature. This control has been set at the factory. In rare instances it will be necessary to re-set. However the instructions for so doing are given in the Maintenance Manual. Resetting must be done by maintenance repair personnel because of the special equipment needed to make the adjustments.

In case of safety shut-down, the cause of failure must be remedied before the engine is again started and allowed to operate automatically. In case of automatic shut-down due to overheated cooling water, the temperature must drop approximately 35° before the engine can be re-started. **NOTE:** Under no circumstances should the operator add cold water to an overheated engine which, by such an act, could be seriously damaged.

STARTING MOTOR

108. The starting motor cranks the engine when the starting switch closes the circuit between the storage battery and the motor. See Figure 50. The Bendix drive engages the starter motor with the engine flywheel when the motor revolves and disengages when the engine starts. When the engine starts, the Bendix drive pinion is driven faster than the sleeve of the Bendix and is therefore forced back along the threads, thus automatically demeshing the gear from the flywheel.

109. CHECKING COMMUTATOR AND BRUSHES

Remove the cover band and inspect the commutator. If the commutator is dirty or discolored, it can be cleaned by holding a piece of No. 00 sandpaper against it while the armature turns. Blow the sand out of the motor after cleaning the commutator. If the commutator is rough or worn, the starting motor should be removed from the engine and overhauled.

The brushes should slide freely in their holders and make full contact on the commutator. Make sure the brushes are perfectly in line with the commutator segments. If the brush holders need repair or if the brushes are worn to less than one half their original length, the motor should be removed for an overhaul by the maintenance repair as outlined in the Maintenance

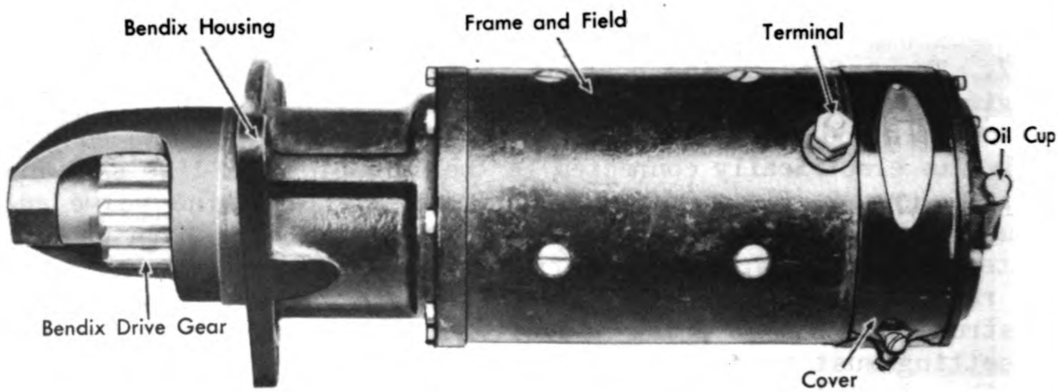


Figure 50. Starting Motor.

Manual, Section II. Inspect the wiring inside the motor around the brush rigging and wiring from the battery to the ground, from the batter to the starting switch, and from the switch to the motor for loose or corroded connections and for frayed in-insulation.

110. LUBRICATING STARTER MOTOR

Add three to five drops of engine oil to the oiler in the commutator end head, at regular periods recommended in Chapter III.

Chapter VII

PREPARING GENERATOR SET FOR STORAGE OR SHIPMENT

111. If the generator set is to lay idle for a long period or if it is to be shipped, special preparations must be made to protect both the Diesel engine and the main generator.

It is also important that the generator set be kept in a dry, clean place and covered with a tarpaulin or some other waterproof material if it is to be shipped or allowed to stand where it is exposed to weather.

112. PROTECTING DIESEL ENGINE FOR STORAGE OR SHIPMENT

Regular Diesel fuel may cause corrosion or gum deposits on the close fitting parts in the injectors that remain inoperative for a period of time. Therefore, the engine should be properly protected before it is finally shut down, otherwise harmful effects of the regular Diesel fuel may result in stuck injector parts and engine starting difficulty.

The injection system can be adequately protected without removing the injectors from the cylinder head. Also the crankcase and the cylinders must be protected from rust.

Oil suitable for rust prevention of the fuel injection system are as follows: a mixture of 20% steam turbine oil and 80% kerosene, or any good grade of light rust preventive oil mixed with equal parts of kerosene to obtain approximately the same viscosity as that of the fuel, but make sure first that both the oil and the kerosene are free from water and dirt. Then proceed as follows:

113. STEPS FOR PREPARING DIESEL ENGINE FOR STORAGE

1. Run the engine until the oil temperature registers at least 120° on the instrument panel oil temperature gauge.

2. Drain the crankcase oil and refill the crankcase with 50% of engine oil and 50% of a good rust preventative.

3. Disconnect the fuel line from the fuel tank, and also disconnect the fuel return line at the fuel pump and operate the hand pump plunger (See Figure 15) until all the regular fuel has been expelled from both the primary and secondary filters and the main gallery of the fuel pump. Then connect the fuel line to a small clean receptacle which contains a mixture of rust preventative for the fuel injection system in a sufficient quantity to fill the fuel system. When you are assured that the whole fuel system (primary and secondary filters and the fuel injection pump) is full of rust preventative, start the engine and let it operate at 500 R.P.M. for about ten minutes.

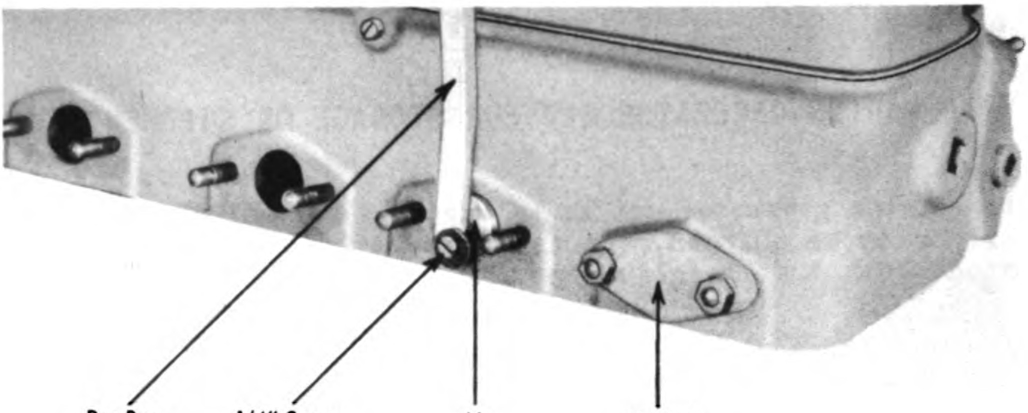


Figure 51. Removing Energy Cell Cover Plates.

114. PREPARING MAIN GENERATOR FOR STORAGE

All the machine parts or surfaces should be slushed with a rust preventative or painted before shipment or storage to prevent rust. If the generator is to be stored for any length of time, those parts subject to rust should be inspected periodically, approximately every 30 days to see that rusting has not started. Re-paint and re-slush parts if required. The main generator should be wrapped with a water-proof paper. **NOTE:** If possible, a safe and reliable heating system should be provided to protect the windings of the generator from alternate freezing and thawing. An electric heater with a thermostatic control is recommended when such equipment is available.

4. Take off energy cell cover plates. See Figure 51. Then remove energy cell plugs and pour one ounce of rust preventative into each cylinder. Then crank the engine over with the starter, with the throttle full open for a full twenty-five revolutions. Then reinstall energy cell plugs and tighten down energy cell cover plates. Then drain the crankcase and also drain the lubricating oil from the injection pump. Fill the lubricating oil compartment of the fuel injection pump with the rust preventative oil mixture. Replace the breather and filler cap and tape the holes at the bottom of the breather of the fuel injection pump and also tape the vent hole in the top of the hand primer of the fuel transfer pump.

5. Remove the rocker arm cover and paint the rocker arm assembly and valve springs with the rust preventative. Replace the rocker arm cover.

Tape the air intake manifold and replace the air cleaner. The engine is now prepared for storage or shipment.

6. Disconnect the storage batteries and store them separately so they are handily available, for an unused or stored battery must be slightly charged once a month. If the battery is allowed to stand in a discharged state, it will be ruined by sulphation.

PREPARING SET FOR SERVICE AFTER LONG STORAGE

115. PREPARING GENERATOR SET FOR SERVICE AFTER A LONG STORAGE PERIOD

If either the main generator or the engine was prepared for storage as outlined in the foregoing paragraphs, the following steps are necessary to place them back in service.

1. Drain the rust preventative mixture from the entire fuel system. Drain the injection lines to the nozzles by disconnecting at the fuel pump.

2. Replace the primary and secondary fuel filters.

3. Drain the lubricating oil compartment of the injection pump, and refill with the proper grade of lubricating oil.

4. Remove the tapes that sealed up the vent and breather holes; remove the tape from the air intake manifold, and exhaust manifold.

5. Re-connect the fuel lines and prepare the engine for starting as given in paragraph 32, Chapter IV, after the following steps have been taken:

6. Clean all the parts of the main generator that have been painted and slushed to prevent rusting.

7. Inspect the alternator and exciter ball bearings. If the grease is hard and has become oxidized, the bearings and bearing housing should be washed out thoroughly with clean gasoline or kerosene and the bearings and housings refilled with the proper grade and quantity of grease. See paragraphs 21 and 22.

8. Inspect the collector rings and commutator. If these appear to be tarnished, the brushes should be raised in the brush holders and the collector rings and the commutator polished with #00 sandpaper.

9. Inspect all the brushes. Make sure that they move freely in the pockets. NOTE: The generator should be run at no load for a period of 15 to 30 minutes in order to determine if the generator is operating normally before applying load.

Chapter VIII

TROUBLE SHOOTING

116. It cannot be repeated too often that over 90% of engine trouble can be prevented by good periodical lubrication, inspection and maintenance, as already outlined in this manual. The time and energy consumed in so doing is only a fraction of what must be incurred when trouble ties up the operator and his operations. But being human, we sometimes do not take the steps that will prevent trouble from developing, and sometimes trouble comes through no fault of our own.

To remedy as quickly as possible, the troubles that may come, the following list of symptoms, causes and remedies is given. When the remedy is not within the scope of the operator, it is so indicated. This means that the engine or the main generator needs the attention of the maintenance shop which has the necessary tools, skill, and data as outlined in the Maintenance Manual, Section II.

The trouble chart is in two sections. The first chart applies to engine difficulties, and the second chart applies to the main generator and control units.

SYMPTOM	PROBABLE CAUSES	REMEDY
A. Sudden stopping	1. No fuel.	1. Refill fuel tank and bleed or vent the fuel injection system.
	2. Insufficient flow of fuel.	2. Check for dirty filters, deteriorating flexible lines, insufficient fuel, and inoperative fuel transfer pump or air leak in suction line. Also may be trouble with safety valve. Check wires and valve.
	3. Air traps.	3. Bleed the fuel injection system of air.
	4. Dirt in fuel.	4. Replace the fuel filters. Clean the tank.
	5. Water in fuel.	5. Drain the filters, the tank, and the fuel injection pump.
	6. Plugged line.	6. Clean the fuel lines and examine for deterioration.

Buda Engine TROUBLE CHART (Continued)

SYMPTOM	PROBABLE CAUSES	REMEDY
A. Sudden stopping (Cont'd)	7. Overheating of engine.	7. Check the water and oil Also check for clogged radiator or other restrictions in the cooling system, loose or broken fan belt.
	8. Low oil pressure.	8. Check for burned bearings, dirt under the oil pressure relief valve, float screen bracket for looseness, or loose oil lines and oil plugs, or diluted or light oil.
	9. Fuel too heavy.	9. Drain the fuel filters and the fuel tank and refill with fuel of proper specifications.
	10. Transfer pump inoperative.	10. Replace the transfer pump as a unit, sending the old one to the maintenance repair shop where trouble will be corrected.
B. Loss of Power.	1. Insufficient fuel.	1. Check fuel tank
	2. Air in fuel lines.	2. Vent or bleed the fuel injection system and check for air leaks.
	3. Restrictions in fuel line.	3. See A3.
	4. Fuel too heavy.	4. See A9.
	5. Weak or missing cylinders.	5. Check valve clearance. Injectors should be checked for atomization. NOTE: To discover which cylinder or cylinders are missing, loosen slightly the nut of the injection line at the injector-no more than a half turn so that the fuel leaks along the nut. If there is no appreciable change in the engine performance that cylinder is not operating.

Buda Engine TROUBLE CHART (Continued)

SYMPTOM	PROBABLE CAUSES	REMEDY
B. Loss of Power (Cont'd)	6. Sticking fuel injection pump plunger.	6. The fuel injection pump should be checked by maintenance repair and replaced with a new one by maintenance repair.
	7. Sticking valves.	7. This is a job for maintenance repair.
	8. Bad compression.	8. This is a job for maintenance repair who will check for pitted, burned or warped valves, insufficient valve clearance, worn piston rings or stuck rings.
	9. Clogged air cleaner.	9. Remove air cleaner and wash the air filtering element in gasoline.
	10. Valve clearance out of adjustment.	10. Check rocker arms.
	11. Faulty Nozzle	11. Check nozzle opening pressure (most likely too low). This is a job for Maintenance Repair.
	12. Fuel injection pump out of time.	12. Re-time fuel injection pump.
C. Hard Starting	1. Insufficient fuel.	1. Check fuel tank
	2. Air traps.	2. See A2.
	3. Incorrect timing, either of valves or fuel pump.	3. This becomes a job for maintenance repair.
	4. Worn rings.	4. This is a job for maintenance repair.
	5. Pitted or warped valves.	5. This is a job for maintenance repair.

Buda Engine TROUBLE CHART (Continued)

SYMPTOM	PROBABLE CAUSES	REMEDY
C. Hard Starting (Cont'd)	6. Dirty injectors.	6. This is a job for maintenance repair.
	7. Battery charge low.	7. Replace with fully charged battery.
	8. Valve clearance incorrect	8. Check rocker arm clearance.
	9. Transfer pump faulty.	9. Replace transfer pump as a unit sending the old one to maintenance repair for overhauling.
	10. Faulty Penn-Safety switch.	10. Check switch (job for maintenance repair).
D. Overheating.	1. Lack of cooling water.	1. Check water in radiator. **CAUTION:** Do not add cold water to an overheated engine. See A7.
	2. Sediment or salt in water jackets, or clogged radiator.	2. Flush out cooling system. See paragraph 100.
	3. Water pump damaged by ice or other substance.	3. Check water pump.
	4. Fuel injection too late or too soon.	4. Pump should be timed by maintenance repair.
	5. Sheared coupling key on fuel injection pump drive shaft.	5. This becomes a job for maintenance repair as outlined in the Maintenance Manual, Section II.
	6. Improper lubrication.	6. See lubrication specifications, Chapter III, paragraph 15.

Buda Engine TROUBLE CHART (Continued)

SYMPTOM	PROBABLE CAUSES REMEDY
E. Knocking	Knocks in the Diesel engine can be divided into fuel knocks and those which cannot be directly assigned to the injection process. Knocks other than fuel are either from loose bearings, pistons, flywheel, improperly adjusted valve mechanism, or blow-by due to sticking piston rings. Excessive fuel knocks are caused by too early injection of the fuel with the speed and load on the engine. This may be due to too great an advance of the injection or improper timing of the fuel pump in servicing. Trouble from knocking, other than fuel knocks can usually be found by sounding the knocks out under different load conditions and by cutting out one cylinder at a time. When the loose or incorrectly adjusted part is found, the remedy is usually obvious and reference to articles under name of the parts affected will be found helpful in making the needed corrections. Because these corrections should be made by an experienced mechanic, the operator should report any of the mentioned conditions to the maintenance repair.
F. Excessive Smoking.	This may be caused by sticking or worn nozzle, leaky inlet or exhaust valves, stuck or worn piston rings, or scored cylinders. Check the inlet and exhaust valve clearance and make sure that the valve is not sticking in the guide. Check for a dirty air cleaner. As a last resort, assume the trouble to be in the fuel injection pump. If the latter is the case, this becomes a job for the maintenance repair.

MAIN GENERATOR TROUBLE CHART

SYMPTOM	PROBABLE CAUSES	REMEDY
. Exciter over-heats.	1. Shorted or grounded alternator shunt field.	1. Job for maintenance repair.
	2. Shorted or grounded exciters shunt field or armature.	2. Job for maintenance repair.
	3. Bearing worn out or defective.	3. Job for maintenance repair.
	4. Ventilation openings blocked or clogged.	4. Clear ventilation openings.
B. Alternator over-heats.	1. Shorted or grounded stator or rotor coils.	1. Job for maintenance repair.
	2. Worn out or defective bearings.	2. Job for maintenance repair.
	3. Ventilation openings blocked or clogged.	3. Clear ventilation openings.
	4. Alternator overloaded.	4. Reduce line load until control panel ammeter registers normal amperes. See name plate amperes.
C. Generator noisy.	1. Exciter or alternator bearings worn out.	1. Job for maintenance repair.
	2. Exciter or alternator bearings improperly lubricated.	2. Open drain holes and release surplus grease.

MAIN GENERATOR TROUBLE CHART (Cont'd)

SYMPTOM	PROBABLE CAUSES	REMEDY
C. Generator noisy. (cont'd.)	3. Alternator stator shorted or grounded.	3. Call maintenance repair.
	4. Alternator connected wrong in panel box.	4. Check connections. See Fig. 17.
	5. Alternator overloaded.	5. Reduce line load until control panel ammeter registers normal amperes. See name plate amperes.
D. No voltage registers on control panel.	1. Voltmeter defective.	1. Job for maintenance repair.
	2. Exciter commutator dirty or brushes not making good contact.	2. Clean commutator and free brushes in holders.
	3. Collector Rings dirty or brushes not making good contact.	3. Clean rings and free brushes in holders.
	4. Exciter shunt field circuit has an open or poor connection.	4. Job for maintenance repair.
	5. Alternator shunt field has one or more coils open circuited.	5. Job for maintenance repair.
	6. Exciter armature short circuited.	6. Job for maintenance repair.

MAIN GENERATOR TROUBLE CHART (Cont'd)

SYMPTOM	PROBABLE CAUSES	REMEDY
5. Control panel voltmeter registers abnormally low voltage.	1. Exciter rheostat improperly set.	1. Turn exciter handle to the right until voltage registers normal. If this fails call maintenance repair.
	2. Defective Voltage Regulator.	2. See Regulator Instruction.
	3. Alternator shunt field shorted or grounded.	3. Job for maintenance repair.
	4. Exciter shunt field shorted or grounded.	4. Job for maintenance repair.
	5. Exciter armature shorted or grounded.	5. Job for maintenance repair.
	6. Exciter commutator or alternator collector rings dirty or rough.	6. Clean and polish commutator and rings.
	7. Alternator connected for wrong frequency.	7. Check link connections. See plate on cover of terminal box.
	8. Engine speed below normal. 60 cycle speed = 1800 RPM 50 cycle speed = 1500 RPM.	8. If ammeter on control panel does not indicate extreme overload, check the engine governor.
	9. Alternator stator winding shorted or grounded.	9. Job for maintenance repair.

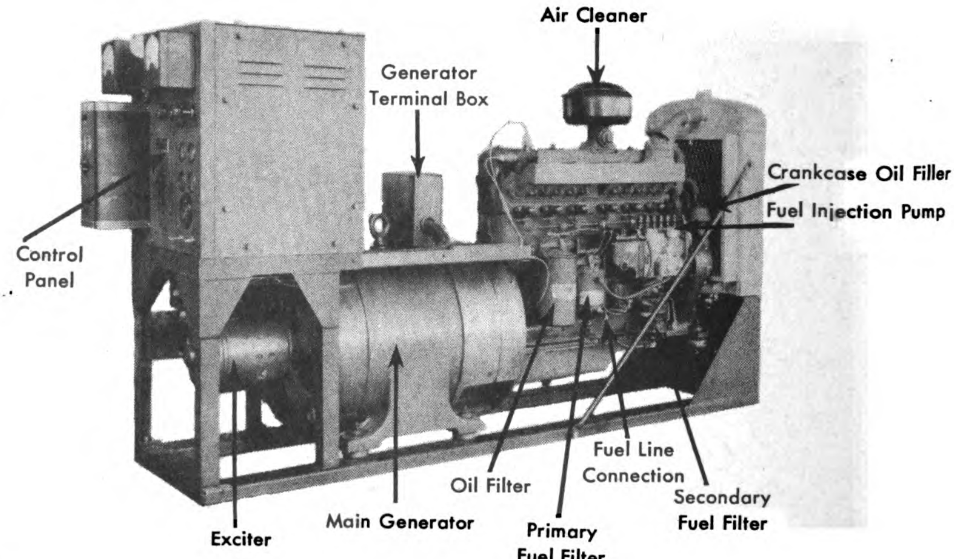
MAINTENANCE MANUAL

FOREWORD

(SECTION II)

This Maintenance Manual is for the information and guidanc of the maintenance repair personnel in overhauling the Buda 6-DT 317 Diesel-powered generator set and its accessories. See Fig ure 101. These maintenance instructions are the result of actua field and shop experience and include specifications, tolerances steps of disassembly and reassembly, inspection and repair, tests and tools and equipment needed for the overhaul, and a few hint for the mechanic.

Included under inspection and repair are such servicing which do not require the removal of the engine from the machine These servicings are given in Chapter VIII. Recommended lubri cants with illustrations of where to lubricate together wit recommended periods of lubrication and maintenance are given i the Operator's Manual, Section I. Instructions for orderin parts are given in the Parts Manual, Section III.



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SPECIFICATIONS

Chapter I

SPECIFICATIONS, TABULATED DATA ON THE
BUDA 6-DTG-317, 30 KW GENERATOR SET

ENGINE MODEL

Buda-Lanova Diesel 6-DTG-317.

TYPE

Vertical in-line, overhead valves, four cycle, six cylinders.

POWER

76 H.P. at 1800 R.P.M., bare engine.

BORE AND STROKE

Bore - 3-5/8"
Stroke - 5-1/8"

PISTON DISPLACEMENT

317 cubic inches

IGNITION

Compression ignition for starting and running.

FUEL CONSUMPTION

Approximately .73 pound per kilowatt hour under full load.

LUBRICATION

Full circulating pressure system to all crankshaft bearings, connecting rod bearings, piston pins, valve rocker arms, and timing gears.

OIL PUMP

Gear type, driven from end of camshaft.

OIL PRESSURE

Regulated by spring loaded by-pass valve. Thirty to forty pounds normal pressure dependent upon speed.

CRANKSHAFT AND BEARINGS

Drop forged; balanced statically and dynamically; Tocco hardened. Ground bearing surfaces; drilled for pressure lubrication. Number of main bearings - 7.

Bearing width #1 - (38.1 mm) 1-1/2"
Bearing width #2 - (27.0 mm) 1-1/16"
Bearing width #3 - (27.0 mm) 1-1/16"
Bearing width #4 - (50.8 mm) 2"
Bearing width #5 - (27.0 mm) 1-1/16"
Bearing width #6 - (27.0 mm) 1-1/16"
Bearing width #7 - (53.9 mm) 2-1/8"
Main Bearing diameter - 3"

MAIN BEARINGS

Steel backed, copper lead, precision type bearings. Number of bolts - 2 on all bearings. Diameter bolts - 9/16".

CONNECTING RODS

Drop forged alloy steel. Heat treated and carefully balanced in sets. Rifle drilled for pressure lubrication of piston pin. Length, center to center, 9-1/2". Number of cap bolts - 2. 7/16" diameter. Material cap bolts - chrome nickel steel. Bearing replaceable precision type, steel back. Diameter - (53.9 mm) 2-1/8"; width - (41.3 mm) 1-5/8".

CRANKCASE AND CYLINDER CASTING

Cylinder and crankcase are in one casting, chrome nickel iron. Carefully ribbed to insure rigidity and permanent alignment of crankshaft bearing. Crankcase breathing through inlet port opening and external breather.

CYLINDER LINERS

Removable dry sleeve type, easily removed or replaced in the field. Material - alloy cast iron, ground finish.

CAMSHAFT

Type forged steel, heat treated, hardened and ground, integral cams. Bearings - precision type, bronze, pressure lubricated. Number - 4.

	Diameter	Length
No. 1 -	(53.9 mm) 2-1/8"	(34.9 mm) 1-3/8"
No. 2 -	(53.9 mm) 2-1/8"	(22.2 mm) 7/8"
No. 3 -	(53.9 mm) 2-1/8"	(22.2 mm) 7/8"
No. 4 -	(38.1 mm) 1-1/2"	(27.0 mm) 1-1/16"

TIMING GEARS

Width - face 1-1/4". Lubrication - force feed. Number of gears - 4. Helical type.

VALVES

Located in cylinder head. Operated by push rods and rocker arms. Number per cylinder - 2. Diameter effective inlet - 1-3/8"; exhaust - 1-3/16". Material - Inlet - Chrome nickel steel. Exhaust - No. 21-12 austenitic steel.

CYLINDER HEAD

Cast chrome nickel iron. Replaceable exhaust valve inserts. Studs - S.A.E. #3135 chrome nickel steel. Number per head - 15. Diameter - 1/2".

PISTONS

Aluminum alloy. Number of rings - 5. Width of rings - compression rings, 1/8"; oil control rings, 3/16".

SPECIFICATIONS

PISTON PIN

Diameter - 1-1/4". Length bearing, total - 2-29/32". Full floating type.

FUEL

In general, fuels from 30° to 35° Baume gravity. See Fuel Specifications in Operator's Manual.

FUEL SYSTEM

Fuel injection by means of positive mechanical (solid) injection pump with fixed length of stroke. Amount of fuel injected into each cylinder automatically controlled by governor.

NOZZLES

Pintle self-cleaning type. Number per cylinder - 1. Horizontal spray, parallel with piston head, does not strike pistons or cylinder wall. Easily removed for inspection.

ENGINE CAPACITIES

Cooling capacity - 24-1/3 quarts
Crankcase capacity - 6 quarts

MAIN GENERATOR AND EXCITER

(Buda Part No. DP-493)

ALTERNATOR

Type	Frame	KVA	KW	R.P.M.	Freq.	Phase	Volts	Amps.
ARC	444	(37.5	30	1800	60	3	127/220	98.5)
		(31.2	25	1500	50	3	230/440	45.1)

Power Factor 80% - Temperature rating: Open, 50° C. - continuous, Class "B" insulation.

EXCITER

Type	Frame	KW	Voltage	Amps.	Winding
DG	204-A	.75 direct current	125	6	Shunt

Class "A" Insulation - Temperature rating: Open, 50° C., continuous, Century Electric Company Machine Spec. No. 6971.

The calculated average efficiencies are as follows:

Load	Efficiency
1/4	72.8
1/2	83.0
3/4	86.7
4/4	88.3

The alternator and exciter are self-cooled, the exciter by means of a fan attached to the shaft of the armature. The large fan bolted to the drive coupling cools the alternator. Manufactured by Century Electric Company, St. Louis, Missouri.

AIN GENERATOR CAPACITIES

Main Generator and Exciter bearing housing grease capacities-

Alternator - 1/2 full - 3 ounces
1/3 full - 2 ounces
Exciter - 4/4 full - 4 ounces

GINE ACCESSORIES

Description	Buda Part No.	Manufacturer	Manufacturer's Model No.
Air Cleaner	DE-52192	Donaldson Company Inc. St. Paul, Minn.	B-954
Battery	DP-2479	Globe Union, Inc. Milwaukee, Wisconsin	25H97
Fan	DE-52272	Service Products Corp. Indianapolis, Indiana	4820-DX
Fuel Filter (Primary)	DE-52191	W.G.B. Oil Clarifier, Inc. Kingston, New York	JF-100
Fuel Filter (Secondary)	DE-55944	American Bosch Co. Springfield, Mass.	FSP-10A2
Fuel Injection Pump	DE-52118	American Bosch Co. Springfield, Mass.	APE6A65P/400/ S521Eng.1060ED4
Fuel Tank	DP-24788	John Wood Mfg. Co., Chicago, Illinois	85 Gal. Capacity Tank
Generator (Engine Battery)	DE-56516	Electric Auto-Lite Co. Toledo, Ohio	GDB-4804D
Governor	DE-5201	Pierce Governor Co. Anderson, Indiana	GC-397
Muffler	DP-2557	Maremount Automotive Prod. Chicago, Ill.	EX-1259
Nozzles and Nozzle Holders	DE-41466	American Bosch Corp. Springfield, Mass.	ADN-12-SD12
Oil Filter	DE-52190	W.G.B. Oil Clarifier, Inc. Kingston, New York.	EM-150
Radiator	DP-2500	Young Radiator Co. Racine, Wisconsin	36976

14.	Safety Switch	DE-5227	Penn Electric Switch Co. Goshen, Indiana	1501
15.	Solenoid Valve	DE-52228	Penn Electric Switch Co. Goshen, Indiana	6500
16.	Starter Motor	DE-56518	Electric Auto-Lite Co. Toledo, Ohio	MBR-4003

Weights and Dimensions

Generator Set (Including Base) . . .	2,995 pounds
Engine	1,210 "
Generator	1,040 "
Control Unit and Frame	250 "
Gross Shipping Weight	3,375 "
Overall Length	90-15/16 inches
Overall Height	49-7/8 "
Overall Width	23-1/2 "

ENGINE TOLERANCES

	Desired	Permissible Clearances for Replacement
Piston to cylinder clearance (at skirt bottom 90° to pin)	.0042	.008
Compression ring gap:	.009 - .014	.025
Oil ring gap:	.010 - .015	.020
All ring to groove clearance:		
Compression and Oil Control	.0015 - .0035	.005
Fire	.003 - .005	.007
Piston pin in piston:	.0001 - .0003 Tight	.001
Piston pin to rod bushing:	.0014 - .0009	.002
Crankshaft end play:	.003 - .009	.015
Main Bearing Clearance:	.0020 - .0042	.006
Connecting Rod Side Clearance:	.003 - .008	.012
Connecting Rod Bearing Clearance:	.002 - .004	.0055
Camshaft bearing clearance:	.002 - .0035	.005

Camshaft end play:	.003 - .009	.015
Idler gear end play:	.004 - .007	.015
Idler gear to stud:	.002 - .0035	.005
All gear back lash:		
Idler gear	.002	.006
Accessory gear (Fuel Pump)	.005	.008
Valve stem to guide, intake and exhaust:	.003 - .0035	.005
Tappet adjustment (set hot)		
Intake:	.009	
Exhaust:	.012	
Valve lifter or tappet fit to guide:	.00025- .00075	.0015
Water pump shaft to bushing:	.0001 - .0006	.001
Oil pump gears back lash:	Not over .002	.005
Oil pump gears to case:	.002 - .003	.004
Oil Pump gears to case flange:	Flush	.001

#1 Valve Opening and Closing in Degrees:

Exhaust opens 45° before bottom center

Exhaust closes 13° after top center

Intake opens 20° before top dead center

Intake closes 30° after bottom center

MAIN GENERATOR TOLERANCES

Alternator

Air gap (Single)	.080
End play	.125 + or - .005

(Alternator mounting is such that end play is centralized in the bearing housing so that the rotor can be moved .0625" either side of center.)

Exciter

Air gap (Single)	
Main pole	.044 + or - .001
Inter pole	.044 + or - .001
End play	.000

ENGINE TORQUE WRENCH VALUES

The following table gives the pounds tension required to tighten studs, nuts and capscrews of the diameter shown.

Diameter	Tension in Foot Pounds
3/8	60 - 75
7/16	75 - 85
1/2	95 - 105
9/16	125 - 135
5/8	150 - 160
11/16	195 - 200
3/4	210 - 230
13/16	230 - 250
7/8	245 - 275
1	285 - 315
1-1/8	325 - 350

TOOLS AND EQUIPMENT FOR COMPLETE OVERHAUL

The tools and equipment necessary for the complete overhaul of the generator set, including the engine, engine accessories, generator, and exciter, are given in the following listing.

NOTE: The tools marked with an asterisk are furnished with the generator set.

SOCKET WRENCHES

Sockets, 1/2" drive, 3/8", 7/16", 1/2", 9/16", 19/32", *5/8", 11/16", *3/4", *13/16", 7/8", 15/16", 1".
*One 15" socket wrench handle
One 12" extension
One drag link socket, 3/4" width blade.

OPEN END WRENCHES

1/4" - 5/16", 3/8" - 7/16", *7/16" - 1/2", 1/2" - 9/16", 19/32" - 11/16", *9/16" - 5/8", 5/8" - 3/4", *3/4" - 13/16", 25/32" - 7/8", *5/16" - 1".

TAPPET WRENCHES

1/2" - 9/16".

ADJUSTABLE WRENCHES

*Two pipe wrenches, 8" and 10".
Three adjustable wrenches, *8", *10", and 12".

*Tools furnished with generator set.

CREW DRIVERS

*One 1/4" width blade
*One 3/8" width blade
One 1/2" width blade

LIERS

One diagonal, 5" or 6"
One linesmen, 8"
One chain nose, 6"
Two adjustable pipe, *6", and 8"
One pointed nose

MMERS

One rawhide mallet, 1# or lead hammer 1#
*One ball pein hammer, 3/4" - 12 oz.
One ball pein hammer, 1-1/2 or 2#

LDERING IRONS

One 3/4#
One 1-1/2#

N PUNCHES

One set 1/16" to 1/2"; set should include punch, *1/8" point by 4-1/2" long, one 11/32" diameter point and 6-1/2" pin length.

HISELS

*One 1/2" x 6"
One 5/8" x 6-1/2"

RASS DRIFT

3/8" x 6"

TEEL RULE

6"

EELER GAUGES

Should contain .0015, .002, .003, .004, .005, .006, .008, .009, .010, .012, .013, .015, .020, .025 inch.

OMMSTONE

One small size, Grade "F".

RAIN PLUG WRENCH

*8-3/4" long

*Tools furnished with generator set.

TOOLS AND EQUIPMENT

VALVE SPRING COMPRESSOR

PISTON RING COMPRESSOR

2-3/4" to 4-1/2" range

VALVE GRINDER

CARBON SCRAPER

ALLEN WRENCHES

Set should include one 1/8" and one 5/16" allen wrenches, measured across flats.

*OIL CAN

SHOP TOOLS

*ONE AIR CELL PULLER

ONE DIAL INDICATOR

ONE CYLINDER SLEEVE PULLER

ONE TORQUE WRENCH

0 to 200 foot pounds

ONE STRAIGHT EDGE

3 feet

ONE SPANNER WRENCH

Hook type, 3/10" hook or pin, for diameter of 2-3/4".

GEAR PULLERS - ONE SET

Should contain one puller with arms at least 8" long beneath cross bar and with an opening of at least 5". Arms should be reversible.

One puller made according to specifications in Figure 298.

MICROMETERS

Outside, 1" to 2", 2" to 3", 3" to 4".
Inside, 1/2" to 6".

TEST TACHOMETER

Range 50 to 2000 R.P.M.

*Tools furnished with generator set.

WORK BENCH AND VISE

CHAIN HOIST

1-1/2 ton

SPECIAL EQUIPMENT

VALVE REFACER

VALVE SEAT REFACER

CYLINDER GRINDER

CYLINDER HONE

PISTON PIN, REAMERS, AND HONES

LATHE

At least 9" swing

CONNECTING ROD ALIGNER

TEST AMMETERS

One, range 0 - 600 amperes
One, range 0 - 50 amperes

TEST VOLTMETER

One 0 - 50 volts.

*Tools furnished with generator set.

Chapter II

GENERAL OVERHAUL OF GENERATOR SET

1.. In this chapter, general overhaul of the generator set will be considered and the necessary steps for the disassembly of the set. However, the steps of disassembly for general overhaul of each unit of the set - the engine and its accessories, the main generator and exciter, and the control unit - will be given in Chapters 3, 4, 5, and 6.

It is obvious that when it becomes necessary to repair any unit of this generator set due to an accident, all the steps of disassembly given here and in the subsequent chapters may not apply. Such individual servicings or repairs that may become necessary in the field are included in Chapter VIII.

It is here pointed out that before the general overhaul, there are four servicings for which the maintenance personnel are responsible after every 128, 256, 384, and 1,000 hours of operation. They are: After every 256 hours of operation, the fuel injectors should be removed, inspected, cleaned, and checked; and after every 1,000 hours of operation, the valves should be ground, the battery, generator, and voltage regulator should be checked and the general visual inspection made of the engine and its accessories, the main generator and exciter, and the control unit. The procedures for these servicings are given in paragraphs 31, 53 to 63, 77, 78, 80, 93 and 94.

The general overhaul should take place after every 2,048 hours of operation. The engine, the alternator and exciter should be disassembled completely and any worn parts replaced or repaired. The control unit with its controls, instruments, and wiring should be thoroughly checked and inspected and any necessary repairs and replacements made.

2. STEPS OF DISASSEMBLY OF THE GENERATOR SET

1. Drain the water and the oil. See Figure 102.

2. Remove the radiator, See Figure 102.

3. Disconnect the fuel line at the primary fuel filter, remove muffler, and disconnect all leads and connections from the engine to the control unit, disconnecting them at the engine, and from the control unit to the alternator and exciter, disconnecting them at the alternator and exciter. See Figure 102.

4. Remove the mounting bolts from the base assembly of the control unit and remove the control unit and base assembly.

5. Remove the nuts of the mounting bolts of the main generator and with a chain hoist, hooked in the lifting eye of the alternator, lift the generator enough to block up the engine so that the engine will rest on the block when the main generator is removed.

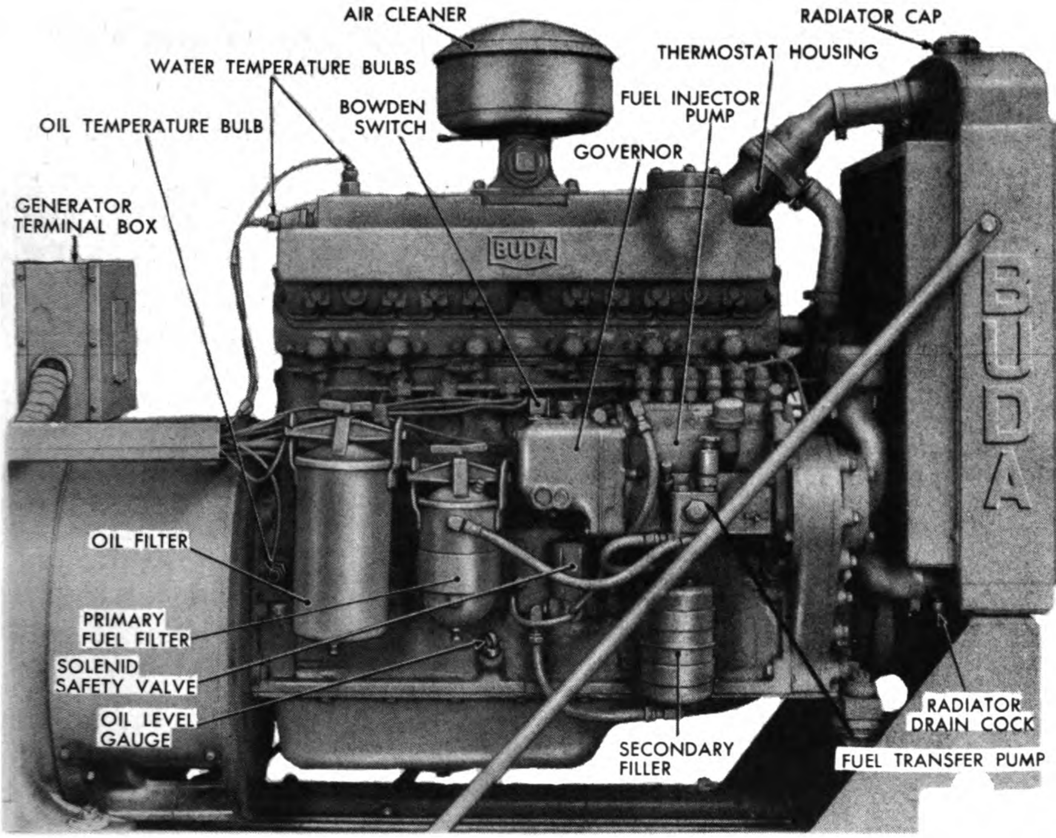


Figure 102. Right Side of Engine on Generator Set.

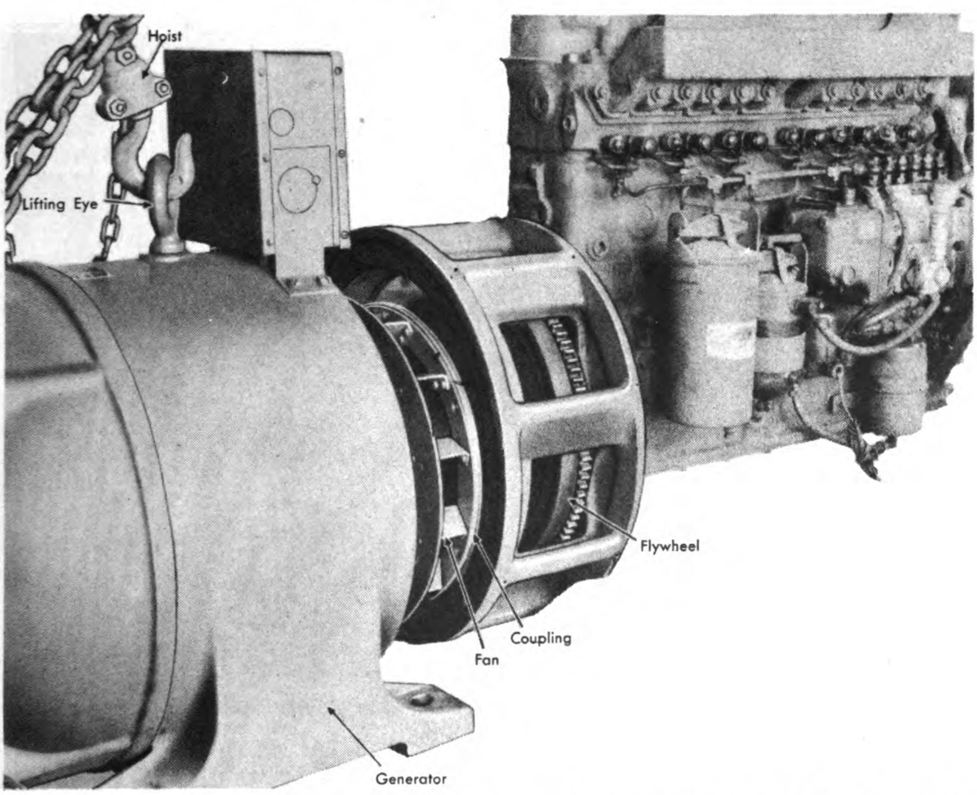


Figure 103. Left Side of 6-DTG-317, 30 K.W. Generator Set, showir' Location of Flywheel, Coupling, Fan, Lifting Hook, etc.

6. Lower the alternator so that the weight is evenly distributed between the blocks and the chain hoist.

7. Remove the coupling capscrew from the coupling and the flywheel. See Figure 104.

8. Remove the bolts that hold the flywheel housing and the generator together and pull the main generator away from the engine. See Figure 103.

9. Remove the engine front mounting bolts and with the chain hoist, lift the engine from the frame.

Each unit is now ready for the complete overhaul.

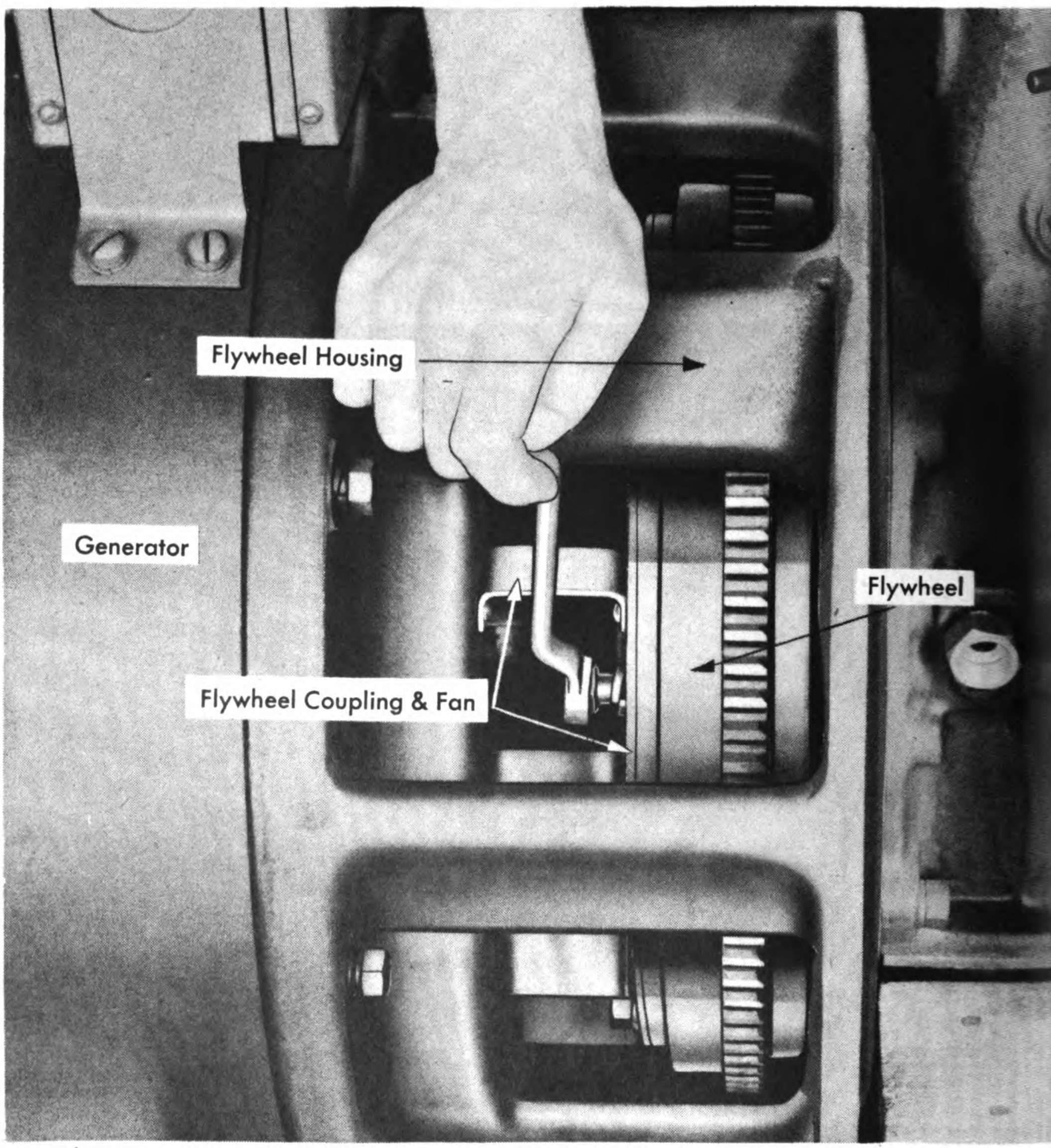


Figure 104. Removing or Installing Generator to Engine.

Chapter III

DISASSEMBLY, REPAIR, AND INSPECTION OF THE ENGINE

3. During the tear-down, the mechanic should observe the conditions of the various parts and assemblies, and he should also make the checks and measurements which are given in the following steps of disassembly. These observations and checks will indicate what repairs and replacements are necessary. If this disassembly and inspection of the engine results only in a thorough cleaning of the engine and its accessories, much will have been gained in lengthening the operating life of the engine and also assuring trouble-free performance.

Discard all gaskets, oil seals - rubber stops and felts - and replace with new ones.

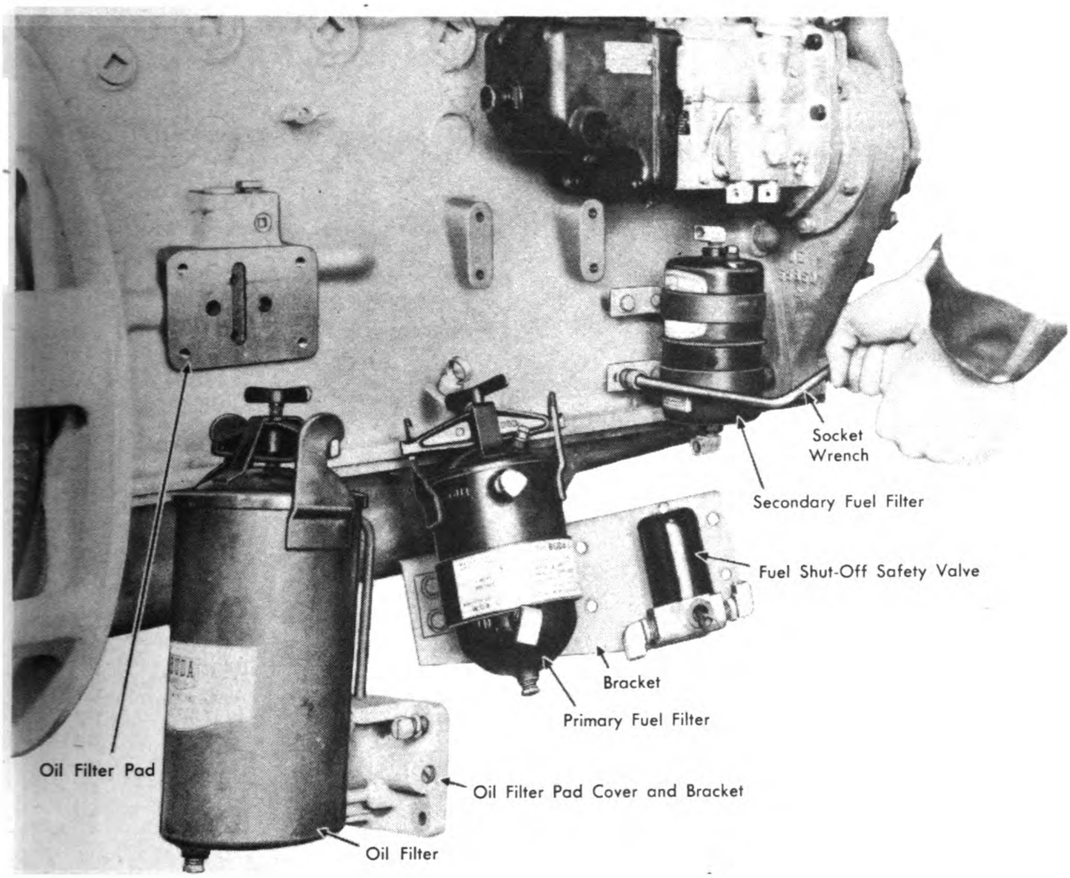


Figure 105. Removing Filters and Solenoid Valve.

STEPS OF DISASSEMBLY OF ENGINE

4. STEPS OF ENGINE DISASSEMBLY

After the starting motor, and the battery charging generator, and the air cleaner have been removed, the following steps of disassembly should be followed: See Figure 102.

1. Remove the fuel lines and plug the holes so no dirt can enter.

2. Remove the oil filter; remove the mounting bracket to which are attached the primary fuel filter, and the solenoid safety valve. See Figure 105. Remove the fuel filter and solenoid from the bracket.

3. Remove the secondary fuel filter. See Figure 105.

4. Remove the injector leak-off lines, both at the injector and at the fuel injection pump, as shown in Figures 106 and 107.

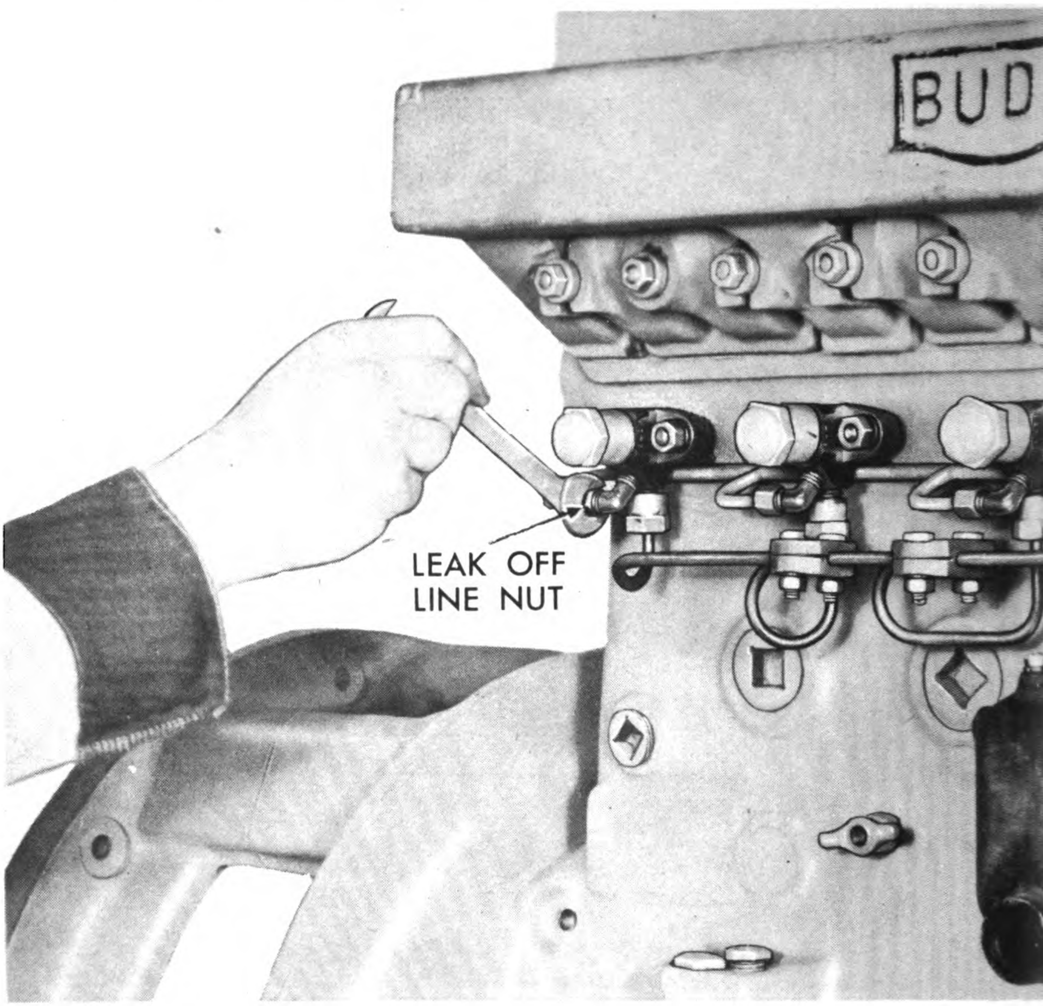


Figure 106. Removing Injector Leak-off Line at Injector.

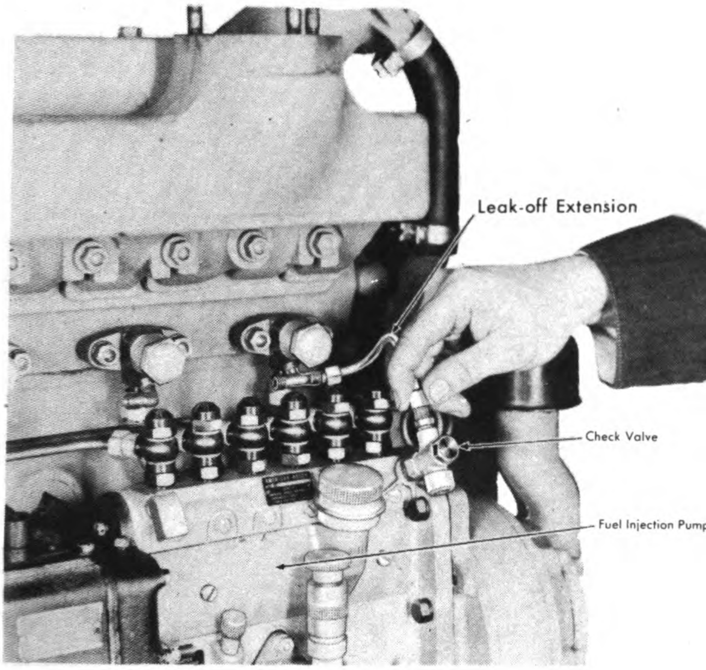


Figure 107. Removing Injector Leak-off Line at Pump.

5. Remove the injection line clamps and unscrew the nuts at the angle connections of the fuel injection pump. See Figure 109. Remove the injector lines at the injector. See Figure 108.

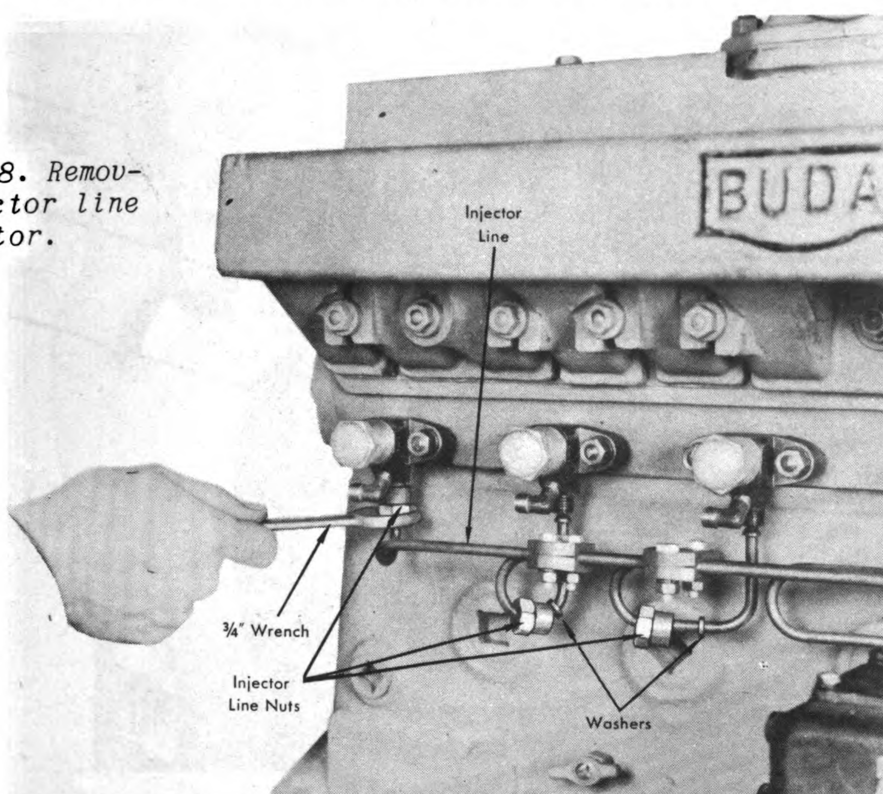


Figure 108. Removing Injector line at Injector.

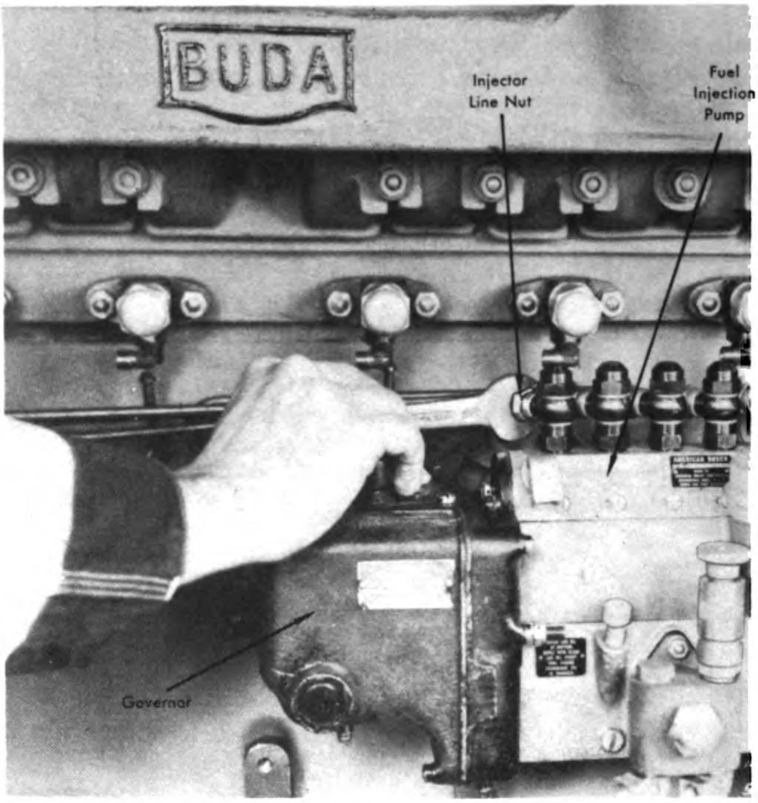


Figure 109. Removing Injector line at Pump.

6. Remove the rocker arm lubricating oil line to the cylinder head. The inlet connection is located in the crankcase directly behind the fuel injection pump. See Figure 110.

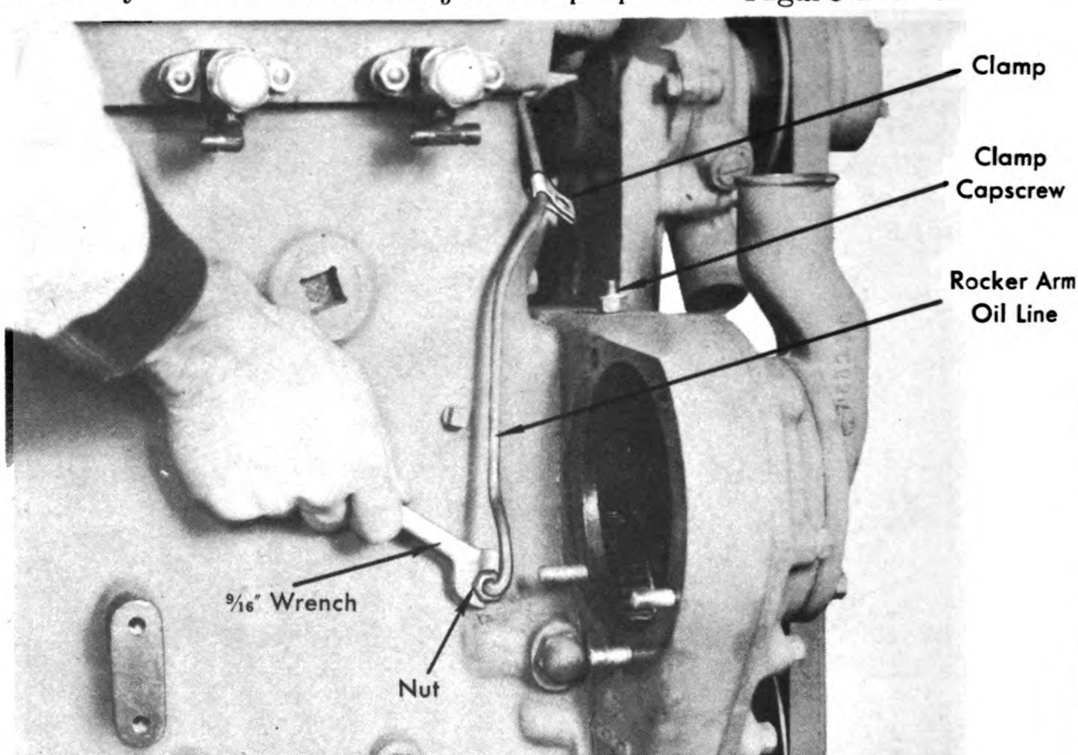


Figure 110. Removing Oil Line to Rocker Arm.

7. Remove the governor, fuel injection pump, and the adaptor plate as a unit from the gear housing. See Figure 111. **NOTE:** It will be necessary to remove the external rocker arm oil line before removing full injection pump. See Figure 110.

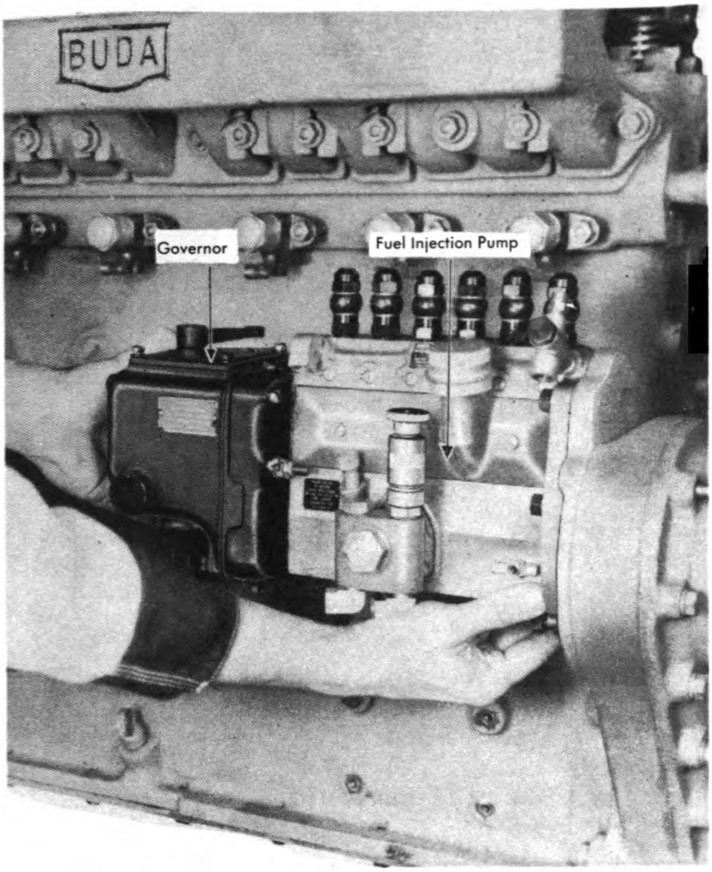


Figure 111. Removing Fuel Injection Pump and Governor.

8. Remove the injectors. If they are carbonized and will not come out easily, they can be pried out as shown in Figure 112.

9. Remove the intake and exhaust manifold. See Figure 113.

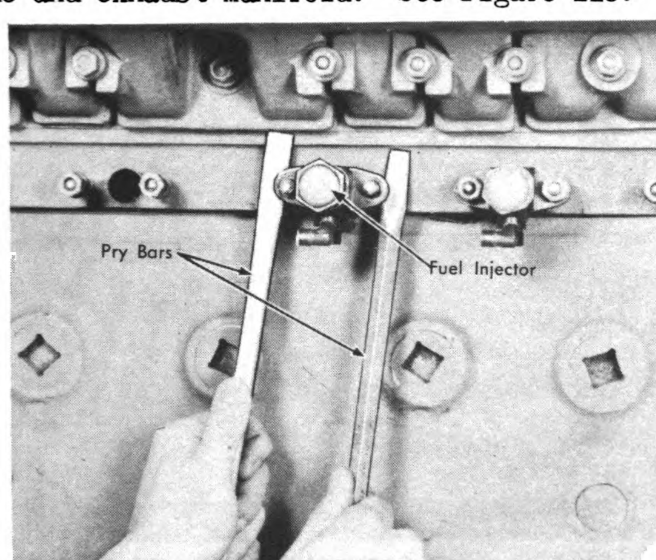


Figure 112. Removing Injectors.

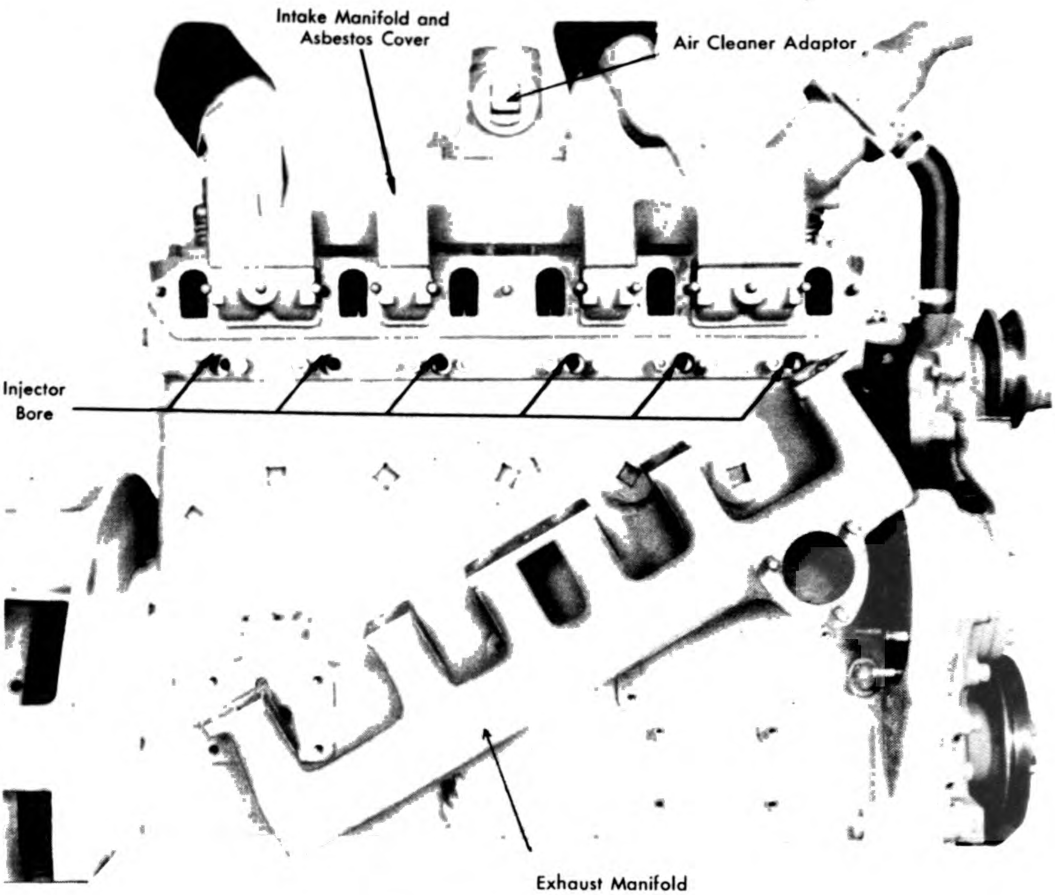


Figure 113. Removing Manifold.

10. Remove the valve cover and unscrew and remove the eight bolts which hold the rocker arm assembly in place, and remove this assembly. See Figure 114.

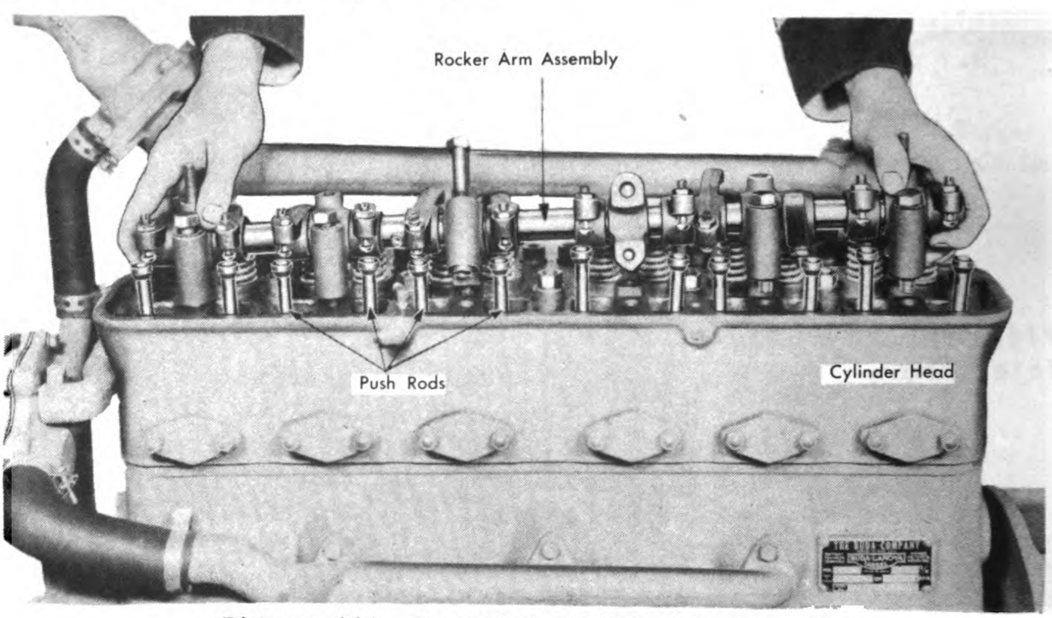


Figure 114. Removing Rocker Arm Assembly.

11. Remove the hose connections to the pump and remove the water inlet and outlet manifolds. Note the water distributors at the inlet manifold in the crankcase. See Figure 115.

12. Remove the cylinder head. See Figure 116.

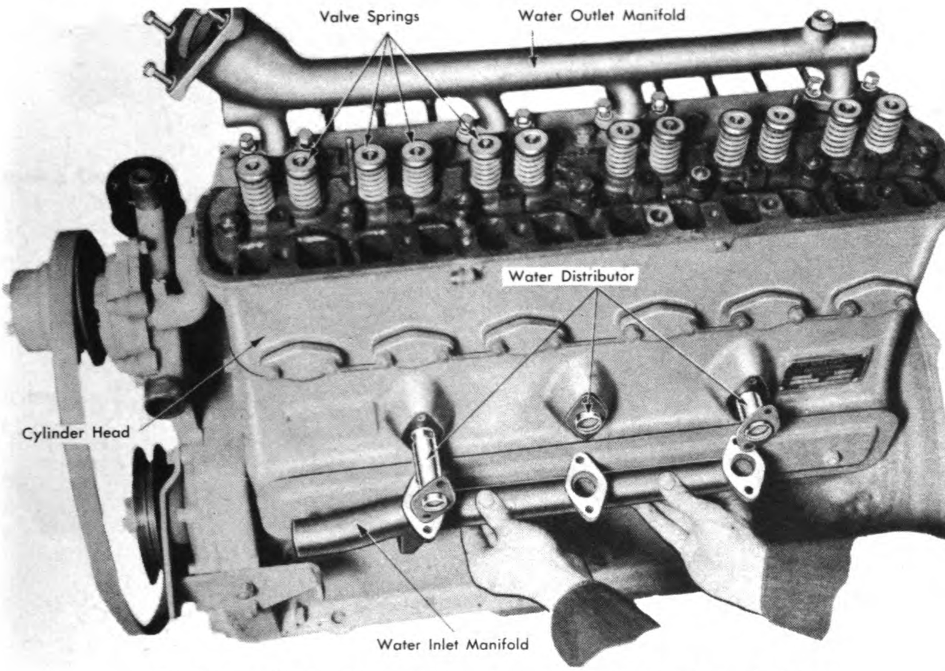


Figure 115. Removing Water Inlet Manifold.

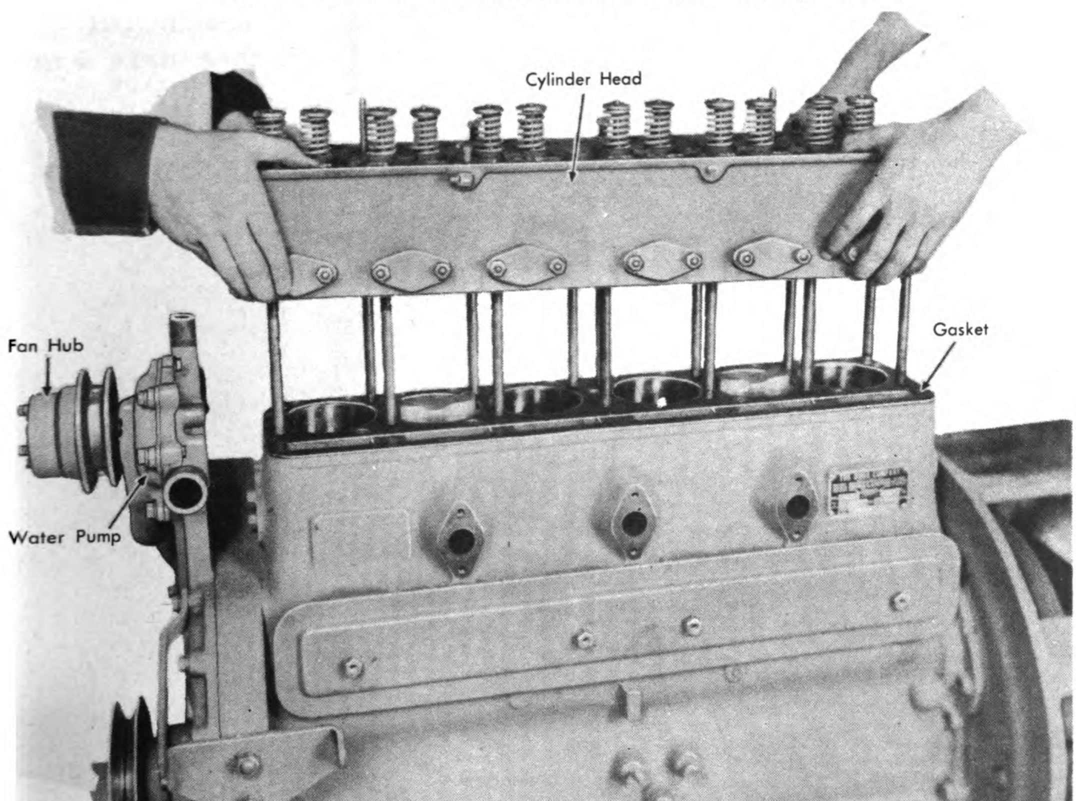


Figure 116. Removing Cylinder Head.

STEPS OF DISASSEMBLY OF ENGINE

12A. Remove the valve lifter cover. Remove bracket capscrews and remove the valve lifter bracket and the lifters, as shown in Figure 117, with the fingers held against the lifters as a precaution against their falling through into the oil pan as the bracket is removed.

13. Remove the water pump. See Figure 118.

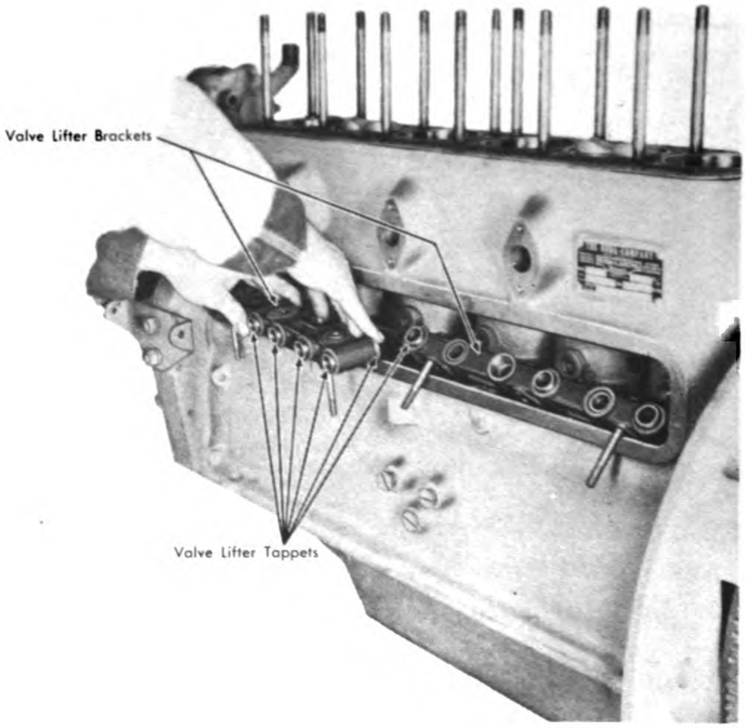


Figure 117. Removing Lifter Bracket.

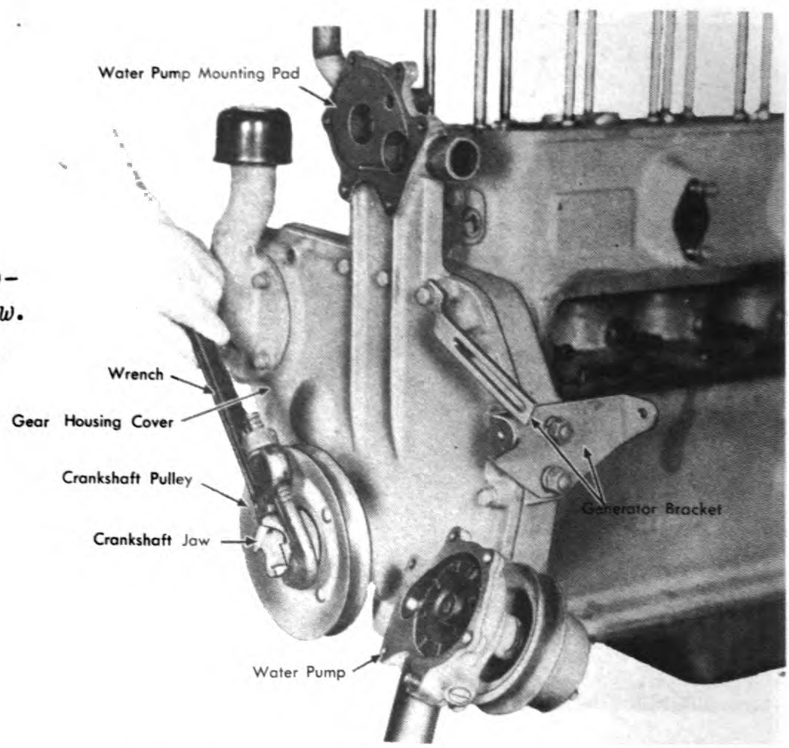


Figure 118. Removing Crankshaft Jaw.

14. Remove the crankshaft jaw, as shown in Figure 118, and with a wheel puller, remove the crankshaft drive pulley.

15. Remove the front gear case cover. See Figure 119.

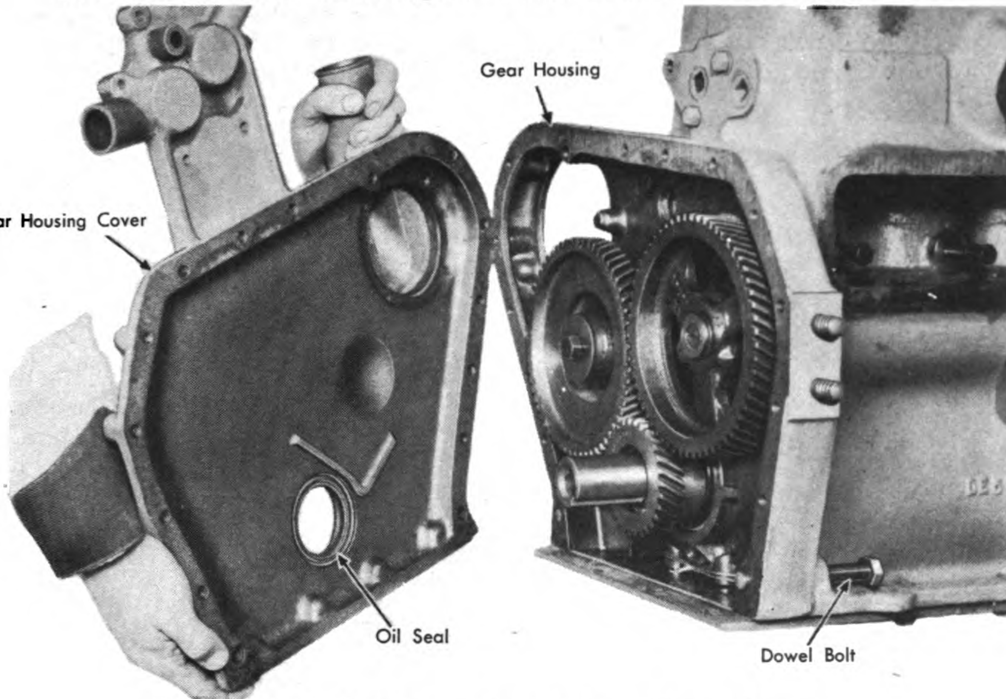


Figure 119. Removing Front Gear Case Cover.

16. Check the backlash on the cam, idler, and crankshaft, gears with a dial indicator, as shown in Figure 120. If the

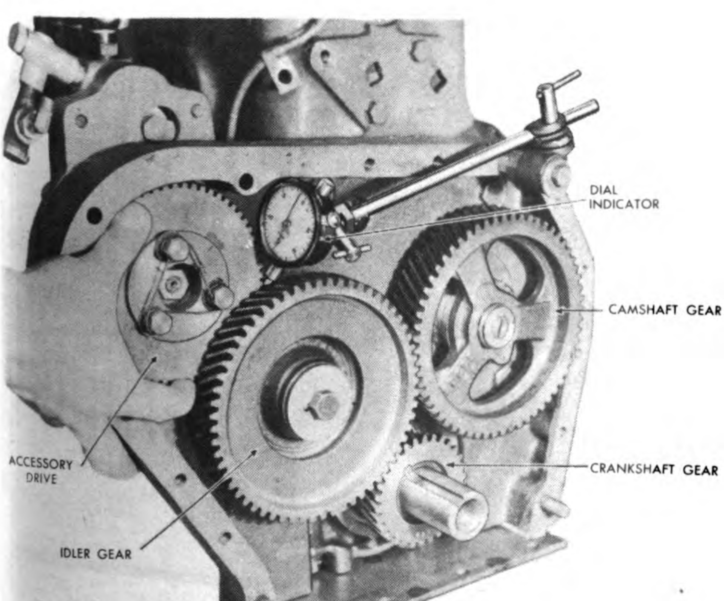


Figure 120. Checking Gear Back Lash.

backlash of the idler gear where it meshes with the other gears, is more than .006", replace the idler gear with an oversize gear.

17. Check the idler gear end play by inserting a feeler gauge between the gear hub and the thrust washer. This clearance should be from .004" to .007". See Figure 121. Excessive end play can usually be overcome by replacing the thrust washer.

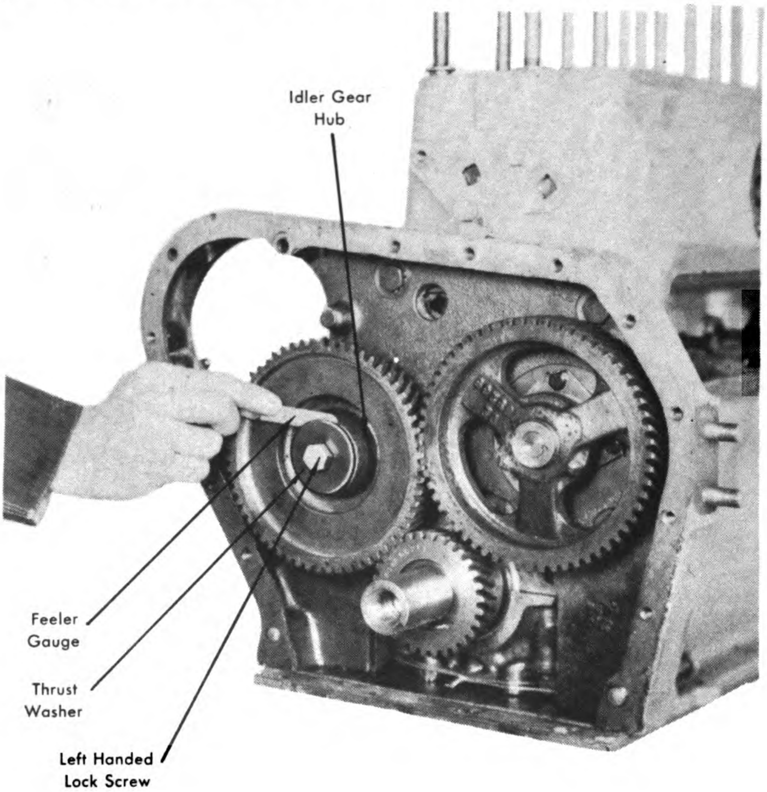


Figure 121. Checking Idler Gear End Play.

18. Remove the idler gear. **NOTE:** The idler gear capscrew has a left hand thread. See Figure 122.

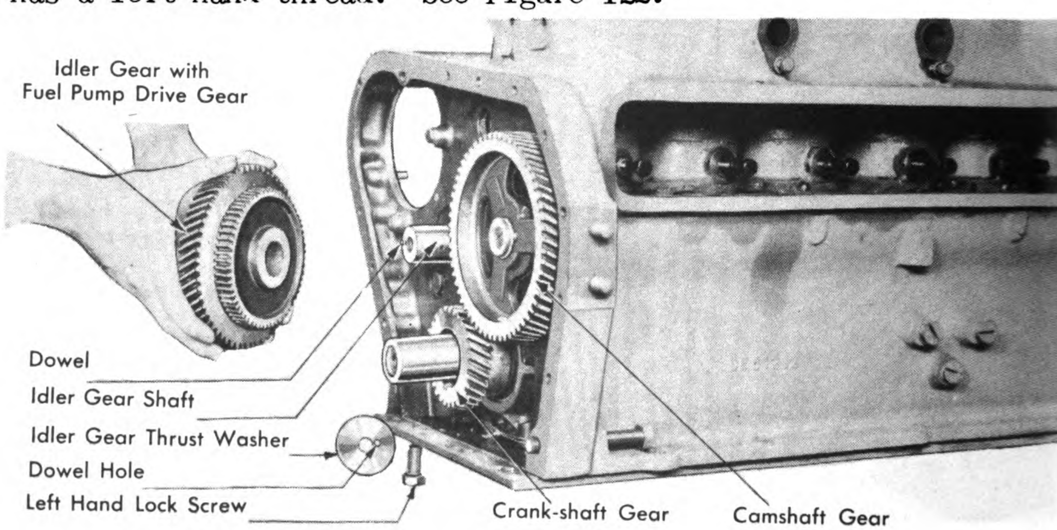


Figure 122. Removing Idler Gear.

19. Unscrew the idler gear shaft lockscrew by first removing the acorn nut shown in Figure 123. The shaft can be pulled out with a short piece of pipe, as shown in Figure 124, with the original capscrew and washer.

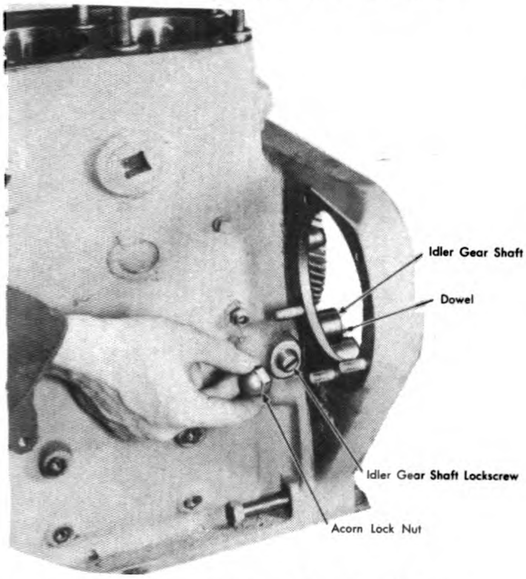


Figure 123. Removing Acorn Lock Nut.

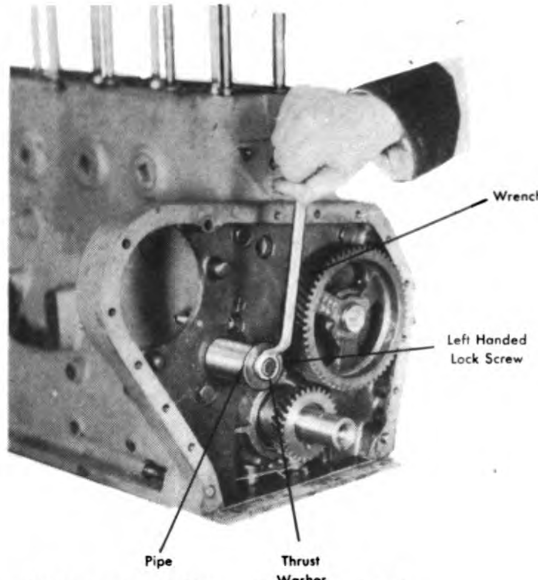


Figure 124. Removing Idler Gear Shaft.

20. Check the camshaft bushing clearance with a feeler gauge between each of the four bushings, which should be between .002" and .0035". See Figure 125. If this is excessive, the bushings must be replaced. The instructions for bushing replacement are given in paragraph 11.

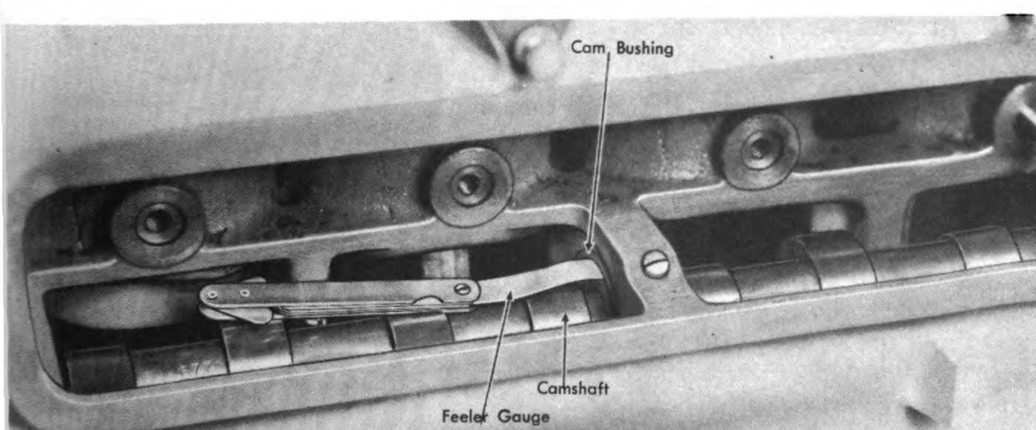


Figure 125. Checking Camshaft Bushing.

STEPS OF DISASSEMBLY OF ENGINE

21. Straighten out the lock that holds the three camshaft thrust plate capscrews (see Figure 126), remove the capscrews,

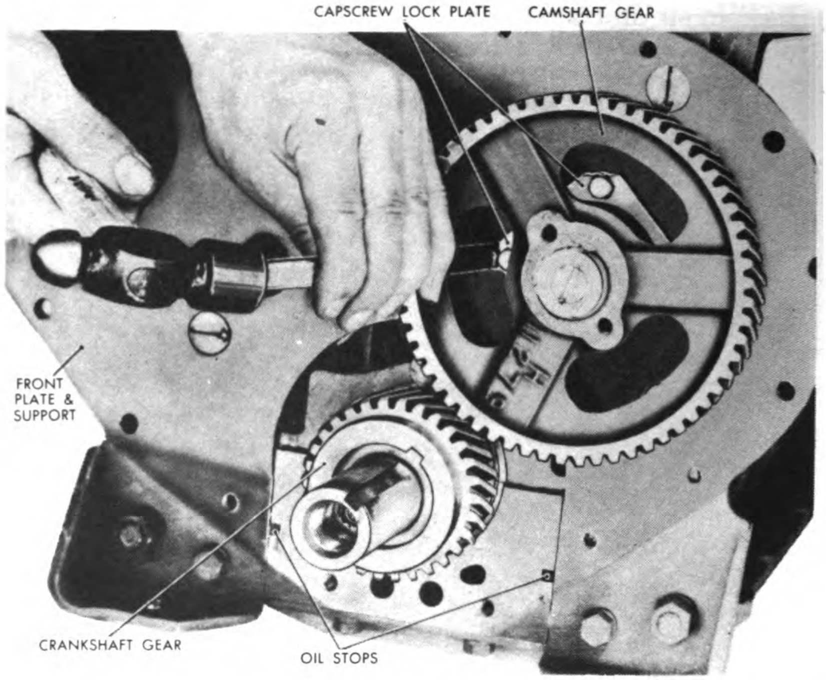


Figure 126. Straightening Thrust Plate Capscrew Lock.

and pull the camshaft out of the crankcase. Be careful when pulling out the camshaft not to damage the bushings.

22. Check the camshaft end play by measuring the space between the hub of the gear and the thrust collar as shown in Figure 127. If excessive, this can be corrected by replacing the gear or the plate or the camshaft. Usually the thrust plate replacement will overcome the excessive end play.

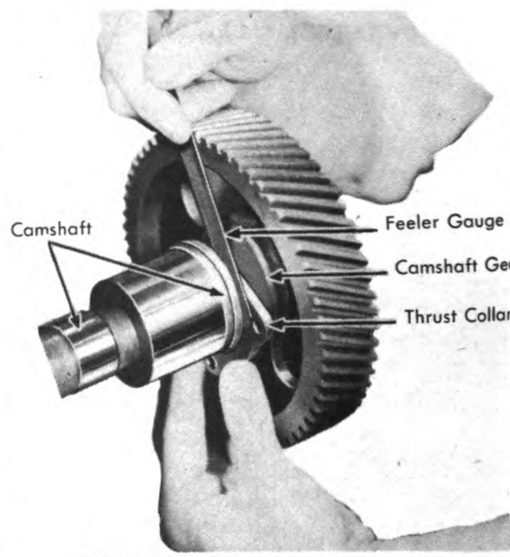


Figure 127. Checking Camshaft End Play.

23. Block up the engine at the back and remove the five flywheel bolt nuts and washers. **NOTE:** These are thin washers, so do not attempt to use them in any other place. Use three 1/2" N.C. capscrews with 1-1/2" of thread about 4" long to push the flywheel off the bolts. Screw these into the three tapped holes in the hub of the flywheel and push the flywheel off as shown in Figure 128. These capscrews can be used as handles to lift the flywheel out of the housing. **NOTE:** In

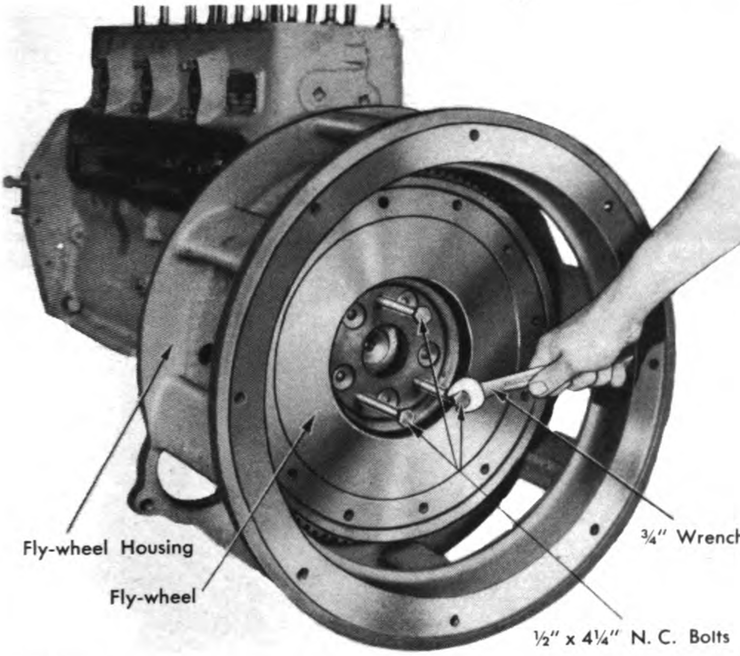


Figure 128. Removing Flywheel.

order to protect the bolt threads on the flywheel bolts in the crankshaft, put the nuts back on.

24. With a chain hoist, lay the engine on its left side and remove the flywheel housing with the aid of the chain hoist after having removed the four capscrews and dowel bolt nuts, as shown in Figure 129.

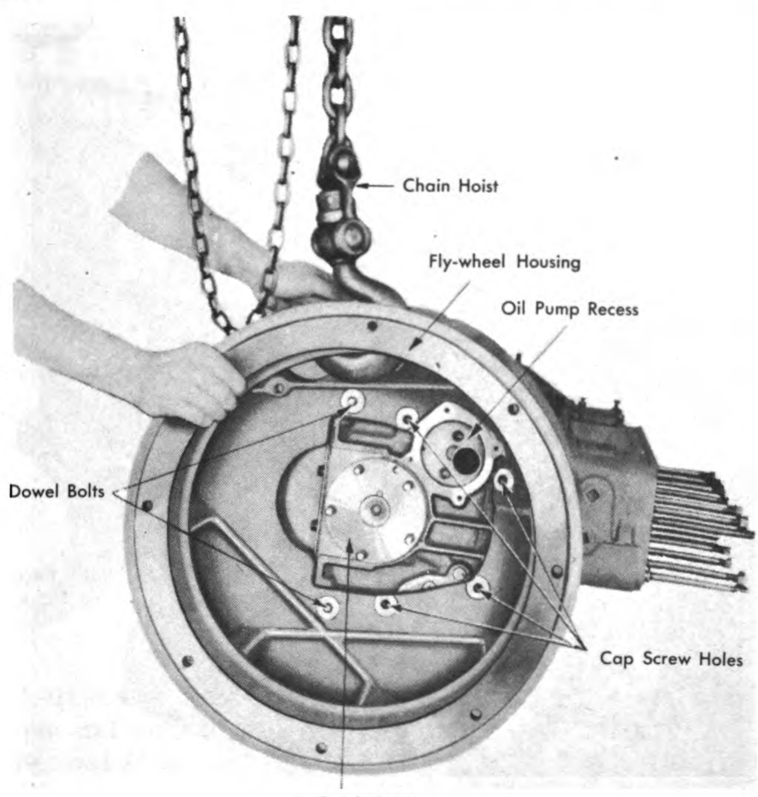


Figure 129. Removing Flywheel Housing.

25. Remove the oil pan capscrews and remove the oil pan.

26. Remove the Float-O bracket, as shown in Figure 130. The Float-O is held in place with three capscrews.

27. Check the crankshaft end play by slipping a feeler gauge between the end of the rear main bearing and the crankshaft, as shown in Figure 131. This clearance should be between .003" and .009". If clearance is greater than .015", a new rear main bearing is needed.

28. Check each connecting rod side clearance with a feeler gauge inserted between the crankshaft throw and the connecting rod bearing, as shown in Figure 132. Be sure to get the feeler gauge down onto the crankshaft journal. This clearance should be between .003" and .008". If greater than .012", bearing replacement is needed.

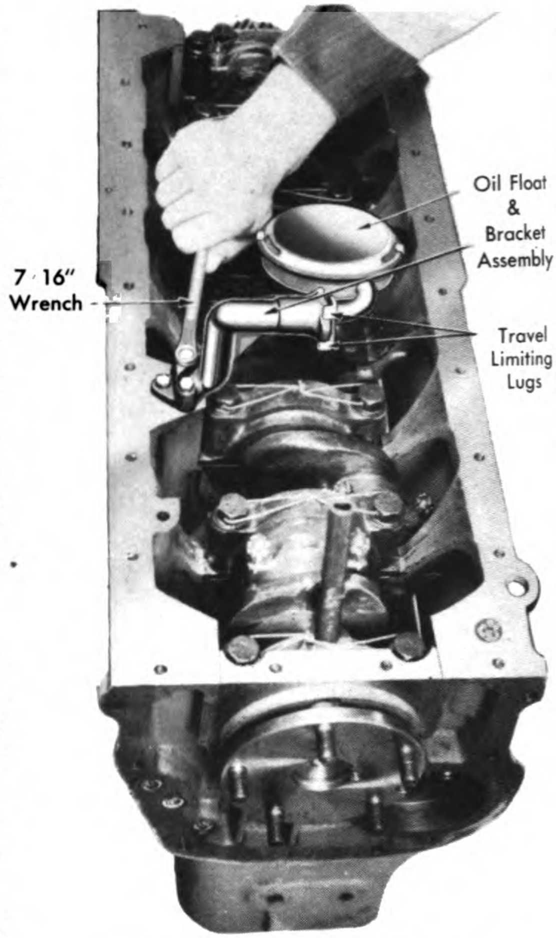


Figure 130. Removing Oil Float Bracket.

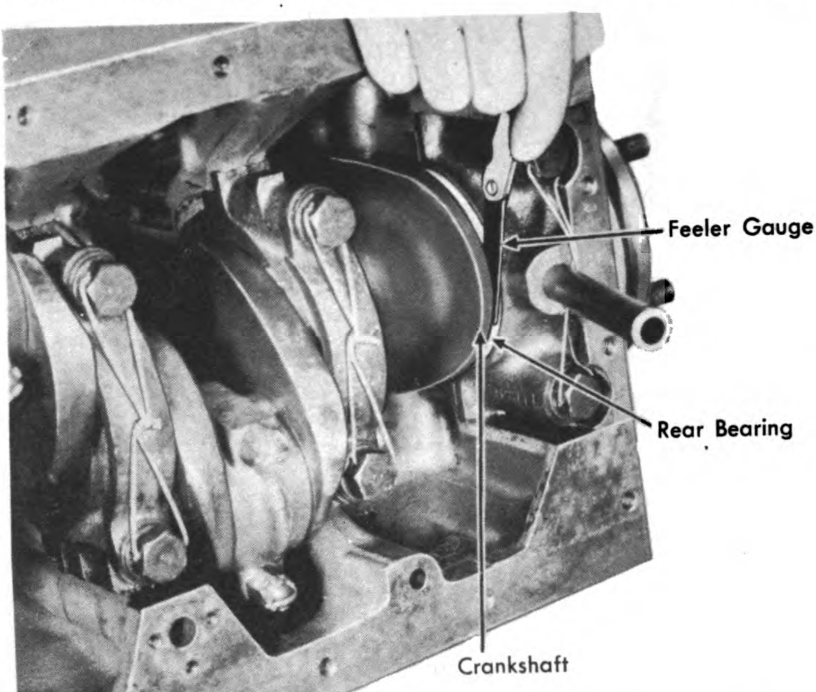


Figure 131. Chec ing Crankshaft E Play.

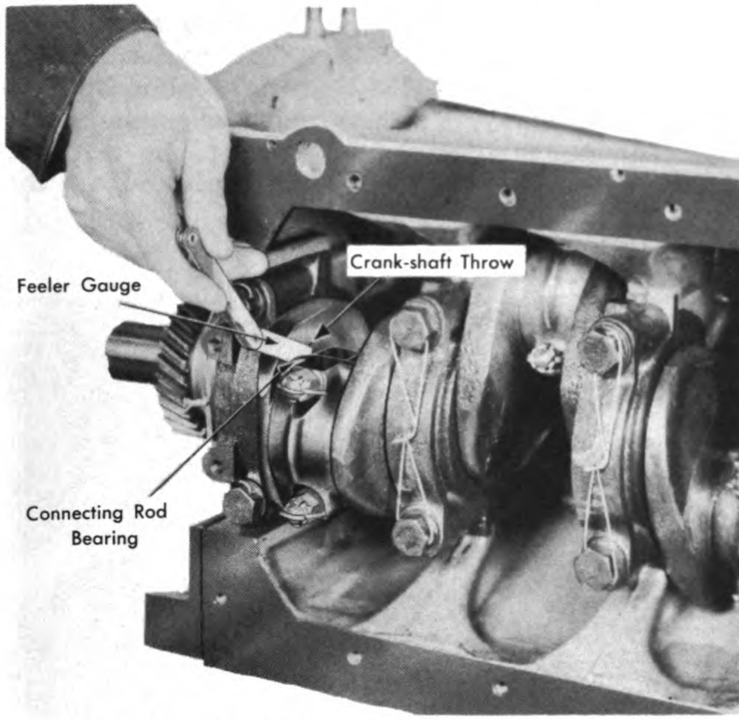


Figure 132. Checking Connecting Rod Side Clearance.

29. Remove the front gear housing. Four capscrews, two countersunk screws, and two dowel bolt nuts, as shown in Figure 133, hold it in place.

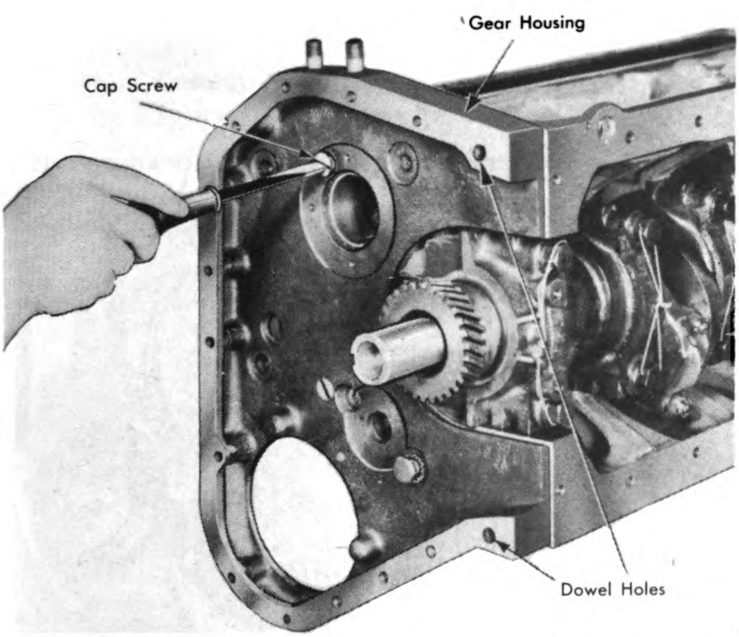


Figure 133. Removing Gear Housing Cover.

30. Remove and discard the cotter pins from the connecting rods. Remove the caps and push the rods out through the cylinder bores. **CAUTION:** Be careful not to mar the crankshaft or the connecting rod bearings. **NOTE:** A good pilot tool for pushing off the pistons is a short wooden handle with a piece of copper

tubing fitted to one end. The tube slips over one bolt and the handle acts as a pilot or guide to avoid damaging the bearing surfaces. See Figure 134. Replace the caps and the nuts on their respective rods. The caps and the connecting rods are all numbered for this purpose. **CAUTION:** Do not reverse the position of the caps, for they must be replaced in their original positions.

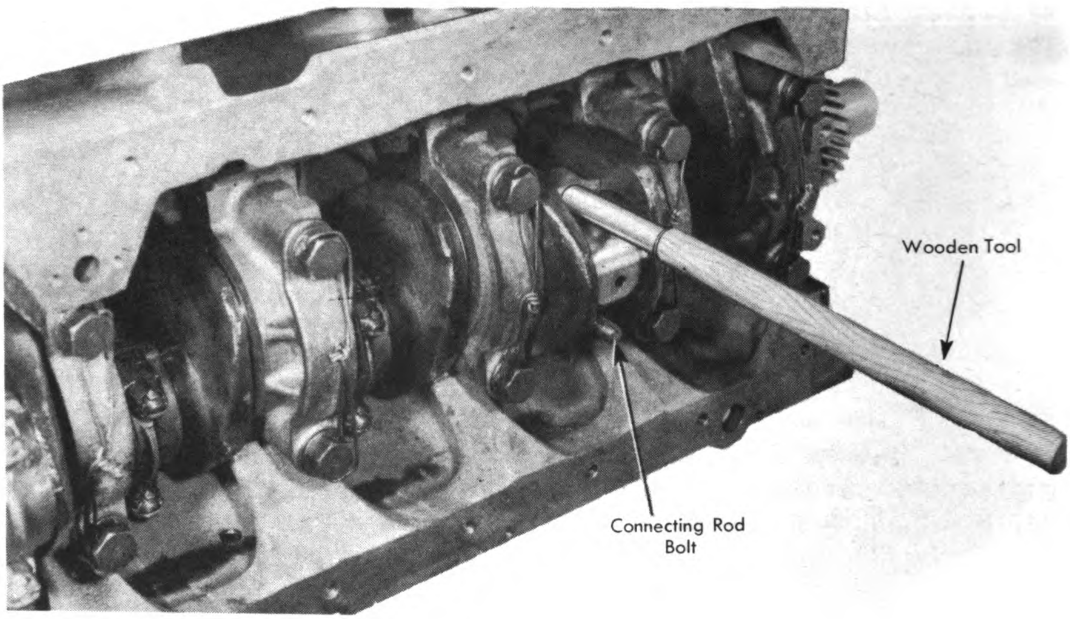


Figure 134. Guiding Connecting Rod Bolt Over Crankshaft Journal.

31. With a chain hoist, stand the crankcase on the cylinder head studs so that when the bearing caps are removed, there will be no danger of the crankshaft falling out.

32. Remove the oil pump which is held in place with four capscrews. See Figure 135.

33. Remove and discard the lock wires of the main bearing caps and remove the caps. The rear bearing cap with the lower half of the oil

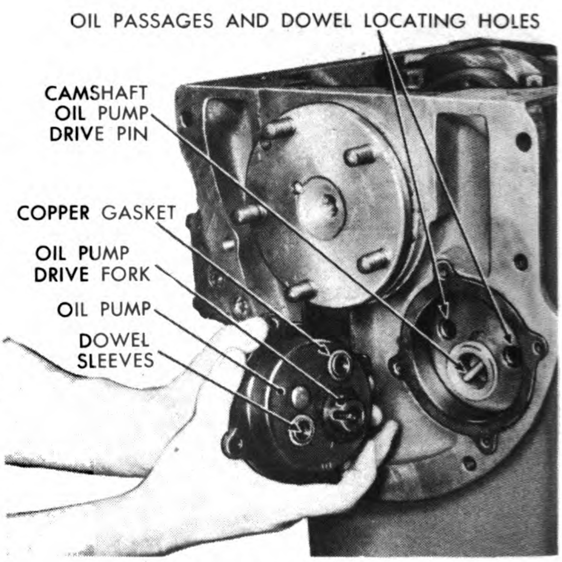


Figure 135. Removing Oil Pump.

seal attached can be removed, as shown in Figure 136, with two pry bars, two blocks of wood, and two bolts. NOTE: The main bearing caps are numbered consecutively, starting at the front end, or fan end, of the engine, 1 to 7 inclusive.

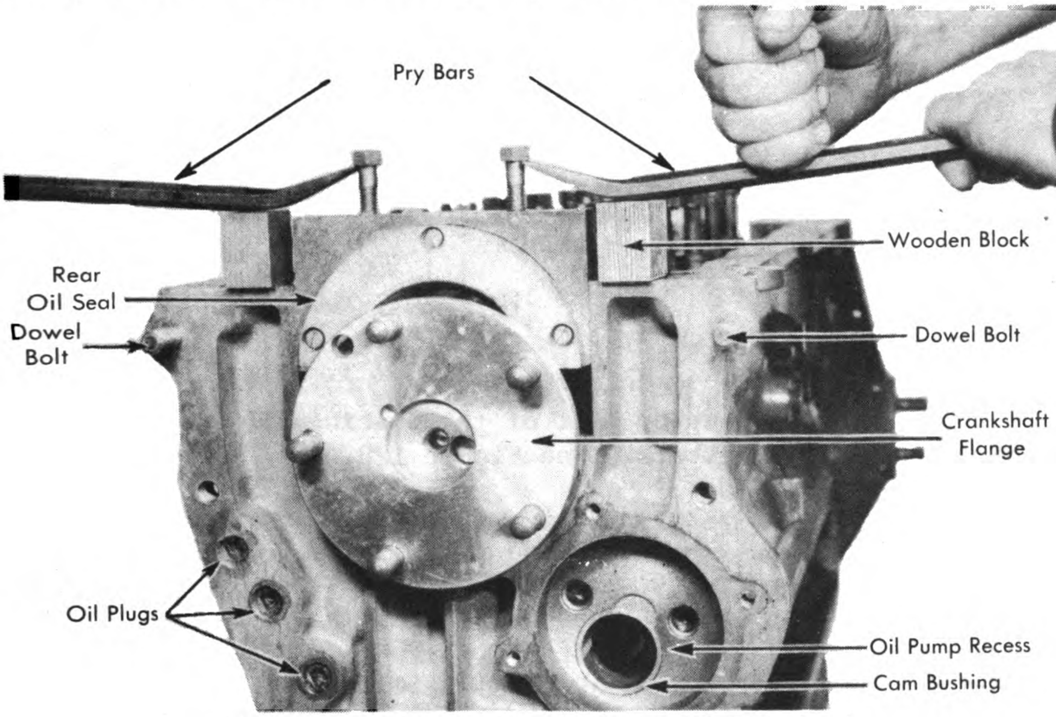


Figure 136. Removing Lower Half Oil Seal.

34. Carefully lift the crankshaft out of the crankcase, as shown in Figure 137, so as not to damage the bearing surfaces.

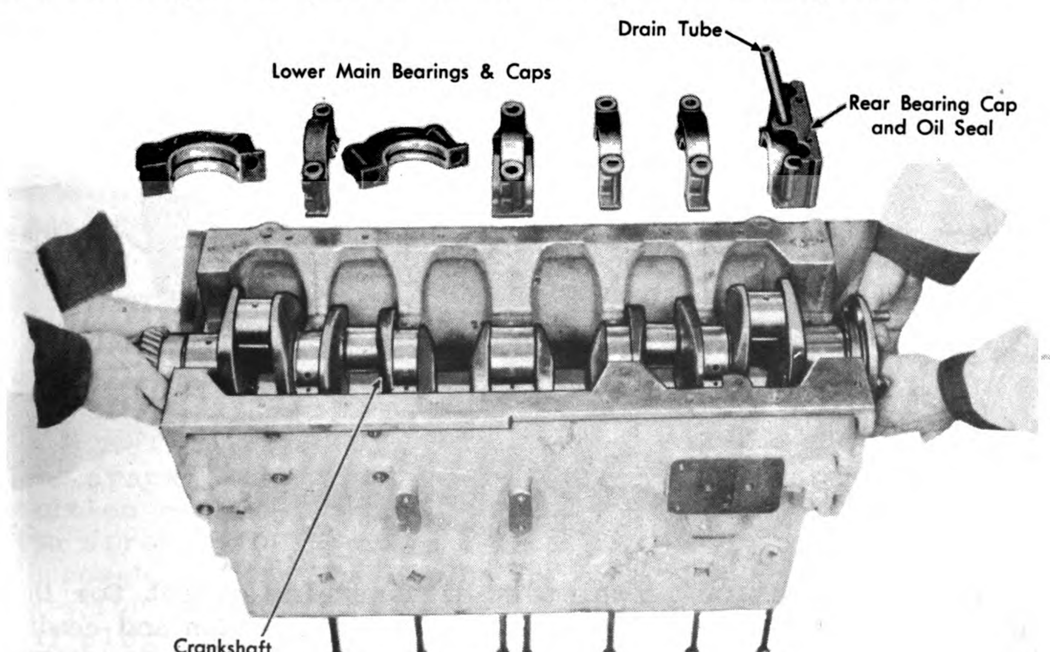


Figure 137. Removing Crankshaft.

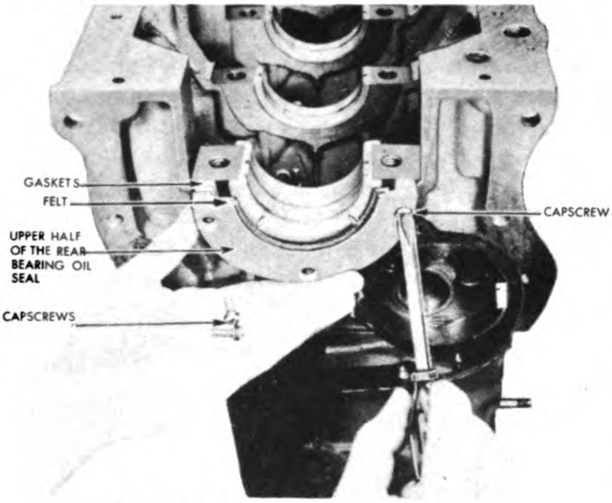


Figure 138. Removing Upper Half Oil Seal.

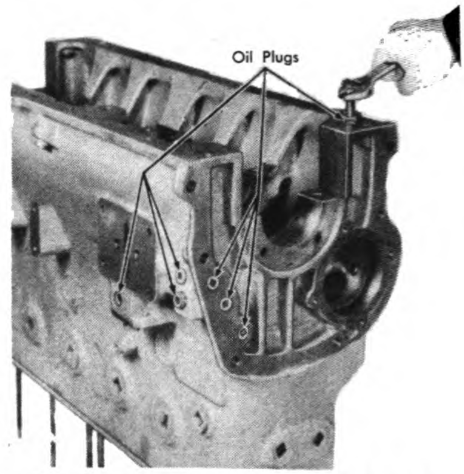


Figure 139. Removing Oil Line Pipe Plugs.

35. Remove the upper half of the bearing oil seal and discard the felts and gaskets. See Figure 138.

36. Remove the bearings from both the crankcase and the caps. **NOTE:** These bearings are not numbered. Therefore, they must be laid away just as removed so that they can be placed back in their respective places exactly as they came out if they do not need to be replaced. Even their individual positions in the crankcase and in the caps must not be reversed. If any one of the bearings is pitted or burned, it is recommended that they all be replaced, and not just one.

37. Remove the oil line pipe plug at the front end of the case and the three at the rear end. See Figure 139.

38. Remove the oil pressure relief valve and the oil line pipe plugs, as shown in Figure 140.

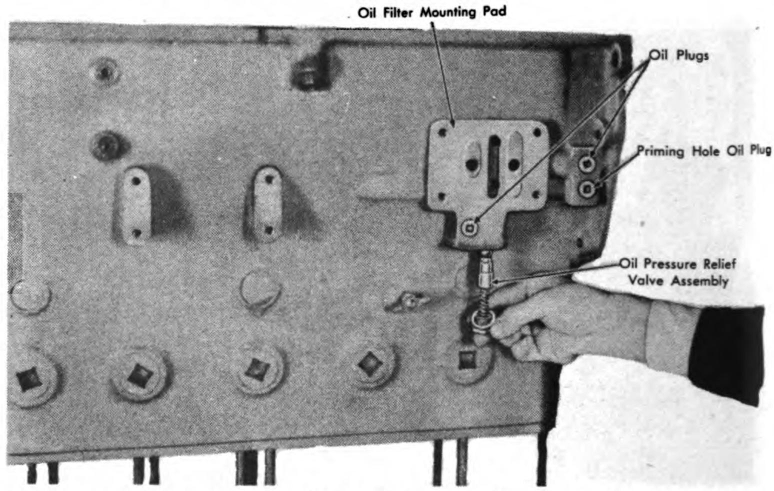


Figure 140. Removing Oil Pressure Relief Valve.

The engine is now completely disassembled except for the engine accessories, and the head assembly. Inspection and conditions for replacement of any parts of the accessories are given in the following CHAPTER IV.

INSPECTION AND REPLACEMENT OF ENGINE PARTS

5. This section deals with the inspection and repair of the engine proper. Instructions here given take into consideration every possible repair or replacement that can be made. It should not be assumed, however, that all of these repairs or replacements are normal. For the most part, some of the replacements will be rare, but all these extreme conditions are given in order to aid the mechanic in doing a skillful job.

NOTE: An accurate inspection can be made only if the parts are cleaned both inside and out. If no cleaning tank is available, washing the parts in kerosene is recommended.

The assemblies or parts of the engine proper to be serviced are listed alphabetically.

The instructions for the overhaul of the engine accessories are given in Chapter IV.

6. CAMSHAFT

The camshaft is of open hearth steel, case hardened, and runs in four bronze bushings which are pressed into the crankcase. The desired camshaft bearing clearance is from .002" to .0035". The camshaft, being case hardened, will never have to be replaced because of too much clearance. The bushings will need replacement if the clearance is excessive. The instructions for the replacement are given under crankcase instructions in paragraph 10. The camshaft end play, which can be checked between the hub of the gear and the thrust collar as shown in Figure 127, should be between .003" and .009". If clearance is greater than .015", the thrust collar must be replaced.

Check the oil pump drive pin for wear. If worn, the pin can be removed from the shaft with a hammer and punch. After installing new pin, make certain that the riveted ends of the pin are flush so that they will not damage the bearing.

7. CRANKCASE

The mechanic should exercise caution when handling the crankcase so that he does not mar the faces of the crankcase. This precaution cannot be stressed too strongly. In order to thoroughly clean the crankcase for inspection, all the oil plugs must be removed, and with a wire brush, as shown in Figures 141 and 142,

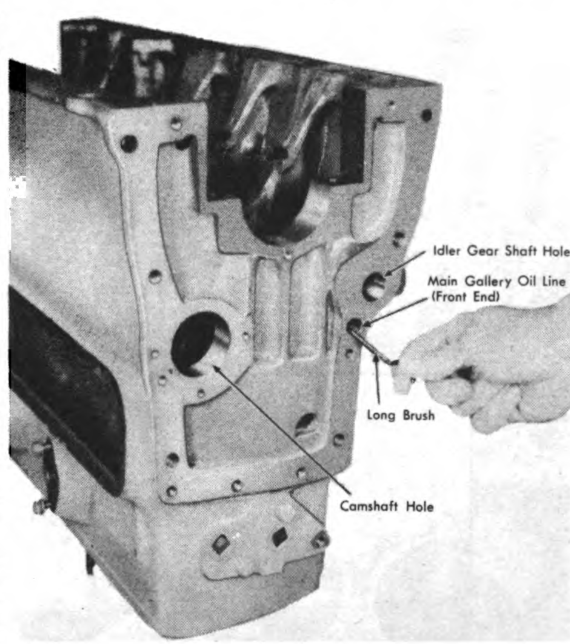


Figure 141. Cleaning Main Galley Oil Line.

brush out all the oil lines to remove any sediment, sludge, or restriction. Blow out the lines with air.

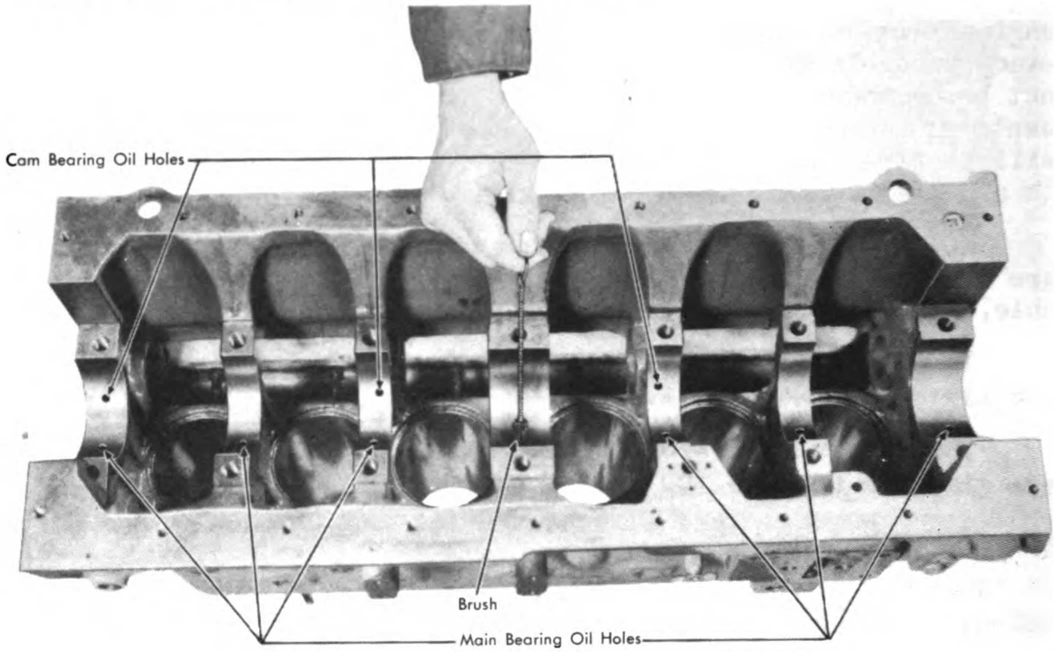


Figure 142. Cleaning Oil Channel.

8. CHECKING FOR OUT OF ROUND AND TAPER

Check each cylinder sleeve with an inside micrometer at the upper end of the ring travel, as shown in Figure 143.

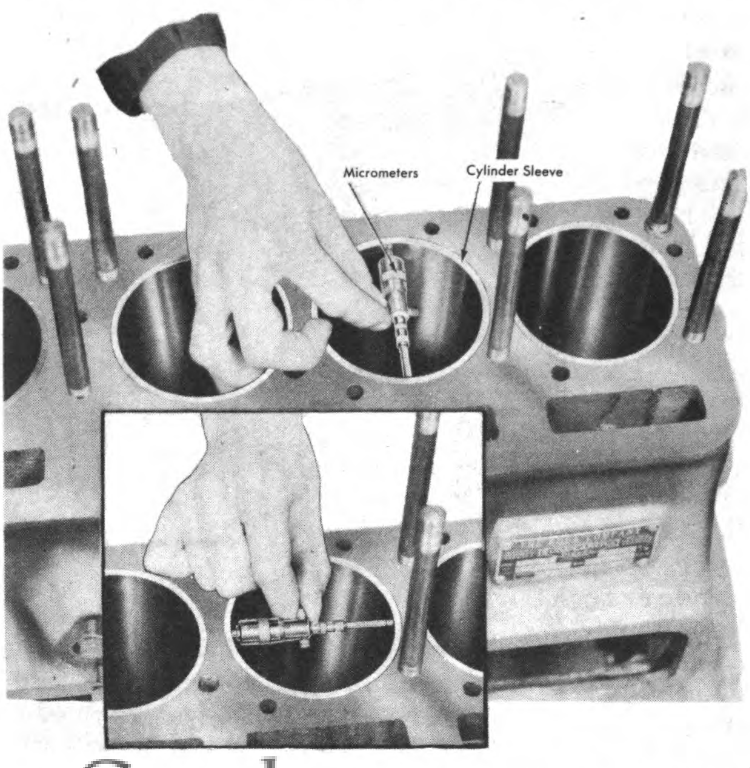


Figure 143."Mixing" Cylinder sleeve.

First check in a position parallel to the crankshaft, and then in a position at right angles to the crankshaft, as shown in Figure 143. The difference between these two readings shows the amount the cylinder sleeve is out of round. To obtain the amount of each cylinder sleeve taper, measure in like manner the bottom of each cylinder by taking two readings, one position parallel to the crankshaft and the other at right angles to the crankshaft. Compare the top parallel reading with the bottom parallel reading and the top right angle reading with the bottom right angle reading to obtain the taper. If the out of round and the taper is more than .005", the cylinder sleeves should be replaced, also the pistons should be replaced.

9. REPLACING THE CYLINDER SLEEVES

The cylinder sleeves are of the dry type and can be removed and replaced with screw type pulling tool as shown in Figure 144. The bore of the block must be wiped out clean and the sleeves dipped in light machine oil before inserting. In order to secure absolute precision in outside diameter, the sleeves are selected on inspection for variations of tens of thousandths of an inch, and the cylinder block and flange of the mating sleeve marked "A", "B", "C", or "AO", "BO", "CO". In ordering a new sleeve to fit a particular bore, be sure to state the "A", "B", "C", or "AO", "BO", "CO" marking found on the top of the cylinder block adjacent to the sleeve in question. Also advise the engine serial number which will be found on the engine name plate.

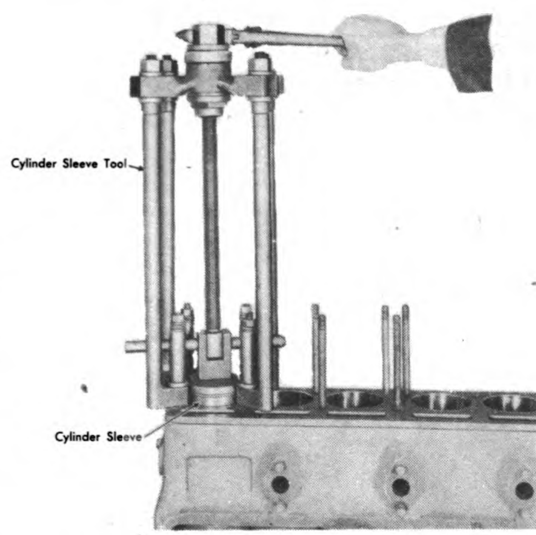


Figure 144. Removing Cylinder Sleeve.

10. CHECKING AND REPLACING CAMSHAFT BUSHINGS

The camshaft runs in four bronze bushings which are pressed into the crankcase. The desired camshaft bearing clearance should be between .002" and .0035". (See Figure 125.) If the clearance is more than .005, replace the bushings. The bushings are of precision type and do not require reaming after being pressed into the case.

11. REMOVING CAMSHAFT BUSHING

With a hacksaw blade, carefully cut through the bushing, taking care not to cut into the crankcase. With a cold chisel and hammer, break the bushing and knock it out. With a tool similar to the one shown in Figure 145, put the bushing in place, being careful to line up the oil holes, and with a driving bar drive it in place. See Figure 146. If such a tool, shown in Figure 145, is not available, use two washers slightly larger than the bushing and with holes in the center just large enough through which a bolt, 1/2" in diameter and at least 3" to 3" long, can pass. Put one washer on one side of the crankcase and the other on the opposite side of the bushing. Insert the bolt and screw on the nut and carefully turn the nut to pull the bushing into position.

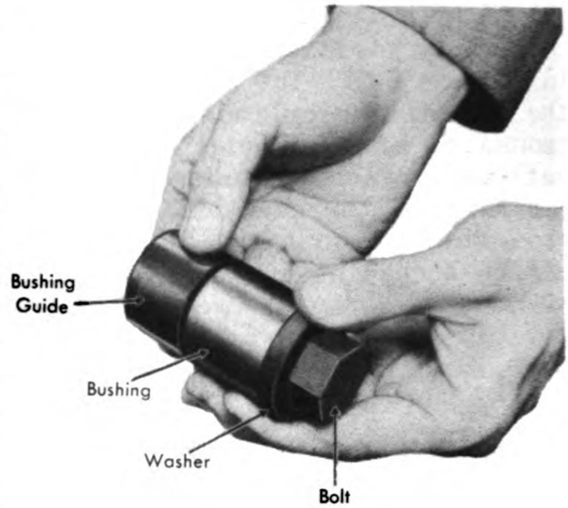


Figure 145. Tool for Installing Camshaft Bushing.

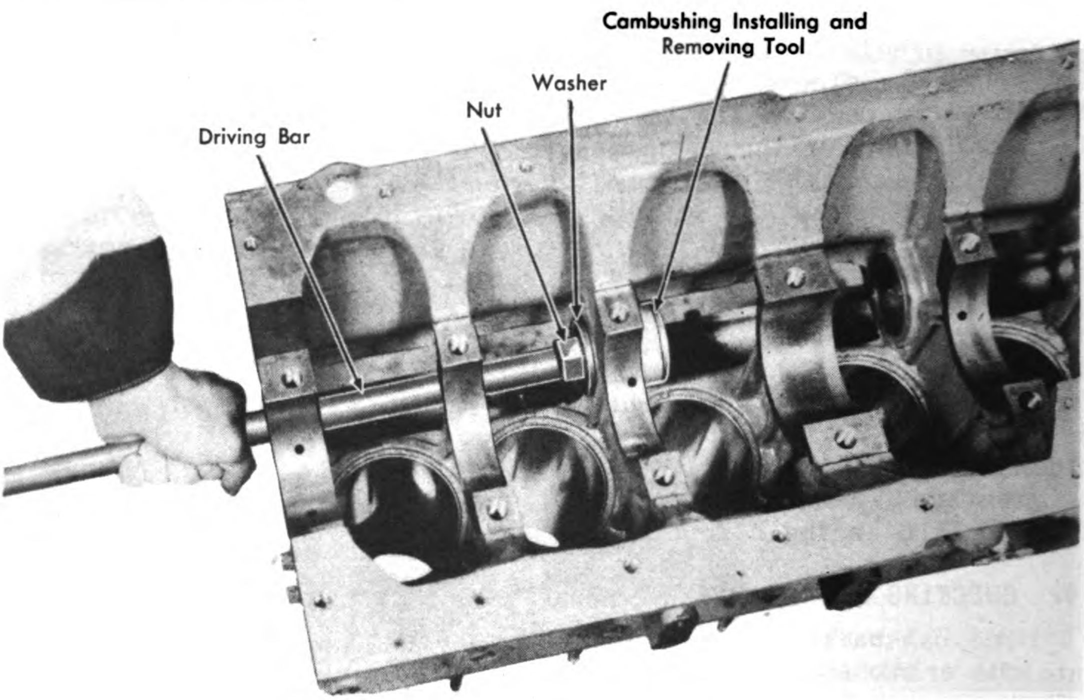


Figure 146. Driving Camshaft Bushing.

12. CRANKSHAFT

The crankshaft has seven main bearing surfaces, one between each crankpin throw and at each end of the crankshaft. The crankshaft is balanced both statically and dynamically.

13. CHECKING CRANKSHAFT WEAR

NOTE: Because of the number of micrometer readings necessary to find the taper and out of round of all the bearing surfaces of the crankshaft as outlined in the following instructions, it is advisable that these readings be recorded in some such diagram as given in Figure 147.

	MAIN BEARING #1			MAIN BEARING #2			MAIN BEARING #3			MAIN BEARING #4			MAIN BEARING #5			MAIN BEARING #6			MAIN BEARING #7		
HORIZONTAL																					
VERTICAL																					

	CONNECTING ROD BEARING #1			CONNECTING ROD BEARING #2			CONNECTING ROD BEARING #3			CONNECTING ROD BEARING #4			CONNECTING ROD BEARING #5			CONNECTING ROD BEARING #6			
HORIZONTAL																			
VERTICAL																			

Figure 147. Chart for Recording Micrometer Readings.

Check the wear of each bearing surface, or journal, with a 2" to 3" outside micrometer. See Figure 147. Before recording, take readings all around one journal to find the lowest reading on the micrometer, or the smallest diameter of the bearing surface, which usually will be at one end. Using that small end as a starting point, take three readings in line, one at the small end, the second at the middle of the bearing surface, and the third at the other end. Record these readings. These three readings will give the amount of taper in this line of this journal. At a point 90^{o} or one-quarter of the way around this bearing surface, again take three readings in line, the first at one end, the second at the middle, the third at the other end. If the first three readings were horizontal, the second three readings must be vertical or vice versa. The second three readings give the amount of taper in that plane, or the vertical position. For the amount of out of round, compare the first horizontal reading with the first vertical reading, the second horizontal reading with the second vertical reading, the third horizontal reading with the third vertical reading. Repeat this procedure on all the other bearing surfaces, both main and connecting rod, of the crankshaft. The main bearing size is 3" and the bearing clearance is .0025" to .004" which is taken off the shaft. Therefore, the original size of the shaft is 2.996" to 2.9975". If the wear of the shaft is more than .0015" or measures

less than 2.9945", the crankshaft should be reground to a standard undersize, .010, .020, .030, or .040 of an inch, depending upon the amount of wear.

The connecting rod bearings are 2-1/8" and the bearing clearance is .002" to .004" which is also taken off the shaft. Therefore, the original size of the crankpin is 2.121" to 2.123". If the wear of the crankpin is more than .0015" or measures less than 2.1195", it should be re-ground to one of the undersizes already mentioned.

Check the crankshaft flange for nicks and smooth them if necessary. The flywheel bolts should be tight in the flange. Also check the oil slinger for burrs that might cut the oil retainer. See Figure 148. If the oil slinger is bent, straighten it, being careful not to damage it.

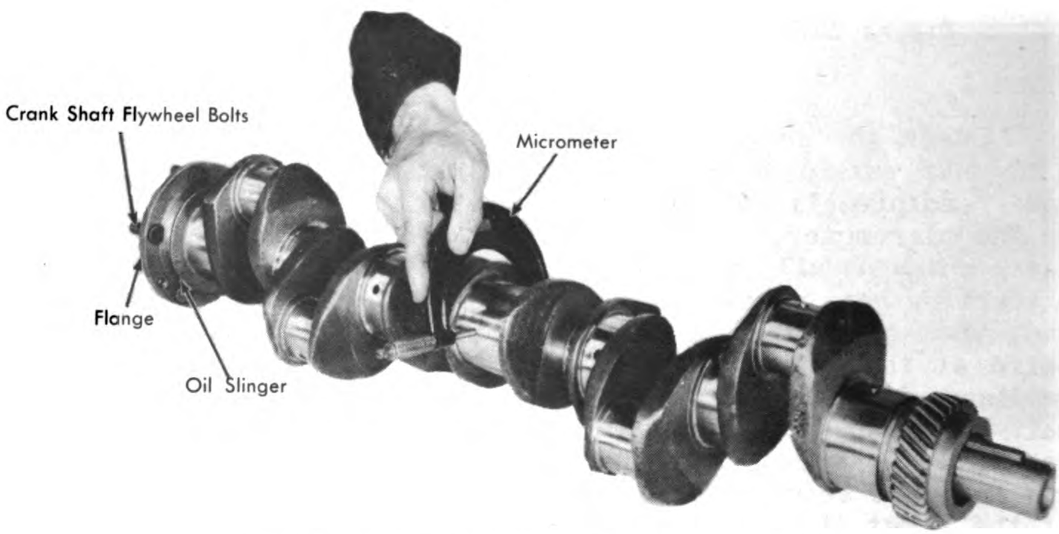


Figure 148. Checking Crankshaft Wear.

14. CHECKING CRANKSHAFT GEAR

Check the crankshaft gear for wear. If worn excessively, replace the gear with the same size as marked on the old gear. See paragraph 36.

15. CONNECTING RODS AND CONNECTING ROD BEARINGS

The connecting rods are rifle drilled for pressure lubrication to the piston pin. The side clearance of the connecting rod between the side of the bearing and the crankshaft should be maintained at .003" to .008", maximum .012". See Figure 132.

16. INSPECTING AND REPLACING CONNECTING ROD BEARINGS

The bearings are steel back, precision bearings which require no hand scraping and are replaceable. If necessary, these bearings can be replaced in the field by removing the cap and removing the old bearing and replaced as shown in Figure 149. If the crankshaft is reground to a standard undersize, the bearing must be replaced with the same standard undersize to fit. If the connecting rod bearing inserts are loose, they should be replaced.

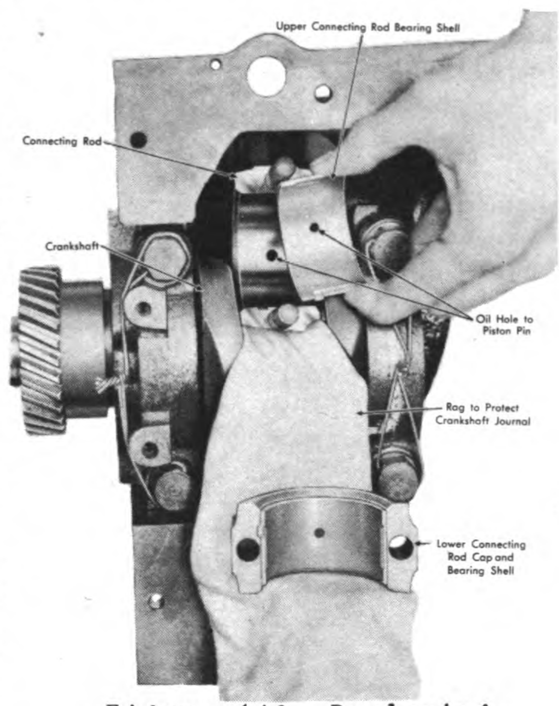


Figure 149. Replacing Connecting Rod Bearing.

The wear of the connecting rod bearing (cap in place) should be checked with an inside micrometer. If worn more than .0015" or the reading is more than 2.1265", the bearings should be replaced with standard, provided that the crankpin bearing surface wear is negligible and no regrinding of the crankshaft is necessary.

17. INSPECTING AND REPLACING THE CONNECTING ROD

If the bushing is loose in the connecting rod, usually the entire rod must be replaced, as even the new bushing would fit loosely.

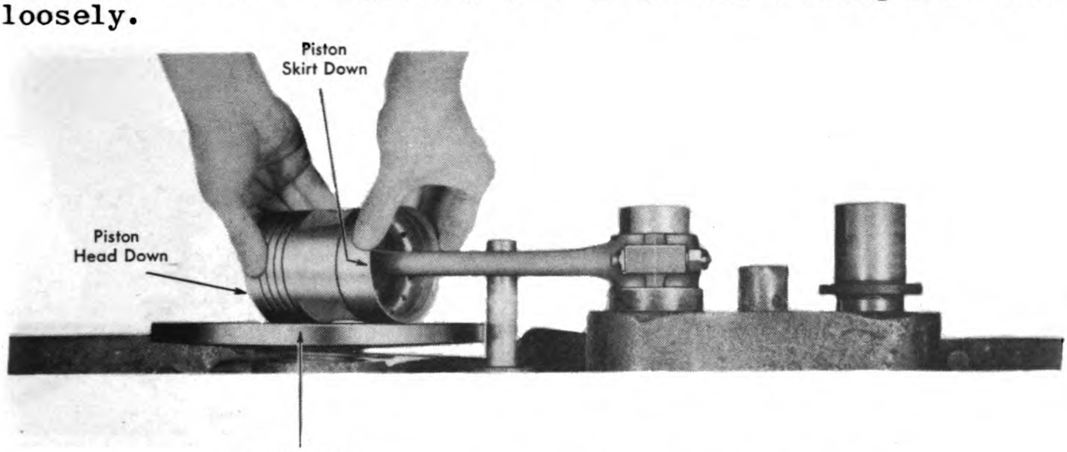


Figure 150. Checking Rod in Aligner, Head Down.

18. CHECKING THE ALIGNMENT OF CONNECTING ROD

With piston and connecting rod assembly clamped onto the mandrel of the aligning fixture, swing the rod into a horizontal position (parallel to the floor). See Figure 150. With the piston held diagonally to the rod (Piston head pointing to the floor) observe the space between the face of the fixture and the skirt of the piston as shown in Figure 150; if this space is not equidistant the rod is twisted out of line. **NOTE:** The ring lands at the top of the piston are smaller than the skirt; therefore, check the alignment of the rod along the full length of the skirt only. Twist the rod with a large wrench until space between the aligner and the piston is even. See Figure 151. Now check

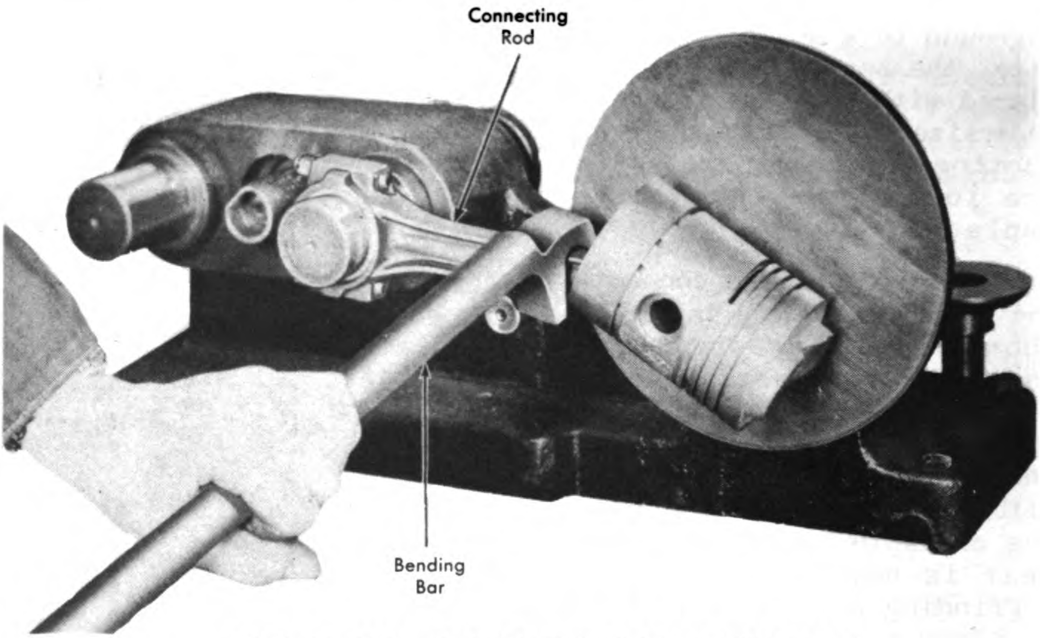


Figure 151. Twisting Rod into Alignment.

for a twist in the opposite direction by moving the piston into the opposite diagonal line to the rod (piston head pointing up). See Figure 152. Observe the space between the aligner face and

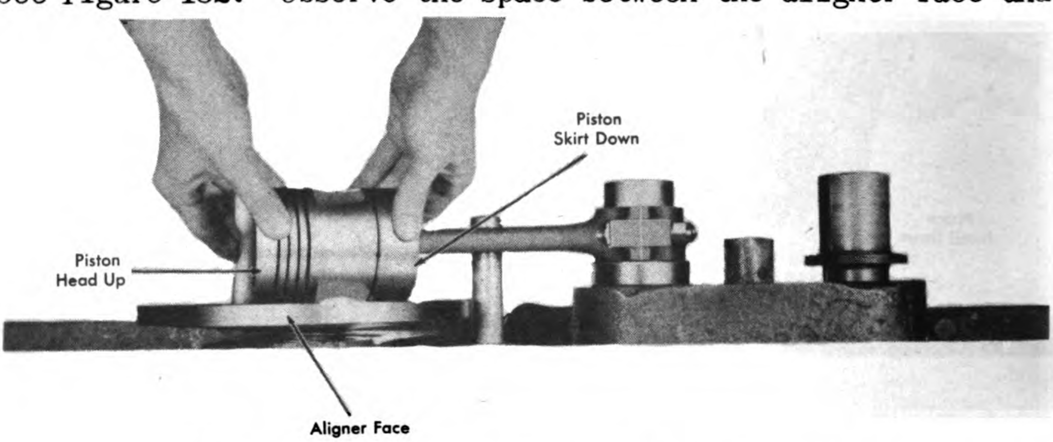


Figure 152. Checking Rod in Aligner, Head Up.

piston skirt; if the space is uneven, twist the rod with a large wrench until true alignment is obtained. Check for a bent rod by moving the piston into a parallel position with the connecting rod, see Figure 153, and observe the space between the aligner

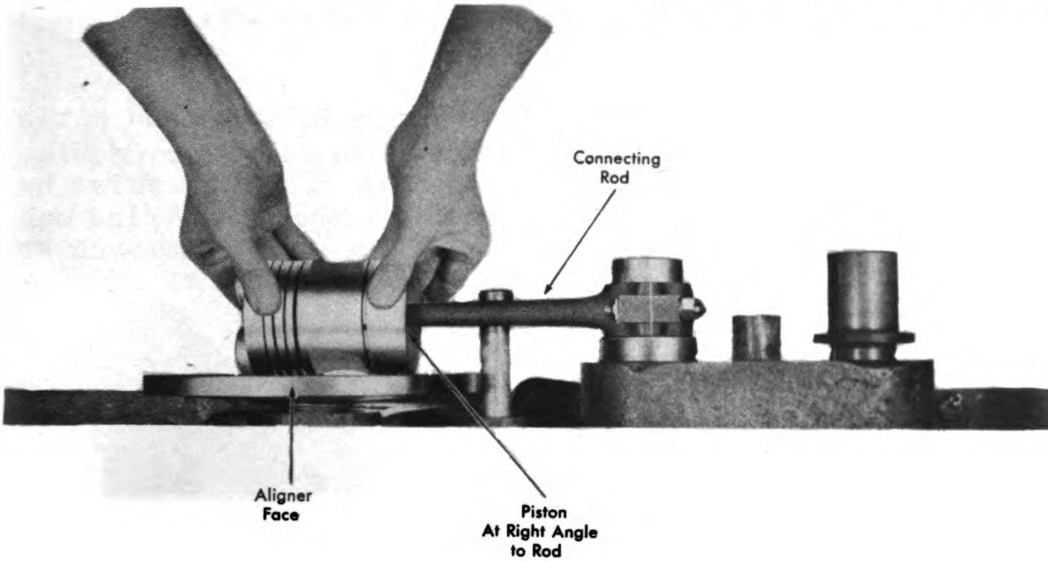


Figure 153. Checking Rod in Aligner, Piston Parallel.

face and the piston skirt; if the space is not even the rod is bent. See Figure 154. Straighten by carefully bending the rod with a large wrench.

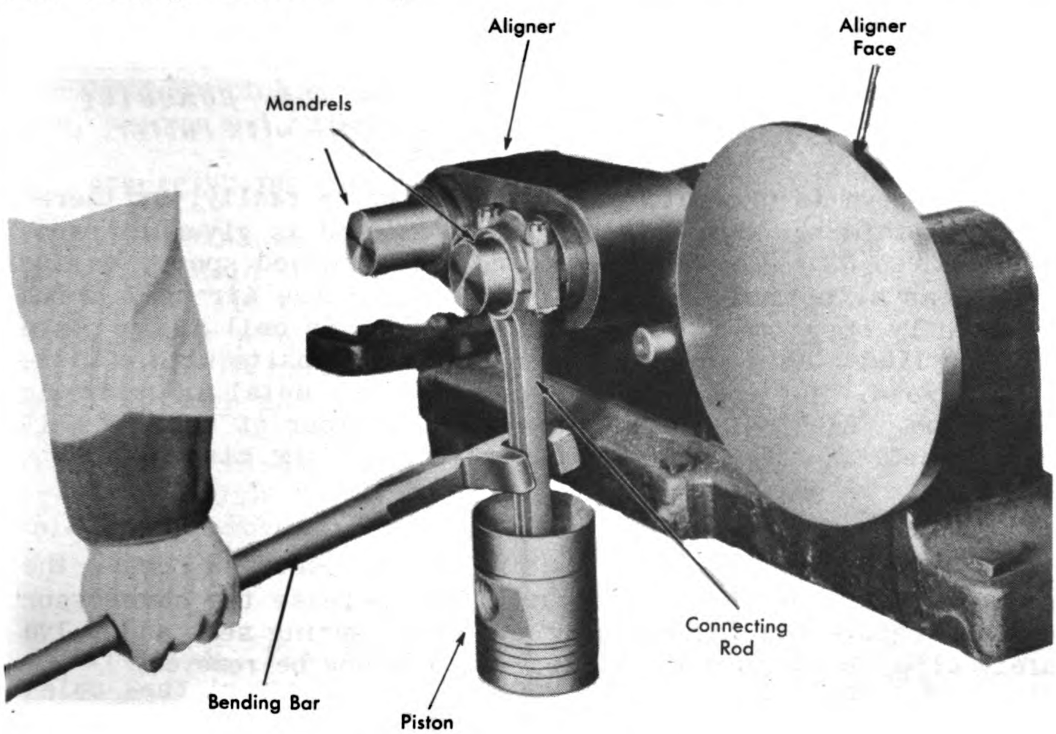


Figure 154. Straightening Rod in Aligner.

19. CYLINDER HEAD

Thoroughly clean the cylinder head and all its parts, removing all carbon deposits. Check the head for cracks. Check the cylinder head breather tubes and clean. These tubes partially vent the crankcase. The tubes are shown in Figure 184.

20. CHECKING AND REPLACING AIR CELL

The air cell flanges are held in place by studs and nuts. After the air cell retaining flange has been removed by taking out the two capscrews, the air cell plug can be removed first by inserting a screw of 3/8" diameter with a washer, and pried out as shown in Figure 155. The inner cell can then be removed by a puller, as shown in Figure 156.

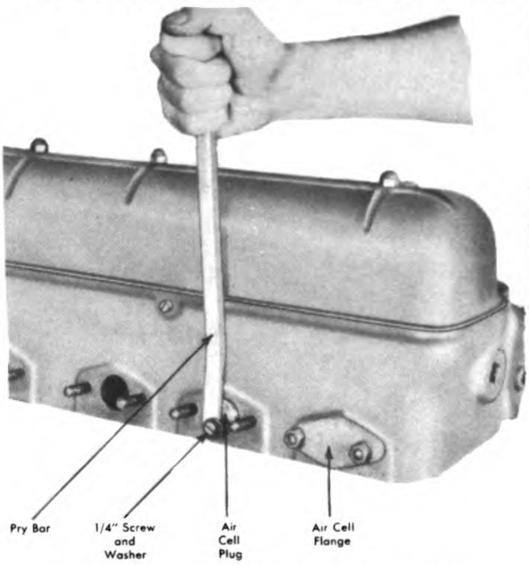


Figure 155. Removing Air Cell Plug.

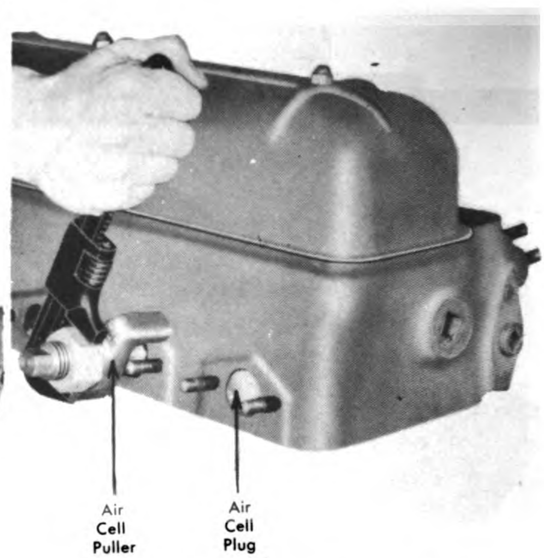


Figure 156. Removing Inner Cell with Puller.

If carbon is present, the injector may be faulty, and therefore, the injector should be carefully checked as given in paragraphs 53 to 63. Inspect the air cell for burned spots, paying particular attention to the leading edge of the air cell which is directly opposite the injector when the air cell is in place in the cylinder head. Clean out any carbon deposits with a piece of hard wood. Do not use emery paper or any metal in removing the carbon. **CAUTION:** Do not change the contour of the air cell in any manner. If burned internally, replace the air cell.

21. REMOVING THE VALVES

Compress the valve spring with a compressor and remove the retainer halves as shown in Figure 157. Release the compressor tool and remove the valve spring and valve spring seat and valve safety clip, see Figure 158. The valve can now be removed.

NOTE: As a precaution, check the edges around the groove in which the safety clip seats to be certain that no burrs have been made when installing or removing the clip. The burr, or burrs, may scratch the guide when the valve is slipped out; therefore, remove the burrs with a hand stone before removing the valve if there is a burr on the stem.

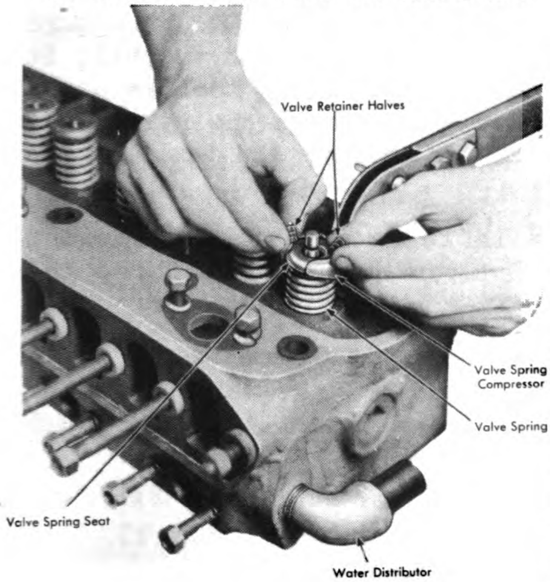


Figure 157. Compressing valve spring to remove retainer halves.

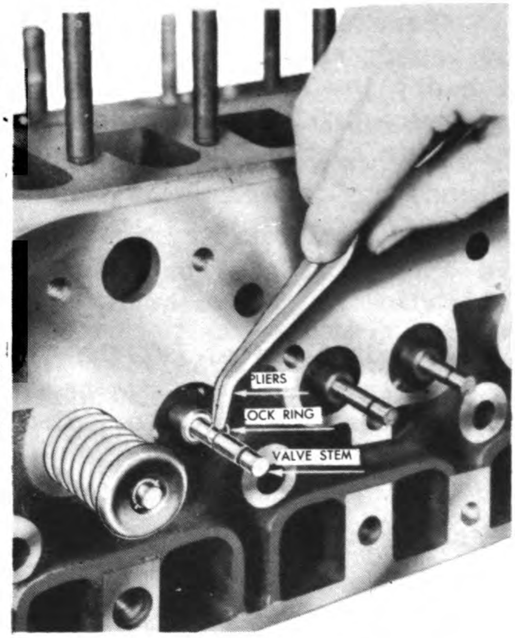


Figure 158. Removing Valve Safety Clip.

22. CHECKING VALVE SEATS AND VALVE GUIDES

Inspect the exhaust and intake valve seats for cracks or burns. The exhaust valve seats can be replaced if they are in a very bad condition. The intake valve seats can be refinished with a valve seat reamer or grinder. Check the valve guides for wear by inserting a valve and noting the amount of side play. If worn, remove and replace the guide and also replace the valve.

23. REPLACING THE EXHAUST VALVE INSERTS

The exhaust valve seat insert is held in place by a shrink fit. To remove the insert, center punch the insert and drill. Be careful not to drill through into the valve seat insert recess. With a small cold chisel, carefully break through the drilled holes and remove the insert. See Figure 159.

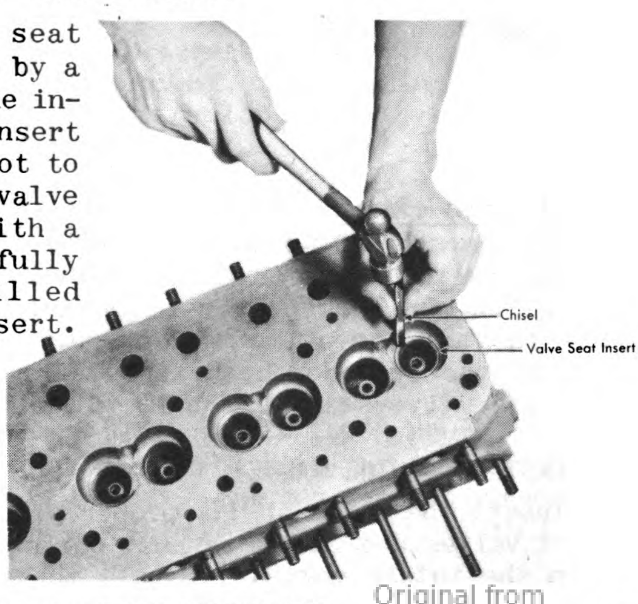


Figure 159. Removing Valve Seat Insert.

NOTE: The mechanic should exercise care so as not to mar the face of the cylinder head.

Remove all the burred edges around the hole and be sure the insert recess is clean. To install the new insert, chill it with dry ice and drive it in place with a driving tool as shown in Figure 160. It will be necessary to refinish the valve seat with a grinder. The same grinder can be used on the intake valve seat.

NOTE: If no dry ice is available or climatic conditions are such that the foregoing procedures are not feasible, the following is recommended:

In hot climate, let the cylinder head stand in the sun until it gets as hot as the sun can heat it. Cool the valve seat insert as much as possible. Then drive the insert into the block as shown in Figure 160.

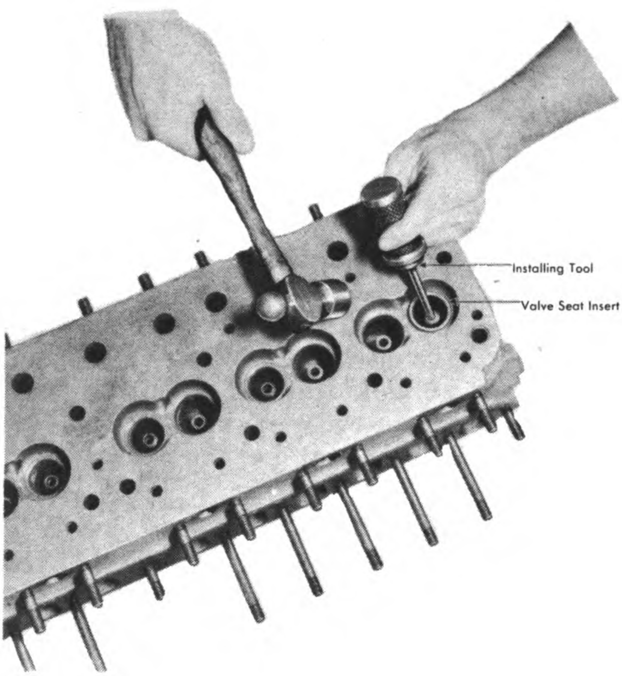


Figure 160. Installing Valve Seat Insert.

In cold climate, lay the valve insert on ice or let it remain outdoors until it is thoroughly chilled. Remove the chill from the cylinder head by filling the water jackets with boiling water. It may be necessary to change the water three or four times to warm the cylinder head sufficiently. With the water still in the cylinder head to retain as much heat as possible, drive the valve seat insert in place as shown in Figure 160.

24. INSTALLING THE VALVES

Insert the valve in its proper place. Make certain that the exhaust valves are in the exhaust ports and that the intake valves are in the intake ports. Install the safety clip in the groove on the valve stem, as shown in Figure 158. Assemble the valve spring and valve spring seat. Compress the spring as shown in Figure 157, and install the retainer halves. NOTE: Keep each valve in order so that it can go back in its original place.

25. CHECKING WATER DISTRIBUTOR TUBE

Remove the water distributor tube from the cylinder head and tap it lightly to remove any rust and free any holes in the tube that may be clogged. If the tube comes loose from the pipe nipple, either solder or replace the tube. See Figure 187.

26. INSPECTING VALVES, AND ROCKER ARM ASSEMBLY AND PUSH RODS

The inspection of the valves and rocker arm assembly includes valve springs, valve spring seats, retainers, lifters, rocker arm push rods, adjusting screws, and the brackets. The inlet valve effective diameter is 1-3/8"; the exhaust, 1-3/16".

27. INSPECTING THE VALVES FOR GRINDING AND REPLACEMENT

If the valves are warped or burned, they must be replaced. If they are pitted, they should be refaced in a refacing machine at a 45^{o} angle.

28. CHECKING THE VALVE SPRINGS FOR REPLACING

Check the spring tension of each spring with a spring scale designed for this purpose. The tensions should all be equal. If the springs are weak, cracked, or broken, replace the spring.

NOTE: When the spring is compressed to the length of 2" which is equal to valve open position, the scale should read 35 to 40 pounds, 37 lbs. desired; when the spring is compressed to the length of 1-33/64" the reading should be 84 - 89 lbs., 86 lbs. is desired.

29. CHECKING THE LIFTERS AND BRACKETS FOR REPLACEMENT

The lifter is of mushroom type and is made of grey iron with a chilled head. Check the head for cracks and replace if cracked. Check the lifter holes in the bracket by inserting a lifter in the hole. If the fit, or fits, are loose or more than .0015, replace the bracket and lifters.

30. REPLACING THE RETAINERS AND SEATS

Only because of loss or accident should it become necessary to replace the valve spring seats and retainers.

31. VALVE GRINDING

When grinding the valves after every 1,000 hours of operation, use a good quality, water soluble valve grinding compound. This type of compound loses its cutting properties on contact with oil. A valve grinding tool like the one shown in Figure 161 or one similar is recommended.

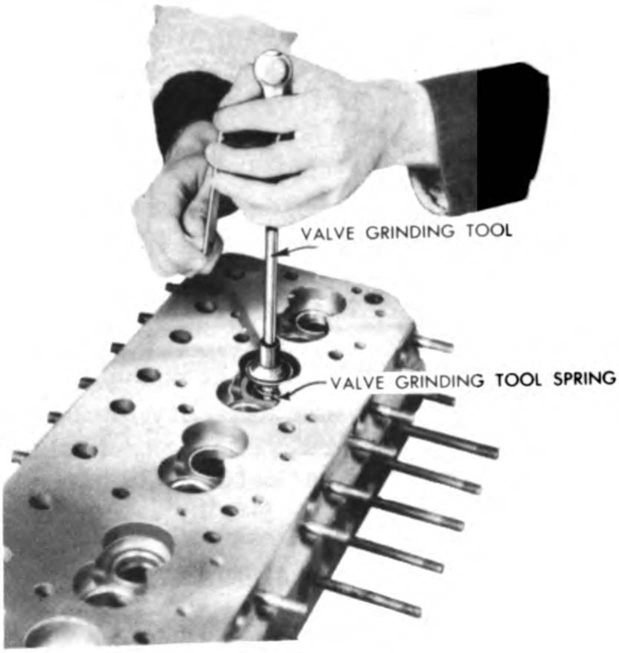


Figure 161. Grinding Valves.

32. VALVE GRINDING PROCEDURE

To release the valves compress the springs and remove the retainer halves, as shown in Figure 157. Clean the carbon off the valves and inside the ports. Do not clean the oil varnish off the valve stems.

NOTE: If the valve seats are pitted, they should be refaced in a 45^{0} valve refacer.

To grind the valves, put a small quantity of valve grinding compound on the valves, just sufficient to cover the seating area. Grind the valves with a light but firm pressure letting the valve grinding spring lift the valve from the seat every two revolutions of the valve grinding tool crank. As soon as the "grinding feel" diminishes, wash the valve and seat in kerosene and examine the seat and valve. If the valve face or seat has lines or rings ground in them, this indicates that either the valve grinding compound was ground out, or too much pressure was applied, or the valve was not lifted off the seats often enough during the grinding operation. Therefore, the grinding must be done over.

If the valve and seat have the appearance of grey emery paper, apply a small amount of Prussian Blue on the valve face. Wipe off the excess so just a faint trace of blue appears. Insert the valve and turn the valve on the seat one complete revolution under slight pressure. If the valve seat has a slight ring completely around the seat, this will indicate that the valve is seating properly. If the line is not complete, the valve and seat are not making complete contact and must be ground until they do.

Be sure to wash off the compound when the job is finished, and again check to see that all loose pieces of carbon around the valves and particularly between the piston head and cylinder walls are removed, for many well-done jobs of valve grinding are ruined by failing to remove small particles of carbon.

33. FLYWHEEL AND FLYWHEEL HOUSING

Inspect the flywheel ring gear for damaged teeth. If teeth are mutilated, replace with a new ring gear. Examine the bolt holes; if they are loose or worn, replace the flywheel and flywheel bolts. Inspect the bell housing for cracks; if cracked, replace the housing.

NOTE: The flywheel housing bore should be checked for out of round and out of alignment when reassembling engine. With a dial indicator attached to the flywheel as shown in Figure 162, slowly crank the engine to check the bore. The maximum tolerance allowed is .005. If more replace the housing.

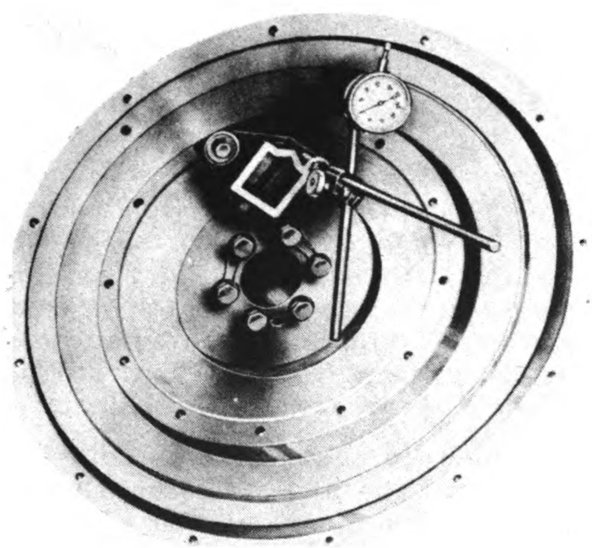


Figure 162. Checking Bore of Flywheel Housing.

34. INSTALLING RING GEAR

To remove the old ring gear, lay the flywheel flat on the floor with the front side of the flywheel up. With a 3/16" drill, drill two or more holes through the gear parallel with the teeth and in a line drawn from the center of the flywheel to the rim. With a cold chisel, cut the remaining metal between the holes to split the gear completely in two. Drive off the ring gear with a punch and hammer. Boil the new ring gear in oil for fifteen minutes, or heat evenly with a torch to expand the gear. With the flywheel flat on the floor, front side or crankshaft side up, lay the heated ring gear in place with the bevel end of the teeth up. Be sure the ring gear is seated properly against the shoulder, then allow to cool.

GEARS

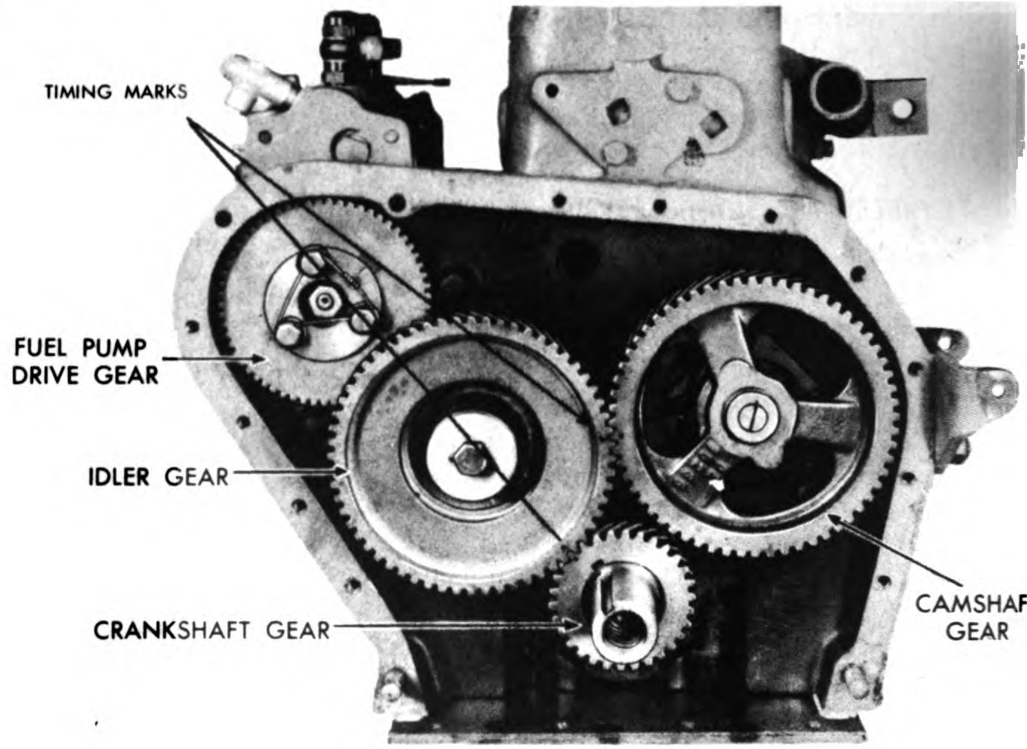


Figure 163. Timing Gears.

35. GEARS

The crankshaft gear drives the camshaft and the fuel pump drive gear through an idler interposed between the three. See Figure 163. The camshaft and accessory drive shaft turn in the same direction as the crankshaft. The gears are on fixed centers, and adjustments are made by selecting oversize or undersize gears.

The idler gear rotates on a stud which is pressed into the crankcase. The stud is secured by a lock screw which screws into the right hand side of the case. See Figure 123. The timing gears are made of cast iron and steel, a selected combination of metal that assures long wear and quiet running.

36. CHECKING FOR WEAR AND REPLACEMENT

The crankshaft, idler, and camshaft gears should be fitted with .002" backlash while the fuel pump drive gear can have .005" backlash. See Figure 120 and paragraph 4, step 16. When ordering one gear for replacement, use the size marking of the old gear with allowance for wear on the others.

Each gear is marked with a number within either an O or a letter U, thus ● or ᗜ. The surrounding symbol denotes oversize (O) or undersize (U) respectively, and the number gives the deviation from the standard in thousandths of an inch. The letter S denotes standard size. **NOTE:** The new gear, or gears, for replacement must correspond in size to the gear or gears replaced. Due allowances should be made for wear on the other gears.

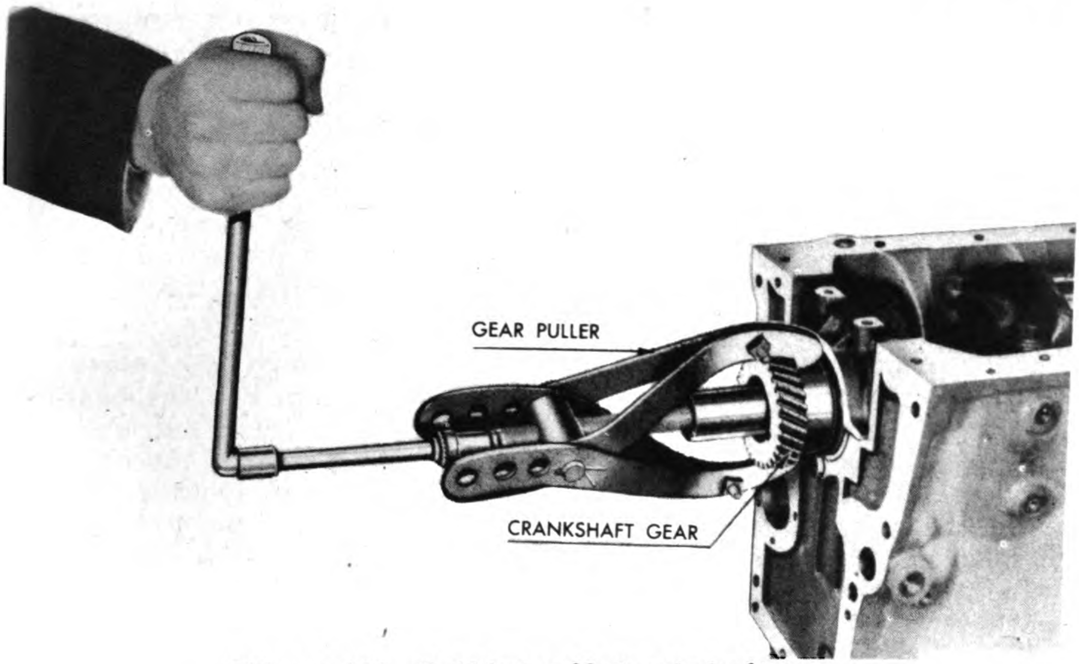


Figure 164. Pulling off Crankshaft Gear.

If necessary to replace the crankshaft gear, pull it off with a wheel puller as shown in Figure 164. To install a new gear, see paragraph 43, Step 9 and Figure 177.

37. REPLACING THE IDLER GEAR BUSHINGS

If the idler gear wabbles, the bushing needs to be replaced. **NOTE:** If the bushing is replaced, it must be bored in a lathe to a running fit on the stud. Hand reaming will not be straight, and will cause the gear to run out. The clearance between the idler gear bushing and stud should be .002" to .0035" of an inch, maximum .005". It is recommended a new idler gear be installed rather than rebush the gear.

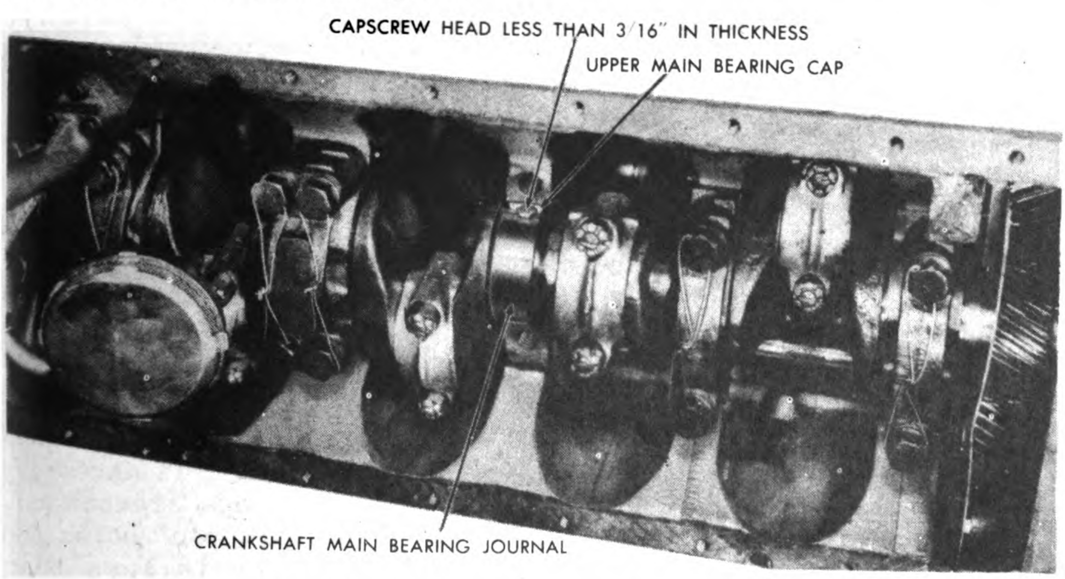


Figure 165. Pushing out Main Bearing.

MAIN BEARINGS

38. MAIN BEARINGS

The main bearings are hard copper lead of steel backed precision type, and can be replaced individually. No scraping and fitting is required. Replacement can easily be made in the field by simply pushing out the old shell as shown in Figure 165. This is best done by inserting into the oil hole in the crankshaft journal, a small bolt of practically the same diameter as the oil hole in the shaft but with the head filed down to less than 3/16". Slowly turn the crankshaft by hand and push the old shell out.

To install the new shell, as shown in Figure 166, start the shell into position by hand being careful not to mar the bearing. After it is well started in, insert the same bolt that was used to remove it, only this time, allow the head to project over the bearing shell to keep it from raising up as you slowly turn the crankshaft by hand. When almost in place, stop and back up the crankshaft to release the bolt from over the shell and insert a bolt of the same diameter but with a higher head, and slowly push the shell into position by turning the crank.

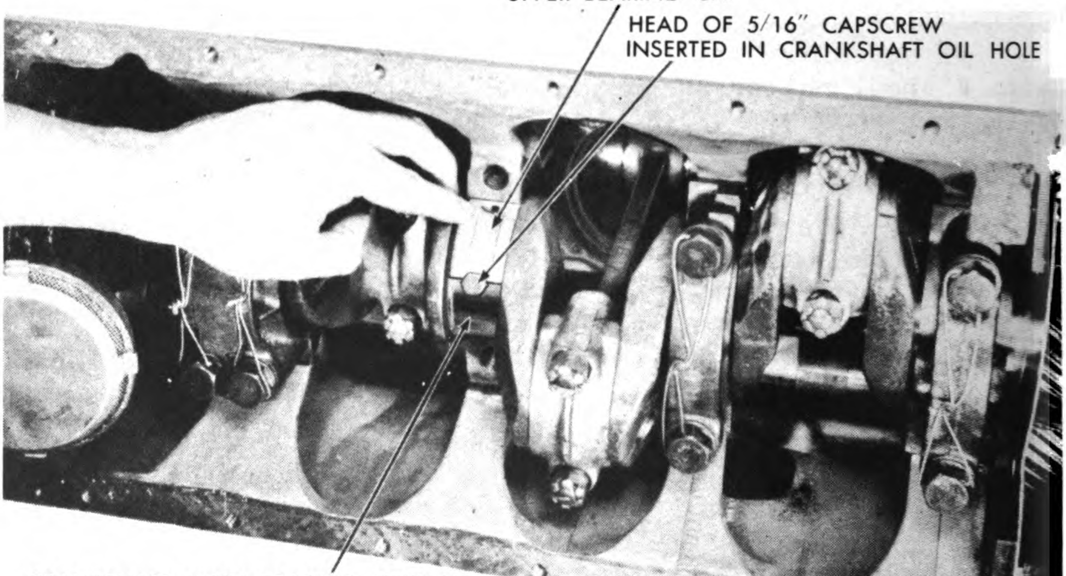


Figure 166. Installing New Bearing Shell.

NOTE: It is recommended that if one main bearing needs replacing, they all should be replaced. The upper shells are not dowelled, the lower shells being dowelled in the caps to hold them in place. No shims are required.

39. INSPECTING BEARINGS

Look for holes or cracks in the bearing surfaces and check the assembled bearings with an inside micrometer. It is necessary that the main bearings be in the case and the caps clamped on, to obtain the accurate measurements. If there are "pin" holes and cracks in the bearings and the crankshaft wear is less than .0015", replace with new bearings of standard size. New main

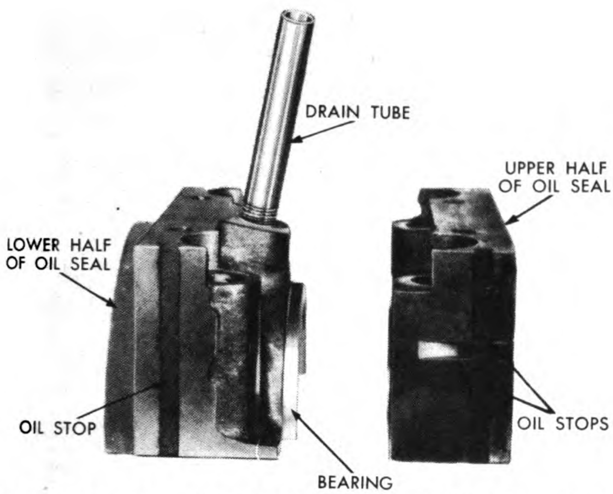


Figure 167. Rear Bearing Cap and Tube.

bearing standard size is 3.000". If the main bearing wear is more than .0015" and the crankshaft wear is negligible, replace them with new bearings of standard size.

NOTE: Replace the rear main bearing cap oil stops. If the standard oil stops are not available, the grooves can be packed with candle wick, which should be firmly calked into place by means of a small tapered tool or punch and hammer, pounding the yarn gradually up to the grooves until they are packed full.

The rear bearing cap has an oil drain tube attached to it which leads down below the oil level in the oil pan in order to assist in preventing oil leaks through the rear main bearing. Figure 167 shows the cap with a tube in place. Replace the rear bearing oil seal felt. To replace the rear bearing oil seal felt, remove the old felt from the groove with a knife, but do not cut away any of the metal. Coat one side of the felt with

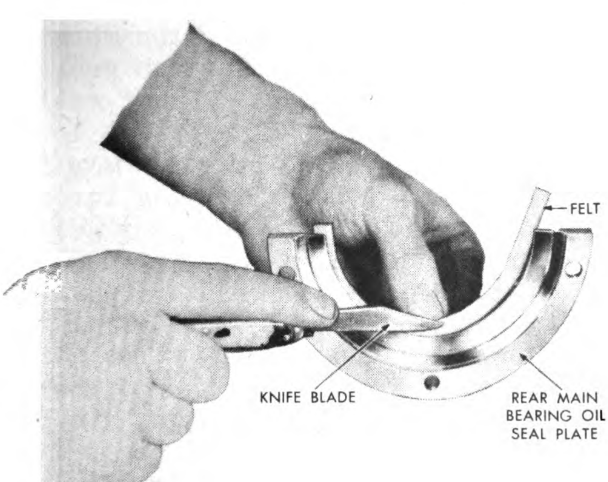


Figure 168. Inserting Rear Bearing Oil Seal Felt.

shellac and calk the felt into the groove with the shellac side down, as shown in Figure 168. The shellac must not be allowed to penetrate through to the crankshaft side of the felt. Oil the surface of the felt with graphite grease to keep them from burning up when the engine is first started.

NOTE: Engine serial numbers 13087 through 13096, 13170 through 13179, and 13182 through 13216 are provided with bronze thrust flanges to control the crankshaft end play. The thrust flanges are in two sections, upper and lower, and are interchangeable. The dowels which hold the thrust flanges in place should be checked for wear and replaced if necessary.

40. PISTONS

The pistons are of aluminum alloy and have four rings above and one below the piston pin. The top three rings are compression rings and the lower rings are ventilated oil rings. If the

cylinder sleeves are replaced, this will necessitate replacing the pistons. After the pistons and connecting rods have been disassembled and the piston rings removed, thoroughly clean the piston and visually inspect the grooves and ring lands for cracks, particularly checking the ring lands for burns. Replace if they are burned or cracked. Also check the head of the piston and the skirt both inside and out for cracks and replace if necessary.

The piston to cylinder clearance (at skirt bottom, 90° to the pin) should be .0042" - new.

41. CHECKING THE PIN WEAR AND REPLACING THE PIN

The piston pins are the full floating type and are made to rotate in either the piston or the connecting rod bushings. The pins are held in place by means of two snap rings which lock in grooves in the outer end of the piston pin bosses which prevent the piston pin from coming in contact with the cylinder walls. Check to see that these grooves are not worn so that the locks will not fit tightly in these piston grooves. The pins have the ends ground flat and polished to prevent their cutting through the lock rings. The pin to piston is a .001" to .003" tight fit. The piston pin to connecting rod bushing is .0014 to .0009 If replacement is necessary, replace the pin with the next first oversize and ream out the piston and connecting rod bushings. Replace the bushing in the connecting rod and ream it to fit a new standard size pin provided that there is no wear between piston and pin. If there is wear between piston and pin, a standard oversize pin must be used and the piston and connecting rod bushings reamed to fit. It will be necessary to realign the connecting rods. See paragraph 18.

NOTE: To install the pin into the piston, allow the piston to stand in boiling water for about five minutes, after which install the pin. The reason for the heating is to allow the piston pin boss to expand so as to allow the pin to be installed. The pin to connecting rod is a very light push fit. See Figure 169.

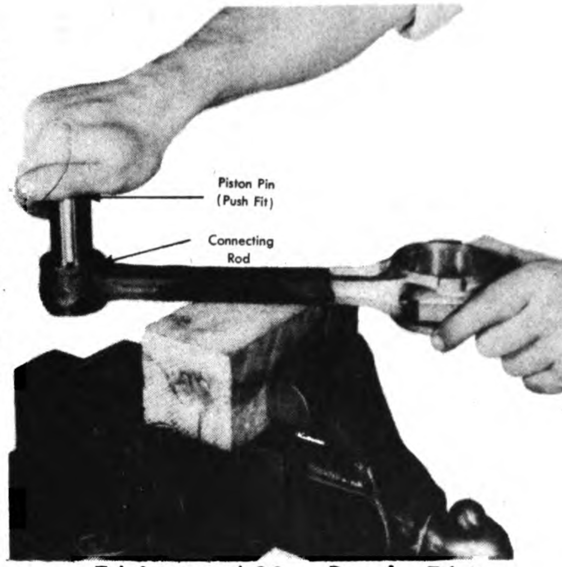


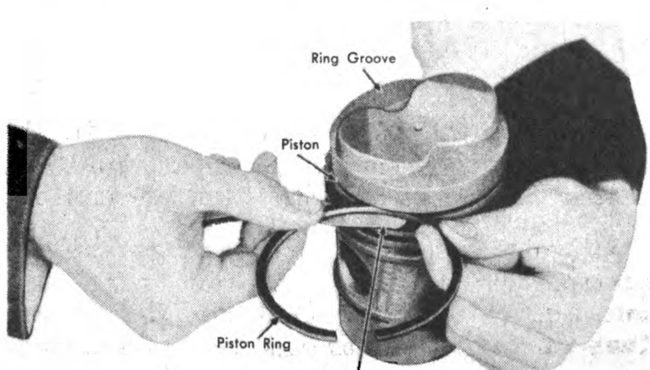
Figure 169. Push Fit Pin to Connecting Rod.

42. CHECKING AND REPLACING THE PISTON RINGS

Always replace the piston rings during the overhaul whether or not the cylinder sleeves have to be replaced.

NOTE: If at any time after 100 hours of operation, a piston or the pistons, have to be removed from the engine, always replace the rings with new ones. This is advisable because it will be impossible to get the piston rings back into the same positions that they wore in. Therefore, if they are not replaced, there is a possibility of the pistons pumping oil. It is also recommended not to slip the new rings onto the pistons until they are ready to be put back into the engine. Check the depth of the ring groove and check the groove clearance as shown in Figure 170. Compression and oil control ring to groove clearance is .0015 to .0035. The fire ring, which is the top ring, to groove clearance is .003 to .005. Check the gaps of all the rings with a feeler gauge as shown in Figure 171. The compression ring gap should be .009" to .014" and the oil ring gap, .010" to .015".

Figure 170. Checking Ring to Groove Clearance.



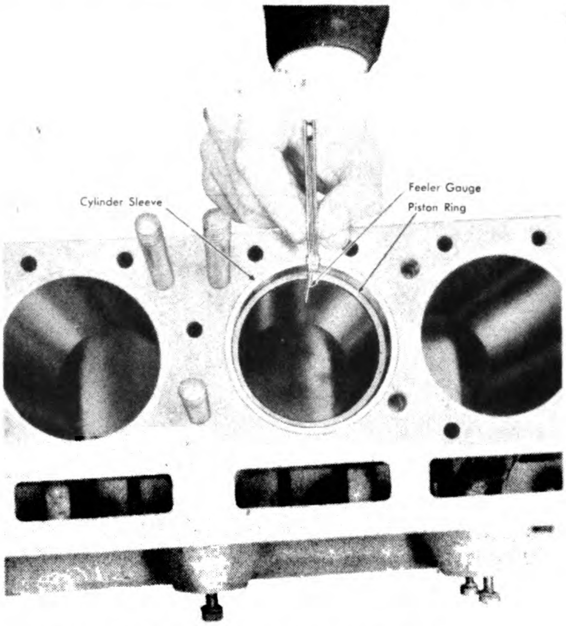


Figure 171. Checking Ring Gap Clearance.

43. STEPS OF ENGINE REASSEMBLY

At all times during the steps of reassembly of the engine, the mechanic should bear in mind that dirt is the engine's worst enemy. Therefore, the parts should be wiped clean, and note particularly to remove lint. Do not use waste for wiping; use a lint-free cloth. An air hose can be used to blow off any fine dirt or lint remaining on the parts after wiping. Only clean fresh oil should be used in oiling the parts as they are reassembled. Be sure to replace all gaskets, oil seals, felts cotter pins, and locks with new ones.

The following steps are the recommended sequence of reassembly: (after the crankcase is set on its studs and supported so it cannot tip)

1. Shellac or "Permatex" the oil line plugs. Insert one plug in the front of the gallery oil line (see Figure 141), three at the rear end of the crankcase, one at the bottom side, and three on the outside of the crankcase. See Figure 139.

NOTE: The plugs at the front and rear ends must be screwed below the surface of the crankcase so as not to interfere with the surfaces of the flywheel housing and the timing gear housing.

2. Insert the two dowel bolts in the front end and "Permatex" and install the timing gear housing and gasket, and tighten the four capscrews and two counter-sunk capscrews. See Figure 172.

3. Unless the main bearings are new, each must go back in that main bearing support from which it was taken. Their positions in the support must not be reversed. Insert the upper halves of the main bearings in the support. See Figure 173.

4. Install the upper half of the rear bearing oil seal (See Figure 138) but first insert enough gaskets to locate the position of the oil seal half way between the crankshaft oil

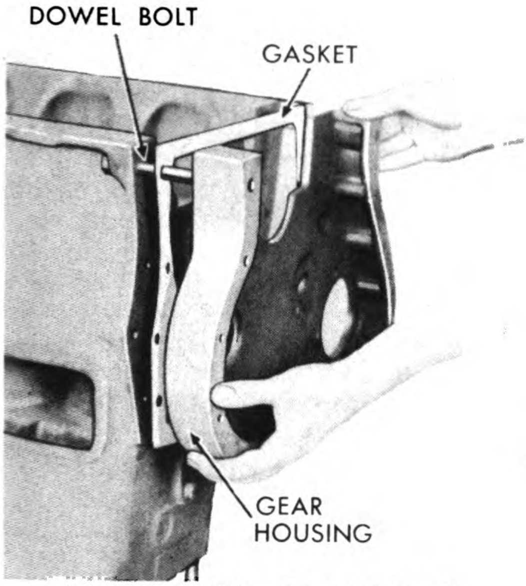


Figure 172. Installing Gear Housing.

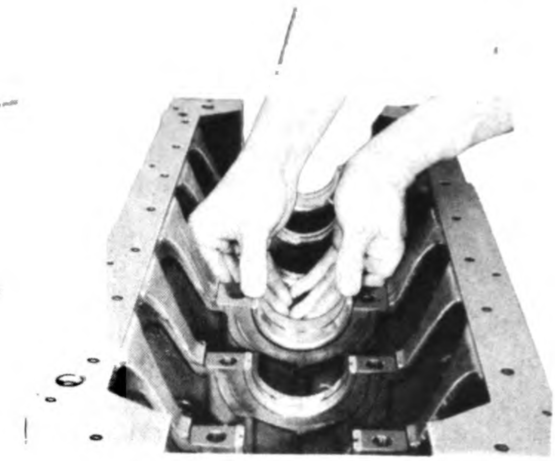


Figure 173. Inserting Main Bearing Upper Halves.

slinger and the flywheel bolt heads, so the clearance between the oil slinger and rear bearing oil seal is .004". See Figure 174.

NOTE: Check to be sure a new oil seal felt is in place. See paragraph 39.

NOTE: The accuracy of this position however, cannot be checked until the crankshaft is laid in place. If this setting is not correct, lift out the crankshaft and add or remove one or more gaskets whichever is necessary: The same number and thicknesses of gaskets must be used in both the lower and upper halves of the oil seal.

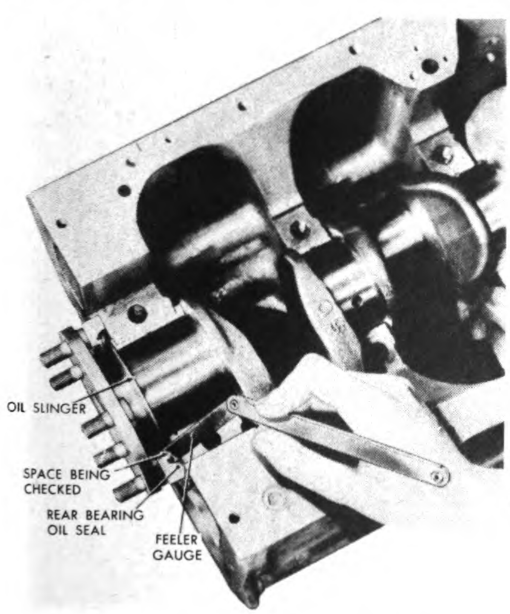


Figure 174. Locating Oil Seal.

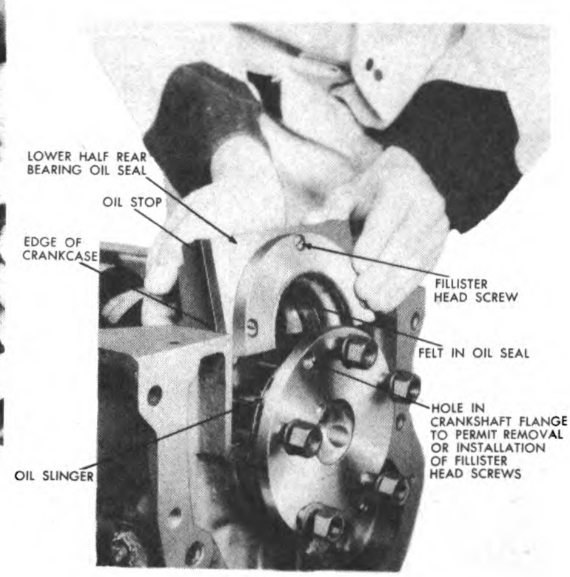


Figure 175. Installing Lower Half of Oil Seal.

5. Carefully lay the crankshaft in place so as not to mar the bearing surfaces. The flywheel bolts should be in place before installing the crankshaft. Note the extra hole in the crankshaft flange. This hole is for the purpose of getting at the fillister head screws in the upper half of the rear bearing oil seal in order to remove the oil seal without having to take out the crankshaft. See Figure 175.

6. Assemble the lower half of the oil retainer seal onto the rear bearing cap. See Figure 175. Be sure to put the copper gasket under the center fillister head screw. Before installing the cap with the bearing and the lower half of the oil seal assembled to it, be sure to check the position of the upper half of the oil seal in regard to the crankshaft as instructed in Step 4. If not correct, adjust it as indicated. **NOTE:** New oil stops should be installed on the cap. These oil stops seal the sides of the cap to the crankcase and prevent oil from leaking through.

When installing the rear cap, be careful not to tear the oil stops when slipping the cap in place. After the cap is down in place, trim the ends of the oil stops flush.

7. The main bearing caps are numbered from 1 to 7, starting from the timing gear housing on front end. With the bearing shells in place, these caps should be installed in their respective places so that the single cast lobe is facing the camshaft

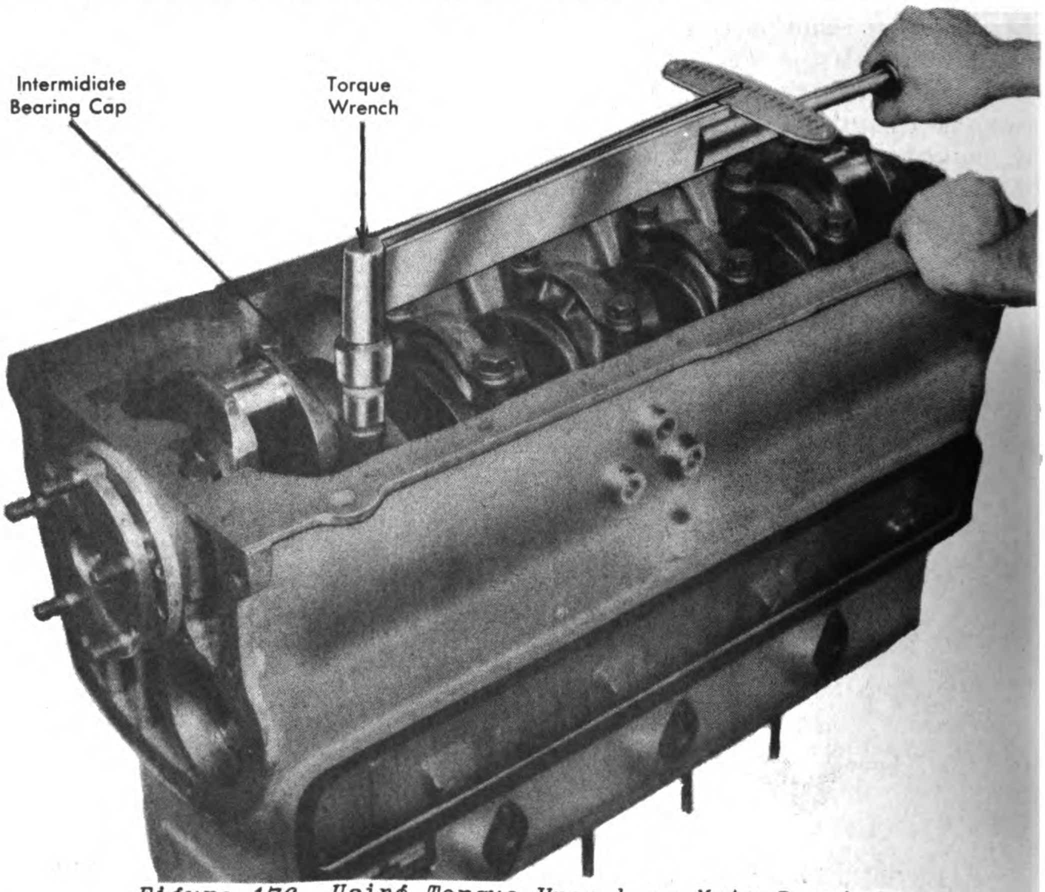


Figure 176. Using Torque Wrench on Main Bearing.

side of the engine. See Figure 137. Tighten the main bearing capscrews with a torque wrench to a tension of 125 to 135 foot pounds. See Figure 176. The bolt threads should be dry and clean. Turn the crankshaft by hand to be sure it is free. Before installing the lockwires, check the crankshaft end play. Slip a feeler gauge between the ends of the rear main bearing and the crankshaft as shown in Figure 131, and run the feeler gauge clear around the shaft. The proper clearance is .003 to .009. If more than .015", install a new rear main bearing or thrust flanges. Install the lock wires.

8. If the camshaft gear was removed for replacement, press the camshaft gear onto the camshaft. Make certain to align the key seat with the key. Slip on the wire retaining ring. Oil the camshaft bearings and install the camshaft into the crankcase. To recheck the camshaft end play, measure the space between the hub of the gear and the thrust collar with the shaft pulled forward, as shown in Figure 127. This measurement should be .003" to .009". If more than .015", this can be corrected by replacing the gear or the thrust collar or the camshaft. Usually replacing the thrust collar will overcome excessive end play. Install the camshaft thrust washer. Tighten the capscrews and bend the capscrew lock over the side of the capscrew head.

9. **NOTE:** The following instructions are given in the event that the crankshaft gear had to be removed and replaced by a new one.

The bench method for installing the crankshaft gear is to boil it in oil for approximately 15 minutes in order to expand the gear as much as possible. At the end of this time, pick up the gear with tongs or pliers and slip it onto the crankshaft. Be sure to align the key seat and the key. This method of heating the gear assures maximum expansion with no injury to the gear.

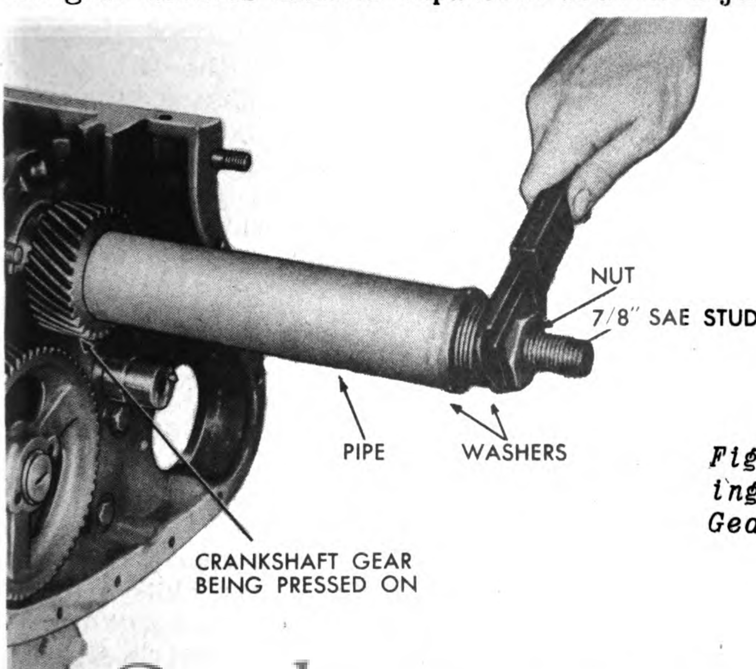


Figure 177. Pressing on Crankshaft Gear.

STEPS OF ENGINE RE-ASSEMBLY

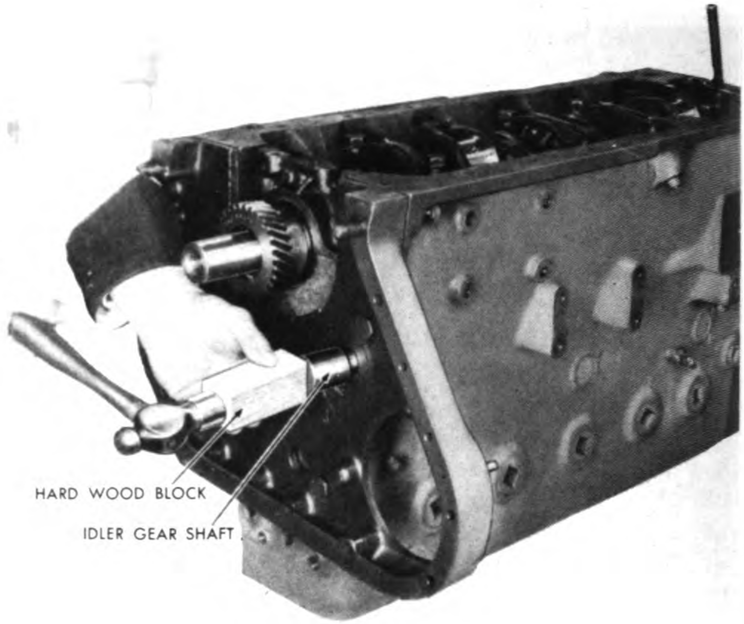


Figure 178. Installing Idler Gear Shaft.

If the foregoing procedure is not feasible, press on the gear as shown in Figure 177. For this procedure, a long 7/8" S.A.E. stud, a pipe with the same outside diameter as the gear hub, washers to fit over the stud against the end of the pipe, and a nut to go on the end of the stud are needed.

First, coat the crankshaft with white lead. Place the gear into position on the shaft with the key way and the key in alignment. Screw the stud into the shaft. Place the pipe over the shaft with the washer in place and tighten the nut to press on the gear. Watch the key to be certain that it stays in position.

10. Install the idler gear shaft. See Figure 178. Be sure to line up the set screw hole in the shaft with the set screw hole in the crankcase. DO NOT MISTAKE THE OIL PASSAGE HOLE FOR THE SET SCREW HOLE. See Figure 123. Insert and tighten the lockscrew. Install the copper gasket on the set screw and install and tighten the acorn lock nut. Install the idler gear on the idler gear shaft with the numbers out so that the oil slinger side of the gear is in towards the crankcase.

NOTE: Be sure to line up the two marks on the idler gear in their respective places - one with the mark on the crankshaft gear and the other mark of the idler gear with the mark on the camshaft gear as shown in Figure 163.

NOTE: If the gears were replaced and the marks were not transferred to the new gears, the timing of the valves cannot be done until the valves are installed. The procedure for timing the valves is given in Step 29. Install the idler gear retaining washer. Install and tighten the screw. This screw has a left hand thread. Make certain that the washer is started on the dowel pin correctly. To check the idler gear end play, which should be .004" to .007", insert a feeler gauge between the idler gear hub and the retaining washer as shown in Figure 121. If the end play is more than .015", either replace the retaining washer or the idler gear.

11. Install the oil pump. Be sure to use new copper gaskets on the dowel sleeves and be sure that they are properly in place. Line up the pin and fork drive and tighten the four oil pump capscrews. See Figure 135. (Now lay the engine on its right side.)

12. Clamp the piston and connecting rod assembly in a vise with lead jaws, to prevent damaging the connecting rod, so that the piston seats tightly against the top side of the jaws. With a narrow strip of clean cloth, clean out each ring groove. If the clearance between the ring lands and the ring has not been checked according to the instructions in paragraph 42, the checks should be made before installing the rings. Install the rings with a ring tool and space the gaps of the rings 90° apart (a quarter of a circle), as shown in Figure 179. The three top rings are compression rings; the fourth and the fifth rings at the bottom are oil control rings.

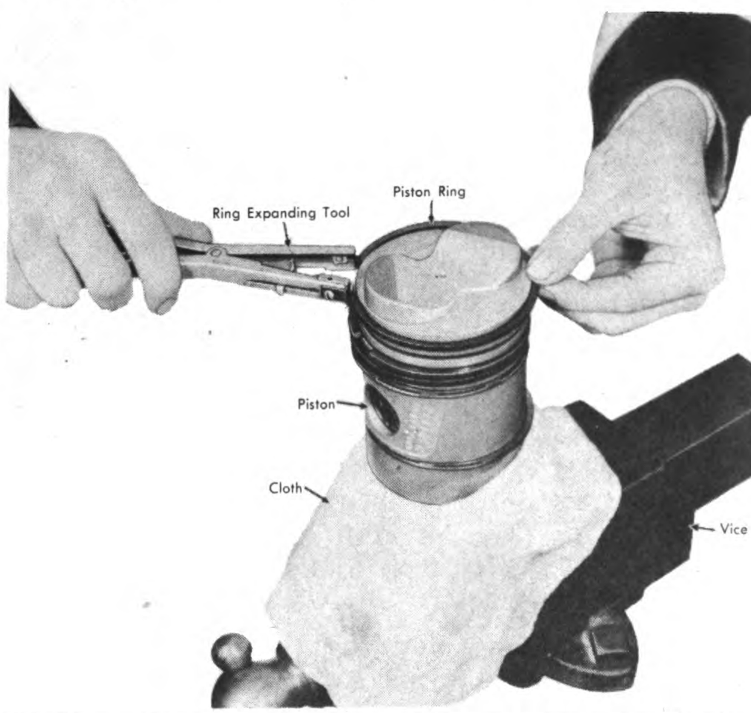


Figure 179. Installing piston rings.

13. To install the piston and connecting rods into their respective cylinders, the arrow on the top of the piston should point to the injector side of the crankcase. Place a ring compressor over the rings as shown in Figure 180. Make certain that the rings are wholly in their grooves before tightening the compressor a little bit at a time, pausing to push the compressor side ways to be sure that the rings are free. Compress as much as possible. A pilot tool, or wooden guide, shown in Figure 134, should be placed over the upper connecting rod bolt to guide the rod into place without marring the bearing surfaces of the crankshaft. Be sure to oil piston.

STEPS OF ENGINE RE-ASSEMBLY

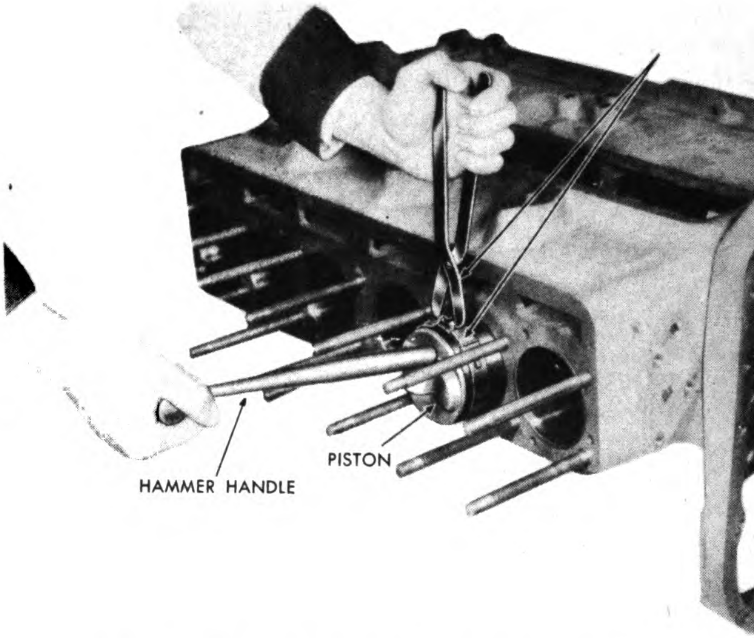


Figure 180. Compressing rings to install piston.

NOTE: The piston and connecting rod assembly should be fitted into the proper cylinder, making certain that No. 1 piston is in No. 1 cylinder with the designating number on the side of the rod at the lower end facing the right side of the engine (opposite of the camshaft) and so on for each respective piston and cylinder. Do not force the piston into the cylinder. If it does not move easily, either the rings are not compressed enough or the connecting rod is catching on the crankshaft.

Install the connecting rod cap and make sure that the number on the cap corresponds and lines up with the number of the rod. The caps are not interchangeable or reversible. Tighten each cap separately with a torque wrench. The torque tension in foot pounds should be between 75 and 85. Check the side play of the connecting rods by tapping each cap lightly as shown in Figure 181. This side play should be from .003 to .008, maximum .012", which can be checked with a feeler gauge. **NOTE:** If there is no side play, the piston and connecting rod must be removed and checked as follows:

Place the connecting rod cap on the crankshaft journal to see if it can be moved side ways. If not, the cap and rod must be filed together as a unit on one side. Usually a few strokes are sufficient to provide side clearance. If there is side play, but the movement is not free when tapping the cap and rod, there is either dirt on the bearing or the bearing is not the proper size. The connecting rod bearing clearance should be between .002" and .004", maximum .0055".

Line up the cotter pin holes, between 75 and 85 foot pounds on torque wrench, and insert pins of large enough diameter to make a snug fit in the hole. The cotter pin should extend about 3/8" to 1/2" to allow enough length for bending. If longer, cut off the excess length.

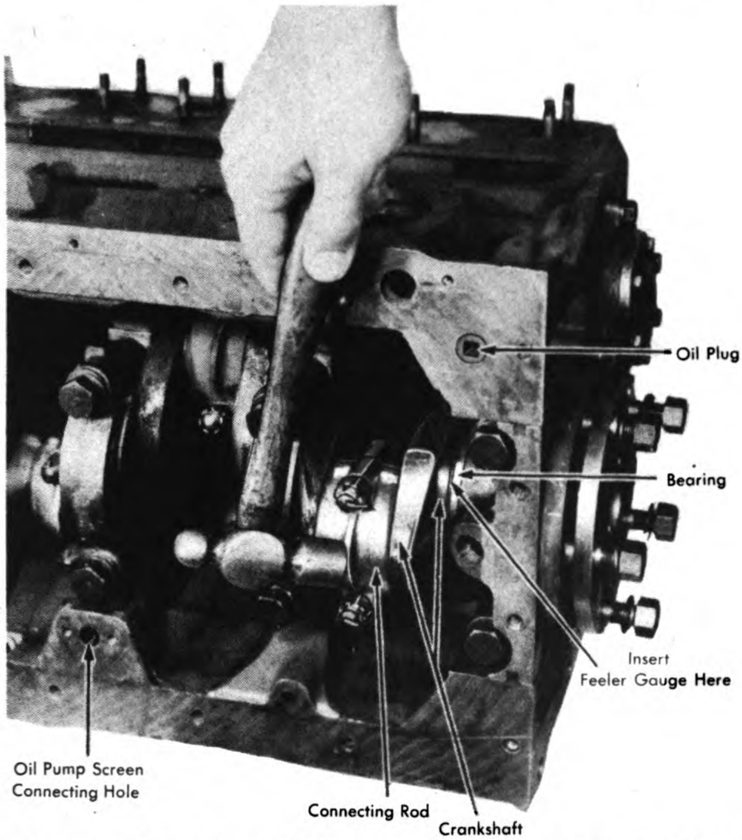


Figure 181. Checking Connecting Rod for Side Play.

14. Install the valve lifter and bracket assemblies in the valve lifter chamber and tighten the capscrews. **CAUTION:** The holes for the capscrews holding the assemblies in place open directly into the cylinder bore, and if, for any reason, any of these capscrews are replaced, ONES OF IDENTICAL LENGTH MUST BE USED, 2" LONG. Otherwise they will bend in the cylinder sleeves. Install the valve lifter chamber cover with the gasket in place and tighten the valve lifter cover nuts.

15. Install the rear bearing cap drain tube and also the oil float bracket with the oil screen in place. See Figure 130. Shellac the gaskets to the oil pan and recheck all the connecting rod cotter pins and main bearing lock wires before installing the oil pan. Install the oil pan.

16. Install the flywheel housing by slipping it into place on two dowel bolts. Install the two dowel bolt nuts and four capscrews anf tighten. See Figure 129.

17. With a chain hoist, set the engine upright so that it rests on the flywheel housing and blocks of wood placed on the edges of the oil pan and crankcase.

18. Install the oil pressure relief valve making sure that the valve seat, ball, and spring are clean. See Figure 140.

19. Install the generator mounting bracket on the gear housing.

20. Install the water inlet manifold to the crankcase. Be sure that the water distributors and gaskets are in place, and tighten the water inlet manifold capscrews. See Figure 115.

21. Place the interlocking cylinder head gaskets in position and install the cylinder head. Make certain that the cylinder head is seated on the two dowel sleeves in the crankcase before tightening the stud nuts. See Figure 182. With a torque wrench, tighten the stud nuts with a tension in foot pounds of 95 to 105. See Figure 176. Check to see that the cylinder breather tubes are in place and that the rocker arm oil line connection is in place. See Figure 184.

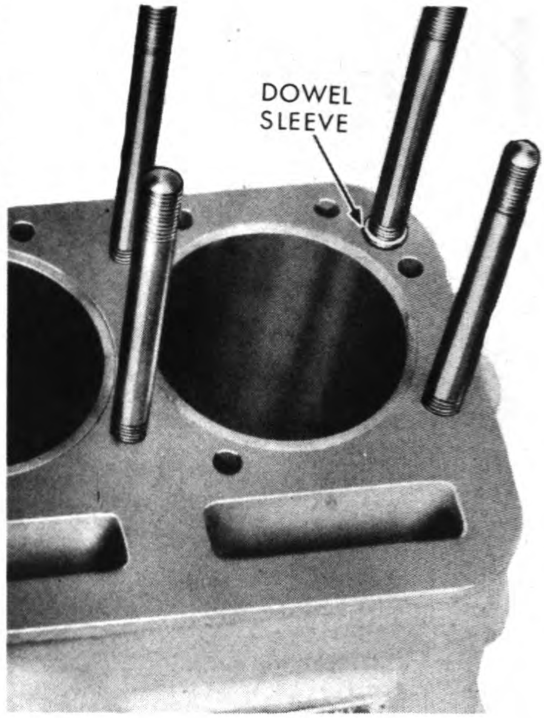


Figure 182. Crankcase Dowel Sleeves.

22. Install the water outlet manifold with gaskets in place on the cylinder head. Insert the thermostat housing with the thermostat and gasket in place and tighten the four capscrews. See Figure 183.

23. Install the intake manifold with the intake and exhaust manifold gasket in place and assemble the shield to the intake manifold. Install the exhaust manifold and securely tighten the manifold mounting nuts - tighten them evenly. Install the air cleaner adaptor and screen to intake manifold. See Figure 113.

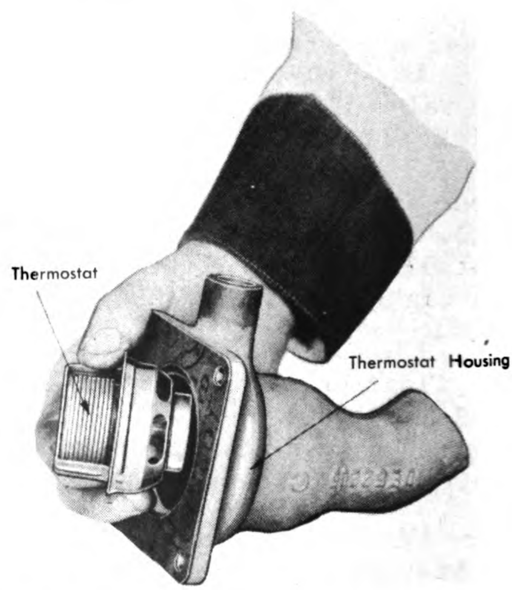


Figure 183. Thermostat and Housing.

24. If the rocker arms need no servicing or replacement, the rocker arms can be installed as a unit after the push rods have been inserted. If it was necessary to replace or service the rocker arms, install the push rods as before, and set the rocker arm brackets in place, just starting the bolts, making

certain that the dowelled brackets go in their proper places. Lay the rocker arms in place in their respective positions and insert the rocker arm shaft turning it as it is being pushed. See Figure 184.

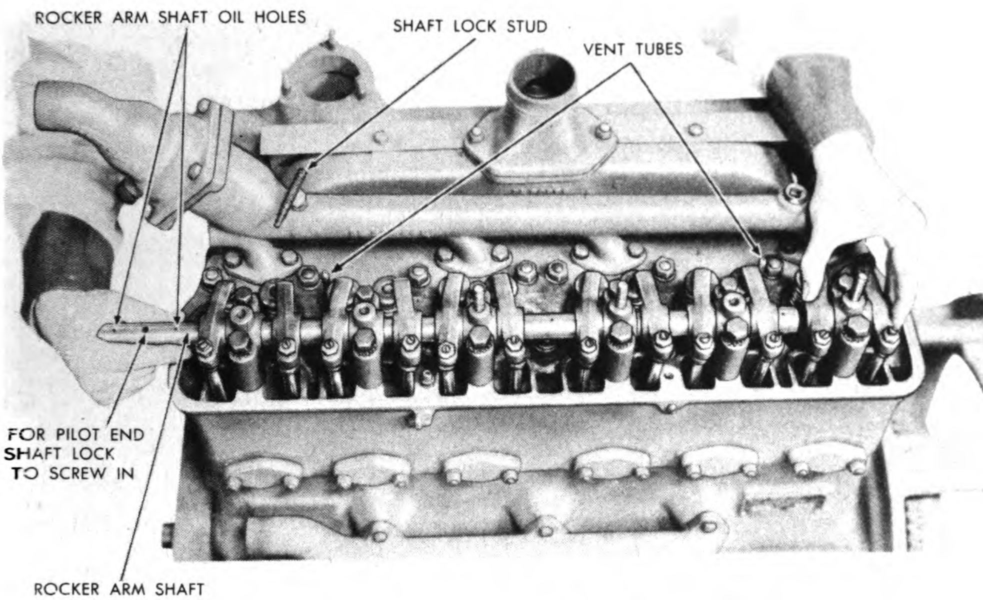


Figure 184. Installing Rocker Arm Shaft.

NOTE: The large hole between the oil holes in the rocker arm shaft should be centered with the threaded hole in the first bracket. After the rocker arm shaft is in position, screw in the rocker arm shaft lock stud. A good method for installing this stud is to use two nuts locked against each other and with a box wrench as shown in Figure 185, tighten the stud in place. Tighten the rocker arm bracket stud and install the spring clips.

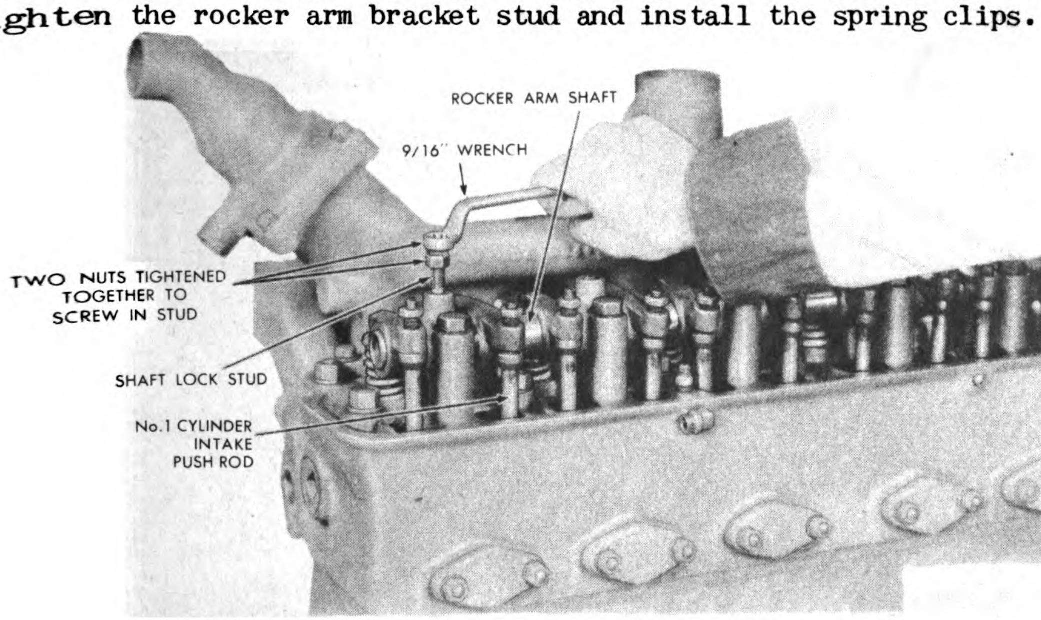


Figure 185. Installing Lock Stud.

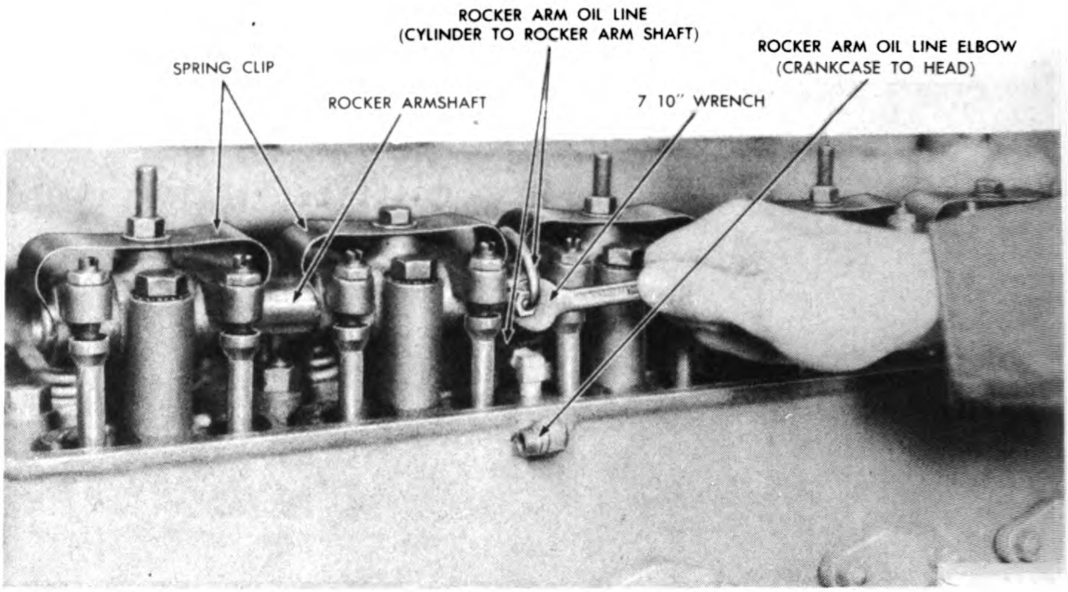


Figure 186. Installing Rocker Arm Shaft Oil Line.

25. Install the rocker arm shaft oil line. See Figure 186.

26. If the water tube distributor in the cylinder head was not installed at the time of servicing the cylinder head, install it now as shown in Figure 187.

27. Before installing the flywheel, make certain that all the dirt has been removed from the crankshaft flange and the crankshaft flange recess in the flywheel. Feel the surfaces for

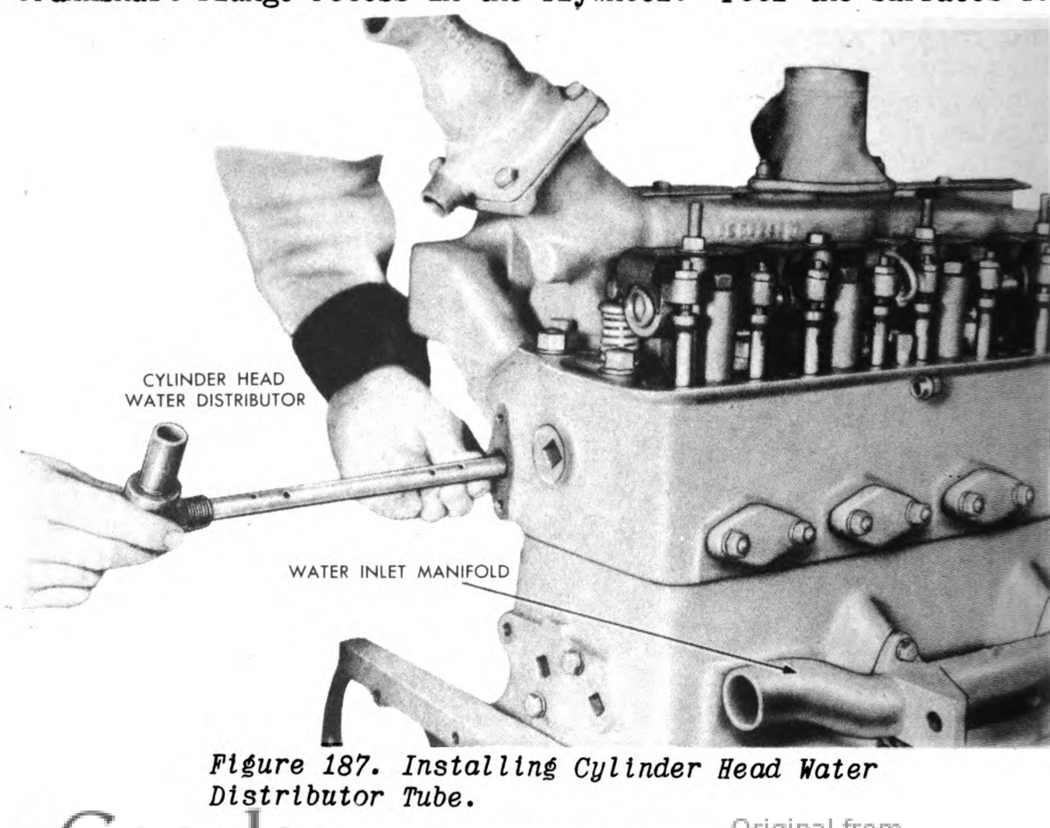


Figure 187. Installing Cylinder Head Water Distributor Tube.

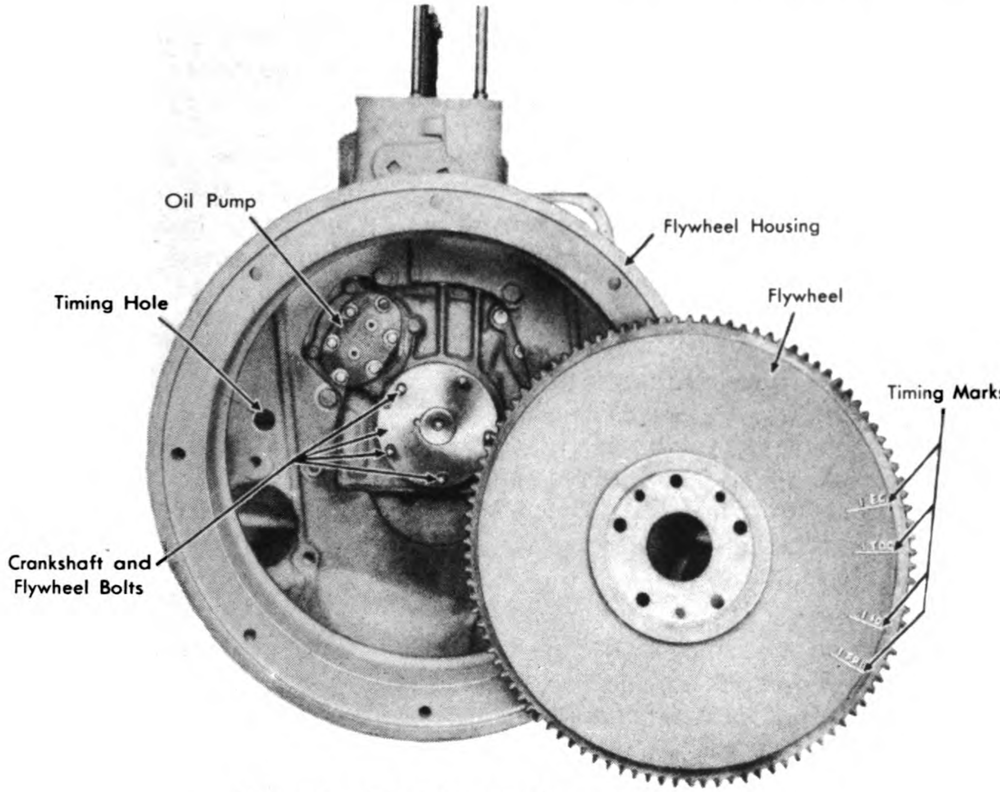


Figure 188. Flywheel and Housing.

burrs and nicks. See Figure 188. To facilitate putting on the flywheel and for timing the engine with the fuel pump, move No. 1 piston or No. 6 to top-dead-center. Next line up the timing mark No. 1 T.D.C. (No. 1 cylinder on top-dead-center) on the flywheel with the timing hole in the flywheel housing. See Figure 188. Because of an offset bolt, the flywheel goes on in one position only. Lift the flywheel into position on the flywheel bolts. Put on the lockwashers and nuts. Be sure to use the special thin lockwashers. Tighten the nuts slowly and evenly by tightening each second nut going around several times until the nuts are tightened.

28. Check the runout of the flywheel with a dial indicator, as shown in Figure 189. The maximum total indicator reading should not exceed .008". Check the housing bore as given in paragraph 33. See Figure 162.

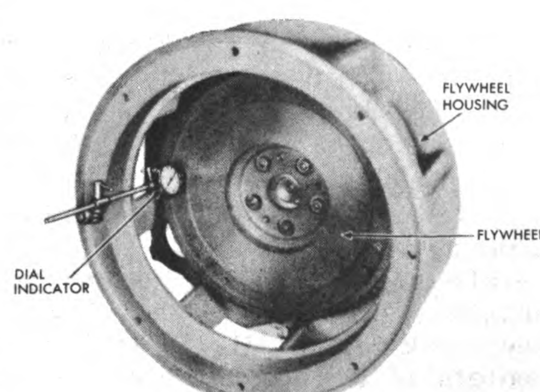


Figure 189. Checking Flywheel Runout.

29. Time valves.

STEPS OF ENGINE RE-ASSEMBLY

NOTE: In case the gears have been replaced and the punch marks for the purpose of timing were not transferred, the following procedure for timing the valves is necessary.

A. Be sure that the intake valve rocker arm of No. 1 cylinder (second rocker arm from the timing gear, see Figure 185) is adjusted to a clearance of .010" and the idler gear is not in place on the shaft and meshing with the other gears. **NOTE:** The hot clearance for the intake is .009". The readjustment must be made during the test run.

B. Turn the crankshaft until the timing mark on the flywheel, No. 1 cylinder I. O. (intake open) is in the center of the inspection hole in the flywheel housing. See Figure 190.

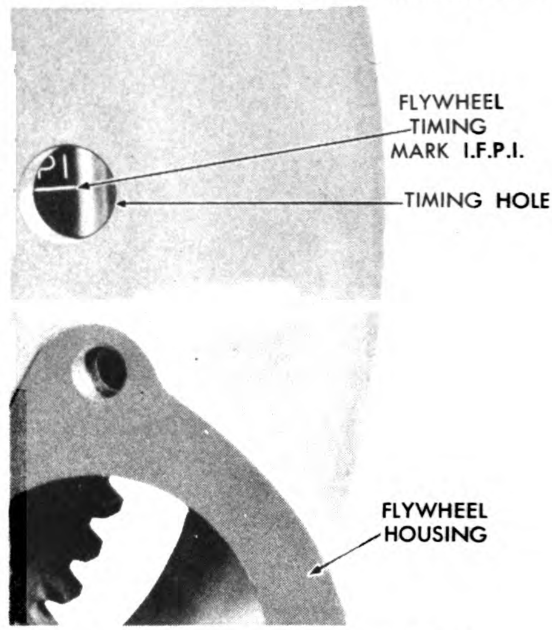


Figure 190. Flywheel Timing Hole in Gear Hub.

C. Turn the camshaft in the direction of rotation (same direction as the crankshaft) until the No. 1 cylinder intake valve lifter takes up the slack between the lifter and the valve stem. This point can be determined by rotating the push rod with your fingers. A slight drag indicates the proper point. Slip the idler gear into mesh with the cam and crankshaft gears. Install the camshaft thrust washer and tighten the thrust screw.

D. To recheck the valve timing, slowly turn the crankshaft almost two revolutions in the direction of its rotation. Toward the latter part of the second revolution, rotate the No. 1 cylinder intake push rod. When a slight drag is felt, the timing mark I. O. (intake open) on the flywheel should be in the center of the inspection hole in the flywheel housing.

30. (A) Before installing the fuel pump and governor as a unit, time the fuel injection pump with the engine as follows: Revolve the crankshaft in the direction or rotation so that No. 1 intake valve opens. See Figure 185. Slowly continue turning the crankshaft until the timing mark No. 1 F.P.I. on the flywheel centers in the timing hole. See Figure 190.

B. Revolve the gear of the fuel injection pump so that the mark on the pump case, shown in Figure 191, is in the center of the timing hole in the gear hub. See Figure 192.

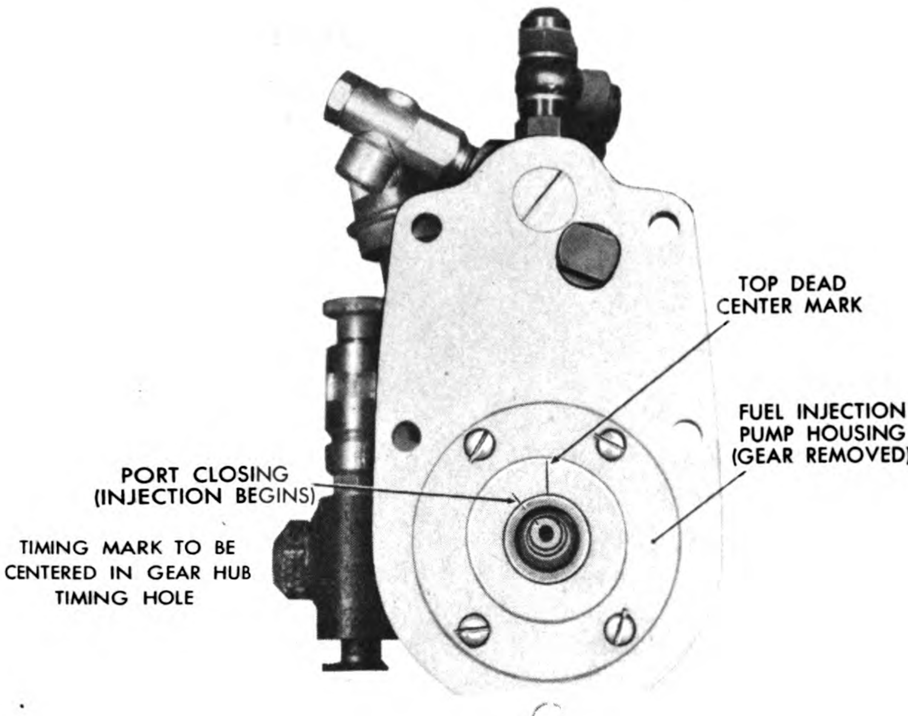


Figure 191. Timing Mark on Fuel Pump Housing.

C. Install the fuel injection pump and governor as a unit. If the gear teeth do not mesh, it will be necessary to turn the gear slightly either to the right or to the left. Install the stud nuts to hold the fuel injection pump in place, but do not tighten. See Figure 111.

D. Install the gasket and gear case cover after installing a new oil seal (see Figure 193) in the cover as shown in Figure 194. Install the fuel injection pump capscrews and tighten the injection pump stud nuts and the gear case cover capscrews and dowel bolt nuts.

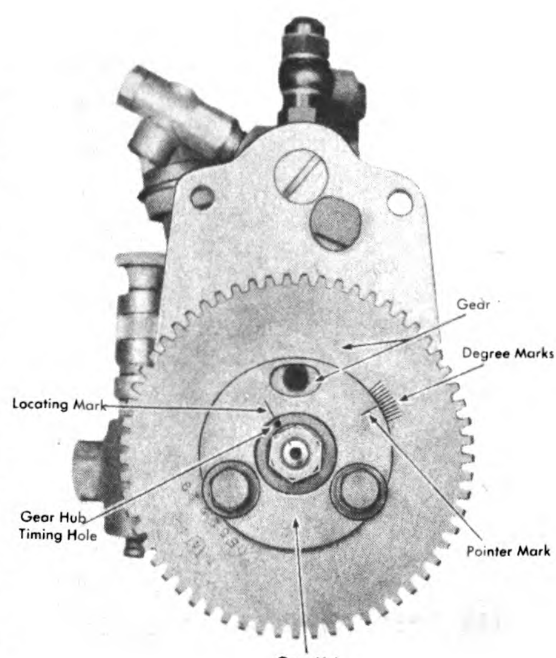


Figure 192. Timing Mark in Center of Timing Hole in Gear Hub.

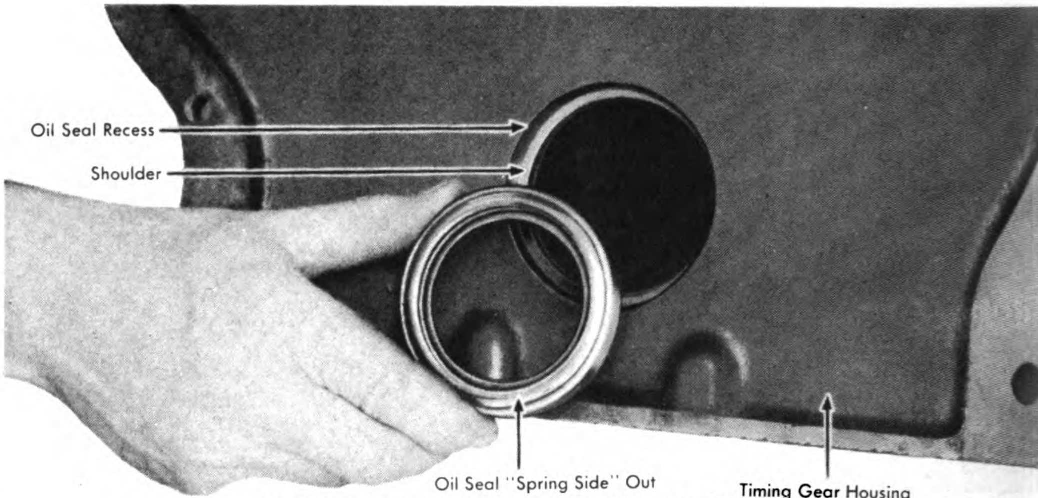


Figure 193. Gear Case Cover Oil Seal.

E. With the oil filler pipe removed, loosen the three capscrews of the fuel injection pump gear hub and turn the hub until the mark on the pump case is in the center of the hole in the gear hub. Tighten the gear hub capscrews and install the lockwire. See Figure 195.

NOTE: It may be necessary to re-set the timing after the test run. See paragraph 202. Install the oil filler pipe with the gasket in place.

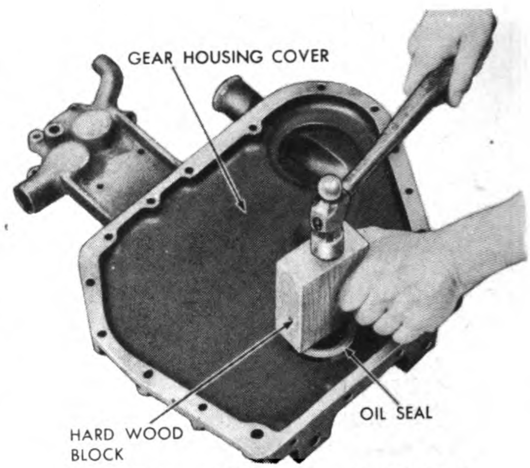


Figure 194. Installing Oil Seal.

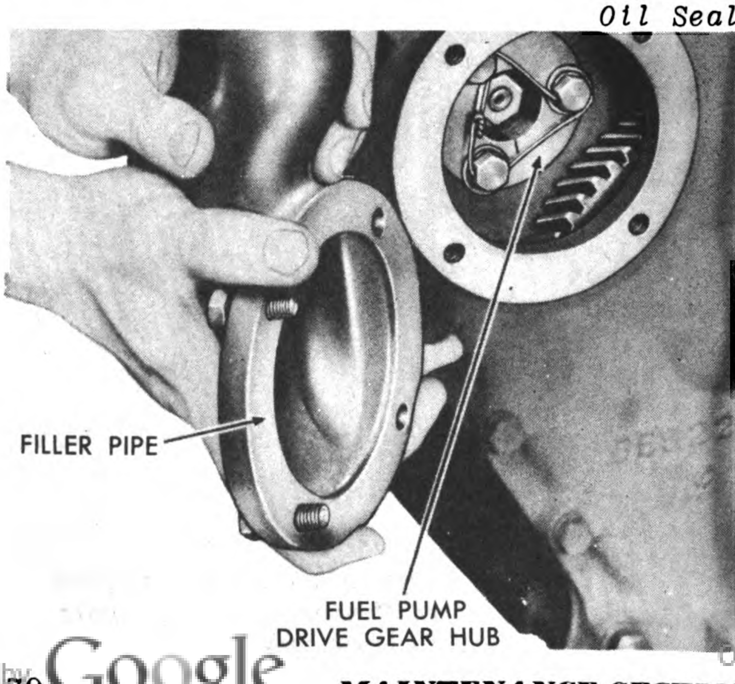


Figure 195. Oil Filter Pipe Removed, Exposing Fuel Pump Gear

30. Install the crankshaft fan drive pulley, line up the key with the key way, and drive it in as shown in Figure 196.

31. Install the secondary fuel oil filter.

32. Install the primary fuel filter and solenoid, or safety shut-off, valve onto the holding bracket and install the bracket on the crankcase. See Figure 105.

33. Install the lubricating oil filter.

34. Install the injectors, or the nozzle holder and nozzle assemblies. Before installing the nozzle holder assembly, the recess in the cylinder head should be thoroughly cleaned. Always install new gaskets. **NOTE:** The assembly should be carefully inserted so that the nozzle tip does not strike against the recess wall. The assembly securing nuts should be tightened evenly to avoid undue strain on the studs.

35. Connect the high pressure lines and leak-off or fuel return lines. Make sure that they are securely tightened, and install the fibre clamps. See Figures 106, 107, 108, and 109.

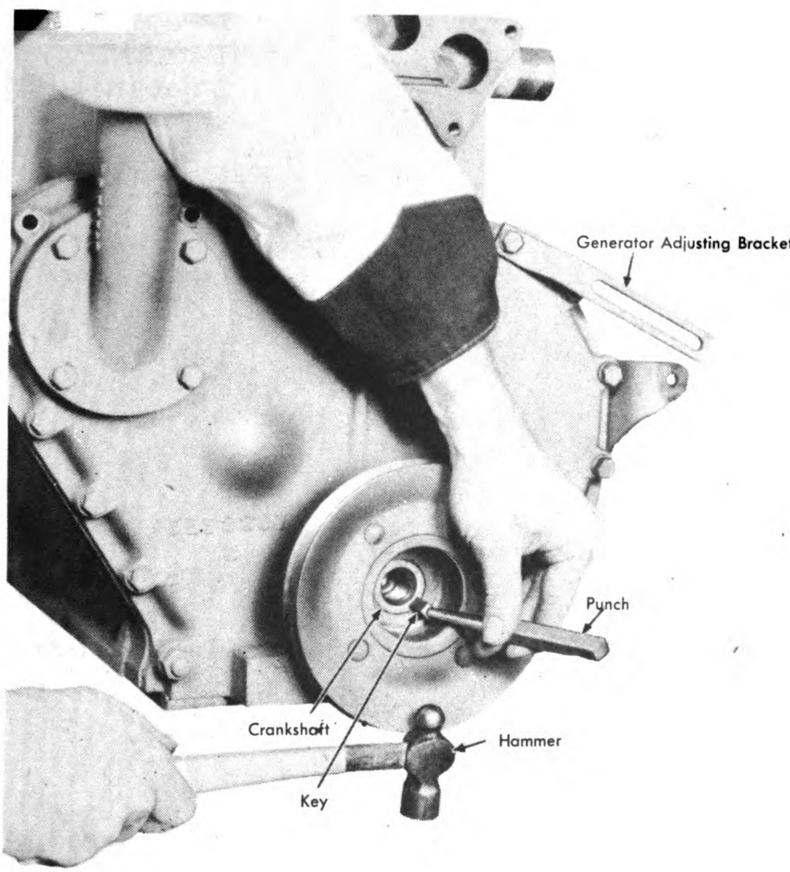


Figure 196. Installing Crankshaft Pulley.

36. Install the fuel connections between the filters, the shut-off valve and the injection pump. See Figure 197.

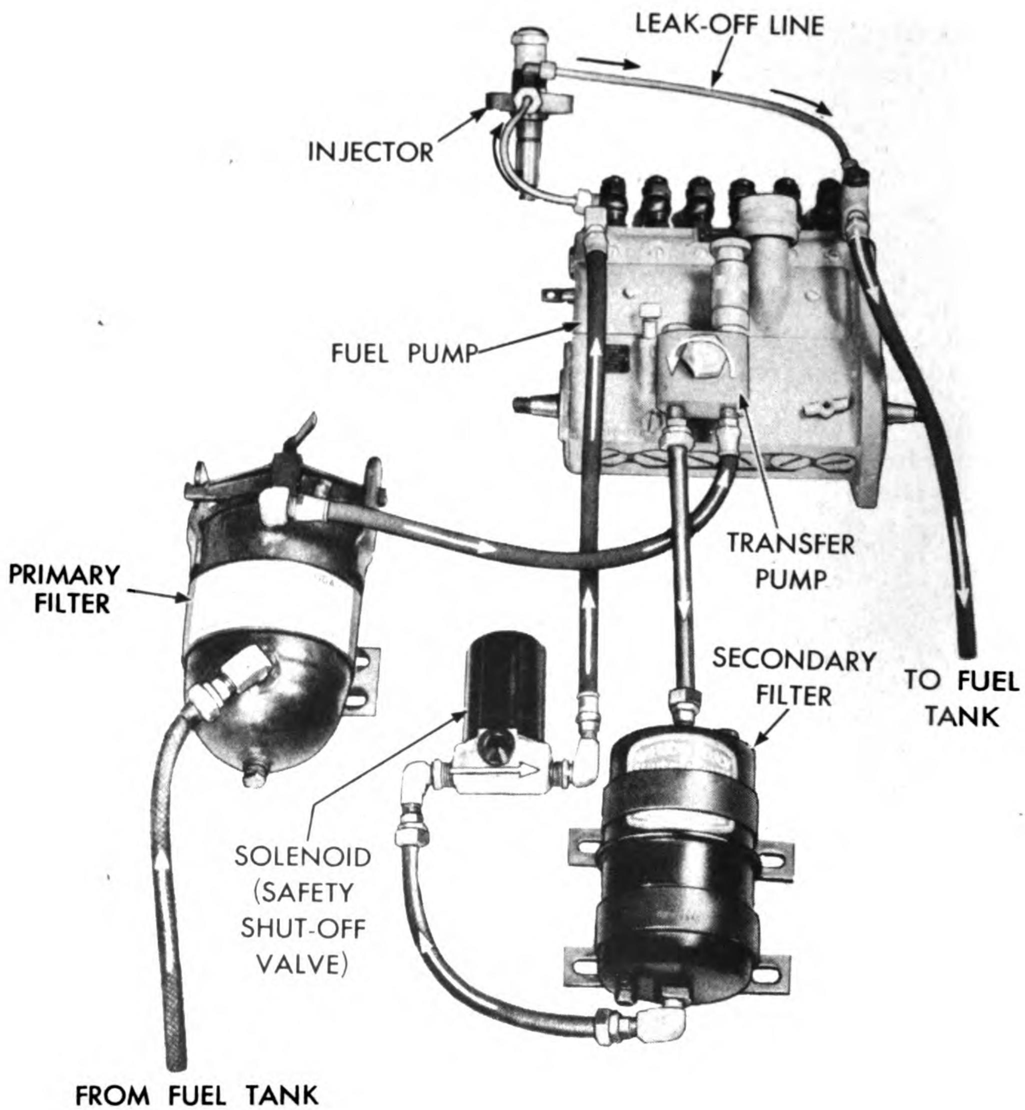


Figure 197. Fuel Line Connection and Direction of Flow.

37. Install the external rocker arm oil line from crankcase to head. See Figure 110.

38. Install the water pump and fan assembly.

39. Install the water hoses and hose clamps.

40. Install the starter motor in the starter motor hole in the flywheel housing and tighten the three capscrews.

41. Install the generator, and install the fan belt and adjust the fan belt tension. There should be approximately 3/4"

slack in the vee belt as measured on the longest side of the triangle which the fan belt makes. See Figure 198.

The engine is now completely assembled, and is ready for assembly to the generator and the control unit.

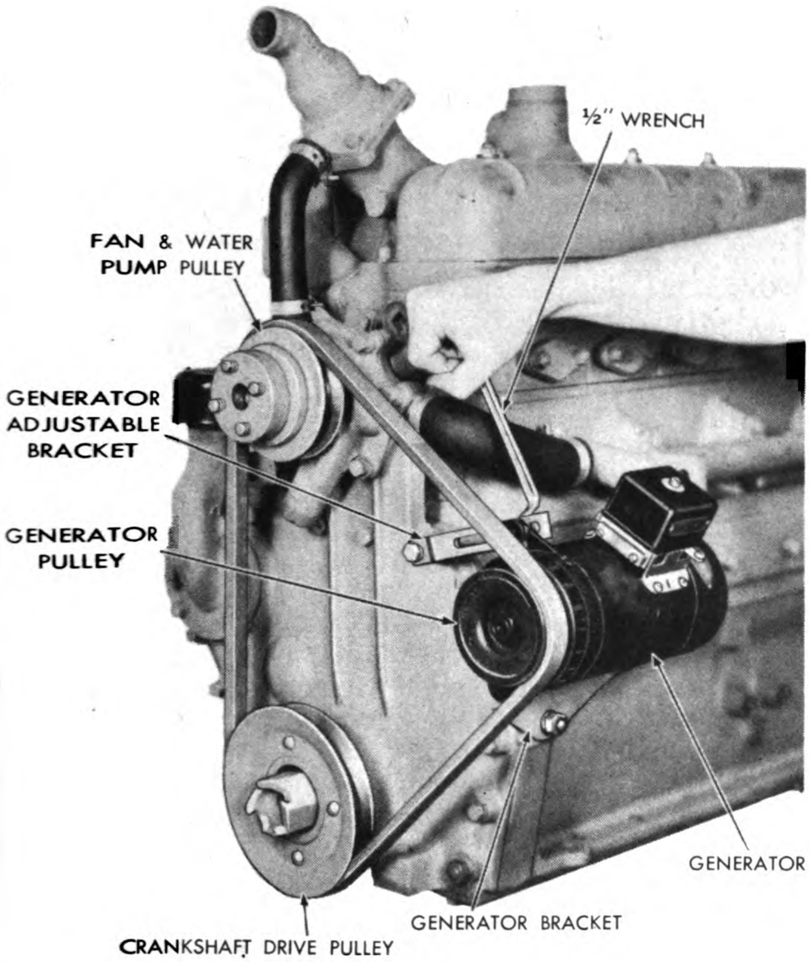


Figure 198. Adjusting fan belt tension.

Chapter IV

DISASSEMBLY, REPAIR AND INSPECTION OF THE ENGINE ACCESSORIES

44. The same care and cleanliness used in overhauling the engine proper must be exercised in overhauling the component systems of the engine. There are certain servicings that the maintenance personnel cannot perform. This applies particularly to the fuel injection pump; because intricate equipment for the fine calibrations required are necessary, together with a high degree of skill plus experience. Therefore, no attempt should be made at major overhaul of the fuel injection pump. The whole unit should be replaced and returned to a designated base or the factory should a pump go bad. A spare pump should be carried by the maintenance personnel.

The component systems included are: fuel, electrical, cooling, and lubricating. NOTE: Although the air cleaner is part of the air induction system, instructions for servicing the air cleaner are given under the fuel system because its function is closely related to the fuel system.

45. FUEL SYSTEM

The fuel system cleans, prepares, controls, and times the flow of the fuel to the engine. The fuel passes first, through the primary filter, then to the fuel transfer pump which maintains 15 pounds pressure, than to the secondary filter, then through the solenoid or safety shut-off valve to the fuel injection pump, from which the fuel is injected through the injection lines, and finally through the nozzles into the combustion chambers. The fuel return line carries off the excess fuel delivered by the fuel transfer pump through the check valve in the fuel injection pump and returns it to the fuel tank. Figure 197 illustrates the flow of the fuel oil.

As a part of the control of the flow of fuel, a single speed governor automatically regulates the speed of the engine. The governor maintains the rate of operation at an even pace for whatever speed it may be set. See Figure 199.

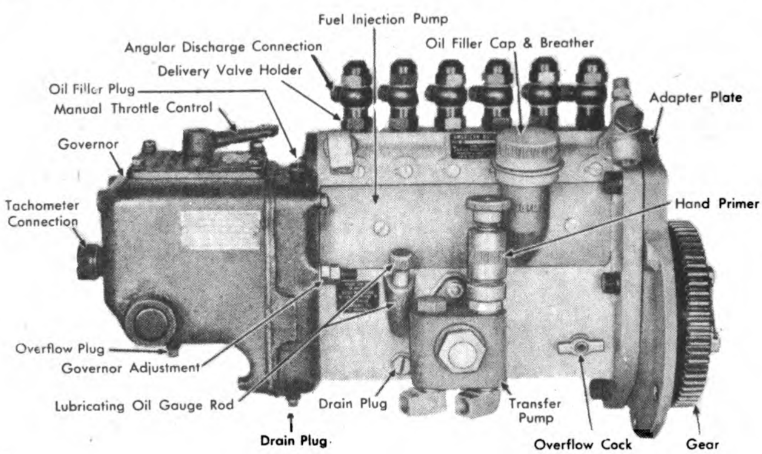


Figure 199. Fuel Injection Pump and Governor.

46. FUEL INJECTION PUMP

The fuel injection pump is of the constant-stroke, cam-actuated, lapped-plunger type. Its purpose is to meter the fuel accurately and to deliver it precisely at a definite moment in a definite time under high pressure to the spray nozzles by which it is injected into the respective cylinders of the engine. See Figure 199.

This type of injection pump, having a self-contained drive, consists chiefly of an aluminum alloy housing (16, Figure 200)

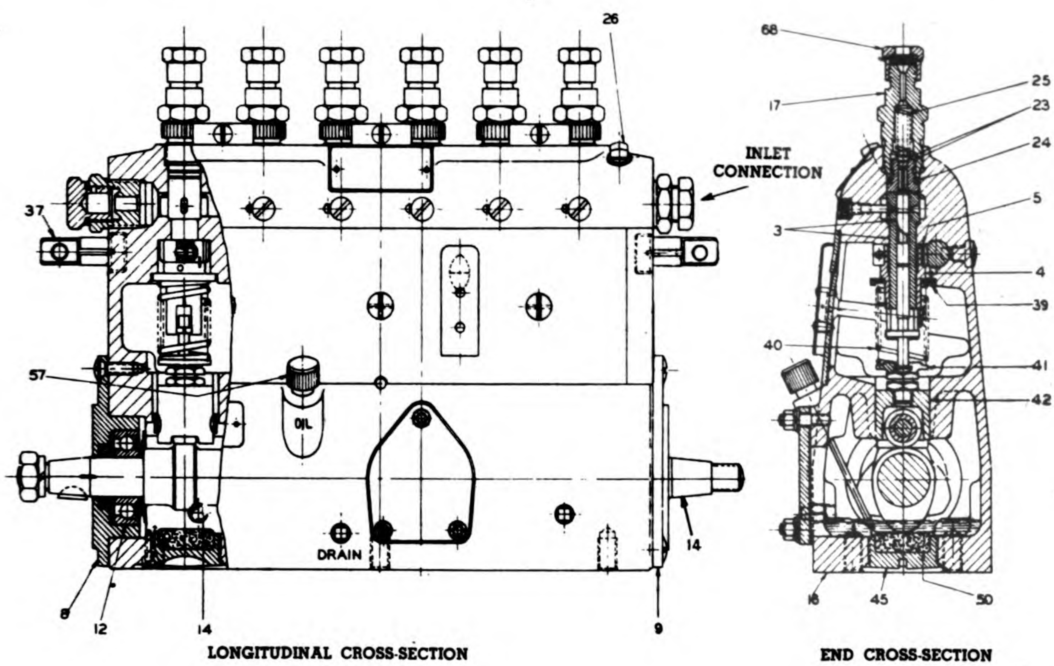


Figure 200. Cross Section View.

with camshaft compartment in the lower half and six pump element assemblies (3) in the upper half. The camshaft compartment contains the camshaft (14) which runs in ball bearings (12) supported by the end plates (8 and 9). Felt cushions (50) in the closing plugs (45) in the housing base facilitate lubrication of the cams and roller followers of the tappet assemblies (42). Directly above these are located the plunger and barrel assemblies (3), control sleeves (4) with toothed segments (5), plunger return springs (40), spring seats (39 and 41) and the control rod (37).

The upper part of the housing contains the fuel sump, delivery valve assemblies (23) with gaskets (24), delivery valve springs (25), delivery valve holders (17) and nipple nuts (68) for connection of the discharge tubings.

The injection pump is driven at half engine speed. The cams are arranged on the camshaft in the same order as the firing order of the engine.

FUEL TRANSFER PUMP

47. GENERAL MAINTENANCE DATA

A. Fuel Injection Pump

The continued long-time service built into the fuel injection pump is directly dependent upon the preservation of its precision parts through intelligent care and maintenance.

No attempt should be made to dismantle or repair the fuel injection pump. Because of the special tools and fine calibrations, a fuel injection pump that is damaged or has failed should be replaced with a new one, and the old one should be returned to the nearest base designated by the Ordnance Department where the special tools, equipment, and data will be available for a complete overhaul.

B. Fuel Transfer Pump

The fuel transfer pump is of the plunger type, and is mounted on the side of the injection pump as shown in Figure 199.

The quantity of the fuel delivered by the transfer pump is regulated by the pressure in the discharge line which controls the length of the stroke of the plunger. The plunger tappet is of the roller type, held in contact with one of the cams on the injection pump camshaft by a spring.

During the plunger stroke, fuel is sucked through a spring loaded valve into the plunger chamber and forced out through the discharge valve on the return stroke. The back pressure in the discharge line prevents the plunger from following the cam during the entire stroke, the length of the stroke depending on the amount of fuel required.

If trouble develops, it will likely be caused by dirt or a broken spring preventing the proper functioning of the valves or plunger. Removing the valve retainer will permit an examination of the valves. The plunger and spring are accessible by removing the plunger retaining screw.

It is recommended that the fuel transfer pump be replaced as a unit if trouble develops and the transfer pump returned to the nearest base designated by the Ordnance Department.

As shown in Figure 102, the transfer pump is equipped with a manual primer for priming the system. If trouble develops in the manual primer, replace as a unit.

48. FUNCTIONAL DESCRIPTION OF FUEL INJECTION PUMP

Through the inlet connection (see Figure 201) the fuel enters the sump in the upper part of the housing. As soon as the upper edge of the plunger, during its downward stroke, opens the two diametrically opposite ports in the barrel, known as inlet and by-pass ports, the fuel rushes into the barrel while the plunger is at the bottom of its stroke (see "A", Figure 201). During the

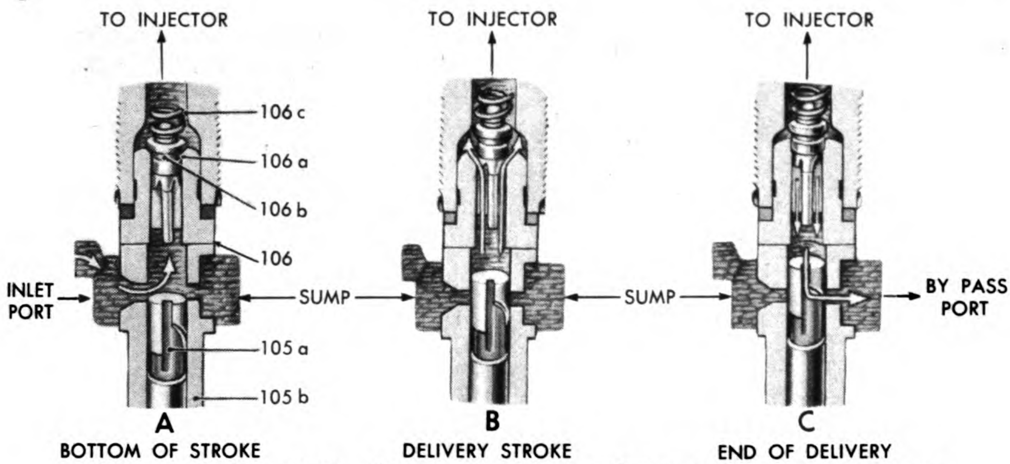


Figure 201.A,B,C. Cross Section of Barrel with Various Plunger and Delivery Positions.

first part of the upward stroke of the plunger, some of the fuel in the barrel is forced back into the sump, through the inlet and by-pass ports, until these two ports are completely closed. With these ports closed, the spring-loaded delivery valve is lifted off its seat, and the fuel is delivered through the discharge tubing into the spray nozzle, whence it is discharged into the combustion chamber of the engine (see "B", Figure 201).

Delivery of fuel ceases as soon as the helix on the plunger opens the by-pass port in the barrel, for at this instant the pressure chamber communicates with the sump by way of the vertical groove and helix on the plunger, allowing the fuel above the plunger not yet delivered to the by-pass back into the sump (see "C", Figure 201). The termination of the fuel delivery, which controls the quantity of fuel delivered per stroke, is varied by turning the plunger in its barrel, i.e., by bringing the helix into various positions with relation to the by-pass port. To accomplish this, a control sleeve (107a, Figure 202) is slipped over the barrel (105b), the sleeve being provided with a toothed segment (107b) at its upper end and with two longitudinal, opposite slots at its lower end in which the cross flange of the plunger (105a) is guided. The teeth

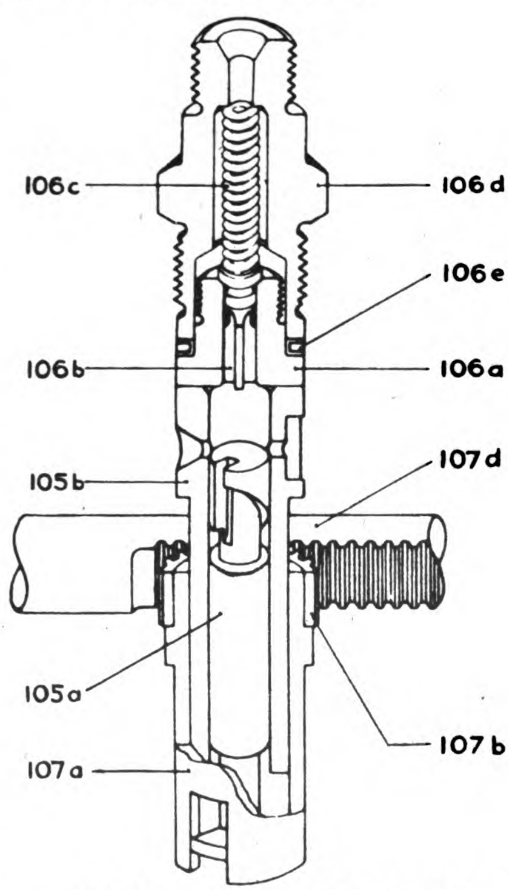


Figure 202. Sectional View of Fuel Injection Pump Element.

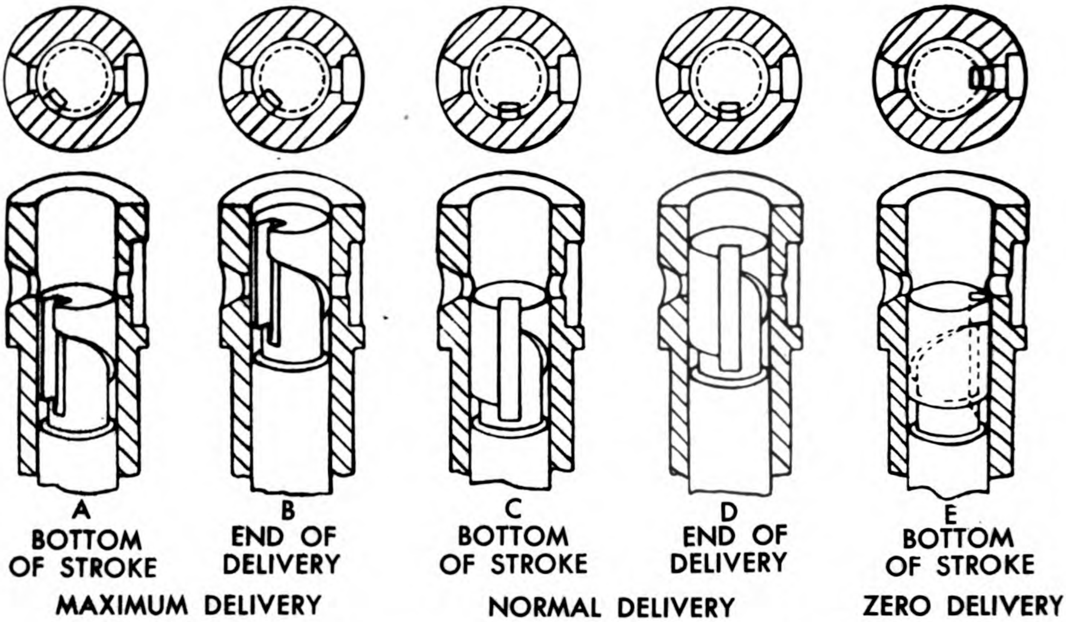


Figure 203. Barrel with Various Plunger Positions.

of the gear segment engage corresponding teeth on the control rod (107d) and, by shifting the latter, either manually or automatically by means of a governor, the plunger is rotated in its barrel in either direction.

The less the control rod is moved away from its "stop" position and the less the plunger is thereby turned in its barrel, the sooner the helix opens the by-pass port and the smaller the fuel delivery per stroke will be (see Figure 203). The farther the control rod is moved away from its "stop" position and the farther the plunger is turned in its barrel, the later the helix opens the by-pass port and the larger the fuel delivery per stroke will be.

For maximum fuel delivery, the plunger, by moving the control rod farthest away from its "stop" position, is turned farthest in its barrel, resulting in very late opening of the by-pass port by the helix, i.e., in the maximum effective plunger lift. For zero delivery, with the control rod at the "stop" position, the plunger is turned in its barrel until its vertical groove registers with the by-pass port. In this position, the pressure chamber in the barrel is in constant communication with the sump during the entire mechanical stroke of the plunger; therefore, no fuel is delivered by the latter.

When the helix of the plunger uncovers the by-pass port in the barrel during the latter part of the upward stroke, the pressure in the barrel is immediately released and the delivery valve is quickly returned to its seat by the combined action of its spring and the great difference in pressure which then exists between the barrel and the discharge tubing. This closes off communication between the pressure chamber in the barrel and the nozzle until the next delivery stroke takes place. In returning to its seat, the delivery valve performs a double function: first, it prevents excessive draining of fuel from the discharge tubing during by-passing as well as during the suction stroke of the plunger; second, it relieves the pressure in the discharge tubing. This pressure relief is accomplished by means of the accurately lapped relief or displacement piston.

Before the delivery valve actually reseats after the helix of the plunger has uncovered the by-pass port in the barrel, it reduces the pressure in the discharge tubing by increasing the volume therein by a quantity equal to the volume of the relief piston, for the latter slides down into the delivery valve seat with a plunger-like action. As a result of this rapid reduction in pressure, the nozzle valve at the other end of the discharge tubing "snaps" to its seat, thus instantaneously terminating the fuel injection from the spray nozzle and thereby eliminating "dripping".

The external control of the fuel delivery per stroke is accomplished by means of the control rod, one end of which is connected to the governor of the engine. There is a certain amount of dead movement of the control rod in its "stop" position, i.e., the rod must be moved about 3/16" from its full stop position before delivery of fuel commences. From that point on, however, the quantity of fuel delivered is directly proportional to the movement of the control rod.

In Diesel engines, speed and power output are controlled solely by a variation of the amount of fuel injected into the combustion chamber. As clearly explained in the preceding chapters, this variation of the amount of fuel delivered by the injection pump to the nozzles is regulated by the simple and foolproof action of the helix on the plungers.

49. LUBRICATION OF THE INJECTION PUMP

The lower part of the injection pump housing (camshaft compartment) should always be filled with a good grade of engine lubricating oil, the proper level of which can be determined by means of the oil gauge rod (Figure 199). This oil gauge rod is provided with a line mark indicating the highest permissible level of lubricant. The lowest level is represented by the end of the oil gauge rod, so that if no oil shows upon its withdrawal from the pump housing, the level is too low and must be brought up until the high mark is again reached. The oil is filled into the pump housing through the injection pump oil filler and breather hole.

It is advisable to change the lubricating oil in the pump housing whenever the engine oil is changed. To facilitate this, a drain plug on the pump housing is provided.

The pump plungers do not require any lubrication, since this is inherently contained in the fuel oil.

NOTE: To adjust the smoke stop see paragraph 66.

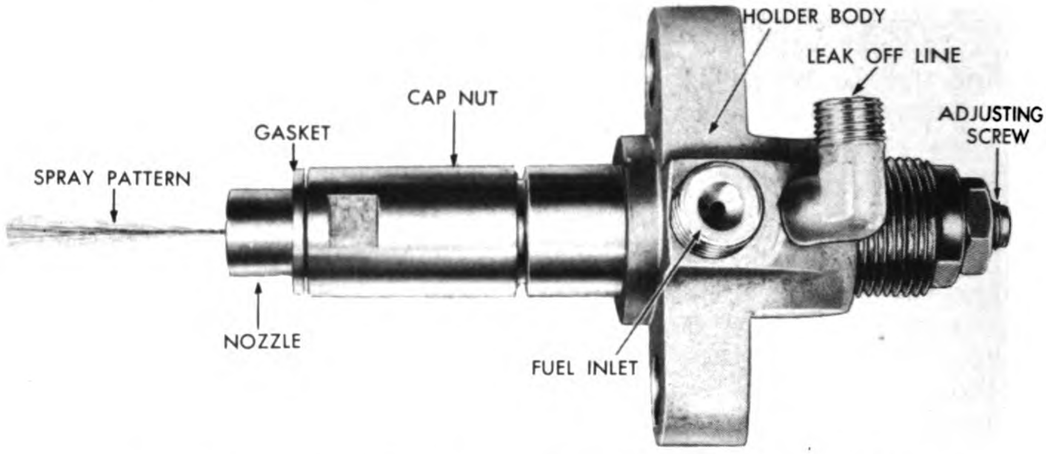


Figure 204. Fuel Injector (Nozzle and Nozzle Holder).

NOZZLES AND NOZZLE HOLDERS

50. NOZZLES

The function of the injector or the nozzle and nozzle holder is to direct the metered quantity of fuel received from the injection pump into the engine combustion chamber in a definite spray pattern and in such a manner as to produce the most efficient engine performance. The spray nozzles are of the closed pintle type. They utilize a spring-loaded valve with a seat at or near the spray orifice to close the orifice after each injection of the fuel into the engine combustion chamber. The valve is operated hydraulically by the pressure of the fuel oil being delivered at the injection pump. See Figure 204.

The spray nozzles consist of only two parts: the nozzle body and the nozzle valve, shown separately in Figure 206. The body and the valve are lapped to form a mated assembly. The lapped fit is so close that measurement of it is impracticable except by a specially designed hydraulic instrument. Therefore, body and valve cannot be exchanged singly but must be kept together at all times.

In Figure 206, note that the nozzle valve carries an extension at its lower end in the form of a pin which pro-

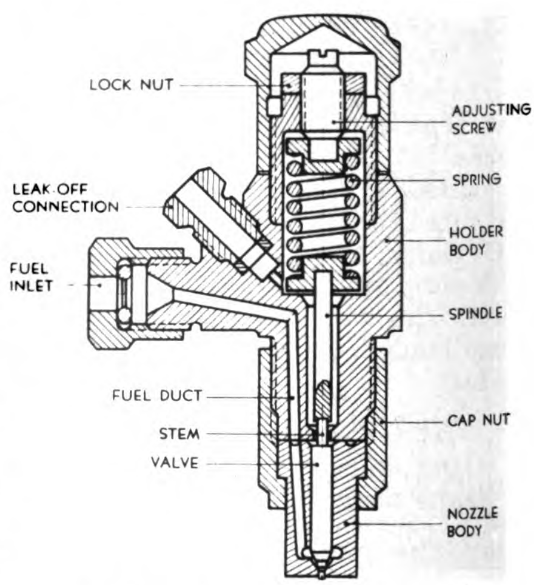


Figure 205. Cross section of injector.

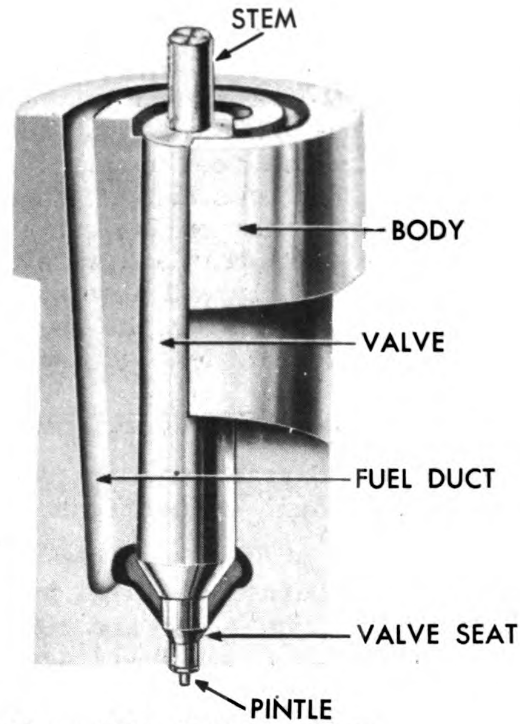


Figure 206. Cutaway View of Nozzle Assembly.

trudes through the closely fitting hole in the nozzle bottom. This requires the injected fuel to pass through an annular orifice, thus producing a hollow cone-shaped spray. The projection of the pintle through the nozzle orifice induces a self-cleaning effect which discourages the accumulation of carbon at this point and appreciably increases the permissible length of service without attention.

51. NOZZLE HOLDERS

The nozzle holder is used to hold the nozzle in its correct position in the engine cylinder and to provide a means of conducting fuel oil to the nozzle. The holder also contains the necessary spring and means of pressure adjustment to provide proper action of the nozzle valve. See Figure 205 and 206

At its upper end, the nozzle valve has an extension of reduced diameter referred to as the stem, which makes contact with the lower end of the spring-loaded spindle. Adjustment of nozzle valve opening pressure is accomplished by means of the spring pressure adjusting screw.

52. FUNCTIONAL DESCRIPTION OF NOZZLE AND NOZZLE HOLDER

The metered quantity of fuel from the injection pump enters the holder through the inlet connection and passes through the connecting ducts to the pressure chamber just above the nozzle valve. At the instant the pressure of fuel acting on the differential area of the valve exceeds the pre-determined spring load, it will lift the valve from its seat and the fuel will flow from the nozzle until delivery from the pump ceases. Then, a positive instantaneous cut-off of fuel occurs as the valve is snapped to its seat by the spring force which eliminates the possibility of after dripping.

A certain amount of seepage of fuel between the lapped guide surfaces of the nozzle valve and its body is necessary for lubrication. This leakage oil accumulates around the spindle and in the spring compartment from which it drains through the leak-off connections provided for that purpose.

53. FACTORS OF NOZZLE TROUBLE

Dirt and water are the two worst factors contributing to injector trouble. Dirt, consisting of minute abrasive particles, damages the valve seats, the fit of the stem, and erodes or clogs the nozzle orifice and causes sticking of the needle in its guide. Water in the fuel causes corrosion which results in enlarged nozzle orifices and sticking needle valves. It is important, therefore, that only clean fuel gets into the nozzle - fuel that is free from dirt and water. The filters should be drained of water regularly and absolute cleanliness should be observed when injection pumps or the nozzles together with the high pressure lines are disassembled and reassembled.

54. REMOVING THE NOZZLE FROM THE ENGINE

1. Before loosening any lines, apply kerosene or fuel oil freely to all connections in order that dirt and grease may be removed.

2. Detach the high pressure tubing and leak-off lines, as shown in Figures 106 and 108 and cover their open ends with cloth or paper caps to protect against the entrance of dirt.

3. Remove the holding nuts and pull the assembly from the engine, being careful not to strike the end of the nozzle against any hard surface. If the assembly is stuck, due probably to carbon, the injector can be removed with two pry bars, as shown in Figure 112.

55. USING THE BUDA HYDRAULIC DIESEL NOZZLE TESTER

The Buda hydraulic Diesel nozzle tester, shown in Figure 207 is a precision instrument capable of producing 7,500 pounds of pressure per square inch. To prevent damage to the gauge of the nozzle tester, DO NOT EXCEED 3,000 POUNDS PRESSURE. The injectors or nozzles are tested for leakage, valve opening pressure, and spray pattern. CAUTION: WHEN TESTING NOZZLE DO NOT OBSTRUCT THE OIL SPRAY AS IT LEAVES THE NOZZLE OR TRY TO RETAIN THE USED OIL. KEEP HANDS AWAY FROM SPRAY AT ALL TIMES. Use only clean Diesel fuel or flushing oil in tank. If possible, the nozzle tester should be hooked up to a filter as shown in Figure 207 to assure clean fuel.

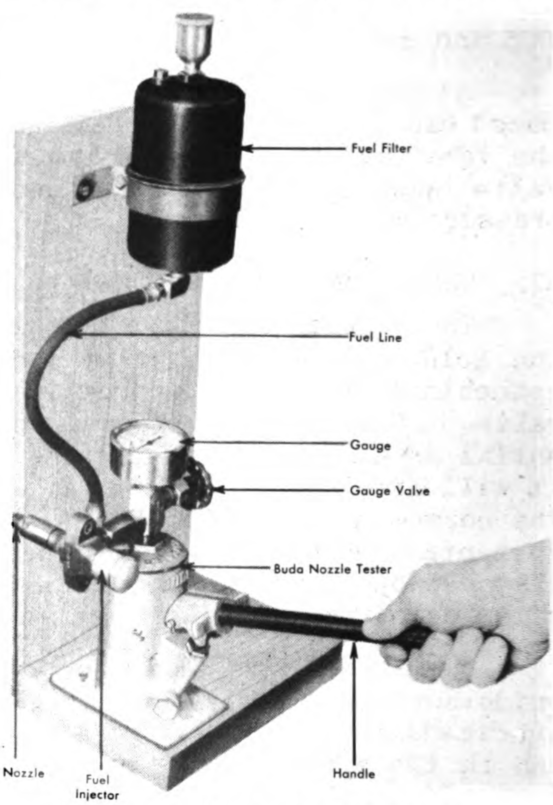


Figure 207. Operating Buda Nozzle Tester.

56. TESTING FOR LEAKAGE

While the absence of dribble is generally required for the throttling, pintle-type American Bosch nozzle, it is recommended a tester stroking speed of not less than 100 strokes per minute be employed. If the speed is lower, the throttling action of these nozzles will cause them to dribble and eject flags, making the nozzle appear to function improperly. However if the throttling nozzle does not leak or dribble to within 300 pounds of the specified opening pressure, the valve seat can be considered tight. If drops, dribbles, or a jet appears, the valve is not seating properly. Thorough cleaning usually corrects the trouble. If not, defective nozzles have to be replaced.

57. OPERATING THE NOZZLE TESTER

a. Remove the cork from the end of the coupling and operate the lever socket until the oil flows.

b. Attach the nozzle and holder assembly, as shown in Figure 207.

c. Close the valve and apply a few quick strokes to lever socket. If lever socket operates extraordinarily hard, it indicates a plugged nozzle. Note the spray pattern and look for leakages as indicated in paragraph 56. If plugged or if there is leakage, the nozzle should be removed, cleaned and lapped according to the instructions given in paragraph 60. The valve opening pressure for the 6-DTG-317 Buda Diesel engine is 2,000 pounds. If the pressure is not 2,000 pounds, the nozzle must be adjusted as given in the following paragraph:

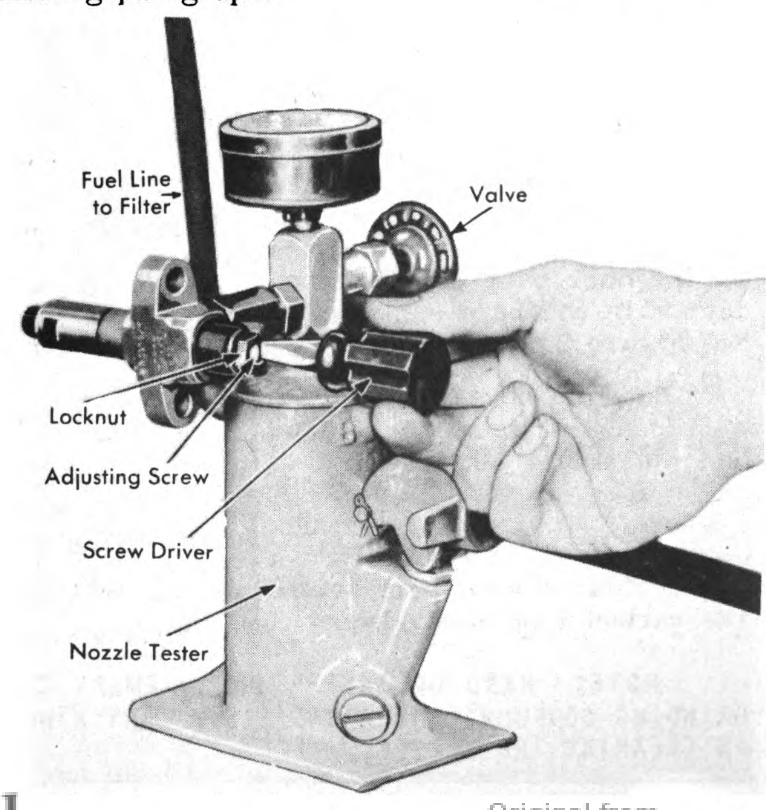


Figure 208. Adjusting nozzle opening pressure.

58. ADJUSTING NOZZLE OPENING PRESSURE

To adjust, remove the nozzle protection cap exposing the spring adjusting screw. Pressure can be increased or decreased by the adjustment of the spring compression screw as shown in Figure 208. Repeat the adjustments and test until the correct opening pressure is reached.

59. LAPPING THE VALVE SEAT TO THE NOZZLE

Wash the pintle valve and the pintle valve body with clean fuel oil by swashing and brushing with a soft wood stick. Cloth or paper might leave lint on the pintle and should not be used. **NOTE:** Hold the valve at the stem end only. Using fuel oil for a lubricant, lap the valve seat by rotating the valve back and forth in the body. Time and patience are often required in removing the particles of dirt from the pintle valve. **NOTE:** No abrasive materials should be used in lapping the pintle in the body, as the clearance between the pintle valve and the body is approximately .00015".

60. DISASSEMBLY AND CLEANING OF THE NOZZLE AND NOZZLE HOLDER

1. Wipe all dirt and loose carbon from the assembly with a clean cloth free of lint.

2. Clamp the nozzle holder assembly in a vise to remove the nozzle holder nut and remove the spray nozzle.

3. Normally the nozzle valve can be easily withdrawn from the nozzle body. However, in some cases, it may be necessary to soak the nozzle in fuel oil, acetone, carbon tetrachloride, or a similar carbon solvent before removal is possible. Do not permit the polished surfaces of the nozzle to come in contact with any hard substances. See Figure 208A.

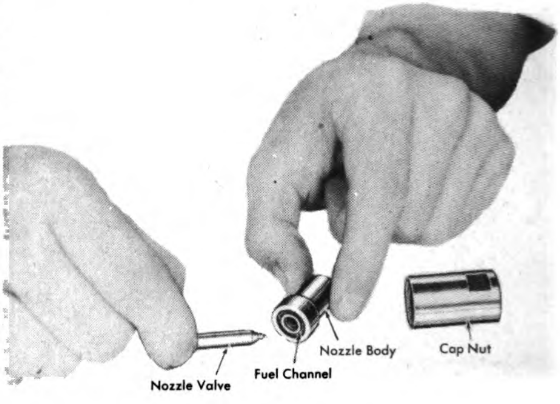


Figure 208A. Valve and Valve Body.

4. The nozzle valve can be cleaned with mutton tallow used on a soft cloth or a soft pad. The valve may be held by its stem in a revolving chuck during this operation. A piece of soft wood well soaked in oil will be helpful in removing the carbon from the valve.

NOTE: HARD OR SHARP TOOLS, EMERY CLOTH, CROCUS CLOTH, GRINDING COMPOUND, OR ABRASIVES OF ANY KIND SHOULD NOT BE USED IN CLEANING THE NOZZLES.

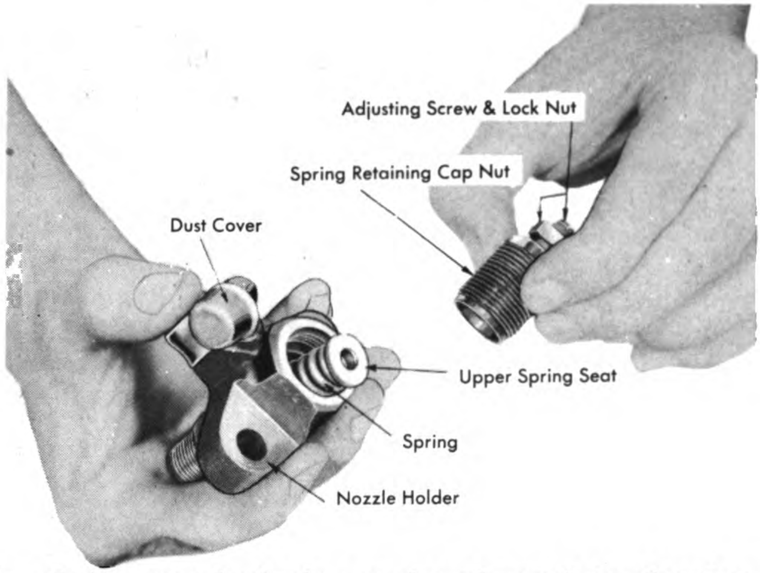


Figure 209. Removing Spring Retaining Nut.

5. The inside of the nozzle body can be cleaned by forming a piece of soft wood, well soaked in oil, the point of which will correspond to the angle of the nozzle valve seat. The orifice of the pintle can be cleaned with a wood splinter.

The outer surfaces of the nozzle body may be cleaned with a soft cloth soaked in the carbon solvent. Do not attempt to scrape carbon from the surfaces around the orifice as serious damage may result.

6. Thoroughly rinse both the valve and the nozzle body in clean fuel oil before reassembly.

61. DISASSEMBLY, CLEANING AND REASSEMBLY OF NOZZLE HOLDER

1. Remove cap nut and gasket.

2. Loosen locknut and spring tension adjusting screw.

3. With a wrench on the flats of the spring retaining nut, remove the retaining nut. See Figure 209.

4. Remove spring and spindle. See Figure 210. Wash the parts thoroughly in fuel oil or gasoline. Examine the small end of the spindle for any irregularities when it contacts the nozzle stem. If the contact surface is pitted or rough, replace the spindle. Check the spring seat for tightness to spindle and cracks or worn spots. Replace if necessary.

To reassemble, reverse the above procedure, leaving the spring adjusting nut loose.

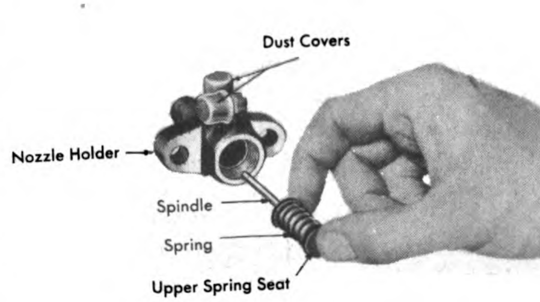


Figure 210. Removing Spring and Spindle.

62. REASSEMBLY OF THE NOZZLE TO HOLDER

1. TThoroughly rinse the lapped end of the nozzle holder shank and the corresponding surface of the nozzle to assure a clean seat between the surfaces.

2. Remove all carbon from the nozzle cap nut before reassembly.

3. It is very essential that the nozzle be perfectly centered in the cap nut, and for this purpose, an assembling sleeve should be used with the nozzle. The sleeve fits over the nozzle and its tapered end centers within the cap nut. After tightening the nut, the sleeve is removed.

4. Install injector in nozzle tester and reset.

63. REASSEMBLY TO THE ENGINE

1. Thoroughly clean the nozzle recess in the cylinder head before reinserting the nozzle holder assembly. Particular attention should be paid to the seating surfaces in order that no small particles of carbon will cause the assembly to be cocked or permit blow-by of the combustion gases. No hard or sharp tools should be used for this cleaning operation. A round piece of wood or brass properly shaped is very effective.

2. Always install new injector gaskets. It is essential that there are no carbon flakes on the surfaces which the gasket seals.

3. The assembly should be carefully inserted so that the nozzle tip does not strike against the recess wall.

4. The assembly securing nuts should be tightened evenly in order that there will be no cocking of the unit.

5. Connect the high pressure lines and leak-off lines. Make sure that they are securely tightened.

GOVERNOR

64. FUNCTIONAL DESCRIPTION

The governor is mounted directly onto the fuel pump and drives from the main pump shaft. See Figure 199. The governor throttle lever is connected to the fuel metering rack by means of an adjustable linkage incorporating a smoke stop.

The regulation characteristics are obtained by means of a balancing centrifugal weight force with a helical extension spring. The engine R.P.M. is set by the means of spring adjustment screw. The sensitivity of regulation is adjustable by varying the effective distance of the spring from the rocker shaft. Instructions for adjusting the speed and for generator synchronization are given in paragraph 65, and in paragraph 66 instructions for adjusting the smoke stop are given.

The governor is manually lubricated by filling the governor case to the oil level plug in the bottom of the body with a good grade of engine oil. See Figure 199. The internal parts are lubricated by splash from the governor gears and from the rotating flyweights.

65. ADJUSTING GOVERNOR SPEED

Load the engine to 30 K. W. Set the governor to 1800 R.P.M. by adjusting the speed adjusting screw shown in Figure 321. Remove the load by moving circuit breaker to "Off" position. The no-load speed indicated on the tachometer should be 1845. If not, remove the lid assembly and turn the surge adjusting screw 1-1/2 turns to the right (in) if the speed is over 1845, and out (left) if under 1845. See Figure 211. Again apply load and set the speed to 1800 R.P.M. as shown in Figure 321. Again disconnect load and check tachometer for 1845 R.P.M. **NOTE:** It may be necessary to repeat the foregoing procedure several times to obtain exact speed which is necessary for parallel operation. Install the lid.

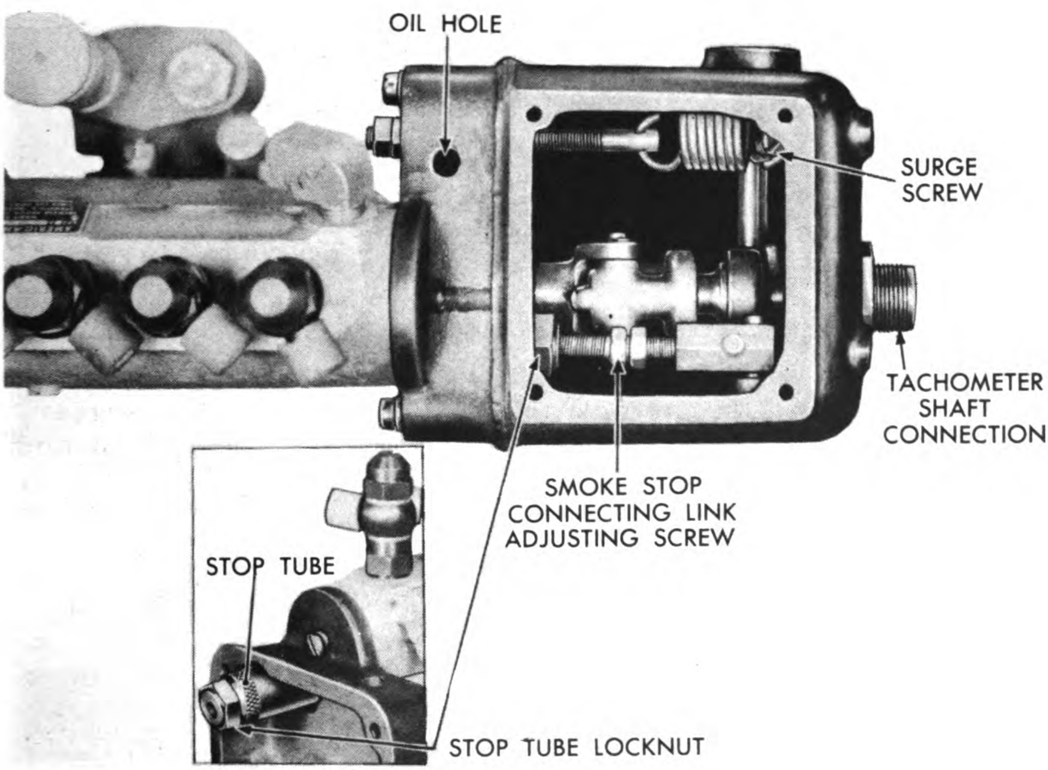


Figure 211. Governor Top View, Showing Smoke Stop and Surge Screw.

66. ADJUSTING SMOKE STOP

Load the generator to 36 K. W. at 1800 R.P.M. Loosen locknut. Turn the stop tube shown in Figure 211 so the rack is forced out. Turn the stop tube until the engine just begins to slow down. Tighten the locknut and replace lid.

67. STEPS OF DISASSEMBLY OF THE GOVERNOR

1. Remove the governor housing from the governor end plate by removing the speed adjusting nuts and the six capscrews. After the governor housing has been removed from the governor housing end plate, remove the governor lid assembly by removing the four lid screws and remove the tachometer shaft coupling, as shown in Figure 212.

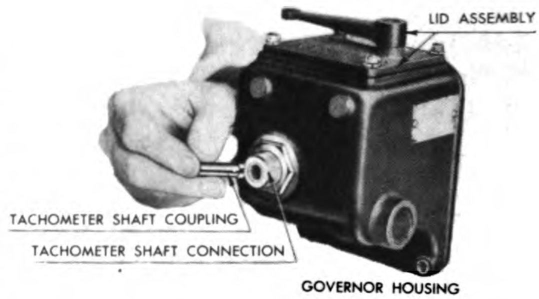


Figure 212. Removing Tachometer Shaft Coupling.

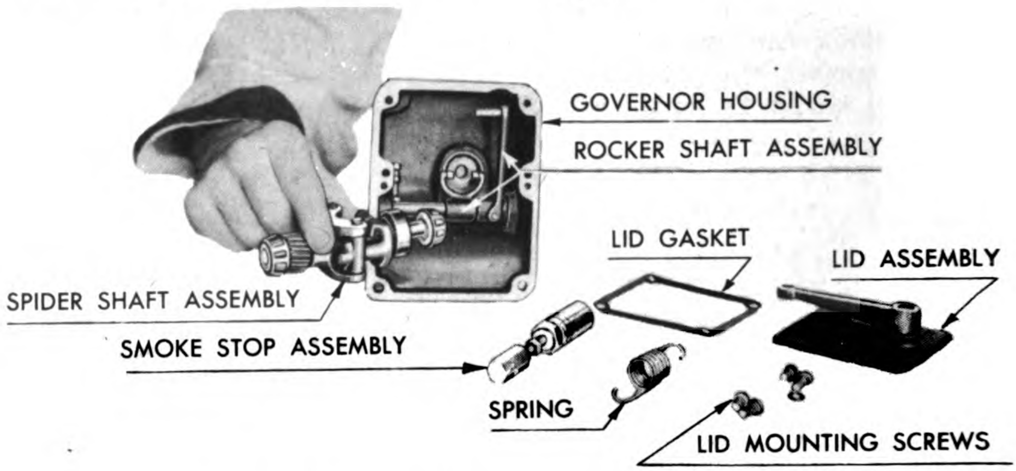


Figure 213. Removing Spider Shaft Assembly.

2. Remove the weight shaft and balance assembly, as shown in Figure 213, after having removed the governor drive gear. **NOTE:** The cone for the end plate bearing is pressed in and cannot be removed.

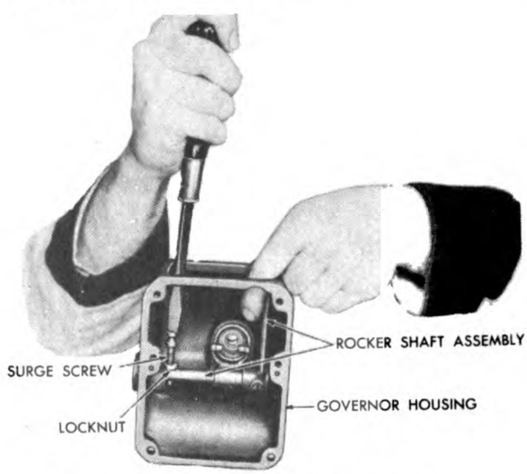


Figure 214. Removing Surge Screw from Rocker Shaft.

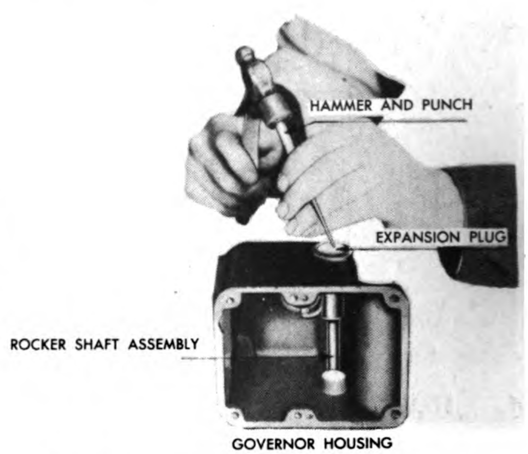


Figure 215. Removing Expansion Plug (Welch Plug).

3. Remove the spring and surge bolt, shown in Figure 214.

4. Knock out the welch, or expansion, plug at the end of the rocker shaft in the governor housing, as shown in Figure 215.

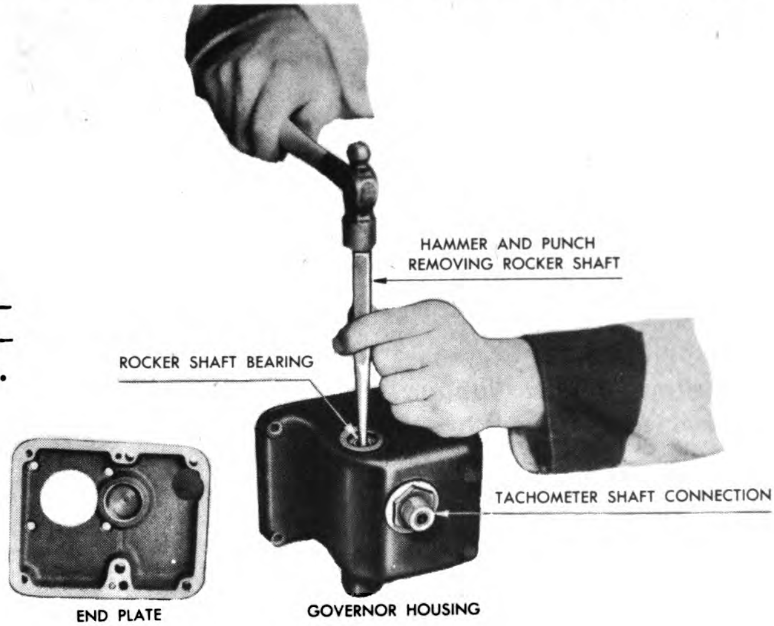


Figure 216. Removing Governor Rocker Shaft Assembly.

5. Drive out the throttle lever yoke and shaft assembly with a hammer and punch, shown in Figure 216. If necessary to replace this, install an entire assembly as these parts are carefully spaced and adjusted for angularity at the factory. Remove the rocker shaft and rocker shaft bearing from the housing shown in Figure 217.

6. Remove the tachometer shaft connection and nut, the bearing adjusting spring and the floating outer race shown in Figure 218.

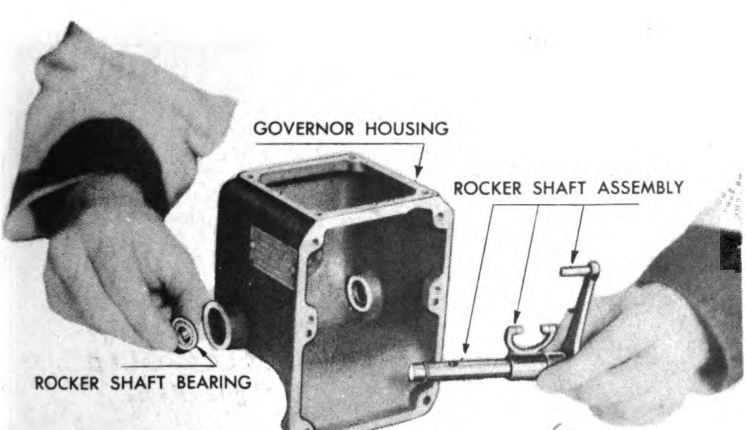


Figure 217. Removing Governor Rocker Shaft.

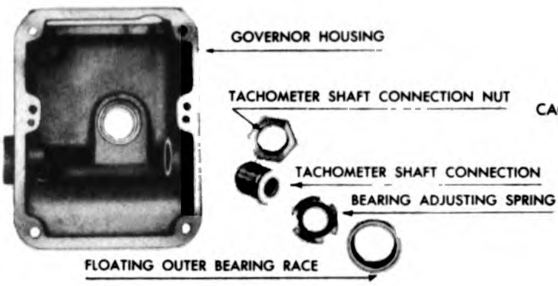


Figure 218. Governor Housing and Tachometer Shaft Connection.

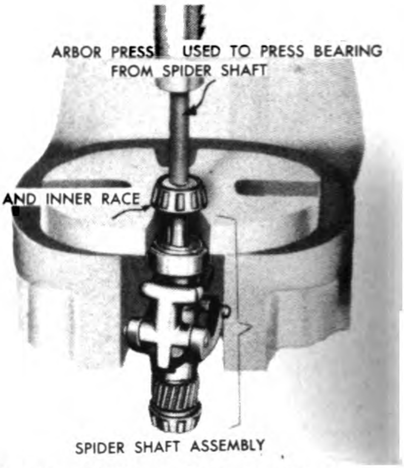


Figure 219. Pressing bearing from spider shaft.

7. Press off the tapered roller bearing with an arbor press as shown in Figure 219.

8. Remove the clip from the weight pin to remove the spider and shaft as shown in Figure 220.

NOTE: Do not attempt to disassemble the balance of spider shaft. If additional parts are needed, it is advisable to replace the complete shaft unit.

9. Remove the smoke tube locknut and smoke tube and push the link pin from the stop link.

10. It is not necessary to remove the end plate unless the governor or fuel pump is to be replaced. If necessary to remove the end plate, unscrew the five mounting screws, shown in Figure 221.

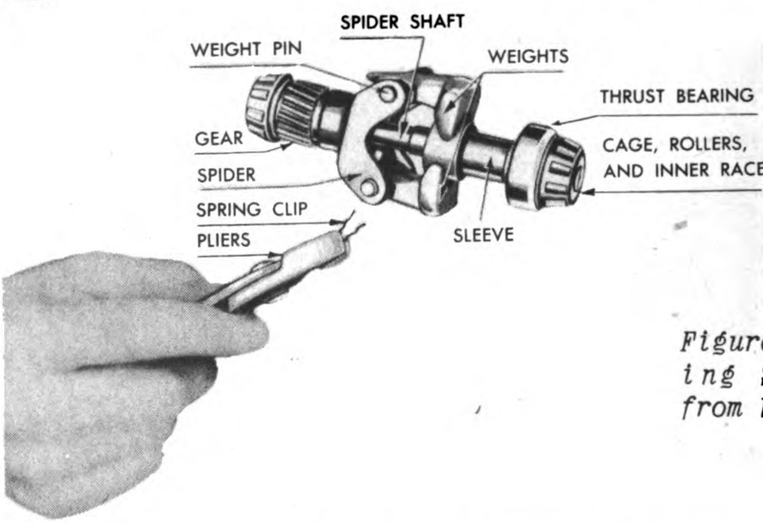


Figure 220. Removing Spring Clip from Weight Pin.

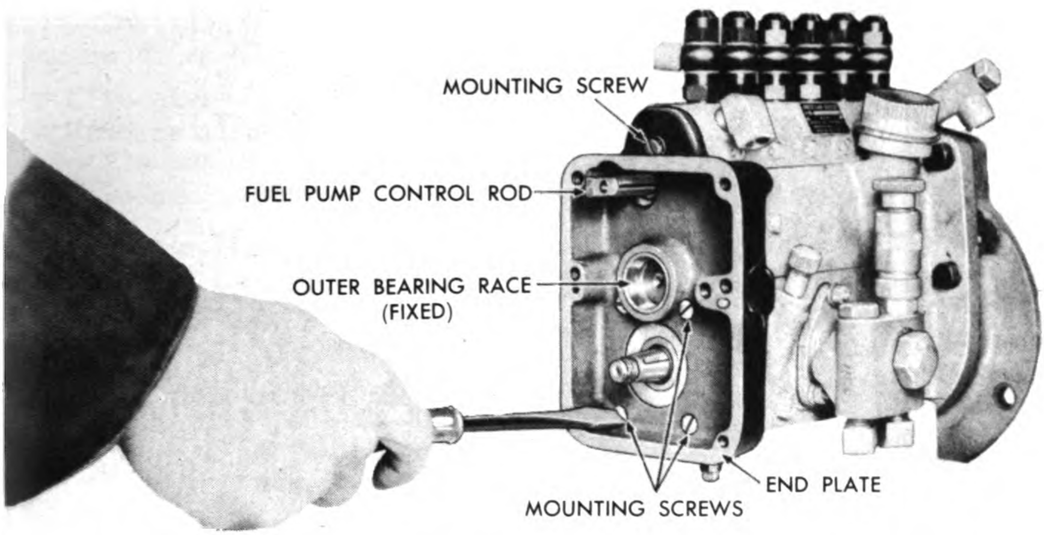


Figure 221. Installing Governor End Plate to Fuel Pump.

68. INSPECTION AND REPLACEMENT OF GOVERNOR PARTS

1. Replace all gaskets and welch plugs.

2. Examine the bearing for any sign of pits, wear, or roughness. Replace,if either of the foregoing conditions exists on the roller bearing against the drive gear.

3. Examine the weight pins for excessive wear; if worn, replace the weights and pins in pairs.

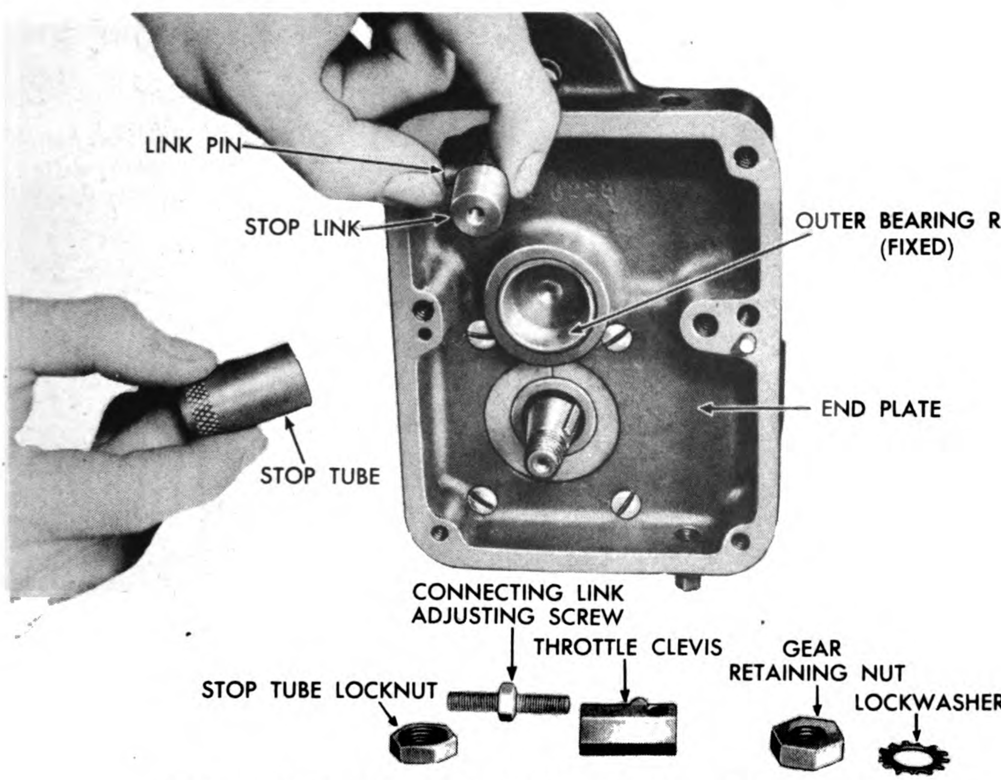


Figure 222. Assembling Stop Link and Stop Tube.

4. Examine the gears for undue wear. If worn, replace the drive gear and spider shaft assembly.

5. Examine the rocker shaft assembly for looseness of the parts in the shaft. If worn, replace the rocker shaft assembly.

69. REASSEMBLY OF THE GOVERNOR

1. If end plate was removed, shellac and install a new gasket between the pump housing and governor housing end plate, and install end plate as shown in Figure 221. With a punch, stake the four counter-sunk mounting screws.

2. Install the smoke stop as shown in Figure 222. No adjustment can be made at the present time.

3. Install spider shaft assembly and governor drive gear together, as shown in Figure 223.

4. Install the connecting link adjusting screw and throttle clevis shown in Figure 211 and 222. Adjust the screw so that the throttle clevis when pulled back by hand pulls the fuel pump rack completely out. (Shut off position.) Lock the adjusting nut.

5. Install tachometer shaft connection and nut, bearing adjusting spring, and race shown in Figure 218.

6. Set the rocker shaft assembly in place and press rocker shaft bearings in place as shown in Figure 224. Screw the surge screw into the rocker shaft. No adjustment can be made at present time. Install the expansion plugs.

7. Set the speed adjusting screw, with spring attached, in place and install the governor housing. Be careful to get throttle clevis on rocker shaft lever pin.

8. Slip the spring over the surge screw and install the nuts on the outside of the end plate.

Figure 223. Installing Governor Drive Gear and Spider.

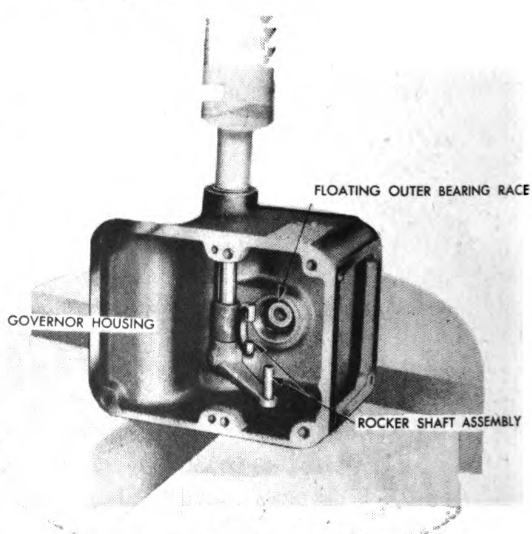


Figure 224. Pressing Rocker Shaft Bearing in Place.

NOTE: Adjustment for speed setting and smoke stop to be made with engine running. See paragraphs 65 and 66.

70. FUEL FILTERS

The engine is equipped with two fuel filters, a primary fuel filter and a secondary fuel filter. See Figure 197. Because fuel oils are less fine than gasoline, they contain more gum, fine abrasives and water. To prevent these from entering the engine and causing trouble, a primary and secondary stage of filtration is employed. Not only should these filters be serviced as recommended, but the fuel line connections should be thoroughly inspected during the overhaul and replaced if there is any evidence that the fuel line is breaking down internally either from age or accident. This internal breakdown would release fine particles into the fuel stream.

71. SERVICING THE PRIMARY FUEL FILTER

Discard the old filter element, thoroughly clean the housing, and install a new filter element.

Every 8 hours of operation, while the engine is still warm, drain the water and sediment from the bottom of the filter by removing the plug. It will be necessary to vent the primary filter by opening the air bleed cock. See Figure 225.

After every 512 hours of operation, drain and clean out the primary filter housing and install a new filter element.

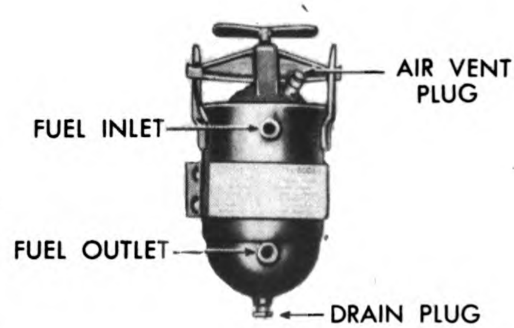


Figure 225. Primary Fuel Filter.

72. SERVICING THE SECONDARY FUEL FILTER

The secondary fuel oil filter is sealed. During the overhaul, it should be replaced with a similar sealed fuel oil filter.

Every 8 hours of operation, unscrew the plug at the bottom to drain out any sludge and water. Replace the plug and unscrew the plug at the top and operate the fuel transfer pump to bleed the air until the fuel oil flows. Replace every 512 hours of operation.

73. AIR CLEANER

As indicated in paragraph 40, the air cleaner is part of the air induction system, however its function is closely related to the fuel system and, therefore, the instructions for servicing the air cleaner is given along with the fuel system components. It is the function of the air cleaner to prevent abrasive dust, which is the chief cause of engine wear, from entering the engine.

See Figure 102. The air cleaner is of the oil bath type. The air is drawn through the filter element before it enters the combustion chamber of the engine.

In order to remove the dirt efficiently, the air cleaner must be properly serviced. The connections between the air cleaner and intake manifold must be kept air tight at all times. Because of normal engine vibration, the clamp should be checked daily, or every 8 hours of operation. The oil cup should be emptied and cleaned and refilled with oil to the oil level bead with engine oil after every 8 hours of operation.

If dust conditions are exceptionally bad, it may be wise to clean the cup and refill with fresh oil every four hours. The felt gasket sealing the oil cup to the intake manifold adaptor should be checked every time the cup is removed for cleaning.

During the overhaul and after every 64 hours of operation, the air filter element and assembly should be soaked in gasoline and blown dry with compressed air. If dirt conditions are exceptionally bad, this servicing should be done every eight hours or oftener.

74. ELECTRICAL SYSTEM

As the Diesel engine is a compression ignition engine needing no spark to ignite the combustible gases, the electrical system for a Diesel is primarily to supply energy for cranking the engine and to operate such electrical controls as the safety stop switch and the solenoid safety shut-off valve. The cranking is done by means of the starting motor which receives its electrical energy from the storage batteries. These batteries are kept charged by a 12 volt generator in combination with the voltage regulator which automatically decreases or increases the rate of current flowing to the batteries depending upon the state of charge. See Wiring Diagram, Figure 226.

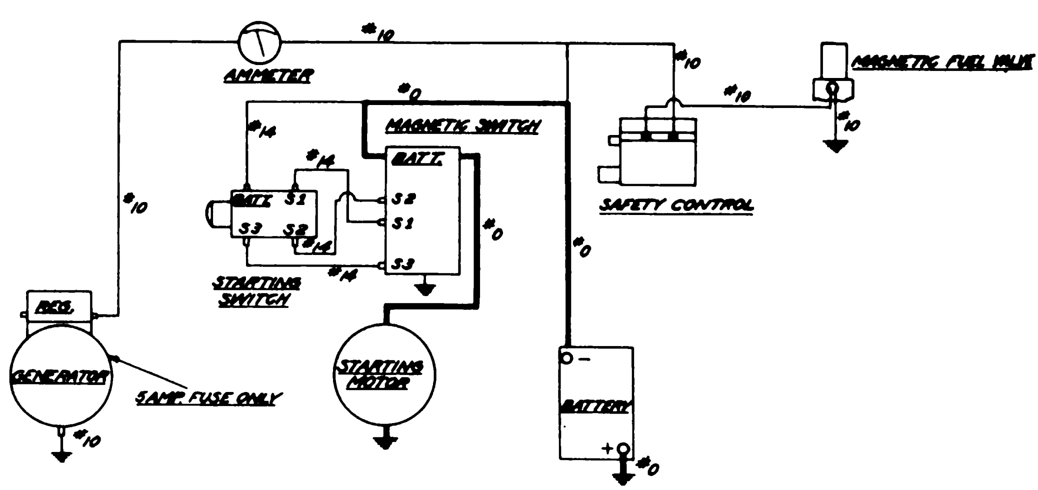


Figure 226. Wiring Diagram (Engine).

The safety control is automatically controlled by the lubricating oil pressure and by the heat of the water in the cooling system. If the oil pressure drops below seven pounds, or if the water temperature exceeds 205° F., the electrically operated safety control will automatically shut off the engine by shutting off the flow of the fuel through the solenoid valve, thus stopping the fuel from entering the fuel injection pump.

75. GENERATOR

The battery charging generator is a device for changing mechanical energy into electrical energy which is stored in the battery for starting the engine and operating such other engine accessories as are electrically operated. See Figure 227.

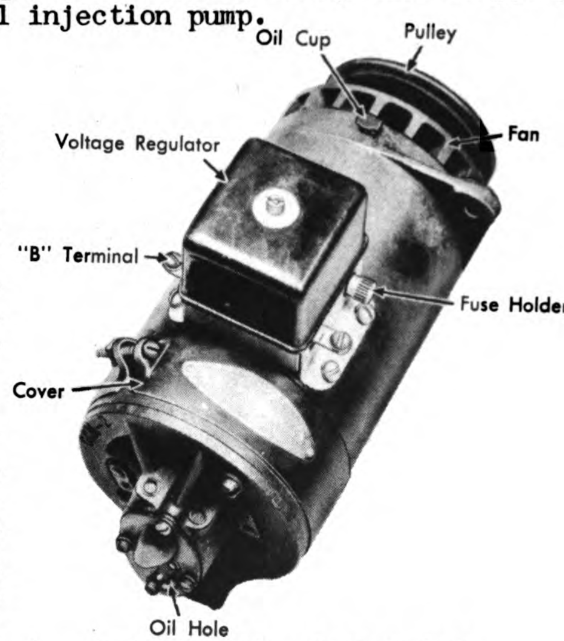


Figure 227. Generator (Auto Lite).

Mounted on the generator frame is a combination circuit breaker and voltage regulator. The circuit breaker is an automatic switch that closes and opens the circuit between the generator and the storage battery. It consists of an electromagnet and a set of contacts. When the generator is not running, the contacts are open. When the generator is started, the contacts are automatically closed to connect the generator to the battery. When the engine is stopped or the generator loses speed, the voltage falls; and as soon as the generator voltage drops below the battery terminal voltage, the contacts automatically open, thus preventing the battery from discharging back through the generator.

The voltage regulator reduces the generator output when the maximum is not needed, thus preventing high voltage and overcharged batteries. When the battery is in a low charged state, the regulator automatically increases the generator output to its maximum, and when the battery reaches a high state of charge, the regulator automatically decreases the rate of charge.

76. SERVICING THE GENERATOR

There are three regular servicings which the maintenance repair personnel should give the generator. They are the 128 hour general inspection, 256 hour tune-up and the 512 hour overhaul.

77. 128 HOUR GENERAL INSPECTION

A. Remove the head band and inspect the commutator. If the commutator is dirty or discolored, it can be cleaned by holding a piece of 00 or 000 sandpaper against it while turning the armature slowly. Blow the sand out of the generator after cleaning the commutator. See Figure 228. If the commutator is rough or worn, the generator should be removed and completely overhauled. See paragraph 82.

B. Inspect the brushes and brush holders. The brushes should slide freely in their holders and should be perfectly in line with the commutator segments. If the brushes do not slide freely, are out of alignment, oil soaked, or worn to less than one-half of their original length, the generator should be removed for a tune-up inspection given in paragraph 78.

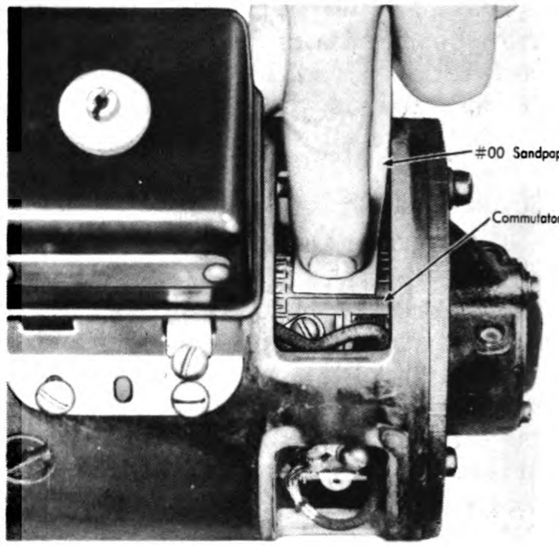


Figure 228. Cleaning Commutator.

C. Inspect all the wiring from the generator to the regulator, and from the regulator to the battery, and from the battery to the ground for worn or frayed insulation, broken wires, and for loose or corroded connections. Repair or replace the defective wiring.

D. Run the generator at maximum output (approximately 1800 R.P.M.) and note the commutator action. If there is excessive arcing between the brushes and commutator, remove the generator for the tune-up inspection according to paragraph 78. Inspect the regulator. Check the wiring as indicated in "C.", paragraph 77.

E. Start the engine and note the ammeter action. Slowly increase the engine speed. The ammeter should show a gradually increasing charge, and if the battery is fully charged, the charging rate will drop back when the output approaches its maximum. If the battery is not fully charged, the generator will continue to charge at its maximum rate. If the regulator does not operate in this manner, it should be given a tune-up inspection as given in paragraph 80.

F. The drive end ball bearings of the generator should be given three to five drops of medium engine oil in the hinged top oiler at the top of the end head. Fill the commutator end oil pocket with medium engine oil in the combination oiler in the commutator end cap cover.

78. 256 HOUR TUNE-UP

A. Remove the generator from the engine and take off the head band.

B. Inspect the commutator and if it is dirty or discolored, clean it by holding a piece of 00 or 000 sandpaper against the commutator while turning the armature by hand. Blow the sand out of the generator after cleaning the commutator. If the commutator is rough or worn, the generator should be disassembled and completely overhauled according to paragraph 82.

C. Inspect the brushes. Each should slide freely and should be free from oil and dirt. Brushes that are oil soaked or are worn to less than one-half their original length should be replaced.

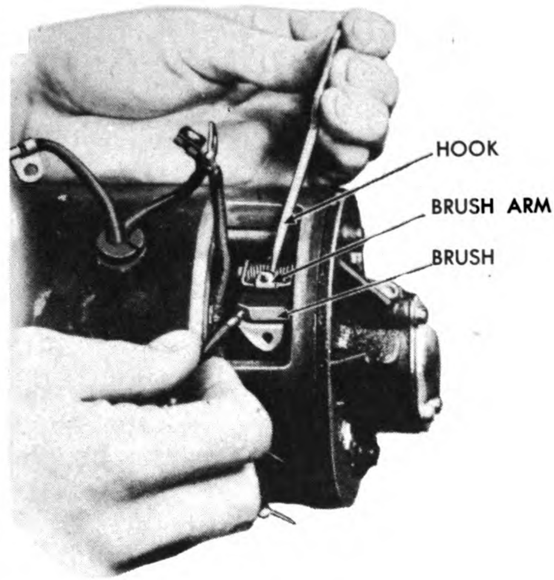


Figure 229. Removing Brush.

D. To remove the brushes, lift the brush arm as shown in Figure 229, and disconnect the brush leads as illustrated in Figure 230. When installing brushes make sure that the brushes are assembled so that the beveled face of the brush fits the commutator. Check the alignment, to make sure that the brush edge is parallel with the commutator segments. If the alignment is off, or if the brushes do not slide freely, the commutator end plate should be disassembled and inspected as described in paragraph 85.

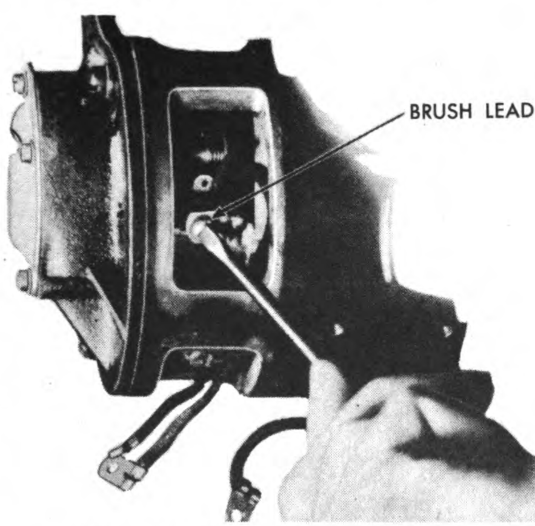


Figure 230. Disconnecting Brush Leads.

E. After new brushes are installed, they should be sanded to make sure of the proper fit on the commutator. To sand the brushes, cut a strip of 00 or 000 sandpaper to the exact width of the commutator. Slip this strip under a brush. With the abrasive side against the brush and the brush at its proper spring tension, draw the sandpaper following the contour of the commutator and make certain that the entire face of the brush is being ground. Do not grind excessively and be careful not to break the edge of the brushes. See Figure 231.

F. Check the brush spring tension. Hook a spring scale under the third brush arm near the end or in the hole in the lip of the main brush arms and pull on a line parallel to the face of the brush. Take the reading just as the arm leaves the brush.

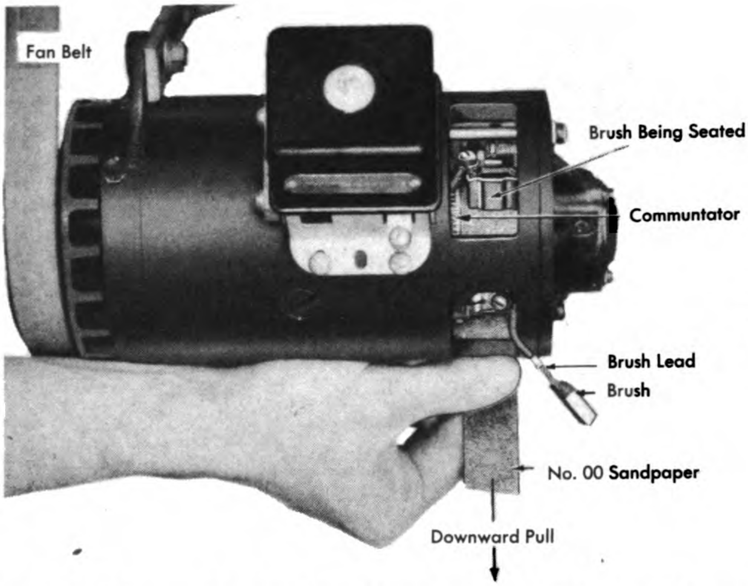


Figure 231. Seating brush.

The main brush spring tension should be 53 ounces, maximum. The third brush spring tension should be 50 to 60 ounces. If the tension is too great, the brushes and the commutator will wear excessively.

79. BATTERY CHARGING GENERATOR BENCH TEST

A. Before subjecting the generator to the bench test, remove the voltage regulator by taking out the regulator mounting screws and disconnecting the regulator leads as shown in Figure 232.

B. Connect an ammeter, battery, and variable resistance in series with a field coil lead and the third brush terminal. Connect a voltmeter from the third brush terminal to the field coil lead. Adjust the voltage to 13.0 volts and read the ammeter which should show 3.23 to 3.57 amperes. If the current is not within these limits, it indicates faulty field coils or connections.

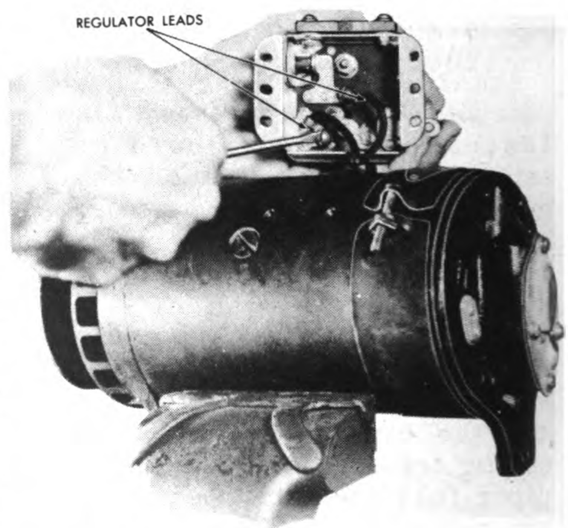


Figure 232. Removing Regulator.

C. Next, connect an ammeter, battery, and variable resistance in series with the armature lead and the generator frame. Ground the field lead to the generator frame and connect a voltmeter from the armature lead to the generator frame. Adjust the voltage at 13.0. The armature should turn slowly, and the ammeter should show 3.89 to 4.31 amperes. If the current is not within these limits, it indicates high resistance connections, worn bearings, or poor brush contact.

(If the following test cannot be done on the test bench, the generator can be mounted on the engine.)

D. Connect the field lead to the ground and connect an ammeter between the armature lead and the battery. Connect a voltmeter from the armature lead to a ground on the generator frame. Operate the generator and increase the speed slowly, noting the maximum charging rate obtained. This charging rate should not be set above the figures given as follows:

14.6 volts, 9.5 to 11.5 amperes, maximum output.
15.0 volts, 10.0 to 12.0 amperes, maximum output.

To adjust the maximum output, advance or retard the third brush by applying pressure to the base of the brush holder.

80. INSPECTING AND ADJUSTING VOLTAGE REGULATOR

NOTE: The regulator should be removed from the generator and the leads disconnected for the following inspection and adjustment.

CAUTION: Tape the battery leads to prevent short circuiting.

A. Remove the regulator cover and inspect the regulator visually for: (1) evidence of burning or abnormal high temperatures at the coils, contacts, insulation, external terminals, or any other point; (2) loose connections resulting from poor soldering; (3) loose nuts on the bottom of the magnet cores; (4) loose nuts and screws, (**NOTE:** All nuts and screws must have lockwashers); (5) broken or altered carbon resistor. Repair or replace any of the items mentioned above that may be faulty.

B. Inspect the contacts. If they are dirty or burned, they can be cleaned with a piece of crocus cloth. See Figure 233. Do not use sandpaper or a file. After cleaning, the contacts should be cleaned, if possible, with refined carbon tetrachloride, to remove any dirt or grease; after which a piece of clean linen tape or hard paper, such as kraft wrapping paper, should be pulled between the contacts to remove any fine lint or dirt.

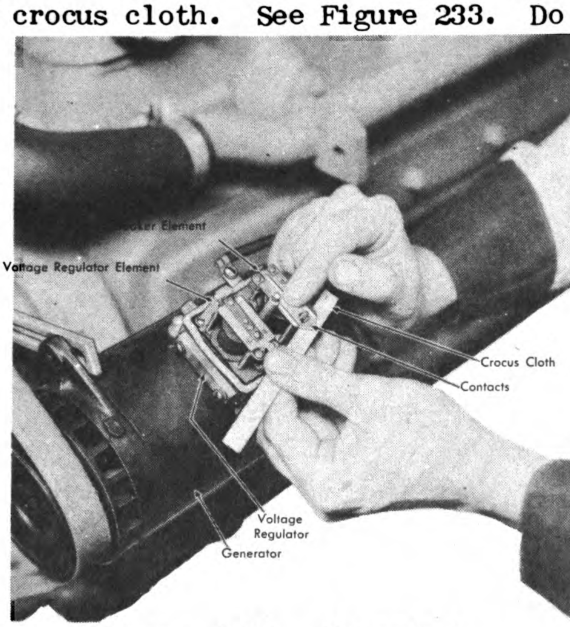


Figure 233. Cleaning Regulator Contacts with Crocus Cloth.

81. TESTING AND ADJUSTING VOLTAGE REGULATOR

A. Connect the voltmeter and a battery so that an accurate control is obtained of the voltage applied between the armature terminal and the base of the regulator. Connect a lamp bulb in series between the battery terminal of the regulator and the regulator base. Connect the voltmeter from the armature terminal to the base. Increase the voltage from "0" and note the voltage at which the circuit breaker contacts close, which will be indicated by the lighting of the lamp. This voltage reading should be between 13.0 and 14.5 volts.

B. Adjust the closing voltage by bending the lower spring hanger (F in Figure 234) on the circuit breaker unit. Bending it down increases the spring tension, and bending it up decreases the spring tension.

C. The contact open specifications under various temperature conditions are as follows:

Temp. F.	50°	60°	70°	80°	90°	100°	110°
Volts	17.30	17.14	17.00	16.86	16.70	16.56	16.43

Reduce the voltage and check the contact closing voltage as indicated by the lighting of the lamp. This voltage should be 2.4 to 2.8 volts below the reading obtained for the contact opening. Adjust by turning the brass cam (E in Figure 234) on the contact side of the voltage regulator yoke. This changes the contact gap (C in Figure 234) which must not be less than .005" after the adjustments are completed. When the regulator is correctly adjusted, apply a drop of air drying varnish to the cam to prevent slipping. Replace the regulator covers and reassemble the regulator on the generator.

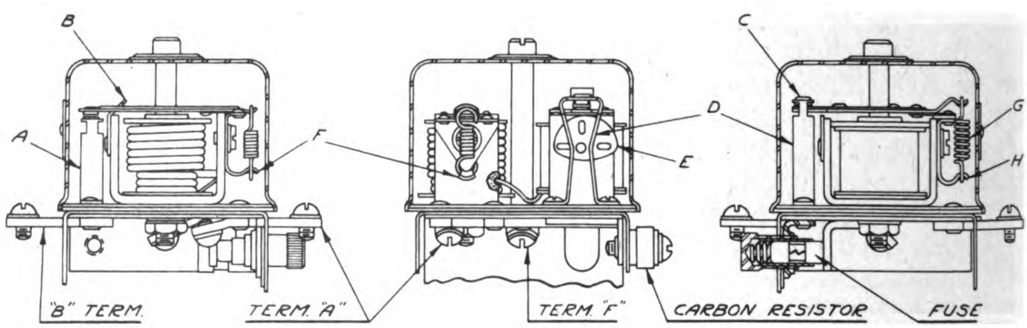


Figure 234. Voltage Regulator.

82. 512 HOUR OVERHAUL

It will be necessary, for the overhaul, to remove the generator from the engine by disconnecting the battery lead from the regulator and removing the mounting bolts. **NOTE:** Tape the battery leads to prevent short circuiting.

Steps of Disassembly

1. Remove the regulator mounting screws and disconnect the regulator leads as shown in Figure 232.

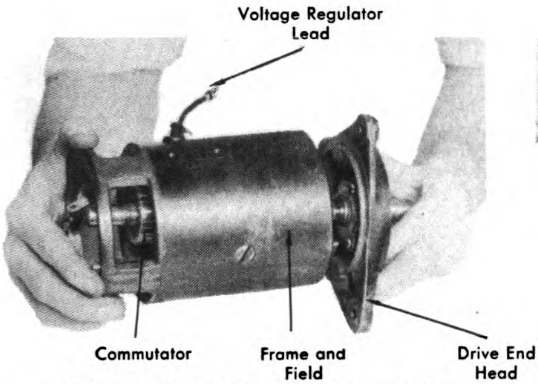


Figure 235. Removing Armature from Generator Frame.

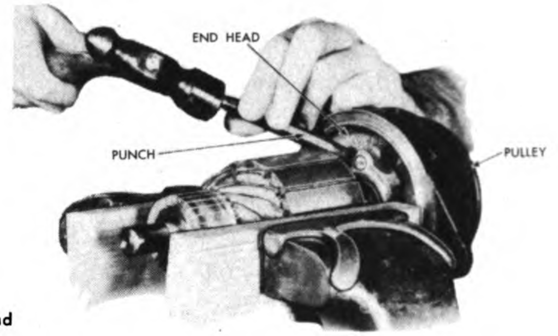


Figure 236. Removing Pulley.

2. Remove the nut and lockwasher from the armature shaft.

3. Remove the generator head band.

4. Disconnect the lead at the third brush and the insulated main brush as shown in Figure 230. Lift the brushes off the commutator as illustrated in Figure 229.

5. Remove the two frame screws at the commutator end. Slide the commutator end head off the generator.

6. Pull the armature, the drive end head, and the pulley from the generator. See Figure 235.

7. Remove the pulley from the armature shaft with a puller or by tapping, as shown in Figure 236. Press the armature shaft out of the end head with an arbor press as illustrated in Figure 237.

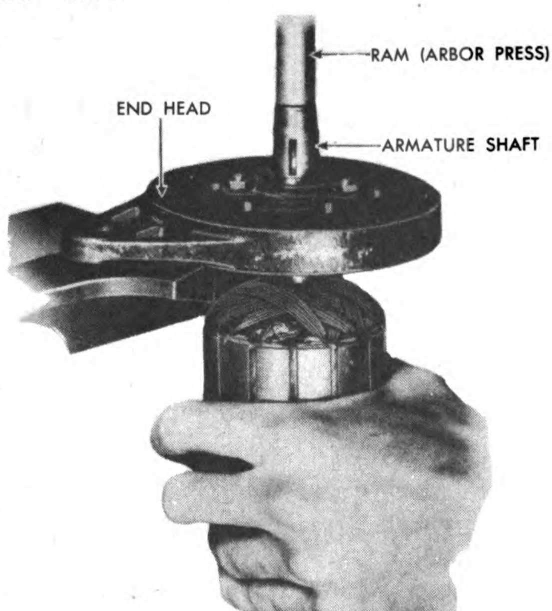


Figure 237. Pressing Armature Shaft from Drive End Head.

83. INSPECTING THE ARMATURE

1. Inspect the armature and commutator for evidences of wear. Inspect the insulation and the soldering to make sure that all coils are in proper working order. Check the armature for grounds with a set of test probes consisting of a lamp in series with two points and connected to a source of electricity. Touch one probe to the armature shaft (not on the bearing surface) and touch the other probe to each commutator segment, as shown in Figure 238. Do not touch the brush surfaces of the commutator as an arc would mar the

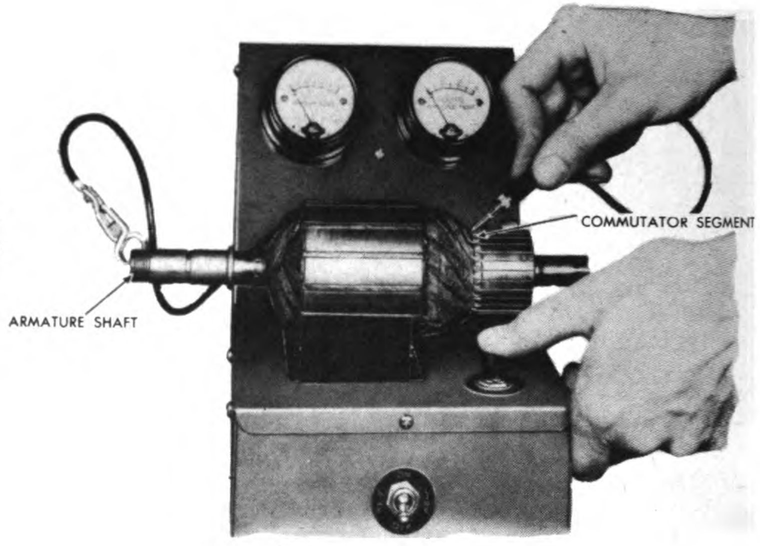


Figure 238. Testing Armature for Grounds.

smooth finish. If an armature coil or commutator segment is grounded, the lamp will light. If the ground is accessible, it should be repaired, otherwise replace a grounded armature.

2. Check the armature for shorts on a growler as illustrated in Figure 239. Replace the armature if it is found to be shorted. Check for opens by touching the test probes to the core of the shaft and each segment. If the lamp fails to light, the coil is open and the armature should be replaced.

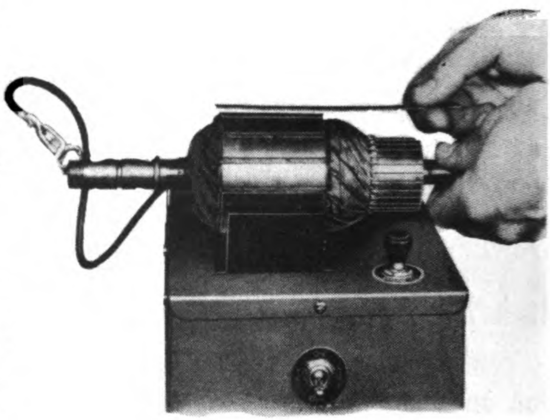


Figure 239. Testing Armature on Growler for Short.

3. If the commutator is rough or worn, it should be turned down in a lathe. Mount the armature on the bearing seats and not on the shaft centers. Take only a light cut and remove all burrs. Undercut the mica to a depth of 1/32" after turning the commutator. The undercut should be square and free from burrs. The maximum eccentricity of the commutator is not to exceed .003".

84. INSPECTING THE FRAME AND THE FIELD

1. Inspect the insulation on the field coils and leads and replace any faulty parts. Inspect the leads and terminal posts for broken wires, frayed insulation or poorly soldered terminals.

2. With test probes check the field coils for grounds and opens. Touch one probe to the field lead and touch the other to an unpainted ground on the frame as shown in Figure 240. If the field coils or the lead is grounded, the lamp will light. Touch one probe to the field lead and tough the other to the third brush lead as illustrated in Figure 241. If the coils or leads are open, the lamp will not light.

Figure 240. Testing Field Coils for Grounds.

3. If it is necessary to replace a field coil, remove the pole piece screws. Assemble the new coils on the pole pieces and tighten securely with pole piece screws that have been dipped in boiled linseed oil. As the screws are tightened, the frame should be struck with a raw hide mallet a few times to settle properly and to align the pole pieces.

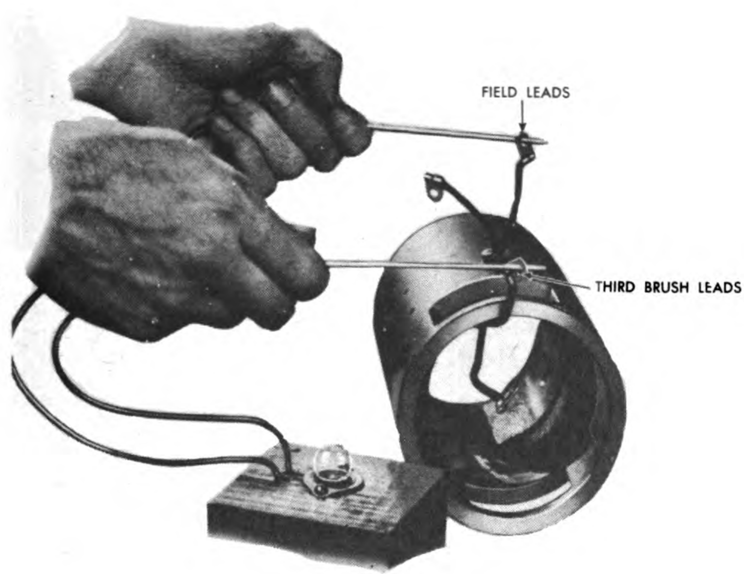


Figure 241. Testing Coils for Opens.

85. INSPECTING COMMUTATOR END HEAD

1. Disassemble the cap cover and oil retainers and take out the felt wick. Remove the third brush plate and brushes and clean both plates thoroughly. With the test probes, check the in-

sulated brush holders for grounds. See Figure 242. Inspect the brush arm and holder to see that they are not bent or corroded. Clean the bearings thoroughly and inspect for wear. Soak the bearing and oil wick in engine oil and assemble the oil retainer and gasket. **NOTE:** Do not assemble the oil wick until after the head and armature have been assembled on the generator.

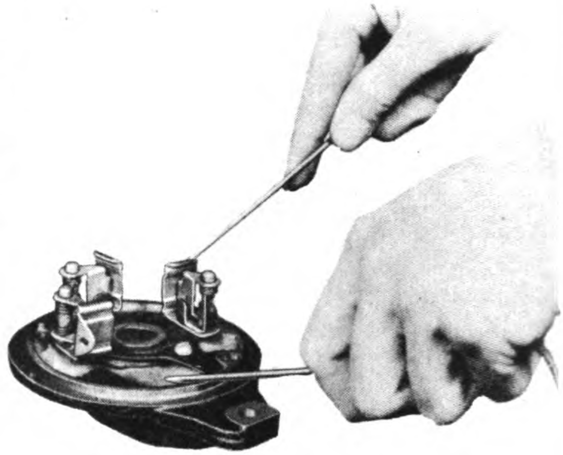


Figure 242. Testing Holders for Grounds.

86. INSPECTING DRIVE END HEAD

1. Disassemble and clean the bearings and retainers. Inspect each part for wear or failures, and replace any faulty part. Pack the bearing one-half full with a high melting point grease, and reassemble the drive end head. The felt washer should be soaked in oil before reassembling the head.

87. STEPS OF REASSEMBLY OF THE BATTERY CHARGING GENERATOR

1. Assemble the armature in the drive end head with an arbor press as shown in Figure 243. Make sure the snap ring on the shaft fits down tightly against the bearing.

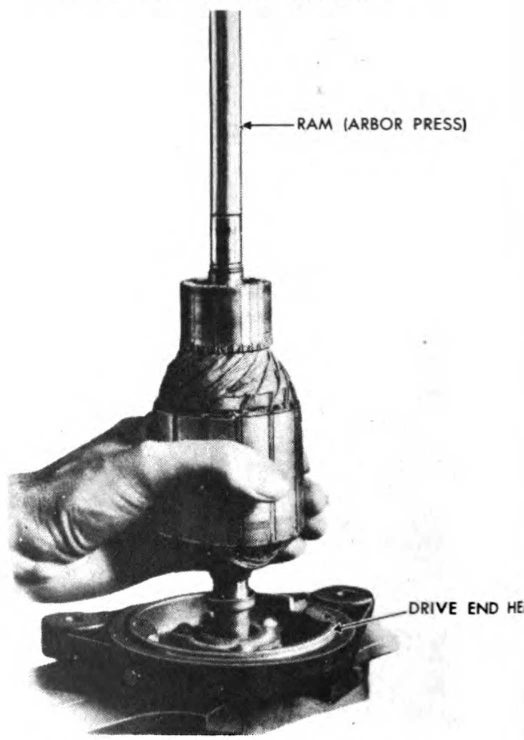


Figure 243. Pressing Armature into Drive End Head.

2. Assemble the drive end head and armature on the frame and field, making sure that the dowel pin is in place.

3. Assemble the commutator end head on the frame and field, making sure the dowel pin is in place.

4. Assemble and tighten the frame screws. Be sure that the frame screw is under the field connection insulation. See Figure 244.

5. Assemble the brushes in their holders and connect the brush leads. Make sure that the brushes are assembled so that the beveled face fits the commutator. If the brushes needed re-

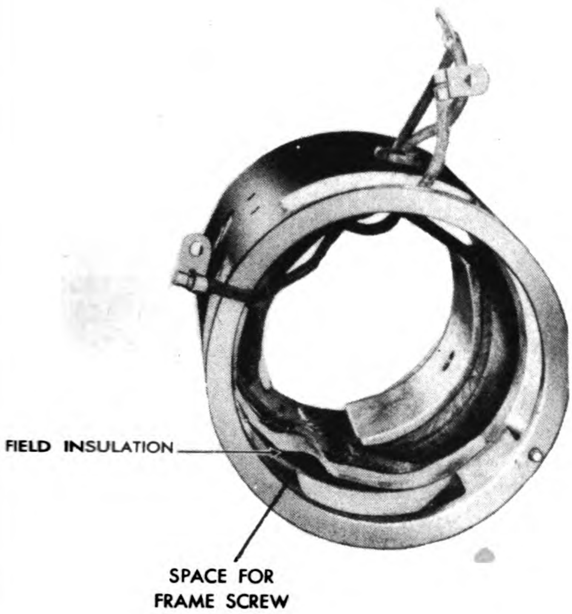


Figure 244. Frame Screw under Field Insulation.

Figure 245. Felt Wick in Commutator End Head.

placing, they should have been sanded according to the instructions given in paragraph 78, step E.

6. Assemble the felt wick in the commutator end head. See Figure 245 for proper position after assembly.

7. Add five to 10 drops of oil to the drive end oiler and fill the commutator and oil pocket to the combination oiler and overflow hole.

8. Test and adjust the generator according to paragraph 79. The voltage regulator should be subjected to the tests given in paragraph 81.

88. VOLTAGE REGULATOR RESISTANCE TESTS

Besides the tests already given for the voltage regulator in paragraph 81, the following regulator tests should be included during the generator overhaul period.

89. RESISTANCE TESTS

Remove the carbon resister and check its resistance on an ohmmeter. If it is not between 2.75 and 2.85 ohms, replace the resistor.

Measure the resistance from the "A" terminal to the regulator base. Replace the regulator if this resistance is not between 53 and 59 ohms.

90. ARMATURE AIR GAP TESTS

1. Circuit breaker unit - .010" to .030".

This gap is measured with the contacts closed and is adjusted by raising or lowering the stationary contact "A" in Figure 234. Keep the contacts aligned.

2. Voltage regulator unit - .045" to + .001".

This gap is measured with the regulator contacts closed. It can be adjusted by raising or lowering the upper contact "C" in Figure 234, by expanding or contracting the bridge "D" holding the upper contact.

91. ADJUSTING CONTACT POINT GAP

1. Circuit breaker unit - .015" to .045".

Adjust by bending the armature stop in Figure 234.

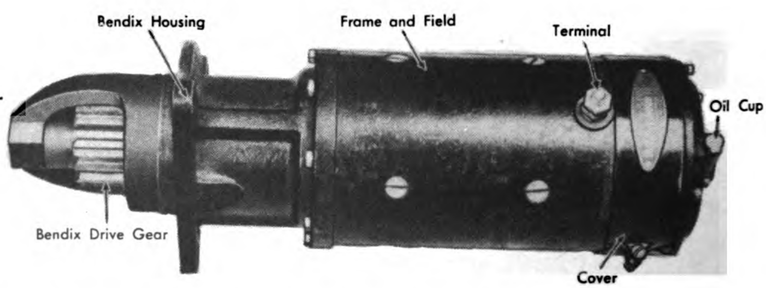
2. Voltage regulator unit - .005" minimum.

Adjust by turning the brass cam E in Figure 234.

92. STARTING MOTOR

The starting motor is designed to crank the engine when the starting switch closes the circuit between the storage battery and the motor. See Figure 246. It consists of five main sub-

Figure 246. Starting Motor.



assemblies, which are: the frame and field, the armature, the commutator end head, the pinion housing, and the Bendix drive.

There are three servicings which the maintenance personnel must give the starting motor. These servicings are the 128 hours of operation check, the 256 hours of operation tune-up, and the 512 hours of operation overhaul.

93. CHECKING STARTING MOTOR EVERY 128 HOURS OF OPERATION

A. Remove the head band and inspect the commutator. If the commutator is dirty or discolored, it can be cleaned by holding a piece of #00 or 000 sandpaper against it while turning the armature slowly. Blow the sand out of the motor after cleaning the commutator. If the commutator is rough or worn, the motor should be removed from the engine for an overhaul.

B. Inspect the brushes. The brushes should slide freely in their holders and make full contact on the commutator. Make sure that the brushes are perfectly in line with the commutator segments. If brush holders need repair or if the brushes are worn to less than one-half their original length, the motor should be removed for an overhaul as given in paragraph 100.

C. Inspect the wiring from the battery to the ground and from the battery to the starting switch, and from the switch to the motor for loose or corroded connections and for frayed insulation.

D. Add three to five drops of engine oil to the oiler in the commutator end head.

E. Inspect the push button and starting switch to see that they are firmly mounted and that the leads are properly connected to the terminals. Check the operation of the units and remove them for a tune-up inspection if the operation is not satisfactory.

94. TUNING UP STARTING MOTOR EVERY 256 HOURS OF OPERATION

A. Remove the starting motor from the engine and take off the head band.

B. Inspect the commutator, brushes, and wiring, and add three to five drops of engine oil to the oiler in the commutator end head.

C. Lift the brushes out of the holders as shown in Figure 247.

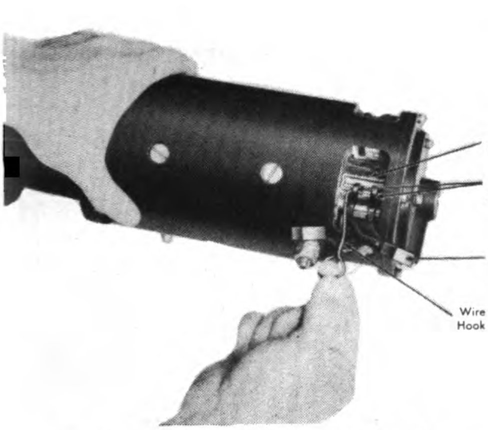


Figure 247. Lifting the Brushes out of the Holder.

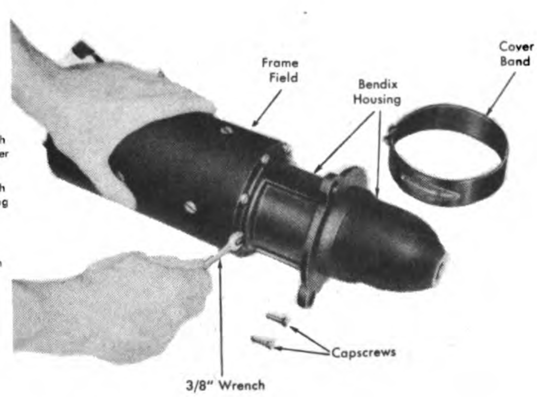


Figure 248. Removing pinion housing screw.

D. Remove the screws holding the pinion housing to the frame and pull the housing and armature off the frame. See Figure 248. Press the armature out of the pinion housing with an arbor press as shown in Figure 249. Loosen the Bendix shaft spring screw as shown in Figure 250 and slide the Bendix off the shaft. See Figure 251.

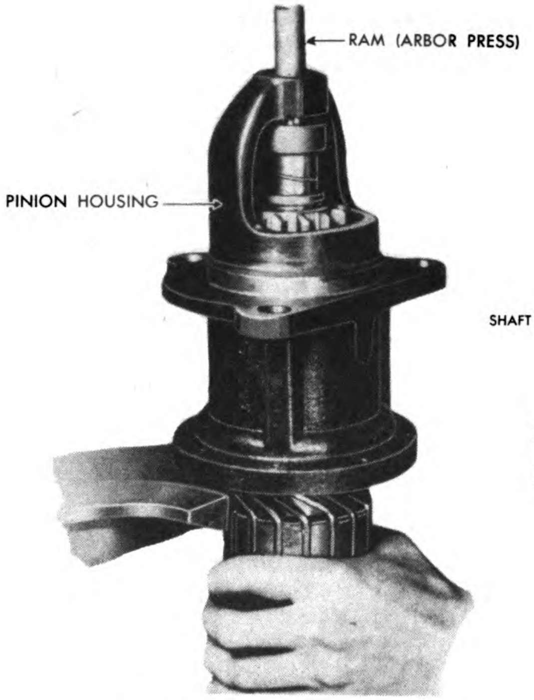


Figure 249. Pressing Armature Shaft Out of Pinion Housing.

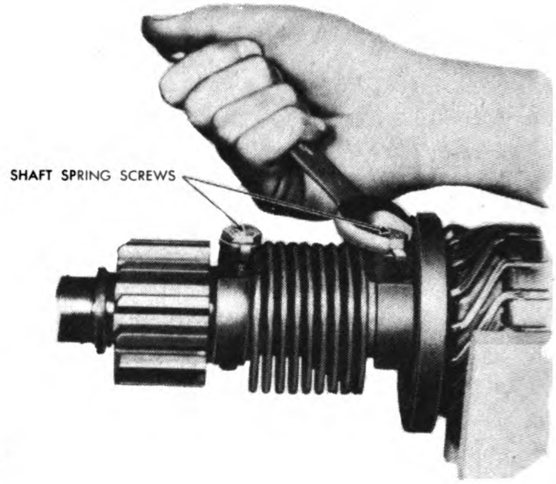


Figure 250. Removing Bendix Shaft Screws.

Clean the Bendix and armature shaft in kerosene and lubricate sparingly with light oil. Inspect the Bendix for worn parts or distorted spring and replace any faulty parts.

E. Assemble the Bendix on the armature shaft making sure the woodruff keys are in place. Tighten the shaft spring screws so that it enters the hole in the armature shaft.

F. Clean the pinion housing and soak the bearings in medium engine oil. Assemble the housing on the motor and fasten to the holding screws. See Figure 248.

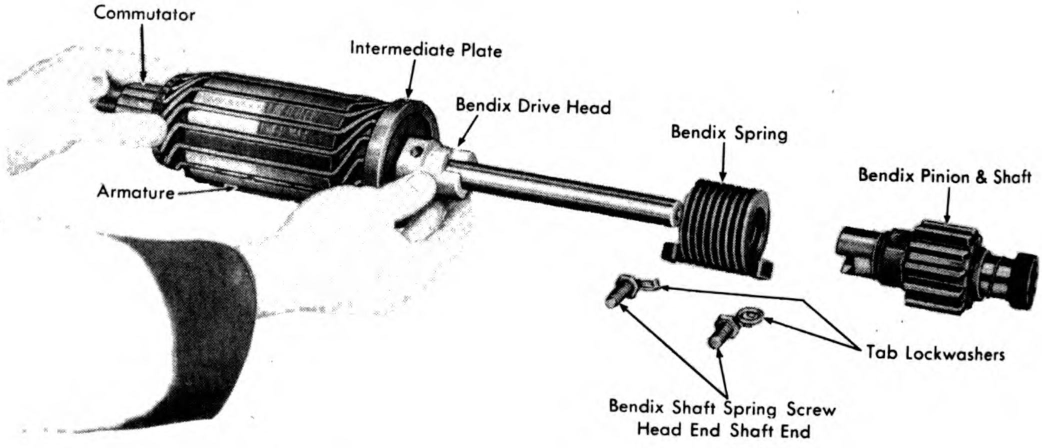


Figure 251. Sliding Bendix off Shaft.

95. STARTING MOTOR NO LOAD TEST

Connect an ammeter, carbon pile rheostat, and battery in series with the motor terminal and the frame. (Starting motor should be removed from the engine for this test.) Connect a voltmeter from the motor terminal to the motor frame. See Figure 252.

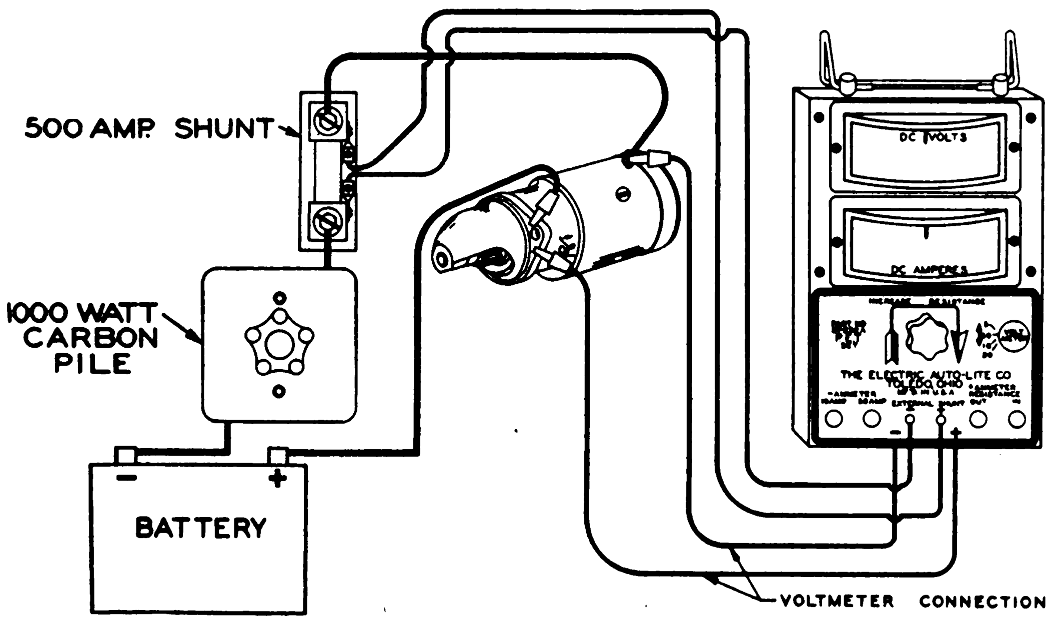


Figure 252. Hook up for No Load and Torque Test.

Adjust the voltage to 11.0 volts and read the ammeter which should not show more than 100 amperes. Hold a tachometer against the drive end of the armature shaft and read the speed while operating at 11.0 volts. The speed should be at least 4000 R.P.M.

If the current is high and the speed low, inspect the bearings for correct alignment and make sure the armature turns freely without interference. If the current is low, inspect the brushes for correct seating on the commutator and inspect the internal connections of the motor for high resistance.

96. STARTING MOTOR LOCK TORQUE TEST

With the motor connected as given in the foregoing paragraph 95, and using a spring scale and torque arm, measure the stalled torque..

Fasten the torque arm securely to the starter motor shaft. The motor should be clamped rigid to a work bench. Hook the spring scale to the torque arm exactly 12" from the center of the motor shaft. With the current flowing through the motor adjust the voltage to 3.0 volts and read the ammeter and spring scale. The current should be 840 amperes maximum and the torque should be more than 29 foot pounds. If the current is high or the torque too low, inspect the motor for high resistance connections, incorrect bearing alignment, and incorrect brush seating.

97. STARTING SWITCH 256 HOUR CHECK

The push button is mounted on the control panel and the magnetic or solenoid switches are contained in the control box. When the push button is depressed, one of the solenoid switches closes immediately and connects the starting motor to the battery through a .0356 ohm resistance. This resistance reduces the large current that would flow through the motor. When the motor begins to revolve, the time delay relay operates and excites the second solenoid switch. When this switch closes the resistance is shorted out and the full battery voltage is applied to the starting motor.

98. INSPECTING STARTING SWITCH

A. Remove the starting switch from the control panel.

B. Take out the terminal studs and remove the cover nuts. The cover will then lift off.

C. Clean the switch and inspect the leads, insulation, and connections for fraying, breaks, or improper and loose connections.

D. Inspect the push button for loose or corroded connections and terminals.

E. Replace the control box cover and assemble the terminal studs.

F. Remount the switch on the panel and connect the leads.

99. CHECKING STARTING SWITCH

With the switch in place on the control panel, connect a voltmeter between the two 3/8" - 16 terminals of the control box. Operate the starter in the normal manner and read the voltmeter. If the voltage reading is larger than .05 volts per 100 amperes, approximately .25 volts during normal starting, the starting switch should be completely overhauled. See paragraphs 110 and 111.

100. 512 HOURS OF OPERATION OVERHAUL

Disconnect the lead from the motor and take out the flange bolts. The motor can then be taken to the bench for an overhaul.

101. DISASSEMBLING STARTING MOTOR

1. Remove the head band.

2. Lift the brushes out of the holder. See Figure 247.

3. Remove the commutator and head holding screws. Take the head off the motor. See Figure 253.

4. Remove the pinion housing and the armature off the frame and field.

5. Press the armature out of the pinion housing with an arbor press as shown in Figure 249.

6. Take off the Bendix shaft spring screw and slide the Bendix assembly off the shaft. See Figure 250.

7. Remove the intermediate plate and thrust washer from the armature shaft. See Figure 254.

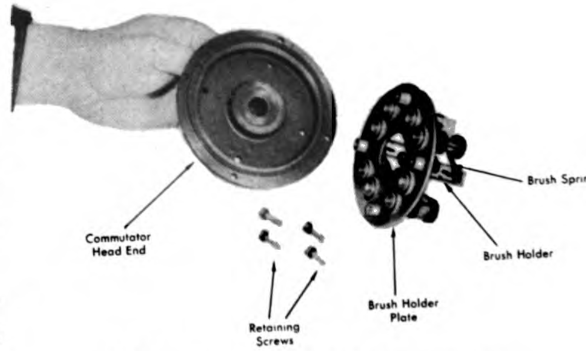


Figure 253. Commutator End Head.

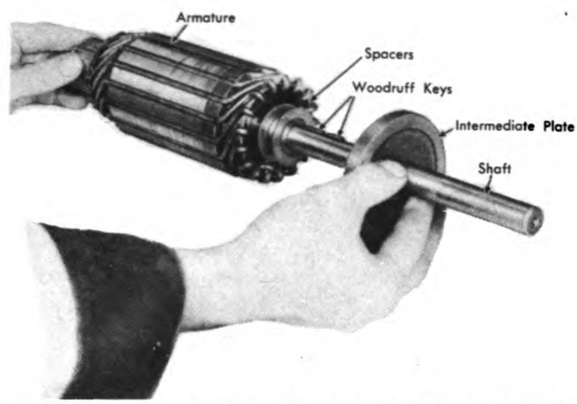


Figure 254. Removing Intermediate plate and thrust washer.

102. INSPECTING THE ARMATURE

1. Inspect the armature and commutator for evidences of wear. Inspect the insulation and soldering to make sure that all coils are in proper working order. Make sure the coils are properly staked to the commutator and core slots. If the shaft or the core is worn, the armature should be replaced. If it is necessary to turn down the commutator in a lathe, take only a light cut with the armature mounted on the bearing seats and not on the shaft centers. Remove all burrs from the commutator and undercut the mica segments clean and square to a depth of 1/32".

2. With test probes, check the armature for grounds. Touch one probe to the shaft and touch each commutator segment in turn with the other probe as illustrated in Figure 255. **NOTE:** Do not touch the probes to the bearing or brush surfaces, as an arc would burn the smooth finish. If a ground is present, the lamp will light. Check the armature for shorts on a growler, as shown in Figure 256. Place the armature on the growler and hold a steel

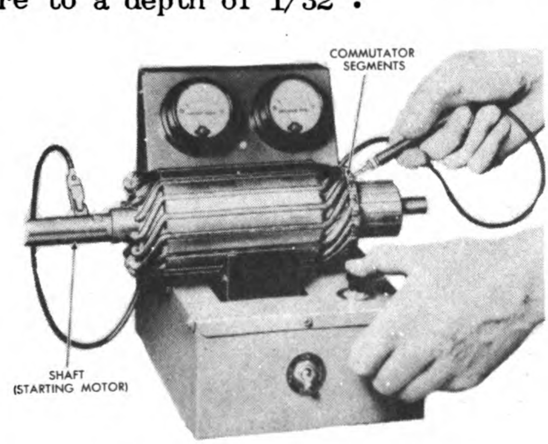


Figure 255. Testing Armature for Grounds.

strip on the core. Rotate the armature slowly and if a ground is present, the steel strip will vibrate. Replace the armature if grounded or shorted.

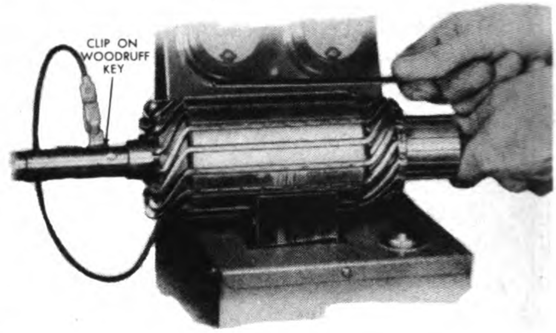


Figure 256. Testing for Shorts on Growler.

103. INSPECTING AND SERVICING THE FRAME AND FIELD

1. Inspect the brushes. If they are oil soaked or worn to less than 3/8" long, they should be replaced. Make sure the grounded brush terminals are securely fastened and are free from corrosion. To replace the insulated brush, unsolder the lead from the brush connector and pry open the lead in the connector. Insert the new brush lead to its full depth in the lip and clinch tightly before resoldering. A good soldering job must be done to prevent loss of starting efficiency due to a poor contact. Seat a new brush as shown in Figure 257 according to the instructions in paragraph 78, step "E".

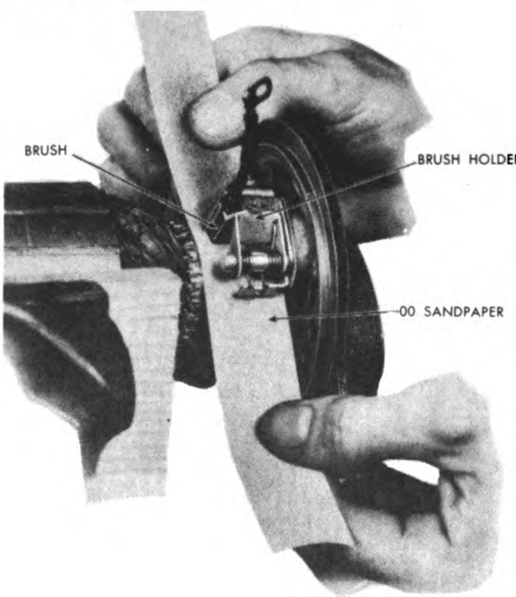


Figure 257. Seating Brush.

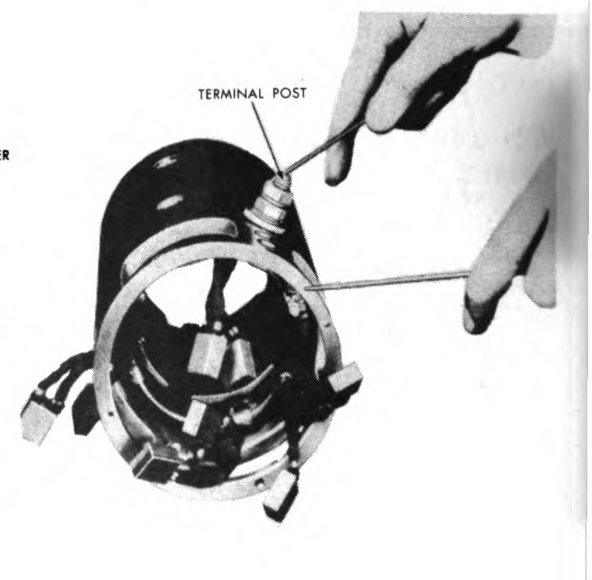


Figure 258. Testing Field Coils for Grounds.

2. Check the field coils and terminal posts for grounds and open circuits with test lamp. Make sure the brushes are not touching the frame or connections, and touch one probe to the terminal post and the other probe to the frame as illustrated in Figure 258. If a ground is present, the lamp will glow. Touch one probe to the terminal post and the other probe to one of the insulated brushes, as illustrated in Figure 259. If an open is present, the lamp will not light.

3. If ground or open is present, disassemble the frame and field and inspect each part.

a. First, remove the terminal post by taking off the nut and washer and pressing the post out of the frame. Inspect the washer and insulated bushing and replace those that are not in good condition.

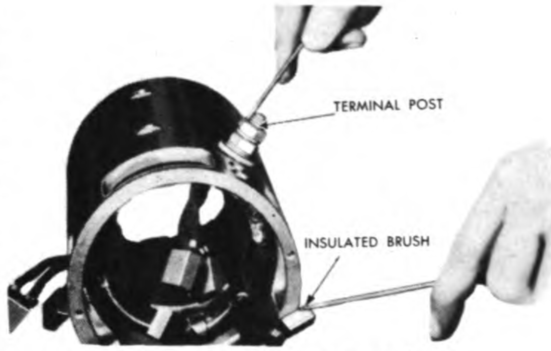


Figure 259. Testing Field Coils for Open.

b. Take out the pole piece screws and remove the pole pieces and field coils. See Figure 260. Inspect the field coils for faulty insulation and check for opens with the test lamp and probes. **NOTE:** If it is necessary to replace any field coil, make sure the connectors are clinched tightly and soldered properly.

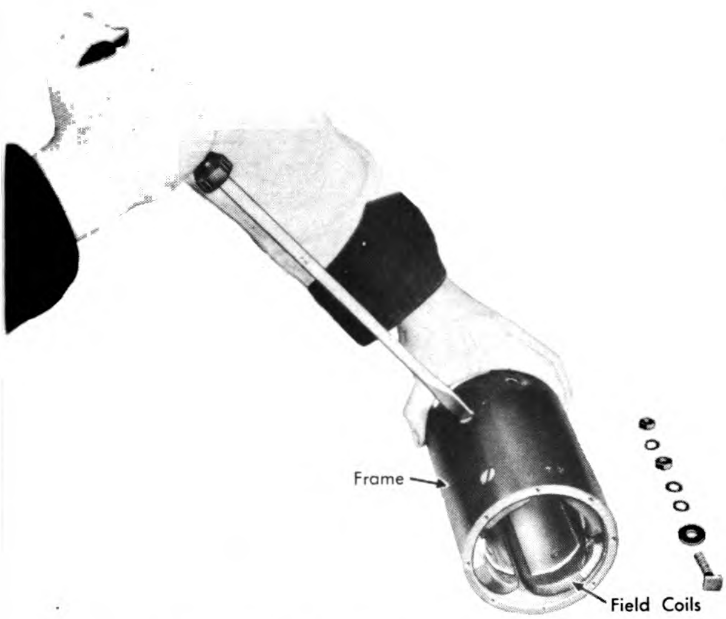


Figure 260. Removing pole piece screws.

c. Reassemble the field coils in the frame, using pole piece screws that have been dipped in boiled linseed oil. After the screws are tightened, hit the frame a few short blows with a raw hide mallet to align the pole pieces property.

d. Assemble the terminal post and washer and again check the assembly for grounds and opens with the lamp and test probes, as given in Step 2.

104. INSPECTING AND SERVICING THE COMMUTATOR END HEAD

1. Disassemble the brush holder plate from the head. See Figure 253.

2. Remove the oiler and felt wick from the head and take out the shaft cover and felt pad. Clean both plates thoroughly and inspect them for cracks. If cracked, replace the plates. Inspect the brush holders for distortion. Check the bearing. If it is worn excessively, replace it. Use the proper arbor to install the new bearing in order to secure the proper bearing fit. Replace the head if it is damaged, and replace the brush holder plate if the brush holders or springs are corroded, distorted, or bent.

3. Soak the bearing and felts in medium engine oil and reassemble the end head. Make certain that the drain hole in the end cap is at the bottom of the head.

4. With lamp and test probes, check the brush holders for grounds. Replace the brush holder plate, if a ground is present.

105. INSPECTING AND SERVICING PINION HOUSING

Clean the housing and inspect it for cracks. Check the bearing for wear and replace it if worn excessively. Use the correct arbor to install a new bearing to secure the right bearing fit. Soak the bearing in medium engine oil.

106. INSPECTING AND SERVICING BENDIX DRIVE

Disassemble and clean the Bendix drive. Inspect each part for wear and distortion. Replace any faulty part and lubricate the threads sparingly with engine oil. NOTE: Use new lockwashers every time the Bendix is assembled.

107. INSPECTING AND SERVICING THE INTERMEDIATE BEARING

Clean the intermediate bearing end plate and inspect for cracks and wear. Replace the plate or bearing if necessary, using the correct arbor to install the bearing. Soak the bearing in medium engine oil.

108. REASSEMBLY OF STARTING MOTOR

1. Assemble the two 1" steel thrust washers on the drive end of the armature shaft and assemble the intermediate bearing on the shaft. See Figure 254.

2. Apply a thin coat of light oil to the armature shaft and assemble the Bendix drive on the shaft. See Figure 251. Make sure the two woodruff keys are in their proper place and tighten the Bendix spring screws. Bend the ears of the lock washers to prevent the screws from loosening.

3. Assemble the armature in the pinion housing and turn the intermediate plate so that the dowel pin fits into the slot. Press the intermediate plate down against the shoulder in the housing.

4. Assemble the armature and pinion housing on the frame and field and fasten with the holding screws. Tighten the screws securely with lockwashers on all screws. See Figure 248.

5. Assemble the fibre thrust washer for controlling end play on the commutator end of the shaft, and then assemble the 5/8" steel washer.

6. Assemble the commutator end head on the motor and fastening with the holding screws. Assemble the brushes in their holders. NOTE: If brushes have been replaced, they should be sanded according to the instructions in paragraph 78, step "E", as shown in Figure 257.

109. FINAL INSPECTION OF OVERHAULED STARTING MOTOR

1. Inspect the alignment of the brushes on the commutator. If the brushes are not perfectly in line with the commutator segments, remove the head and replace the brush holder plate.

2. With a spring scale, measure the spring tension. Hook the scale under the brush spring at the end and pull on a line parallel to the face of the brush. Take the reading just as the spring leaves the brush. If the reading is not between 40 and 50 ounces, remove the head and twist the spring holder with pliers. NOTE: Always remove the brushes from the holders before removing the end head.

3. Check the armature end play. With a feeler gauge, check the clearance between the Bendix stop and the inner side of the pinion housing and bearing with the armature in its two extreme positions. Do not compress the Bendix drive spring. See Figure 261. The end play will be the difference between the two clearances. If the end play is not within .005" to .030", remove the commutator end head and change the fibre washer to one of the following: 1/32" thick, 1/64" thick, or 3/64" thick.

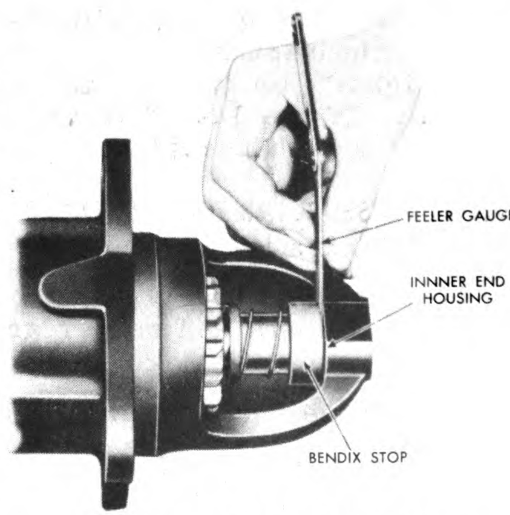


Figure 261. Checking Armature End Play.

4. Add 5 or 10 drops of medium engine oil to the oiler in the commutator end head.

5. Subject the starting motor to the no-load and lock torque tests as outlined in paragraphs 95 and 96.

110. CHECKING PUSH BUTTON STARTING SWITCH

With the push button removed from the panel,

1. Check the push button for grounds and opens. Touch the frame of the button with a test probe and touch each terminal in turn with the other probe, as shown in Figure 262. If the lamp lights, the push button switch is ground and should be replaced.

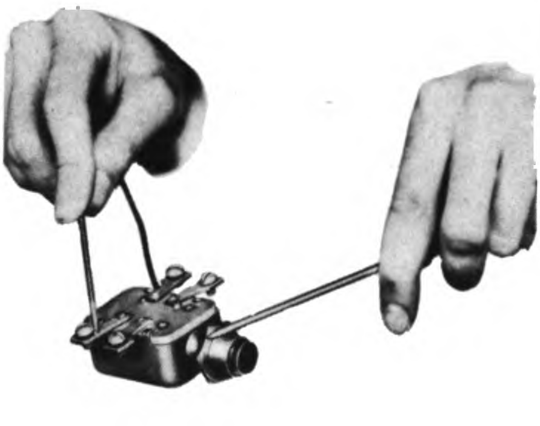


Figure 262. Testing Push Button Switch for Grounds.

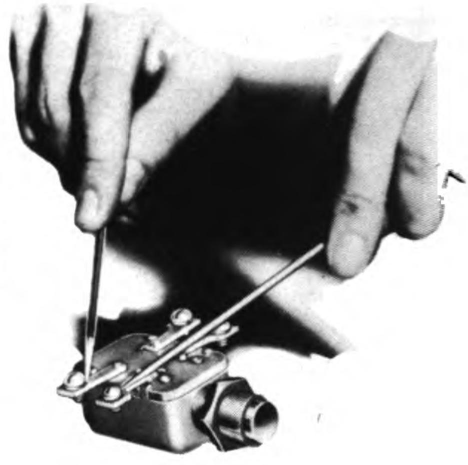


Figure 263. Testing Push Button Switch for Opens.

2. With the button held in, touch the "BAT" and "S1" terminals of the switch, as illustrated in Figure 263. The lamp should light. Touch the "S2" and the "S3" terminals with the button in. If the lamp fails to light in either of these tests, the switch should be replaced.

III. DISASSEMBLING THE SOLENOID STARTING SWITCH FOR INSPECTION AND OVERHAUL

1. Take out the terminal studs with an open end wrench. Remove the washers and rubber grommets from the #10 - 32 terminals.

2. Remove the cover holding nuts. Lift the cover off.

3. Remove the lockwashers from the 3/8 - 16 solenoid terminals. Take off the nut that holds the terminal connector. See Figure 264.

4. Remove the two leads from the relay and the one lead to the solenoid and lift off the connector.

5. Remove the screws holding the carbon resistor. Lift off the lead resister and washer.

6. Remove the nut holding the resistor insulation to

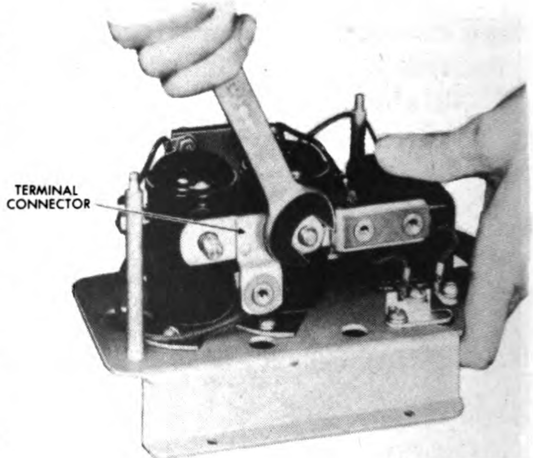


Figure 264. Removing Terminal Connector Nut.

the solenoid terminals. See Figure 265. Take off the lock washer lead insulation and resistance.

7. Remove the leads from the relay terminals.

8. Remove the two solenoid mounting screws that hold the resistor insulation and retainer. Lift off the retainer and insulation.

9. Remove the solenoid and relay mounting screws.

10. Remove the leads from the solenoid terminal

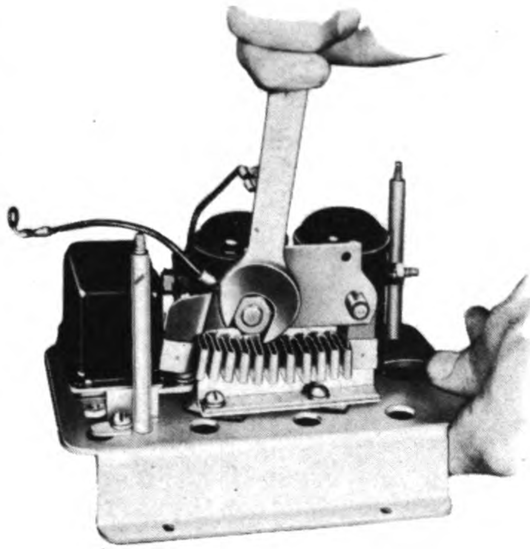


Figure 265. Removing Resistor Insulation Nut.

112. INSPECTING AND SERVICING THE SOLENOID STARTING SWITCH PARTS

1. Inspect the leads for breaks and improperly soldered or corroded terminals, and replace or repair any that are found to be defective.

2. Inspect the carbon resistor for cracks and check its resistance on an ohmeter. Replace the resistor if it is cracked or if its resistance is not within 13.5 to 16.5 ohms.

3. Inspect the metal resistance unit and replace it if it is corroded excessively. Clean the unit thoroughly.

4. Inspect the insulation and washers. Replace any that are cracked or oil soaked. Inspect the terminals at the studs for stripped threads and corrosion and replace any that cannot be cleaned up to give satisfactory service.

5. Inspect the terminal connections for loose terminals, cracked insulation, corroded connectors, and for defective leads, and replace the assembly if any of these conditions are found.

113. TESTING THE SOLENOID STARTING SWITCH

A. Connect a variable resistance in series with #10 - 32 terminal of the solenoid switch, the switch base, and the 12 volt battery. Connect a voltmeter on the switch terminal to the base. Increase the voltage slowly, noting the voltmeter reading when the switch closes as indicated by a click. Reduce the voltage slowly and note the opening voltage.

Replace the switch if it does not close at 7.0 to 9.0 volts and does not open at .75 to 2.0 volts.

B. Connect a 12 volt battery, carbon pile, and a 200 ampere ammeter in series with the two 3/8 - 16 terminals of the solenoid. Connect a voltmeter across the two 3/8 - 16 terminal of the solenoid. Connect the solenoid base to one battery terminal and connect the #10 - 32 terminal to the other battery terminal. Adjust the current to 100 amperes and read the voltmeter. If the voltmeter shows a reading of .05 volts, replace the solenoid starting switch.

NOTE: Repeat the two foregoing tests on the second solenoid switch.

114. TESTING THE RELAY

A. Remove the relay cover and inspect the contacts. If the contacts are burned, file lengthwise and parallel to the armature with a very fine contact file. Clean the contacts with a strip of linen tape wet with carbon tetrachloride and remove any residue with a clean dry piece of tape. Inspect the insulation and the winding for evidences of breakage or cracks, and replace the relay if necessary.

B. Check the armature air gap with a .034" - .038" flat gauge. Adjust the gap by bending the bracket holding the upper auxiliary contact.

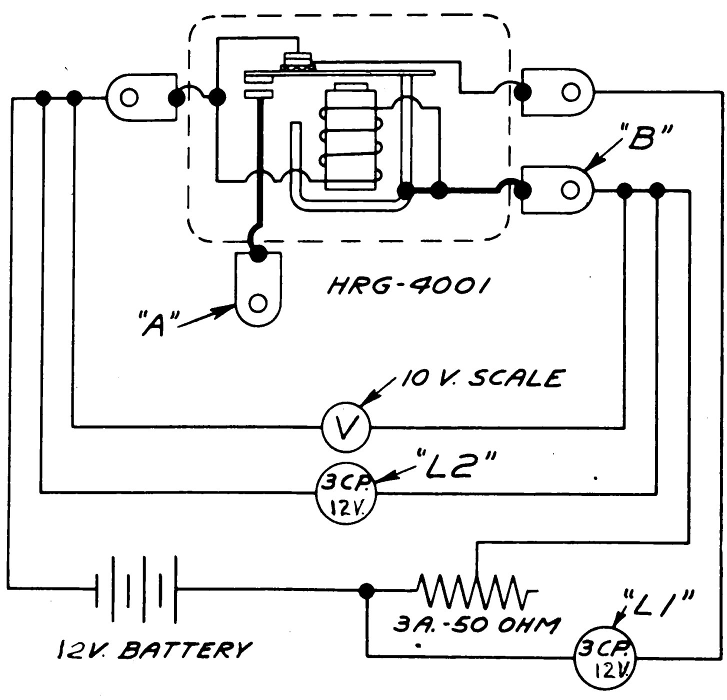


Figure 266. Hookup for Testing Relays.

C. Connect a six volt battery, variable resistance, voltmeter, and two six volt lamps as illustrated in Figure 266. Insert all the resistance in the circuit. Lamp #1 should be lit. Slowly reduce the resistance noting the voltage just as lamp #1 goes out. This voltage should be between 3.0 and 4.0 volts and is adjusted by bending the lower armature spring hanger. Increasing the spring tension increases the voltage at which the contacts close. Decrease the voltage slowly and note the voltage at which light #1 goes on. This voltage should be between 0.4 to 1.2 volts and is adjusted by varying the height of the main stationary contact. Be sure to keep the contacts aligned when adjusting.

NOTE: If the relay cannot be adjusted as indicated in the foregoing paragraph, replace the relay.

D. With test probes, touch the base of the relay with one probe and each terminal in turn with the other probe. If the lamp lights, it indicates a grounded relay which should be replaced. Touch the two terminals marked "a" and "b" in Figure 266, and holds the armature down. If the lamp fails to light, it indicates an open circuit, and the relay should be replaced.

Replace the relay cover and clinch the ears to hold it in place.

NOTE: To reassemble the control box, reverse the disassembly procedure as given in paragraph 111, and remount the control on the engine.

115. ENGINE SAFETY CONTROL

The engine safety control consists of the safety control switch and the solenoid valve. The safety control switch through the manually operated knob permits closing the contacts so that the engine can be started. As soon as the engine starts and oil pressure is obtained, the safety control mechanism automatically moves the knurled knob to "run" position, arrow pointing downward. During operation, should the oil pressure drop below seven pounds or the water temperature in the cooling system go to 205° F., the safety control switch contacts will open, causing the solenoid valve to shut off the flow of fuel to the engine. See Figure 102.

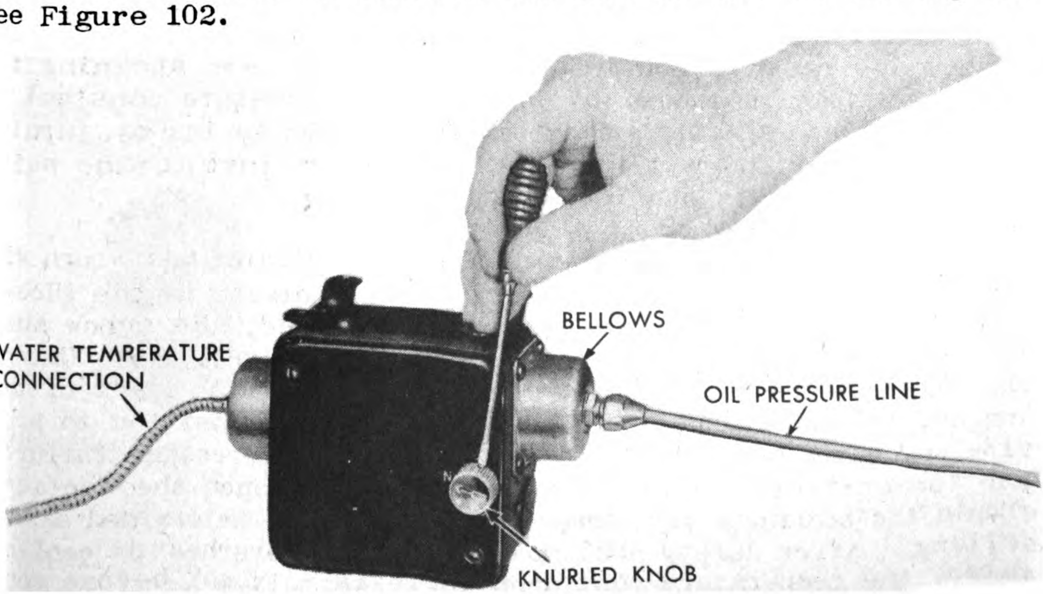


Figure 267. Removing Knurled Knob.

ENGINE SAFETY CONTROL SWITCH

116. SERVICING ENGINE SAFETY CONTROL SWITCH

The only adjustment that can be made is the oil pressure setting and this service will rarely have to be performed. The temperature setting has been set at the factory and is not adjustable. Safety control switches for replacement are also set at the factory and will need no readjustment upon installation on the engine. To change the oil pressure at which the contacts open thus stopping the engine, turn the manual control knob with arrow pointing toward "On". See Figure 267. Remove the knurled knob and the front plate cover, thus exposing the inner workings of the safety control switch. See Figure 268. Connect pressure

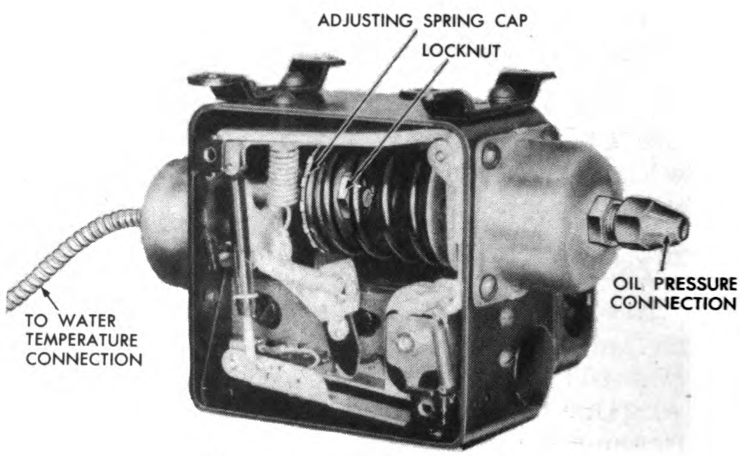


Figure 268. Inside Mechanism of Safety Control Switch.

bellows to air pressure line and apply pressure against the bellows equal to the normal operating oil pressure of the engine or until the knurled knob shaft automatically turns. Bleed pressure from the bellows slowly until the gauge pressure drops to the desired point where contacts are to open stopping the engine (safety shut down to occur). Hold pressure constant at this point and increase tension on the main spring by turning the adjusting nut to the right (clockwise) just to the point where the contacts open.

NOTE: When starting the engine, the operator must turn the manual control knob to "On", placing the contacts in the closed position. When the engine comes up to speed, the arrow must automatically turn to the vertical position. **IMPORTANT:** Unless the oil pressure builds up to normal on the initial start of the engine, the knob cannot release to the vertical position to provide automatic safety shut down in case of oil pressure failure. The temperature mechanism functions only to open the contacts should the cooling water temperature rise to the determined safety setting. After safety shut down because of overheated cooling water, the temperature must drop approximately 40^{o} before contacts can be manually closed for restarting the engine.

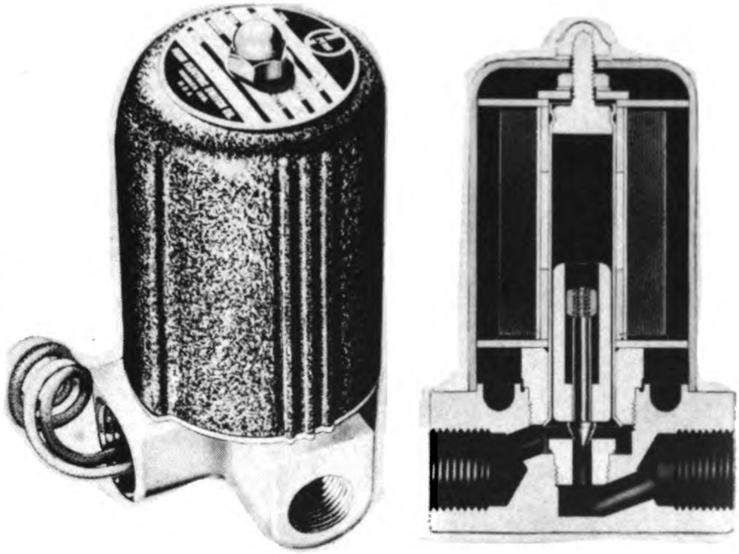


Figure 269. Solenoid Safety Shut-off Valve.

117. SERVICING THE SOLENOID VALVE

When the contacts in the safety control switch are closed, the coil of the solenoid valve becomes energized causing the needle valve to lift off the seat and thus permitting fuel oil to flow into the injection pump. See Figure 269. The only servicing necessary will involve the coil and valve seat and needle.

The valve seat and needle may wear and the coil may weaken over a long period of time.

118. DISASSEMBLY OF THE SOLENOID VALVE FOR INSPECTION AND REPLACEMENT

A. Remove cover nut, name plate, and cover. See Figure 270.

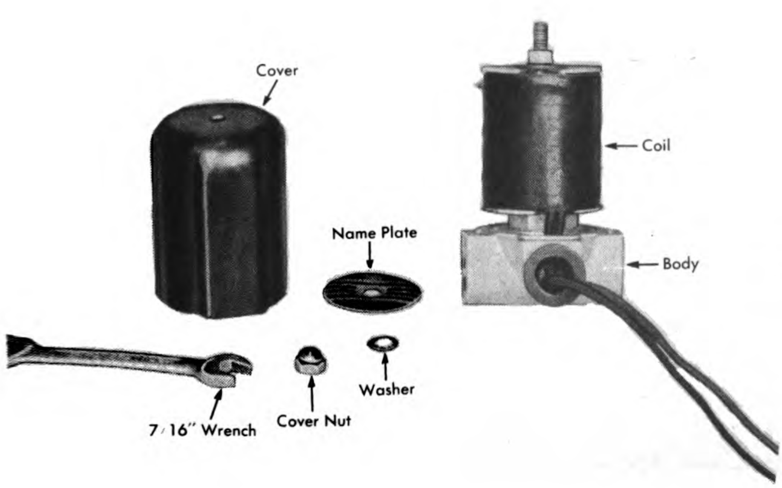


Figure 270. Cover removed from coil.

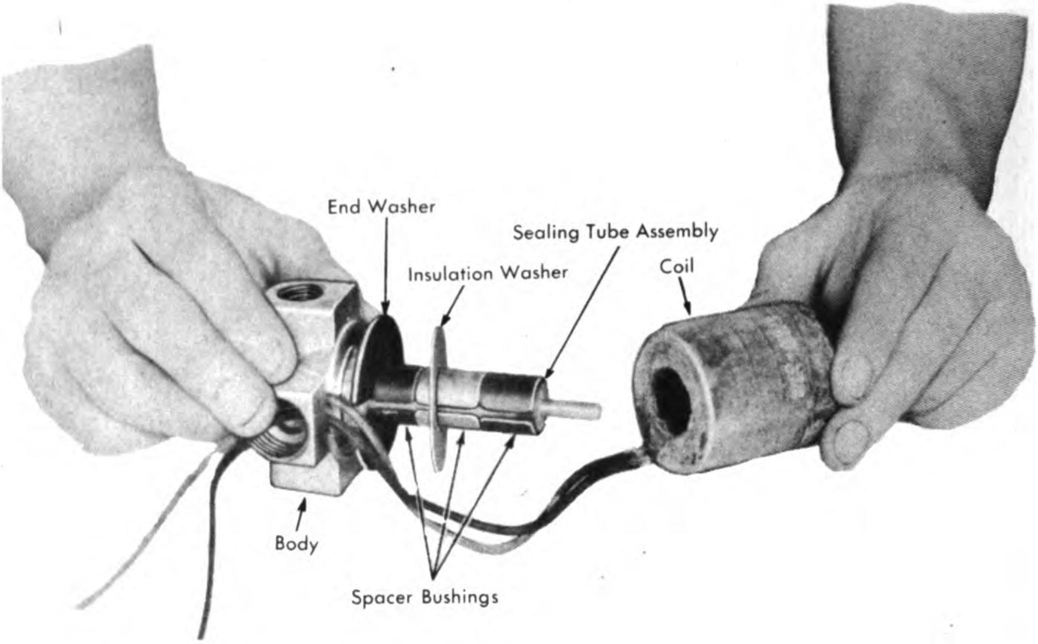
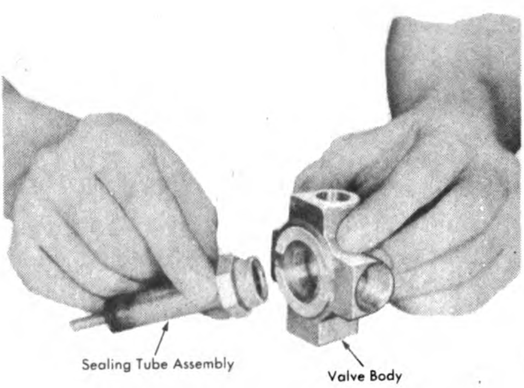


Figure 271. Removing Coil from Sealing Tube.

B. Loosen coil retaining nut and twist the coil slowly to free it from the sealing tube. See Figure 271.

C. Turn the sealing nut to the left (counter-clockwise) until the assembly is turned out of the valve body. See Figure 272. Plunger and needle valve will drop with the sealing tube. See Figure 273.



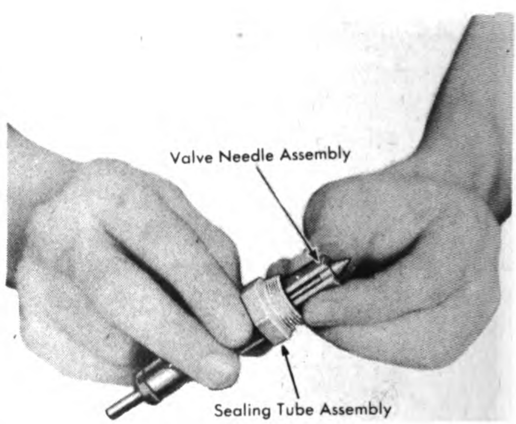


Figure 272. Removing Sealing Tube Assembly.

Figure 273. Removing Needle Valve from Sealing Tube.

Valve seat, plunger, and needle and sealing tube are now open for inspection. Note the condition of the valve seat, plunger, and needle. If there is any indication of wear, such as a ring on the needle and the seat is slightly flattened out, it is well to replace the valve seat and needle. The seat may be removed and replaced by unscrewing the hex nut. See Figure 274.

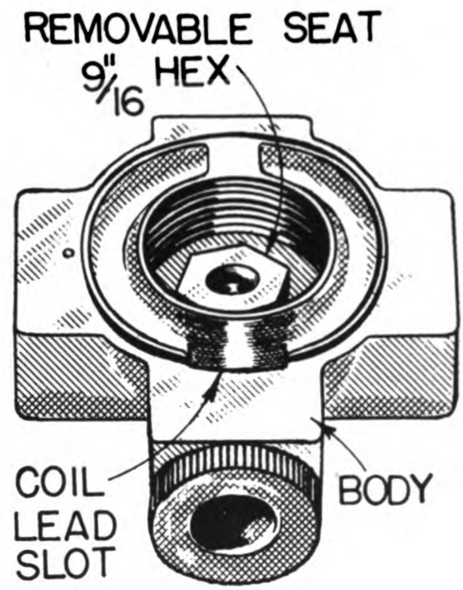


Figure 274. Valve Seat.

119. REASSEMBLING THE SOLENOID VALVE

A. To reassemble, replace needle and plunger in sealing tube with conical needle seat down. See Figure 273.

B. Replace sealing tube assembly in valve body and securely tighten sealing nut. See Figure 272.

C. Install coil and retaining nut (see Figure 271) and replace cover, name plate, and nut.

NOTE: Use care in handling coil leads to avoid twisting, kinking, or straining them in any way.

120. COOLING SYSTEM

The cooling system carries off the excess heat from the engine and holds it to a temperature that makes for efficient operation. This temperature should be approximately 180°. The thermostat so controls the flow of water that when the engine is cool, the water re-circulates around the engine water jackets without passing through the radiator. As the engine warms up, the thermostat opens up and allows the water to circulate through the radiator. The water is circulated by a centrifugal pump through the water jacket and radiator where the cooling takes place. A fan creates a draft through the radiator to cool the water. A water temperature gauge indicates the temperature of the water. The automatic shut-off valve described in the electrical system will automatically stop the engine if the water temperature exceeds 205°.

121. FAN

The fan blades are bolted to the hub of the water pump. The same bolts hold the drive pulley to the hub.

If one blade is damaged, the whole fan should be replaced. Replacing just one blade is apt to throw the fan out of balance and this will cause excessive vibration. If the blades are only slightly bent, they can be straightened.

122. WATER PUMP

The water pump is a centrifugal type pump which has a self-contained bearing that needs no external oiling. This pump is of the packless type and requires no adjustment.

123. STEPS OF WATER PUMP DISASSEMBLY

1. Remove the pump hub by pressing the shaft out of the hub with an arbor press.

2. Remove the bearing retaining lock wire. See Figure 275.

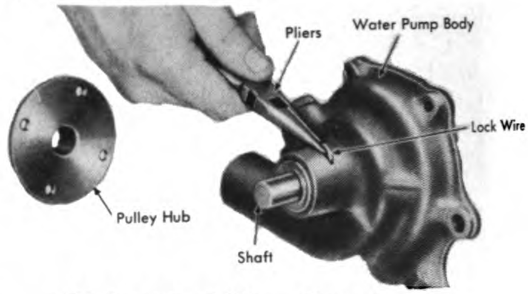


Figure 275. Removing Bearing Retainer Lock Wire.

3. Press the shaft out of the impeller and body with the arbor press and remove the impeller and seal assembly. See Figure 276.

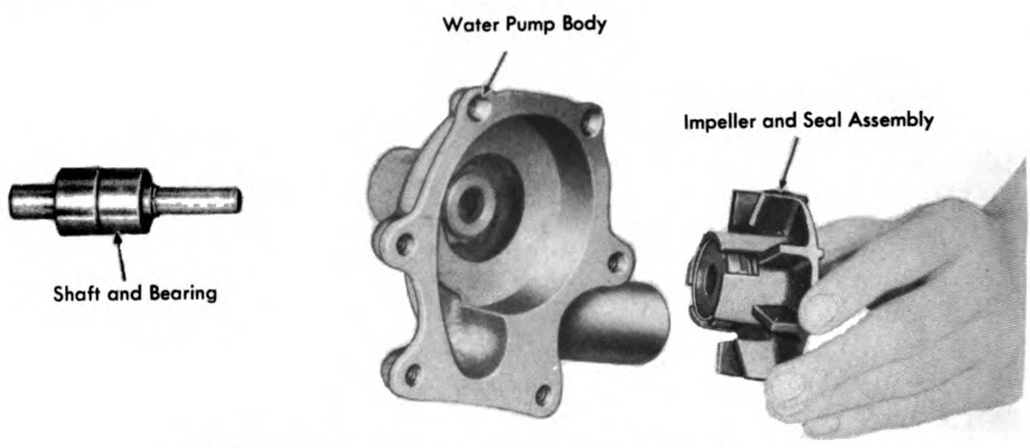


Figure 276. Removing Shaft, Impeller and Seal Assembly.

4. Remove the snap ring from the impeller to remove the seal assembly. See Figure 277.

The pump is now completely disassembled and the following inspections and replacements should be made:

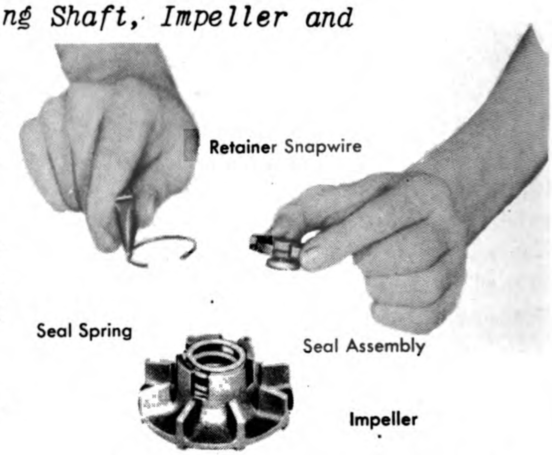


Figure 277. Removing Snap Ring from Impeller.

124. INSPECTING WATER PUMP ASSEMBLY

Examine the impeller for rust, corrosion, and cracks.

Always replace the carbon and rubber seals. Examine the spring and snap rings and the seal protectors. If worn or weak, replace. Also inspect the shaft and the bearing fit in the pump body. If this is not a medium push fit, replace the body.

NOTE: If the shaft and bearing are loose, or if they are bent, replace them as a unit. These should not be disassembled.

125. STEPS OF WATER PUMP REASSEMBLY

1. Assemble the seal assembly in its proper order as shown in Figure 278 and insert the spring and seals into the impeller as shown in Figure 277. Insert the snap spring to hold the seal assembly in place.

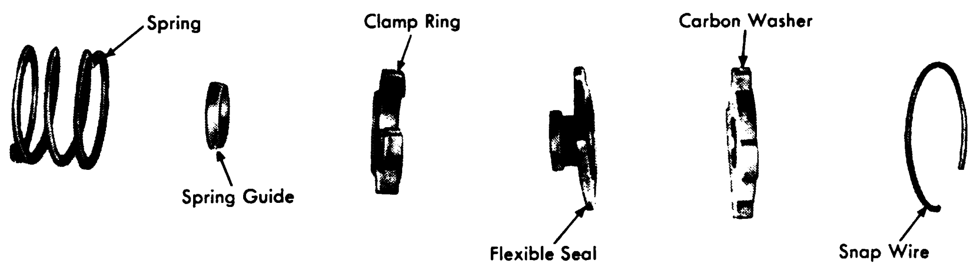


Figure 278. Seal Assembly.

2. Push the bearing and shaft into the body and press the impeller onto the shaft, seal side in. Be sure that the impeller is below the mounting surface of the pump body and also be certain that the impeller turns freely in the body.

3. Press the hub on so that it is flush with the end of the shaft.

NOTE: The flange side should be in.

126. RADIATOR

It is important that only clean soft water be used in the cooling system. The use of hard water will cause scale to form in the engine jackets and in the radiator, thereby tending to clog up circulation. Where the use of hard water cannot be avoided, use a commercial water softener. Blow out bugs or any leaves or lint, or any other obstructions that may have lodged between the fins on the core and the tubes, with air pressure. It is recommended that water be sprayed between the tubes and fins to facilitate the removal of these obstructions with air pressure. Straighten out any bent fins.

127. SERVICING A CLOGGED RADIATOR

Attach a hose to the bottom of the radiator at the drain hole. Turn on twenty to thirty pounds of water pressure. This reverses the flow and will tend to carry the dirt which has been lodged down in the tube back upward and out through the top of the radiator. While doing this, allow the radiator to overflow through the top. If the radiator is so badly clogged that this does not serve to free the circulation, then use a solution of one part of muriatic acid to three parts of water in sufficient quantity to fill the radiator. If muriatic acid is not available, a solution can be used made up of approximately three pounds of commercial lye added to a sufficient quantity of water to fill the cooling system. In either case, the solution should be heated before pouring it into the system and should be allowed to stand in the system for three or four hours. Drain the radiator and thoroughly flush the cooling system with clean water.

128. REPAIRING A LEAKY RADIATOR

Do not use liquid solder or radiator compounds to stop leaks as these tend to clog the radiator tubes. A leaky radiator should be tested under water with about four to five pounds of air pressure. Note the source of the air bubbles and solder the leaks. Make certain to wash off the acid after soldering, for many well-done jobs have been ruined by not washing off the acid which will eat into the tubes. **NOTE:** It is wise to discover the leaks before removing the core from the radiator housing. Unless the leaks are in such places that they are inaccessible for repairing unless the housing is removed, do not remove the radiator housing.

NOTE: Sometimes overheating is caused by too small or restricted water connections at the radiator outlet pump. Therefore, it is advisable to make certain when replacing the hose connections that a wire reinforcement is used in the radiator hose connected to the pump suction pipe so that it will not collapse in service.

129. THERMOSTAT

The thermostat is of the pressure type - bi-metal strip. It is installed in the water outlet connection. See Figure 183. As the engine warms up, the thermostat permits an increasing amount of water to pass through the radiator. Inspect the butterfly valve and pin and bi-metal sprip for proper movement. If it does not function, replace the thermostat.

LUBRICATING SYSTEM

130. A high velocity oil pump provides full force feed lubrication to the internal working parts of the engine. Figure 279 illustrates the flow of oil through the lubricating system. The oil is drawn from the pan through a suction screen to the oil pump. From the pressure side of the pump, it enters a passage drilled in the crankcase casting to the oil pressure relief valve. Here excess oil is by-passes back to the oil pan. The balance of the oil passes on to the main gallery line in the crankcase and to the oil filter. From the main gallery line, side passages are drilled to the main bearings, oil pressure gauge connection,

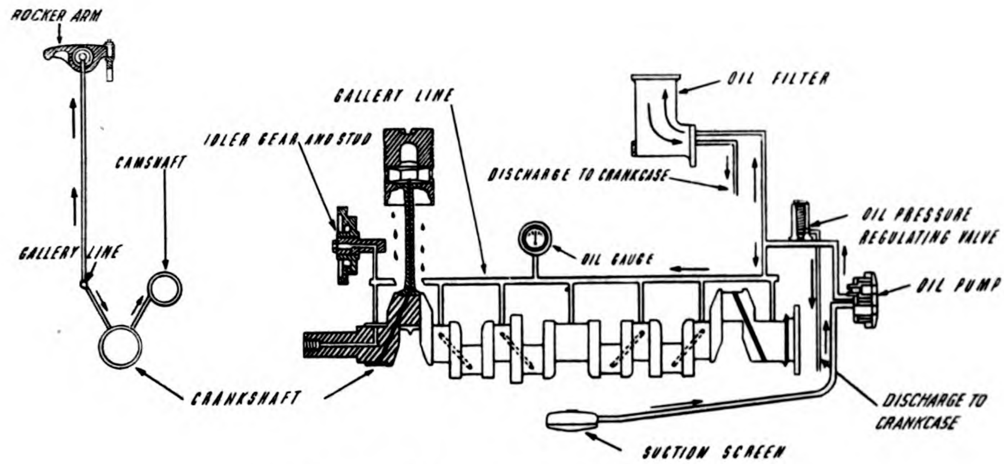


Figure 279. Lubrication Diagram.

idler gear stud, and an external passage which carries oil to lubricate the rocker arms. From the main bearings, the oil is delivered to the connecting rod bearings by means of a drilled crankshaft. The piston pins receive oil through the rifle drilled connecting rods. The cylinders are lubricated by the oil thrown from the connecting rod bearings. From the main bearings, side passages lead to the camshaft bearings.

A supply of oil is delivered to the idler gear hub through the drilled idler gear shaft. Oil from the hub of this gear is thrown out through the drilled hole in the hub and is picked up by a groove in the rim of the gear where it passes through small oil holes drilled in the gear rim between the teeth, spraying the entire gear train.

The operating oil pressure of the engine with S.A.E. 30 oil, under normal operating conditions, will be approximately 25 to 35 lbs. per square inch.

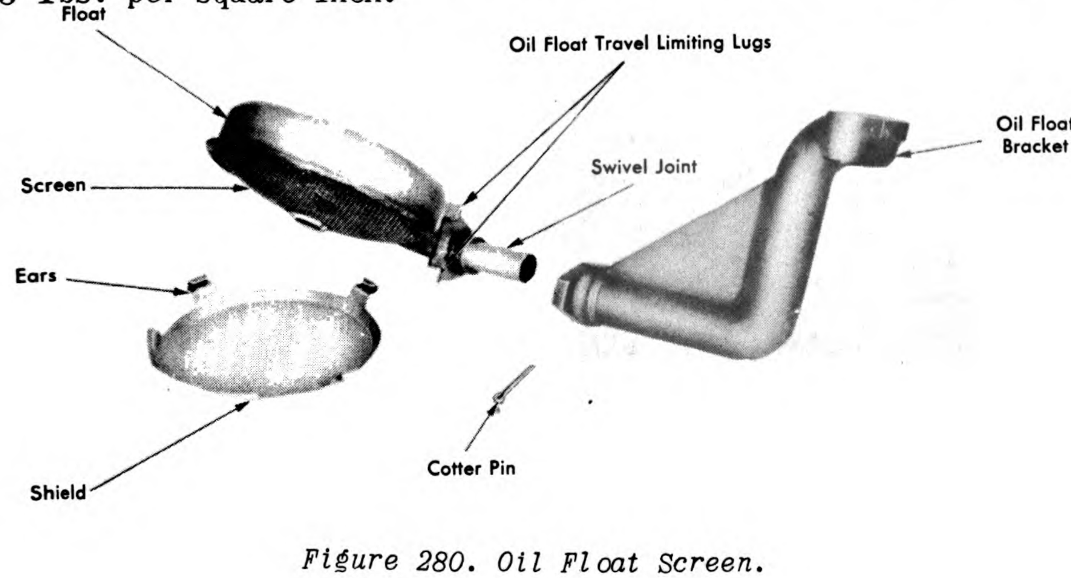


Figure 280. Oil Float Screen.

OIL PUMP

131. OIL FLOAT

The oil float is a floating screen arranged to rise and fall with the oil level in the crankcase so that only the best oil is taken for the bearings. See Figure 280.

132. CHECKING, REPAIRING, AND REPLACING PARTS OF THE OIL FLOAT

First thoroughly clean the float in unleaded gasoline. Blow the screen with compressed air. If the fouling is bad, straighten the ears of the shield, remove the shield, and clean the screen with a wire brush. If the mesh is broken or loose from the float and beyond repair, replace the entire float assembly. If the tube is damaged, the entire assembly must be replaced since the tube cannot be removed and replaced. When putting back the shield, it should be carefully positioned and the ears turned over the body flange. Clinch the ears with pliers, not a hammer.

Make certain the float swivel joint is free to move so that the float can "float" on the surface of the oil.

The float is equipped with travel limiting lugs. Make sure they are not bent out of line. The lugs should be at right angles to the plate soldered on the tube.

Check the bracket for cracks. If cracked, it should be brazed or replaced.

133. OIL PUMP

The oil pump has a hydraulic relief in the casting. The oil which would otherwise be trapped between the teeth is allowed to return through the hydraulic relief to the pressure side of the pump. There are no movable parts in this type of relief. The idler gear and the drive gear have bushings which were machined in the gear blank before the teeth were cut. The gears and bushings should be replaced as a unit. There is an expansion plug provided in the pump body. This plug is used as an oil seal at

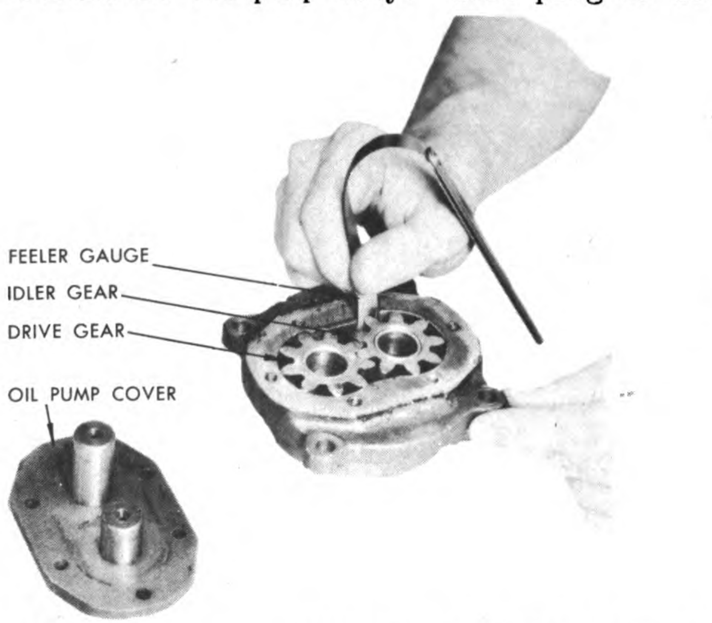


Figure 281. Checking Gear to Case Clearance.

the end of the idle shaft recess and should not be removed. The oil inlet and oil outlet passages go through the two locating sleeve dowels.

134. INSPECTING AND REPLACING OIL PUMP PARTS

To disassemble the pump, remove the six capscrews and oil pump cover. Check the teeth and the bushings in the gear for wear. If either is worn, both the bushing and the gear must be replaced as a unit. Check the clearance between the teeth and the case. See Figure 281. If more than .008", replace with new gears and bushings. Check the backlash as shown in Figure 282. If more than .005", replace the gears. Also if the ends of the gears are not within .001" flush with the case, replace the gears and bushings.

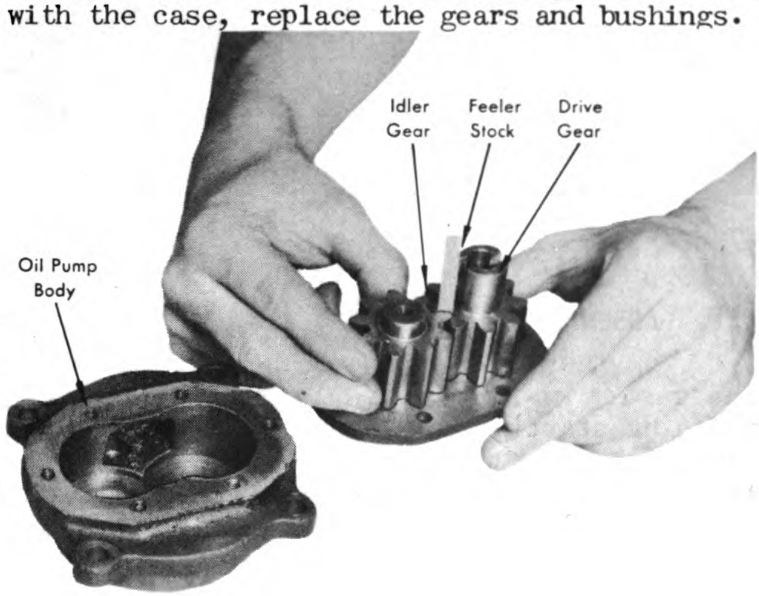


Figure 282. Checking gear back lash.

Examine the studs on which the bushings run. If the studs are worn, replace the studs with new ones. Examine the case for cracks, and replace if necessary.

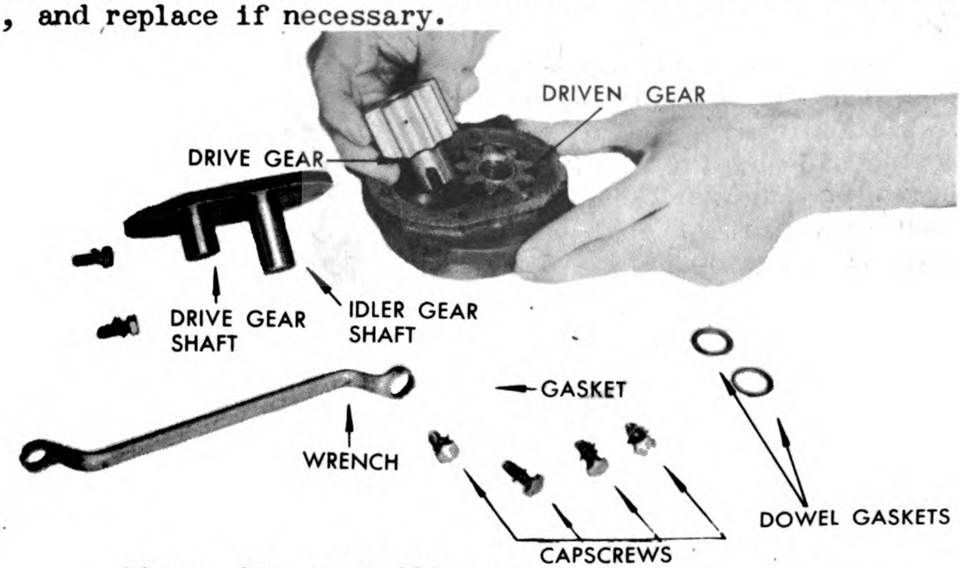
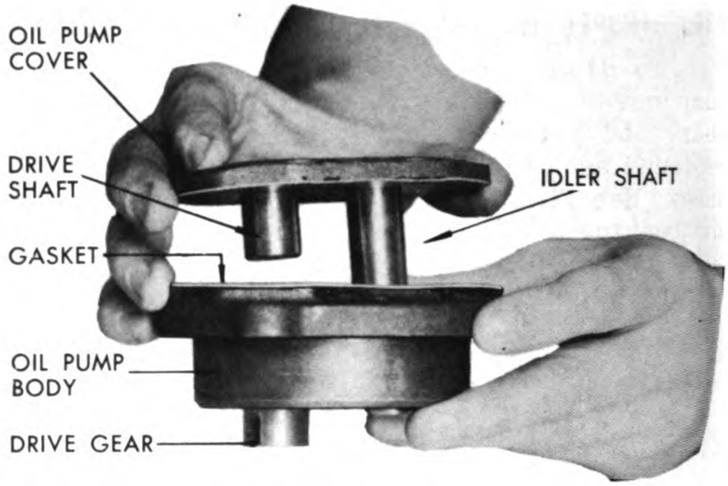


Figure 283. Installing Oil Pump Gear.

Figure 284. Installing Oil Pump Gear Shafts.



135. ASSEMBLING OIL PUMP

Put the drive gear and the idler gear in the housing. Slip the gasket on the housing. See Figure 283. Set the cover in place by starting the idler shaft in the idler gear and then the drive gear shaft in the drive gear. See Figure 284. Make sure the holes of the gasket are in alignment with the cover and body capscrew holes before installing and tightening the six capscrews. Check pump to be sure gears turn freely. To avoid having to prime the pump after it is installed on the engine, fill the pump with oil before installation. When installing pump be sure to install new dowel gaskets as shown in Figure 285.

136. PRIMING OIL PUMP

If it becomes necessary to prime the pump after installation remove the oil plug in the side of the crankcase, shown in Figure 286. Pour about one pint of engine oil into the plug opening. Turn the engine over backwards four or five revolutions. If this is not feasible, the same results can be obtained by connecting a piece of tubing to the oil temperature hole and pour about a pint of oil into the tubing forcing the oil into the suction passage while the engine is running.

Figure 285. Installing dowel gaskets.

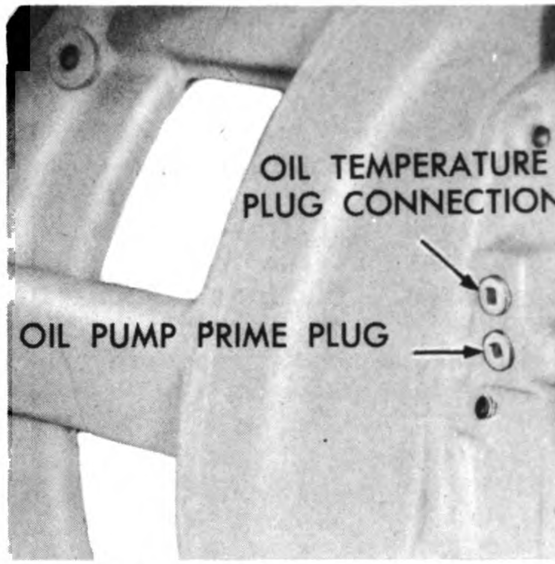


Figure 286. Location of Oil Plugs for Priming Oil Pump.

CAUTION: DO NOT RUN THE ENGINE MORE THAN ONE MINUTE WITHOUT OIL CIRCULATION. As soon as the pressure comes up, the hole should be plugged immediately.

If pressure is not obtained after this, examine oil pressure gauge and relief valve. If these are in good condition, remove oil pump and re-examine the drive pin in end of camshaft, also the copper gaskets on the sleeve dowels.

137. OIL PRESSURE RELIEF VALVE

The oil pressure relief valve is designed to maintain an operating pressure of approximately 30 lbs. at normal speed and temperature. No adjustment is provided. The spring furnished is of the proper weight and length. A temporary adjustment can be made by stretching or compressing the spring. However, a new spring should be obtained as a stretched spring soon loses its tension. See Figure 287.

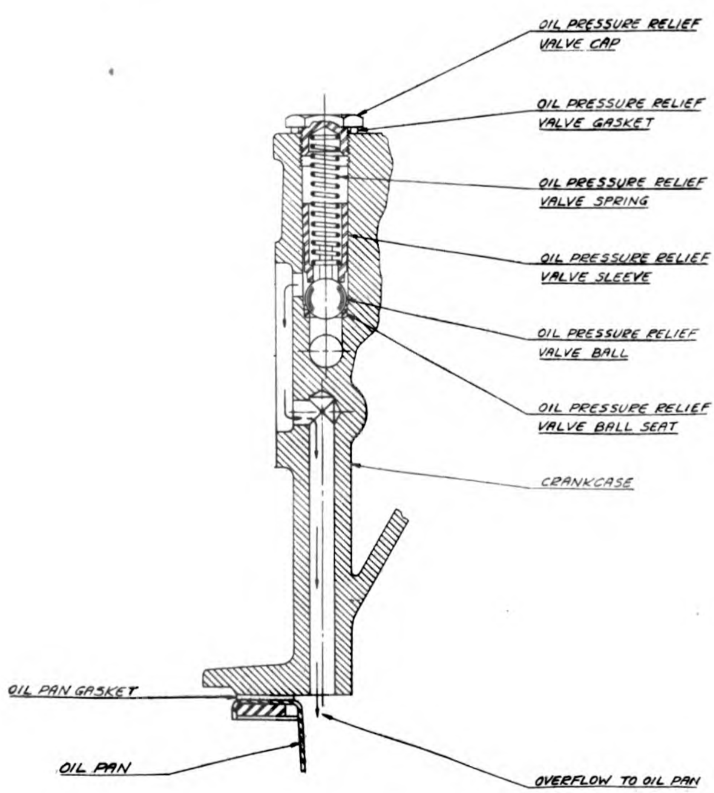


Figure 287. Oil Pressure Relief Valve.

MAIN GENERATOR AND EXCITER

Chapter V

OVERHAULING, INSPECTION AND SERVICING OF MAIN GENERATOR AND EXCITER

138. Because the instructions include the detailed steps necessary for overhauling the generator and exciter, it should not be assumed that a complete tear-down is necessary. Only on rare occasions will it be necessary to tear down the generator as completely as the instructions here given imply. If, during operations, the instructions for inspection and cleaning are followed and the generator and exciter lubricated at the intervals recommended, a major overhaul will not be necessary. See Figure 288.

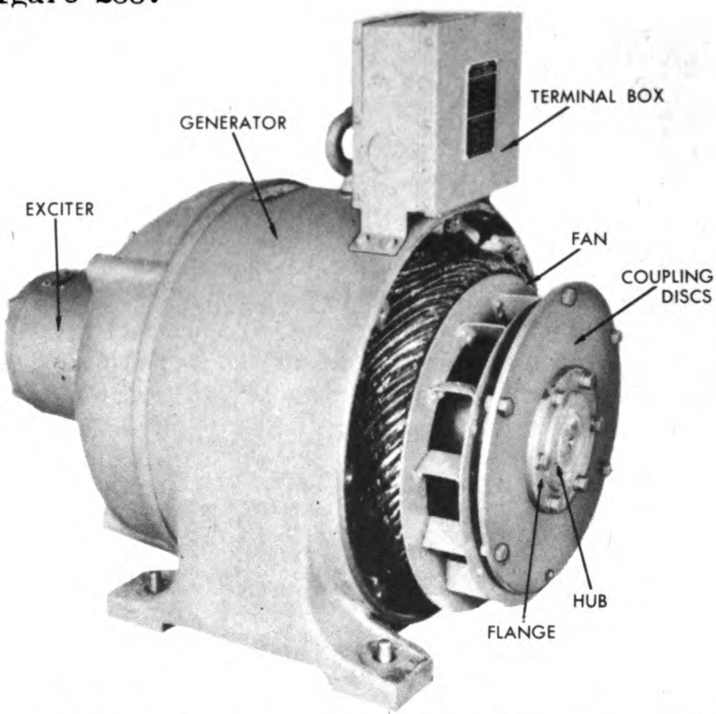


Figure 288. Main Generator and Exciter Showing Fan and Coupling,

If the conditions of operation are extremely hot and dirty, the inspection and cleaning and such other servicings as may be necessary should be done more frequently.

139. MAIN GENERATOR OR ALTERNATOR LUBRICATION

The alternator and the exciter are shipped from the factory with the proper quantity and grade of grease in the bearings to last for a period of approximately 4,096 hours of operation at rated loads and temperatures. See paragraph 141. At the end of 4,096 hours of operation, the grease should be replaced.

140. RECOMMENDED GREASE FOR ALTERNATOR AND EXCITER

For the successful lubrication of the generator bearings and the labyrinth groove, the manufacturer recommends a high grade soda base grease of No. 1 consistency. The Army specifications which come closest to this recommended grease are No. W-2 for the bearing housing and ball bearings and No. WB-3 for the labyrinth groove.

141. MAIN GENERATOR BEARING HOUSING GREASE CAPACITIES

Alternator	Exciter
1/2 full = 3 ounces	4/4 full = 4 ounces
1/3 full = 2 ounces	

NOTE: A column of grease 8" long and 1/8" in diameter will weigh approximately one ounce. This can be used as a guide when regreasing is necessary and when a grease cup of known capacity is not available.

142. HIGH OPERATING TEMPERATURES

NOTE: The recommended greases are on the basis of actual bearing temperatures under 194° F. (90° C.). If operating and climatic conditions are such that the bearing temperatures exceed 194°F. (90° C.), the grease should be changed more frequently. The following is recommended:

195° F. to 225° F., change every 3,072 hours.

143. REMOVING OLD GREASE FROM MAIN GENERATOR AND ADDING NEW GREASE

To remove the old alternator bearing and housing grease, introduce hot oil (O.E.-#20 - over 2 ounces) in the housing and run the machine for a few minutes to allow the oil to thin out the grease. Remove the drain plug and drain as much as possible. See Figure 289. Replace the drain plug and repeat this operation as often as is necessary to remove all the grease. Let the generator run for a few minutes with the drain pipe open in order to remove any flushing oil that may be trapped. Replace the drain plug and with the machine running, add grease in the quantities given in paragraph 141. Add grease slowly.

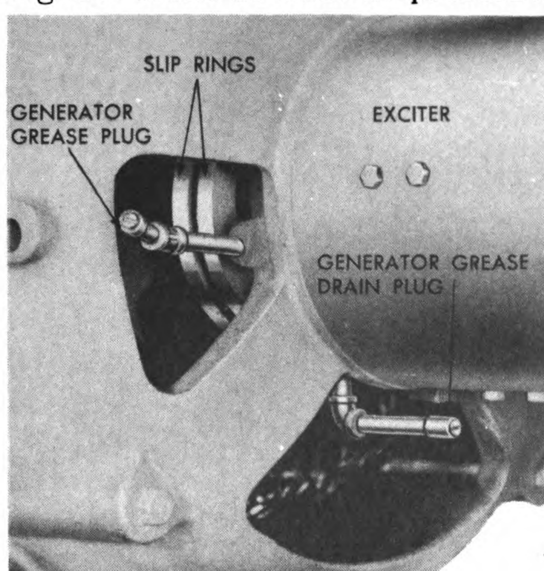


Figure 289. Grease and Drain Plugs.

CAUTION: Do not overgrease and do not allow dirt and grit to enter the bearing housing. Keep grease and greasing equipment clean. If grease is added in excess of the quantities indicated, the bearing will overheat and throw grease inside the generator. Should this excess grease thus thrown find its way to the collector ring or commutator, it will seriously affect the operation of the generator and may even cause complete failure.

The use of high pressure grease guns should be avoided if at all possible since there is no accurate method of determining the amount of grease being introduced into the bearing housing.

In the absence of grease cups, it is suggested that a screw type grease gun with a straight nozzle be used. Before using, however, the amount of grease expelled per turn of the grease gun screw should be ascertained. If a grease cup of known capacity is available, this can be screwed into the filler pipe and used instead of a grease gun.

144. REMOVING OLD GREASE FROM EXCITER BEARING HOUSING

The exciter bearing, being of the full sealed type, requires a somewhat different treatment in removing the old grease than that described for the main generator, or alternator.

The exciter bearing housing has no drain. Therefore, the end bracket should be removed and the grease washed from the bracket and bracket cap with clean unleaded gasoline or kerosene. See Figure 290. Do not wash out the ball bearing. After the bracket is replaced, completely fill the bracket cavity with grease (.4 ounces).

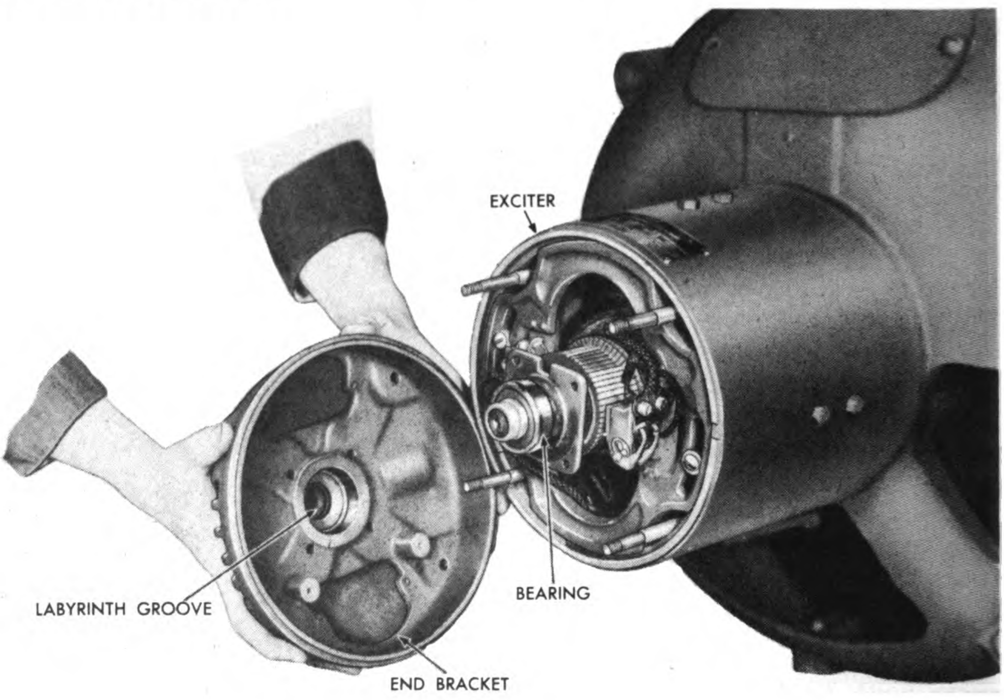


Figure 290. Removing Exciter End Bracket, showing Labyrinth Groove.

145. INSPECTING THE ALTERNATOR RINGS, EXCITER COMMUTATOR, AND BRUSHES

The brushes should be inspected for wear, proper spring pressure, and freedom in the holders. If the brushes are stuck with dirt or other foreign substances, they should be removed and cleaned. Brush holders and insulating supports should be carefully cleaned. Brush pigtail connections should always be kept tight. Collector rings should be inspected for roughness or a pitted condition. They should be smoothed in accordance with the instructions given in paragraph 148. Badly roughened or grooved rings should be trued in a lathe.

The commutator should be inspected for dirt and oil on the brush contact surfaces, high or low bars, carbon deposits in the undercutting grooves. A commutator in good condition will have a highly glazed appearance and show a light brown color. This condition is conducive to long commutator and brush life and should not be disturbed other than to clean with a piece of canvas of non-linting cloth. If commutator is rough, blackened, or pitted, it should be polished with #00 sandpaper. See paragraph 147. The remedy for high or low bars is to true up the commutator in a lathe.

146. CLEANING THE MAIN GENERATOR AND EXCITER

The alternator and the exciter should be kept as clean as possible, both internally and externally. Accumulations of oil or dirt should be removed with a rag slightly dampened with gasoline or kerosene. Be sure all parts are cleaned and dried before operating machine to avoid danger of fire. Again it is emphasized, do not use gasoline or kerosene in or around the machine when it is in operation, since a spark from the collector rings or commutator may ignite the cleansing fluid.

Keep the windings of the alternator and exciter clean, preferably by blowing with dry compressed air. Make certain that no moisture is in the compressed air lines. Also air of extreme pressure should not be used for this purpose, since there would be danger of lifting the insulation and damaging the windings. Air pressure in excess of 25 pounds should not be used in blowing out the machine.

NOTE: If the machine is operated in extremely dirty atmosphere, cleaning should be done more often than indicated in the periods of maintenance.

If the exciter or alternator windings become caked with grease or other substances, that can not be removed with air, then the machine should be disassembled and the windings thoroughly dried before reassembly.

147. CLEANING AND SMOOTHING THE EXCITER COMMUTATOR

The commutator should always be kept clean and well-polished with a piece of canvas or non-linting material. No vaseline or oil of any description should be used on the commutator. See Figure 291.

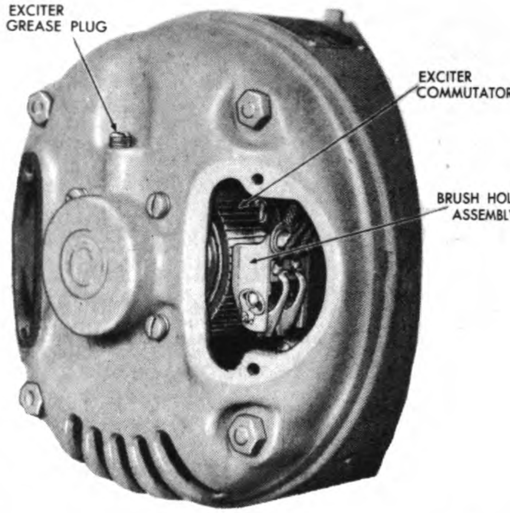


Figure 291. Exciter Commutator and Brush Assembly.

If the commutator becomes rough, the roughness may be removed by polishing the commutator with a piece of sandstone from which a segment piece has been cut having the same radius as the commutator. If the sandstone is not easily obtainable, #00 sandpaper may be used by pressing it against the surface of the commutator, with a block shaped like the sandstone. See Figure 293. In both cases, the commutator should be run at the highest engine speed during the polishing. When removing the roughness, the sandstone or sandpaper should be moved back and forth along the surface parallel to the shaft, with the engine running at its highest engine speed. NOTE: Be sure that the brushes are raised from the commutator during this operation to avoid unnecessary brush wear and particles of the abrasive becoming imbedded in the surface of the brush.

Carbon deposits can be removed from the undercutting grooves by using a small piece of hard wood shaped to the width of the grooves and used as a scraper. Also suitable for this operation is a piece of hacksaw blade from which the set has been ground off. When using the hacksaw blade, however, exercise care to avoid scratching the commutator. After the commutator has been smoothed, the commutator and brush faces should be carefully cleaned to remove any grit which might cut or scratch the commutator. NOTE: EMERY CLOTH SHOULD NEVER BE USED ON A COMMUTATOR OR BRUSH.

148. CLEANING THE SLIP RINGS (Collector Rings)

Before attempting to polish the rings, all the brushes should be raised to avoid unnecessary brush wear and to prevent the particles of abrasive becoming imbedded in the surfaces of the brushes.

The slip rings should always be kept clean and well polished with a piece of canvas or non-linting material. See Figure 292. No vaseline or oil of any description should be used on the rings or brushes. If the slip rings become rough or pitted, the rings should be smoothed by polishing with a piece of sandstone from which a segment piece has been cut having the same radius as the ring. If sandstone is not available, then sandpaper may be used by pressing against the surface of the slip rings with a block of wood shaped like the sandstone mentioned previously. See Figure 293. In either case, the machine should be run at its highest speed during the polishing process. If the rings are badly roughened or pitted, coarse sandpaper or sandstone should be used first, then followed up with a finer grade of sandpaper for the final polishing. After this is done, the rings and brush holders should be carefully cleaned in order to remove any grit or abrasive which might cut or scratch the slip rings.

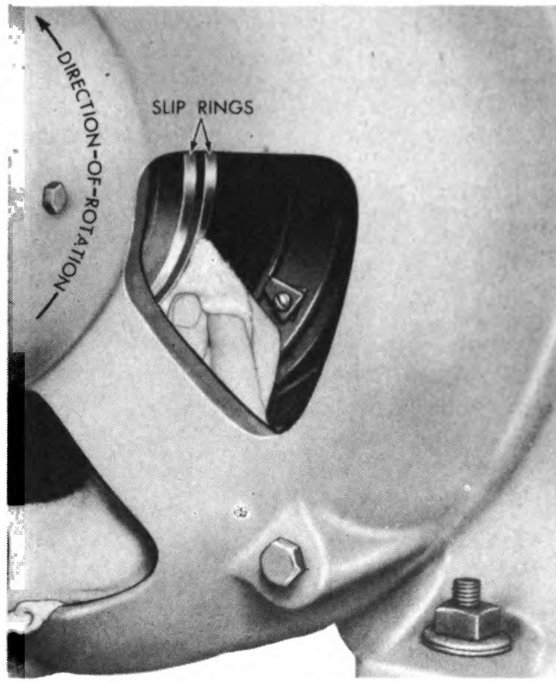


Figure 292. Cleaning Slip Rings.

149. CHECKING BRUSH SPRING TENSION

The alternator brush holder springs are designed to give a pressure of 7 to 9 ounces. This pressure is not critical on the slip rings and the spring pressure will be maintained indefinitely unless the brush pigtail circuit opens and permits the brush holder spring to carry the current. If this occurs, then the spring will lose its temper and should be replaced. The exciter brush holder spring is designed to give a pressure of 10 to 13 ounces. This spring, like the alternator brush holder spring, will maintain the correct tension indefinitely unless the brush pigtail circuit opens and permits the brush holder spring to carry the current. If this occurs and the spring pressure falls below 10 ounces, the springs should be replaced.

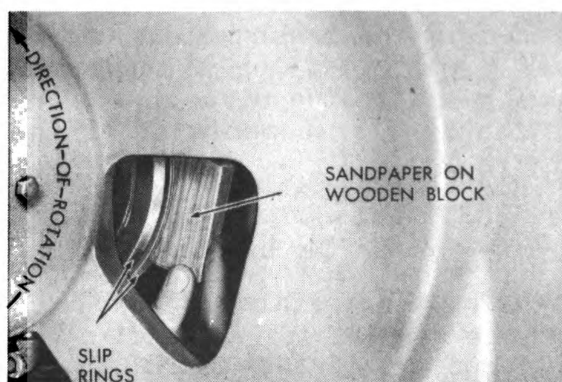


Figure 293. Smoothing Slip Rings With Sandpaper on Block of Wood.

To check the spring pressure, hook a small spring scale having a capacity of approximately 1 to 2 pounds under the brush holder finger at a point where it bears on the brush. Pull the spring in a direct line in the direction of the brush travel in the brush holder, and when the finger is just lifted off the brush, the reading should be made.

150. REPLACING AND SEATING BRUSHES

If the brushes of either the exciter or alternator are worn to less than half their original length, they should be replaced. In fitting, or seating, the new brushes, the brush should be

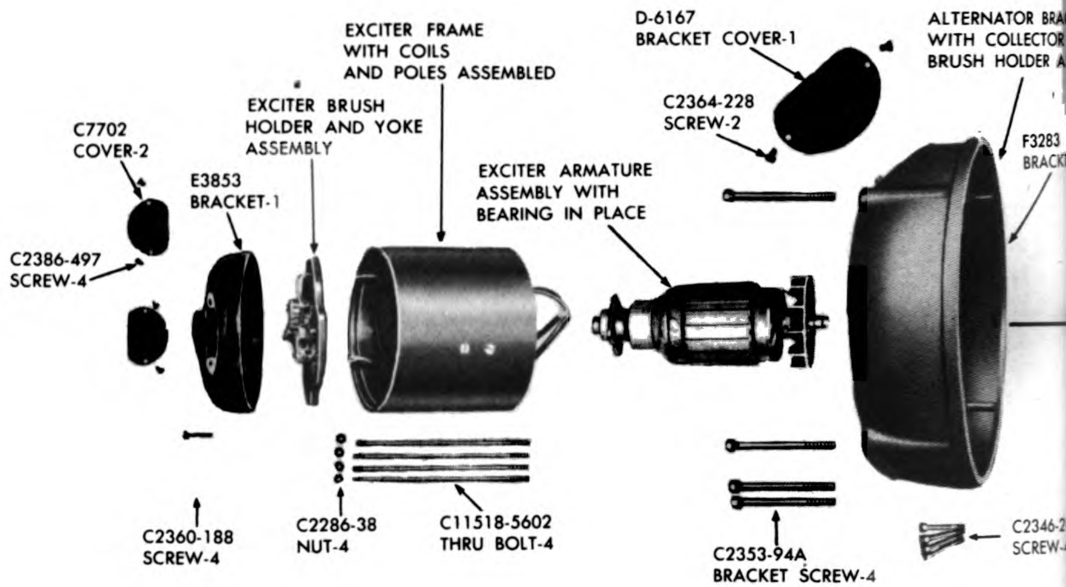


Figure 294. Exploded Alternator and Exciter

placed in the brush holder under normal brush spring tension. Draw a strip of #1 or #2 sandpaper, with the sanded side against the brush, in the direction of rotation following the contour of the exciter commutator or the alternator slip ring. See Figure 231.

CAUTION: Do not use emery cloth on the slip rings, the commutator, or the brushes.

The final finish should be done with #0 or #00 sandpaper. Run the machine for a few minutes and inspect the brush contact surfaces for perfect seating. If not perfectly seated, repeat the foregoing operation with #0 or #00 sandpaper.

CAUTION: It is extremely important that the brushes of both the alternator and exciter be replaced with the same type and grade recommended by the manufacturer.

151. MAIN GENERATOR AND EXCITER

The following steps should be observed in disassembling the alternator after the alternator has been removed from the engine according to the instructions given in paragraph 2:

1. Disassemble the generator coupling and remove the ventilating fan, as follows: Mark coupling discs, hub, and flange to indicate their relative positions in order to reassemble them in their correct positions. See Figure 288.

2. Remove the six capscrews from the flange and remove the discs from the hub. **CAUTION:** Leave at least one bolt and nut in the outer rim of the coupling disc to prevent the discs from separating. See Figure 288.

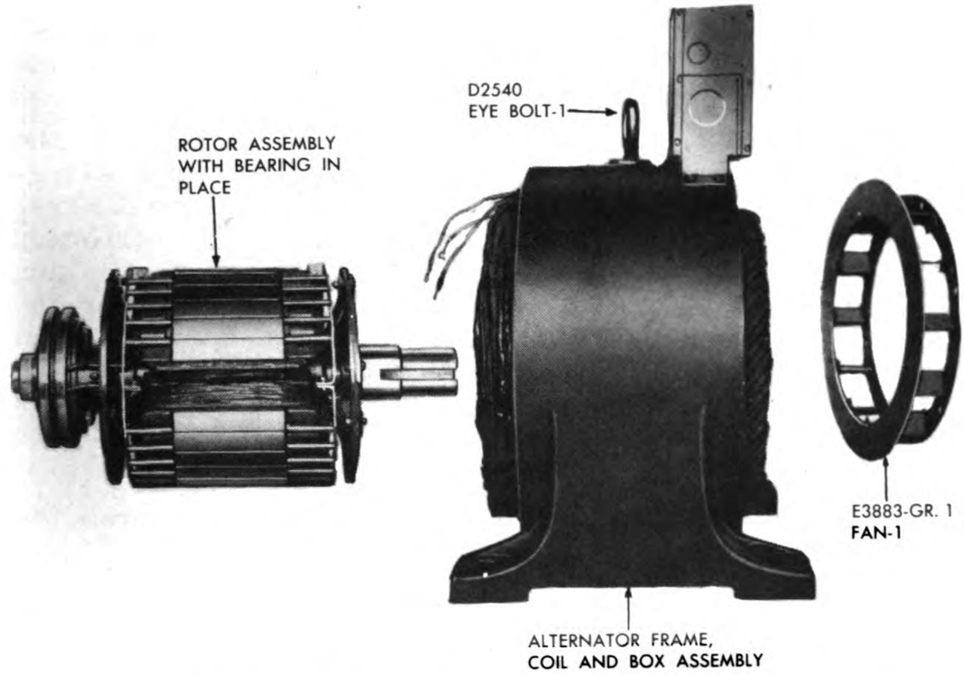


Figure 294. Exploded Alternator and Exciter

3. Remove the coupling flange from the alternator shaft as follows: Use a wheel puller on the flange hub. If hub does not readily move, use a torch to rapidly heat flange while engaging the wheel puller. **CAUTION:** Do not let flame touch the shaft and do not overheat.

4. Remove exciter as follows: (Refer to Figure 294.)

a. Disconnect the exciter leads from the collector ring brush holder stud and breaking open the rheostat lead which passes through the alternator frame into the terminal box. Remove the exciter lead clamps inside the alternator end bracket.

b. Remove the four through bolt nuts at the exciter end bracket.

c. Remove the four ball bearing capscrews at the exciter end bracket.

d. The exciter bracket can now be removed by tapping against the end bracket bead with the aid of a blunt tool and hammer.

e. Slip the exciter frame and brush holder assembly off over the exciter armature after raising the exciter brushes off the commutator. The exciter leads that pass through the alternator and bracket for connection to the collector rings should be carefully fed through the opening to prevent damaging the insulation and placing undue strains on the connections.

f. The exciter armature can now be removed by simply pulling in a direct line parallel to the alternator shaft.

g. Remove the alternator end bracket after first lifting the collector ring brushes and removing the four end bracket cap screws and the four alternator ball bearing cap screws. Tap the end bracket loose at the bead by using a blunt tool and hammer. Drive the bracket off evenly to avoid pinching at the bracket fit or in the bearing housing.

h. The alternator rotor can now be removed from the stator by pulling the rotor out far enough to attach a wide sling. The whole rotor surface may be considered as subject to damage. Every precaution should be taken to avoid damaging the collector rings, damper winding, field coils, etc. The best type of sling is a wide metal or leather band which should be slipped under the laminated pole pieces of the rotor. This should be positioned so that the weight of the rotor is carried on at least two of the pole pieces. If a rope sling is used around the shaft, a spreader should be used to avoid side pressure against the rotor balance flanges. These flanges are cast iron and will break easily.

NOTE: To reassemble main generator and exciter, reverse the foregoing procedure.

To install the coupling, heat the coupling hub in oil to 400°. If this method is not feasible, use a torch on the hub, being careful not to overheat, coat the shaft with white lead to prevent scoring and push the hub onto the shaft. Install the discs, making sure to line them up with the marks on the hub. Install the flange also making certain to line up the flange with the marks on the hub and discs. These marks were made before disassembly.

To avoid overheating hub, use a piece of soft core solder which has melting point of approximately 400°. Heat the hub up to the point where the solder begins to melt.

DISASSEMBLY OF SUB-ASSEMBLIES

152. ALTERNATOR STATOR

The alternator stator is not sold as a disassembled unit, therefore, there will be no disassembly of this member, except for rewinding the stator when this becomes necessary. Winding and connection data will be found under "Winding and Connection Data".

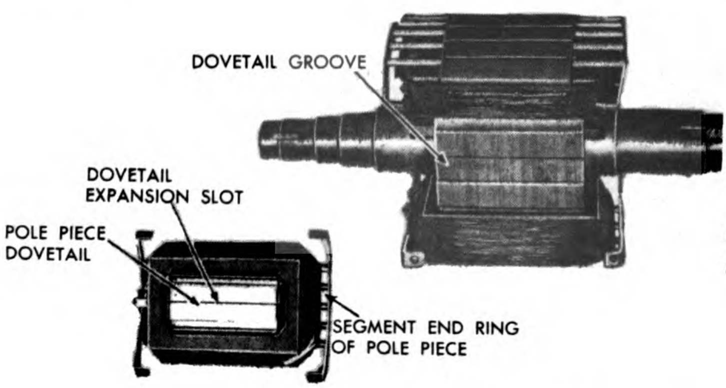


Figure 295. Rotor Stripped of Bearing Rings, Flanges, with one coil removed.

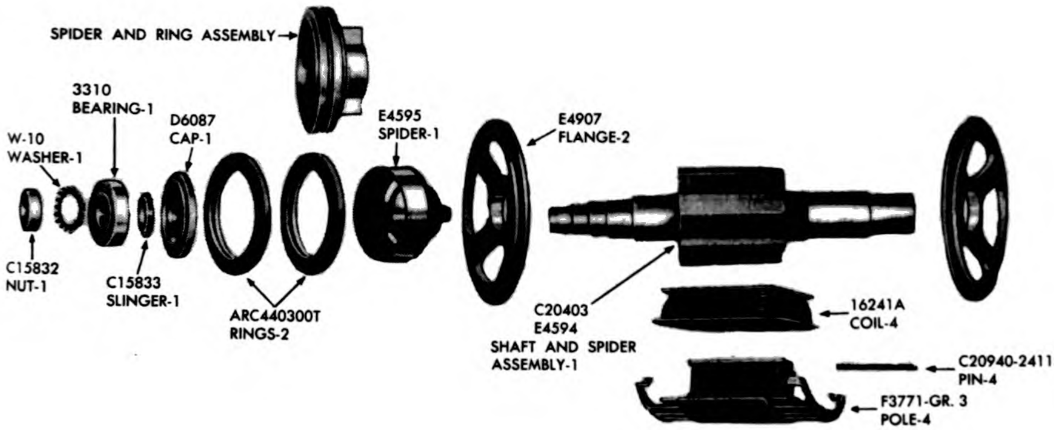


Figure 296. Exploded View of Main Generator Rotor.

153. ALTERNATOR ROTOR ASSEMBLY

(See Figures 295 and 296.) The alternator rotor assembly is composed of the following:

1 shaft and spider assembly
4 shunt field coils
4 pole pieces
2 balance flanges
1 collector ring spider
2 collector ring assemblies
1 ball bearing cap
1 ball bearing
1 ball bearing lock washer
1 ball bearing lock nut
1 ball bearing grease slinger

The disassembly of this member is as follows: Remove the ball bearing by first lifting the tongue of the ball bearing lock washer out of the groove in the ball bearing lock nut. The ball bearing nut having a right hand thread can then be backed

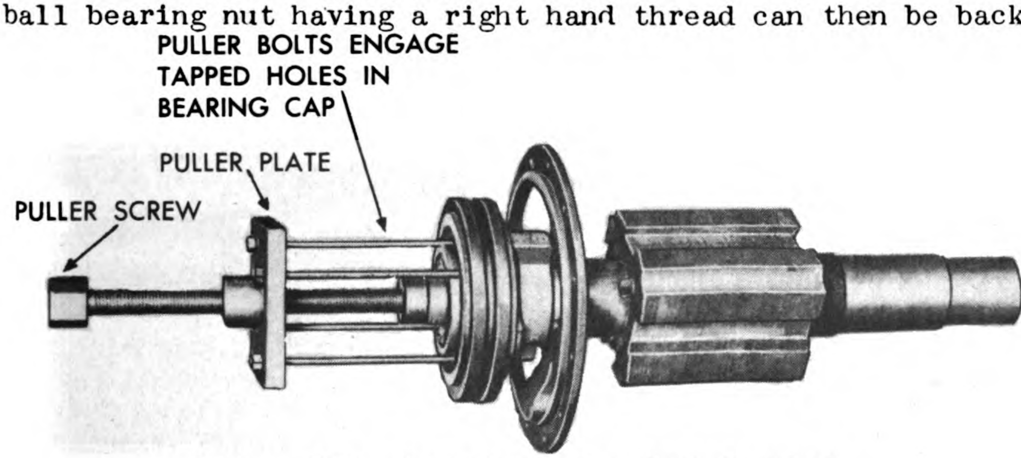


Figure 297. Removing Rotor Ball Bearing.

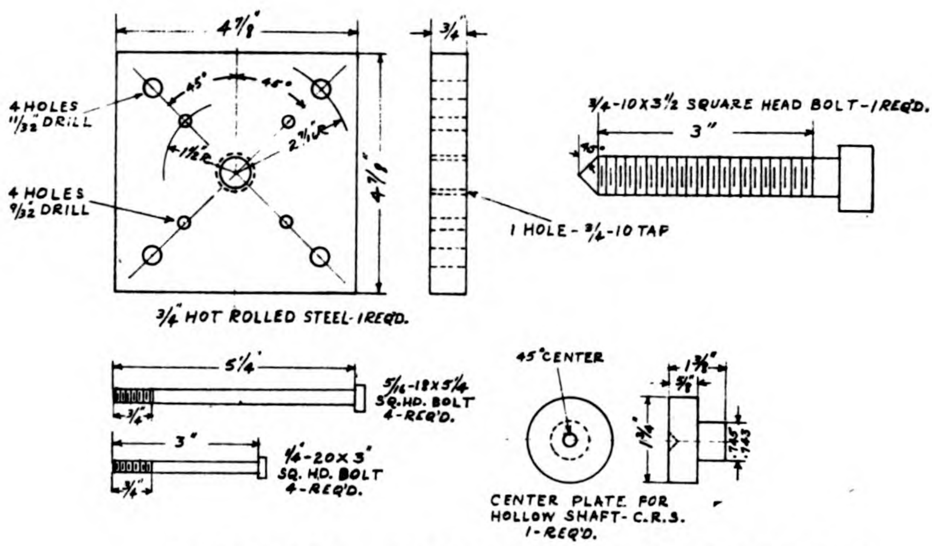


Figure 298. Diagram Special Bearing Puller.

off, using a spanner wrench. Pull the ball bearing from the shaft using a puller similar to that shown under Figure 297, or Figure 298. It will be noted that this puller has four bolts which pass through the puller plate and engage the four tapped screw holes in the ball bearing cap.

154. REMOVING COLLECTOR RINGS AND SPIDER

The collector ring and spider assembly can be removed by using a puller similar to that shown under Figure 299. It will be noted the hooks of the puller engage the hub of the collector ring spider. Do not attempt to pull the collector ring spider from the outer diameter since there is danger of damaging not only the collector rings but also the spider casting.

155. REMOVING BALANCE FLANGES

The balance flanges are secured in position by Allen set screws. These screws should first be loosened and the position of the balance flange marked with reference to the rotor shaft.

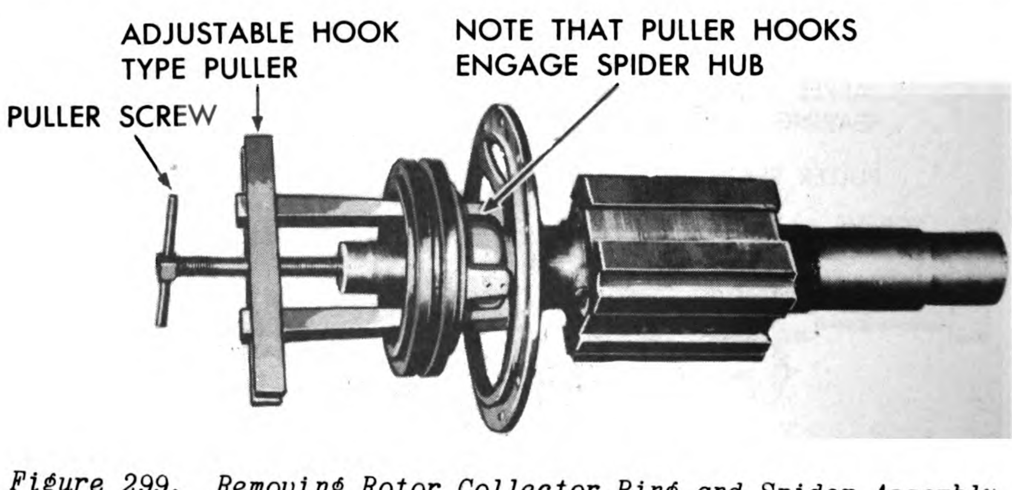


Figure 299. Removing Rotor Collector Ring and Spider Assembly.

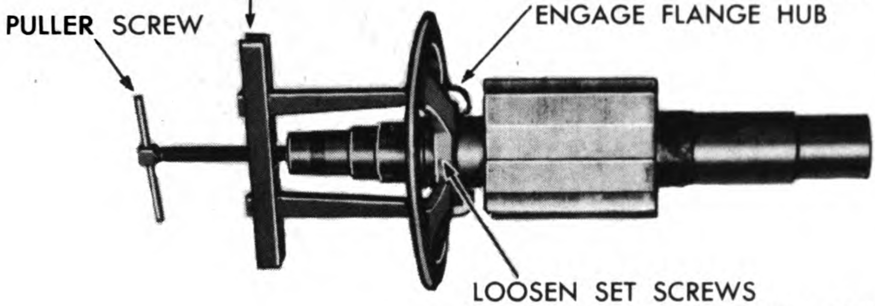


Figure 300. Removing Rotor Balance Flanges.

The balance flanges can be removed by using a puller similar to that shown under Figure 300. The puller hooks should engage the flange hub.

CAUTION: When replacing the balance flanges, be sure to replace them in exactly the original location. Failure to do this will result in the rotor being out of balance.

156. REMOVING ROTOR FIELD COIL

1. Remove the bolts which connect the squirrel cage slip ring segments together.

2. Remove the pole piece wedge pin by driving out toward the back end of the shaft.

3. Place rotor in an arbor press and press off the pole pieces, toward either end of the rotor. Pressure should be applied against the dove tail of the pole piece, using a punch shaped similar to the pole piece dove tail. Do not attempt to press off the pole piece by pressing against the pole piece body as this tends to create a wedging action which prevents the pole piece from slipping. The field coil can now be removed from the pole piece.

157. ALTERNATOR END BRACKET AND COLLECTOR RING BRUSH HOLDER ASSEMBLY

The only assembly work necessary on the alternator end bracket is to mount the collector ring brush holder assembly on the bosses inside the bracket. This assembly is mounted with four screws. For assembly of the collector ring brush holders see "Alternator Bracket and Brush Holder Assembly" Figure 301.

158. DISASSEMBLY OF EXCITER ARMATURE

1. Remove the exciter vent fan by first backing out the Allen set screws located in the hub of the fan. The fan can then be pulled off with the conventional hook-type puller. The hooks of the puller should engage the fan at the fan hub to avoid damage. Before removing the fan, be sure to mark its location with reference to the shaft so that it can be replaced in exactly the same position. Failure to do this may result in the armature being out of balance.

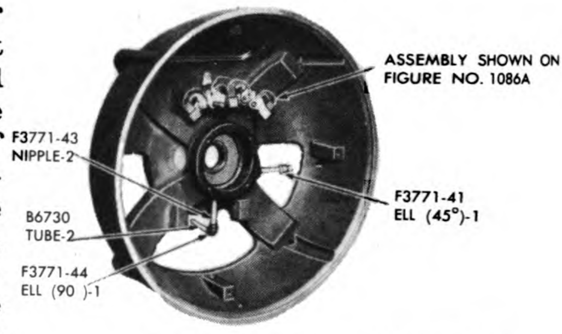


Figure 301. Alternator Bracket and Brush Holder Assembly.

2. The ball bearing can be removed with a puller similar to that shown under Figure 302, or Figure 298. The four bolts which pass through the head of the puller plate should engage the tapped screw holes in the ball bearing cap. The ball bearing is held on the shaft by a press fit and a retainer collar which presses against the front side of the ball bearing.

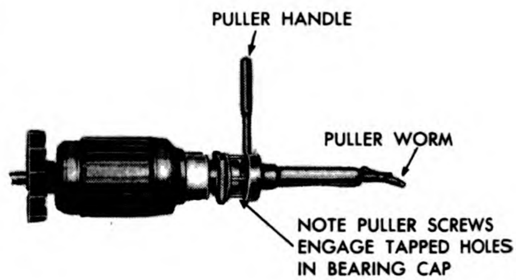


Figure 302. Removing Exciter Ball Bearing.

159. DISASSEMBLY OF EXCITER FRAME AND COIL

The exciter main poles and interpoles are each held in place by two flat head screws which pass through the exciter frame and engage tapped holes in the pole pieces. These screws are locked in position by drawing a portion of the frame metal into the slot in the pole piece screw. Before attempting to loosen the pole piece screws, it will therefore be necessary to remove this locking metal from the screw head slot.

The air gap of the exciter is regulated by shims of varying thickness behind the pole pieces, therefore, it is absolutely essential that the number of shims be noted behind each pole piece upon removal so that these same shims can be replaced when reassembling. The single gap for both shunt and interpoles is .044".

The exciter frame has two main pole and two interpole coils. The main pole coils are placed in the frame so that they are in the horizontal plane, and the interpole coils are placed at the top and bottom.

The pole piece holes in the exciter frame are not drilled centrally. Assembly the coils in the frame so that the coil leads are toward the brush holder mounting bosses.

All brush holder and field leads should be securely tied to the coil heads so that no strain will be exerted on the connections inside the coils.

160. DISASSEMBLY OF EXCITER BRUSH HOLDER

The exciter brush holder and yoke assembly is composed of two brush pocket assemblies mounted on canvas base, phenolic strips which are in turn riveted to the cast iron brush holder yoke. For illustration refer to Figure 303.

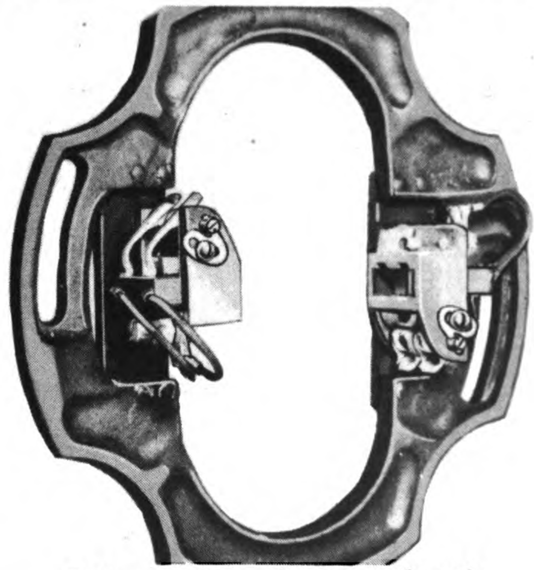


Figure 303. Exciter Brush Holder Assembly.

The brush holder pocket assemblies are interchangeable, i.e., there are no right or left assemblies.

The cast bronze body of the brush pocket is machined and drilled to accept the spring shaft on which two springs, two brush fingers and four washers are mounted. The spring shaft is held in position by the spring shaft adjustment plate and screw. Adjustment of the spring tension is made by removing the spring shaft adjustment plate screw and turning the spring shaft in a counter-clockwise rotation, while facing the adjustment end of spring shaft. A screw driver slot is provided in the end of the spring shaft for adjustment purposes. Spring tension should be adjusted carefully to agree with the spring tension limits of 10 to 13 ozs. Refer to "Method of Checking Brush Spring Tension".

161. DISASSEMBLY OF ALTERNATOR BRUSH HOLDER

The alternator brush holder assembly is composed of four separate brush pocket assemblies. Two assemblies are mounted on each brush holder stud and secured by a cup point, slotted-head, set screw which is locked in position with a locking nut.

The brush pockets are cast bronze and are machined and drilled to accept the cast bronze brush holder finger. The brush spring adjustment notches are cast integral with the brush holder pocket. Secure the brush finger on the supporting shaft with a short length of #22 guage brass wire through the small hole drilled in the spring shaft.

Adjust brush spring tension by locating the free end of the spring into the adjustment notch that will give a tension of 7 to 9 ozs. Refer to "Method of Adjusting Brush Spring Tension".

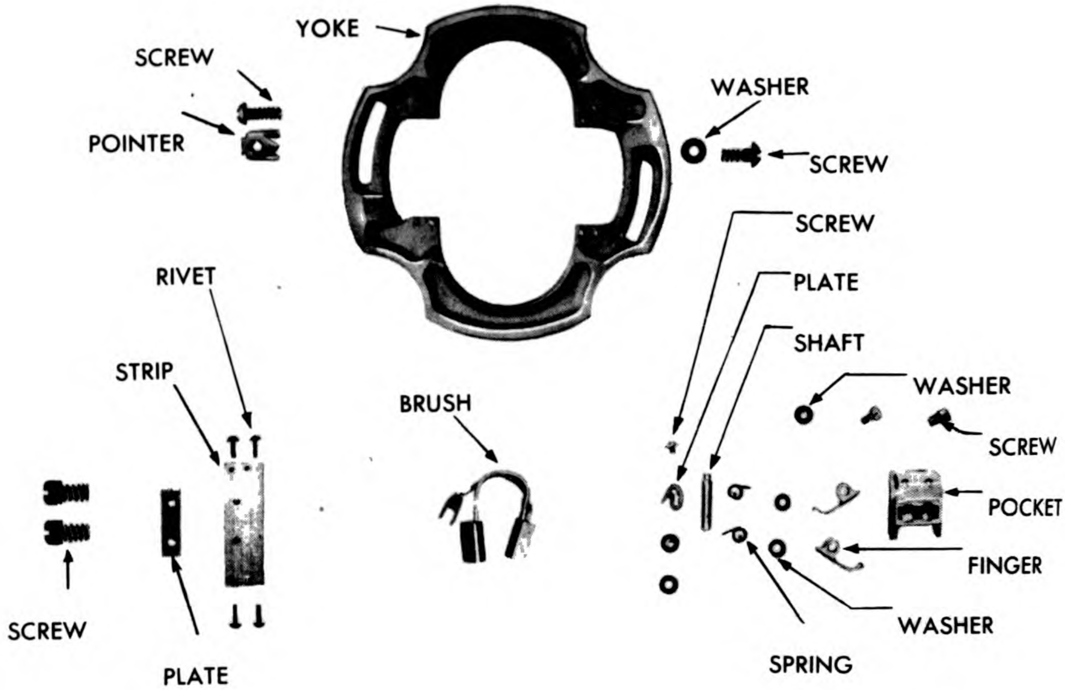


Figure 304. Exciter Brush Holder and Yoke Assembly

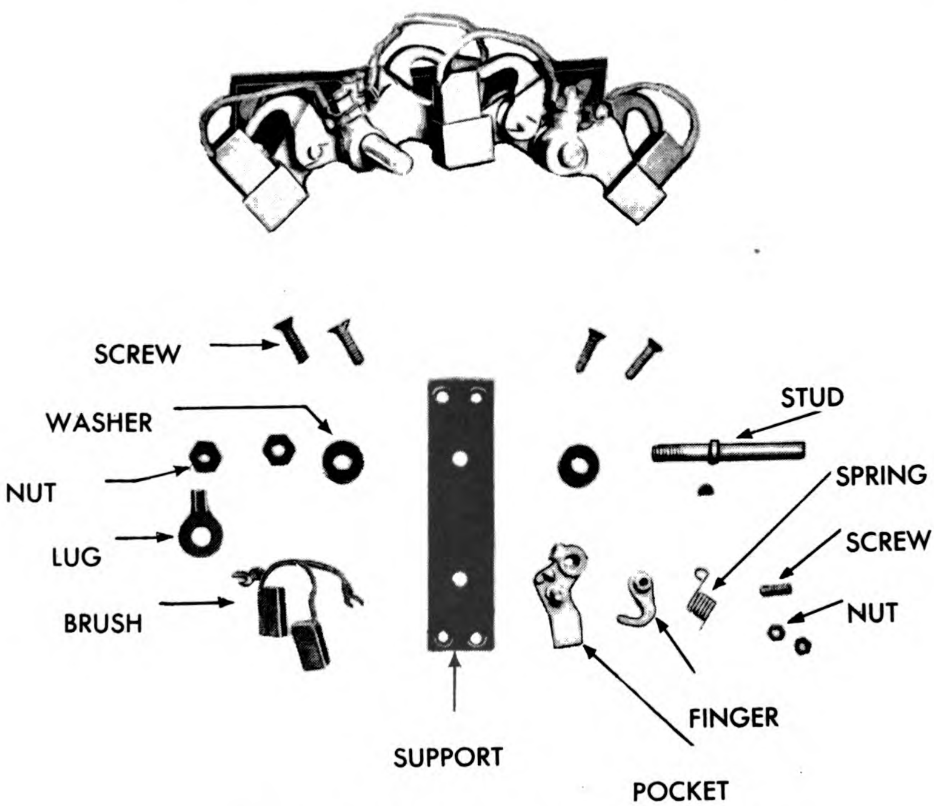


Figure 305 Alternator Brush Holder and Support

The brush holder studs mount on a strip of canvas base, phenolic material, with a steel flat washer on either side and secured by two brass lock nuts.

162. ALTERNATOR TROUBLES

1. The stator and rotor coils of the alternator are ungrounded. A single ground in the alternator may not render the unit inoperative but may result in shock to the operator. The remedy to such a condition is to locate the ground with the aid of a high potential ground test. The ground will show up in the form of a spark or burning. This is especially true if the ground is at some point in the coil heads. A ground in the stator slot may not show up in this manner, therefore, it may be necessary to open the internal star connection and check each phase and each phase pole. If the ground is located in the stator slot, it will generally be necessary to strip and rewind the entire stator, since it is impractical to repair a winding which has been thoroughly impregnated with polymerizing varnish.

Grounds in the stator coils may be determined by connecting one terminal of two 220 volt lamps connected in series to the frame of the generator and the other successively to the stator terminals with the generator operating at normal voltage. Lighting of the lamp indicates the presence of one or more grounds. The presence of high resistance grounds may be determined by following the procedure previously described, except by the use of a megger or bridge measurement and with the machine not running.

Grounds in the alternator rotor circuit may be determined (after first checking to see that there is no ground in the exciter) by operating the unit at normal voltage and connecting one terminal of a 120 volt light to the frame and the other terminal, successively, to the two collector ring brush holder

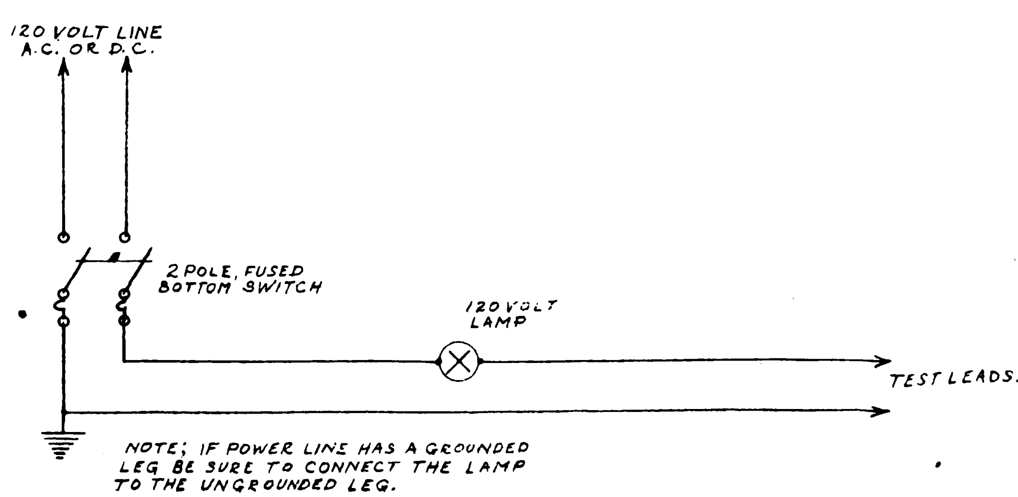


Figure 306. Test Lamp Connection for Locating Grounded Coil.

studs. The lighting of the lamp indicates a ground. To locate the grounded coil of the rotor, connect a 120 volt lamp in series with a circuit of equal voltage, using one terminal of the lamp and the other side of the line as test loads. See Figure 306.

To locate the grounded rotor coil, first open the circuit between each coil and test between one of the coil terminals and the rotor shaft or core. Lighting of the lamp indicates a grounded coil.

If the ground is not toward the outside surface of the coil, where it can easily be corrected, then it is advisable to replace the faulty coil. Be sure to check rotor balance before reassembling if coil replacement is necessary.

163. SHORTED ROTOR COILS (Failure to obtain full AC voltage on voltmeter on Control Panel)

This condition is not to be confused with exciter troubles since symptoms are similar. (See Exciter Troubles.)

Short circuited turns, total or partial, in one rotor field coil, will generally be evidenced by uniform overheating of the other coils and possibly cool operation of the shorter coil. The extent of the short circuit can be determined by impressing a voltage of approximately 120 volts (AC or DC) across the collector rings and measuring the voltage drop across each coil with a voltmeter. The variation of individual readings should not exceed approximately 5%. The shorted coil will show a drop less than the other, the amount depending upon the extent of the short.

CAUTION: Be sure that the exciter circuit is disconnected from the rotor field circuit before making this test.

164. OPEN CIRCUITED ROTOR COILS (No voltage registers on voltmeter on Control Panel)

An open circuited rotor field coil will result in the failure of the alternator to build up a voltage in spite of proper exciter and collector ring voltage. Test for open circuit using the test lamp shown on "Figure No. 306" by testing between the two coil terminals at each rotor coil. Failure of the lamp to light indicates the coil is open circuited.

NOTE: Replacement of rotor field coils is not recommended in the field except in cases of emergency since the entire rotor is balanced as a unit, therefore, any change in weight at a given point will cause the rotor to be out of balance. For this reason it is always good practice to check the rotor balance in a dynamic balancing machine when coil replacements are necessary.

165. EXCITER TROUBLES

The exciter at full field (rheostat turned full-out) will deliver the following minimum voltages at full alternator field load and no load.

	Volts	Amperes
NO LOAD	185 (approx.) cold	
	175 (approx.) hot	.0
	160 (approx.) cold	7.6 (approx.)
LOADED	150 (approx.) hot	6.06 (approx.)

Check voltage at collector rings. For no load reading raise the collector ring brushes in the brush holder pockets so that no contact is made between brush and ring. If voltage values considerably lower than listed above are observed, check as follows.

(a) Check shunt field for shorts; this can be done by checking the voltage drop across each of the two shunt coils. The coil having the lower reading will be the faulty coil. A badly shorted coil will remain cool and the good coils will overheat considerably.

(b) Check armature for shorts; symptoms usually are, sparking at commutator, blackened commutator and burnt bars. If badly shorted the exciter may not pick up a field. In this event, remove the armature and check in a growler.

(c) Check armature for open circuits; symptoms are similar to those described under ("b") except flashing at brushes is apt to be more violent and accompanied by a ring of fire around the commutator. In some cases the exciter will fail to pick up a field.

(d) Check for shorted interpole coil; symptoms are sparking at brushes and voltage slightly lower than normal. Locate faulty interpole coil by measuring the voltage drop across each coil with a low reading voltmeter. The shorted coil will have the lowest voltage drop.

(e) Check brush neutral setting; the index pointer should be opposite the chisel mark on the brush holder yoke. Symptoms are unusual sparking at brushes and slightly abnormal exciter voltage.

(f) Check brushes; the brushes may be stuck in the holders or may be too short to make good contact with the commutator. See that brushes are perfectly seated to the contour of the commutator.

166. EXCITER FAILS TO GENERATE

(Voltmeter on control panel does not register a voltage).

If no voltage can be measured at the exciter, check as follows after raising the brushes off the commutator and disconnecting the two leads from the right brush holder.

(a) Check exciter shunt field for open circuit. Use test lamp (Figure 306) and test between the right hand brush holder lead marked (F2) and terminal marked (RHEO.-F1) located in the alternator panel box. If not open the lamp will light.

(b) Check rheostat for open circuit by testing with test lamp (Figure 306) across the two rheostat terminals. Failure of lamp to light indicates rheostat is open circuited. NOTE: Disconnect leads from one side of rheostat before making above test.

(c) Check the resistance tube for openings after disconnecting leads from one of the terminals. Test with test lamp (Figure 306) directly across the two outside terminals of the tube inside the alternator panel box. Failure of the lamp to light indicates tube is open circuited.

(d) Check the voltage regulator for open circuits. See instructions furnished by The Buda Company and General Electric Company.

(e) Check brushes - the brushes should make good contact with commutator and work free in the brush holder pockets.

167. METHOD OF LOCATING EXCITER BRUSH NEUTRAL

The brushes of the exciter must be set on the neutral point in order to obtain satisfactory performance, commutation, and normal brush and commutator life. If it becomes necessary to replace or rewind the exciter armature the brush neutral position should be checked and reset if necessary. The following is the only practical method in this instance due to the design and application of the machine and is known as the Induced Voltage or Kick Method. This method requires the field circuit to be separated from the armature circuit and separately excited, and the induced voltage built up in the armature observed on a low reading voltage meter connected directly to the brushes. Proceed as follows:

1. Separate the field and armature circuits by disconnecting the leads from the exciter brush holders and removing the connection link from the rheostat circuit terminals inside the alternator panel box. This link is located at the extreme top and is the shortest of the links. See Figure 307.

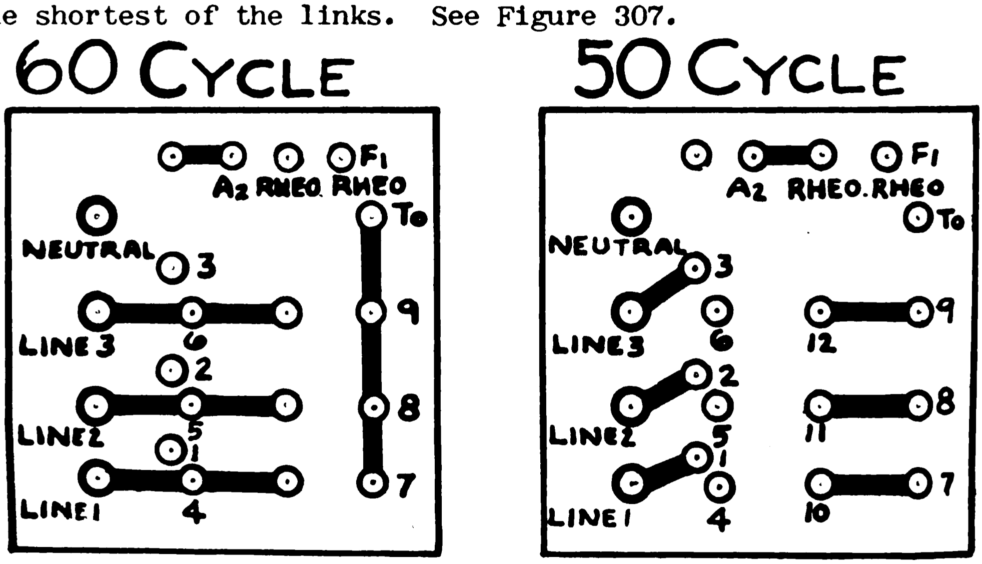


Figure 307. Arrangements of Connection Links.

2. Connect the terminals of a low reading voltmeter (having a scale of 3-0-3 or 10-0-10 volts) directly to the pigtail of one of the brushes on each side of the commutator or to the brush holder pockets.

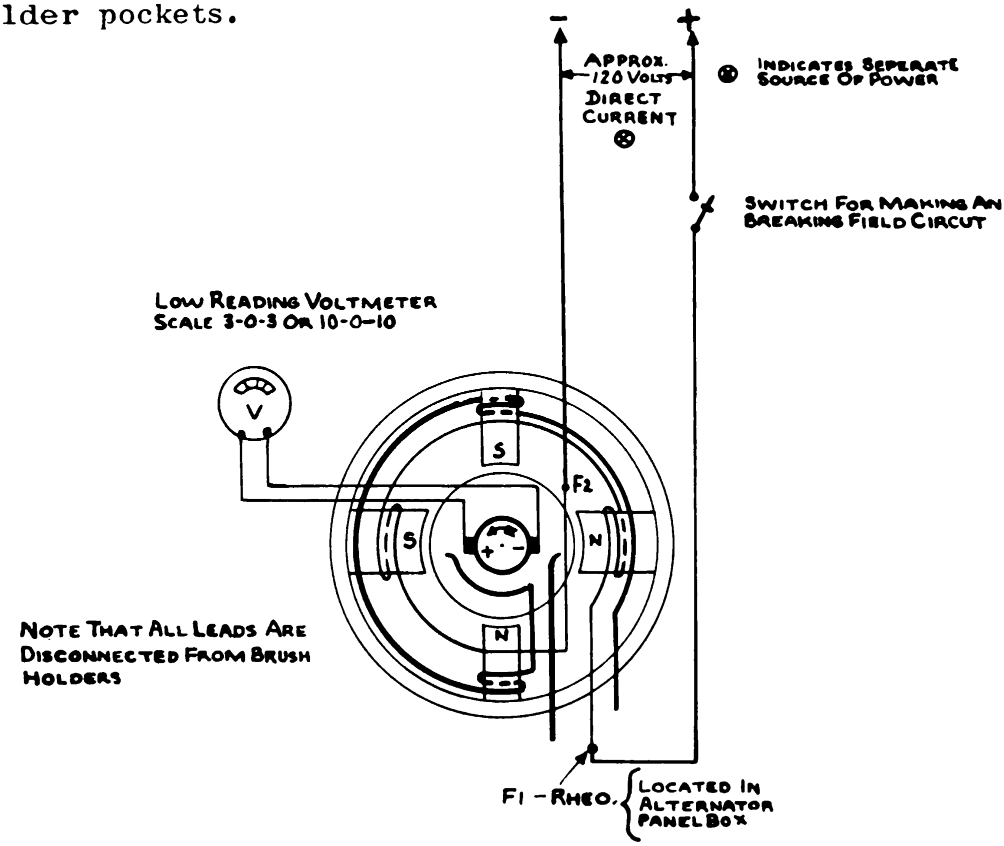


Figure 308. Kick Test Diagram for Brush Neutral.

3. Connect the exciter shunt field leads F2 and RHEO-F1 across a separate direct current source of power having a potential of approximately 120 volts. This circuit should be provided with means of making and breaking the circuit quickly. See Figure 308. Shunt lead F2 will be one of the leads connected to the right hand brush holder pocket. Shunt lead RHEO-F1 is located inside the alternator panel box. See Connection Diagram Figures 309 and 307.

4. Close the field circuit and maintain the field for a few seconds until the field is thoroughly saturated, and then break the circuit quickly and observe, accurately, the deflection or "kick" of the voltmeter needle.

Rotate the armature in the direction of rotation for a distance of not over two commutator bars and repeat the operation just described. Continue this procedure until readings have been taken for at least one-half the distance around the commutator. When the neutral point is reached, the voltmeter will deflect both to the right and left of the zero, with equal intensities and an equal number of deflections to the right and left of zero taking into consideration the number of test positions involved in rotating the armature one-half revolution.

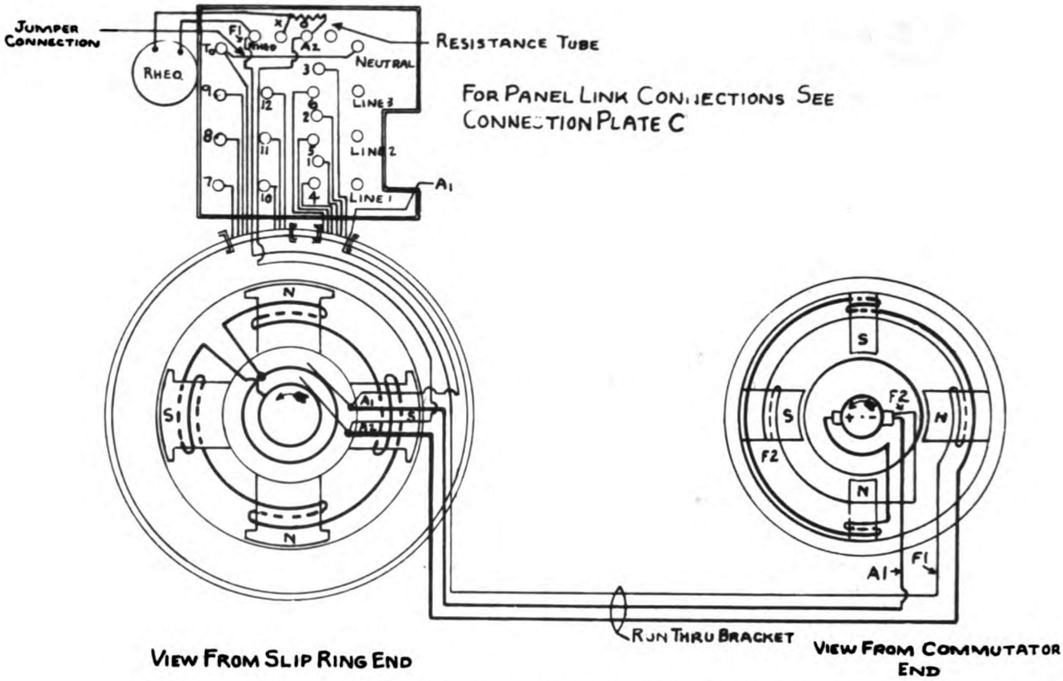


Figure 309. Connection Diagram.

Adjust the brush holder position by loosening the two brush holder yoke clamping screws and by moving the yoke to the right or left. After each setting of the brush holder be sure to clamp the yoke tightly in position. Failure to do this will affect the accuracy of the readings. When the neutral point is approached the voltmeter deflections will become smaller, therefore, if the deflection is greater than that observed at any previous setting, it is an indication the brush holder yoke should be moved in the opposite direction. Make and break the field circuit at evenly timed intervals.

NOTE: Brush setting is of utmost importance and should be accomplished as accurately as possible. Be sure the brushes are perfectly seated and that the brush holder yoke is clamped tightly in all positions when testing for the neutral point. Since the armature must be moved very little for each reading, the engine crank will be most useful for locating each test position. It will probably be necessary to relieve the cylinder compression of the engine in order to maintain a fixed armature position during the test procedure.

If the original neutral does not coincide with the new one, it should be removed and a new point marked on the brush holder yoke opposite the index pointer. A small chisel is suitable for this purpose.

NOTE: If the exciter polarity is reversed upon completing the neutral brush setting, the exciter residual magnetism should be reversed by exciting the shunt field for a few seconds in the opposite direction: i.e. inter-change the two line leads shown on Figure 308.

168. EXCITER ARMATURE WINDING DATA

Coil Data

Number of Coils	57
Number of Coils per Slot. . .	3
Number of Slots	19
Turns per Coil.	10
Size of Wire.	#18 S.C.E.
Coil Pitch.	Slot 1 to Slot 10
Number of Commutator Bars . .	57
Commutator Pitch.	Bar #1 to Bar 2
Center Line Through First Armature Coil Passes . . .	Between slots 5 and 6 and between bars 2 and 3
Weight of Armature Winding. .	4.8 lbs.
Armature Resistance @ 25° C .	1.52 ohms.

NOTE: Tape all three coils together at coil heads (front and back) with .007" cloth tape 1/2 overlapping. Insulate coil leads with 1/8" cotton sleeving.

NOTE: See Figure 310 for slot insulation details.

Figure 310. Cutaway View of Exciter Armature Slot, Showing Coil and Slot Insulation.

169. VARNISH TREATMENT

Preheat completely wound armature and dip while hot in black baking varnish. Leave immersed until bubbling ceases. Drain well and bake at 250° F. until thoroughly dry. Repeat process to give three coats.

170. EXCITER FIELD WINDING DATA

	SHUNT	INTERPOLE
Wire Size	*#24 #23	#13
Wire Insulation	Heavy Formvar	S.C.E.
Turns Per Coil	*1350 T #24 650 T #23	164
Resistance @ 25° Per Coil	63.5	.27 ohm
Weight in lbs. Per Coil	2.1 of #24 1.6 of #23	2-1/8
Lead Wire Size	#14 R.C.C.	#14 R.C.C.
Single Air Gap	.044"	.044"

*Wind the 1350 turns of #24 next to pole.

171. VARNISH TREATMENT OF EXCITER COILS

Shunt Coil

Dip the completed coil quickly in black baking varnish, drain thoroughly and bake at 225° - 250° F. until thoroughly dry. Repeat to give 2 coats. Apply one coat of air drying varnish after coils are assembled in the frame.

NOTE: See Figure 311 for coil insulation details.

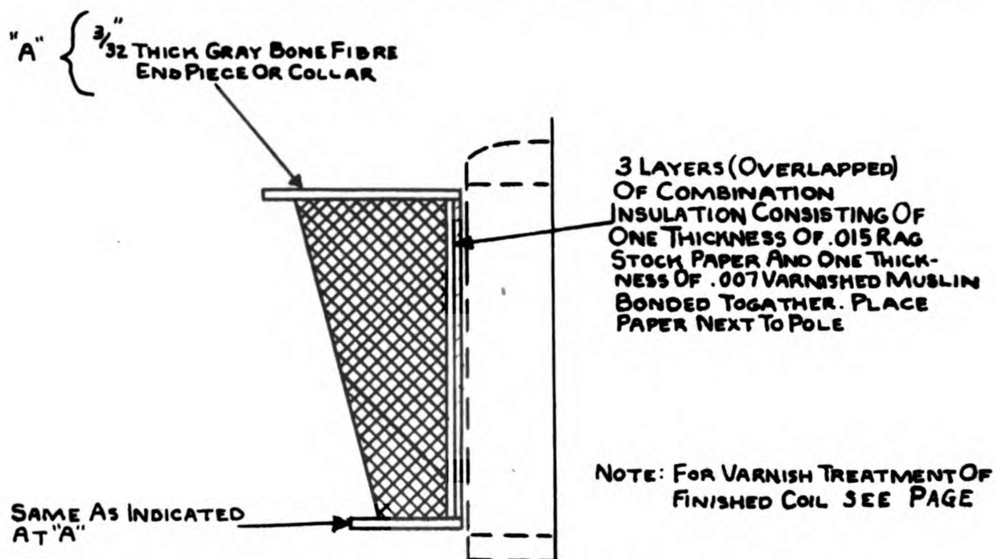


Figure 311. Sectional View Through One Half of Exciter Main Pole Coil.

Interpole Coil

Preheat completed coil and dip while hot in black baking varnish. Drain well and bake at 225° - 250° F. until thoroughly dry. Repeat to give 3 coats. Give coil one coat of air drying varnish after it is assembled in frame. See Figure 312.

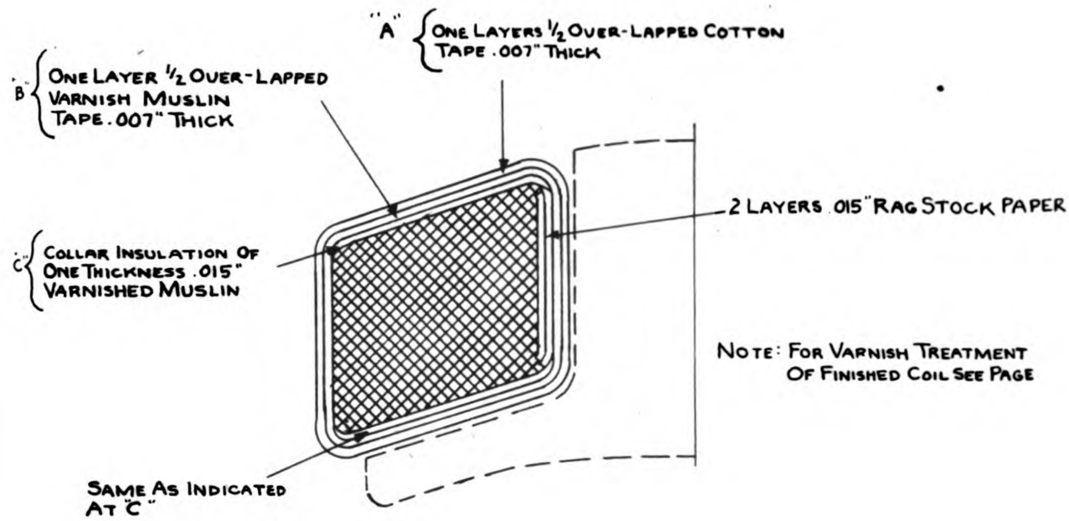


Figure 312. Sectional View Through One Half of Commutator Pole Coil.

173. REVOLVING FIELD WINDING DATA

FIELD WINDING	SHUNT
Wire Size	#16 #15
Wire Insulation	S.C.C.
Turns Per Coil.	225T-#16 - wind next to pole 525T-#15
Resistance @ 25° C. . .	5.15 Ohms per coil
Weight in lbs..	3.02 - of #16 11.15 - of #15
Poles in Series	4
Leadwire	#10 Asbestos covered
Single Air Gap.	.080"

NOTE: See Figure 313 for details of bobbin insulation.

174. VARNISH TREATMENT OF FIELD WINDINGS

Preheat the completely wound coil and dip while hot in black baking varnish. Leave submersed until bubbling ceases and drain well. Bake at 225° to 250° F. for 8 to 10 hours. Repeat to give two coats. Apply one coat of Red Protective Sealer after coil has cooled.

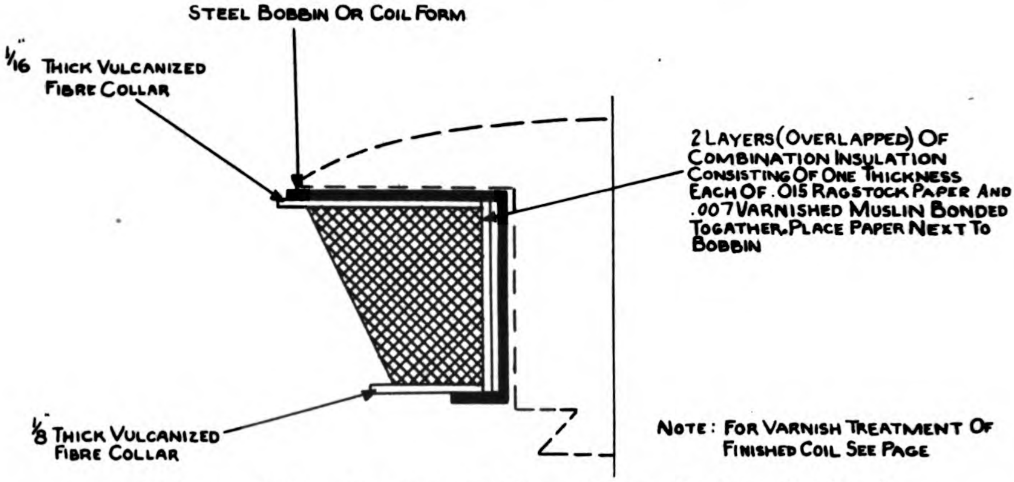


Figure 313. Sectional View Through One Half of Alternator Revolving Field Coil.

175. ALTERNATOR STATOR WINDING DATA

	MAIN WINDING	AUXILIARY WINDING
Number of Poles	4	
Number of Slots	72	
Number of Coils	72	36
Turns per Coil	* 5½	* 1
Wire Size	3 of #13	2 of #12
Wire Insulation	S.C.E.	S.C.E.
Coil Span	Slot - 1 to Slot - 14	Same
Lead Wire Size	#8 V.C.C.	#8 V.C.C.
Weight of Copper, lbs.	55	4.2

Resistance @ 25° C. Ohms Line to line on 220 volt, 60 cy. = .0322 ohms
" " " " 400 " 50 cy. = .143 "

Single Air Gap . . . . .080"

Connected . . . . See Figure 314.

*Wind each pole group of main coils 6-5-6-5-6-5, then wind the auxiliary winding in with the 5 turn main coils. Auxiliary winding is sleeved the entire length with 3/16" cotton sleeving. Total approximate length of auxiliary is 13-1/2 feet for each phase pole group.

NOTE: Insulate all coil and cross-over leads with 3/16" cotton sleeving.

Tape all coil heads with .007" cotton tape 1/2 over lapping.

Extend slot insulation, slot liner and top stick 1/2" beyond edge of stator iron.

Separate each group of phase coils for full width and length with combination insulation consisting of one piece .015" ragstock paper and one piece .007 varnished muslin bonded together.

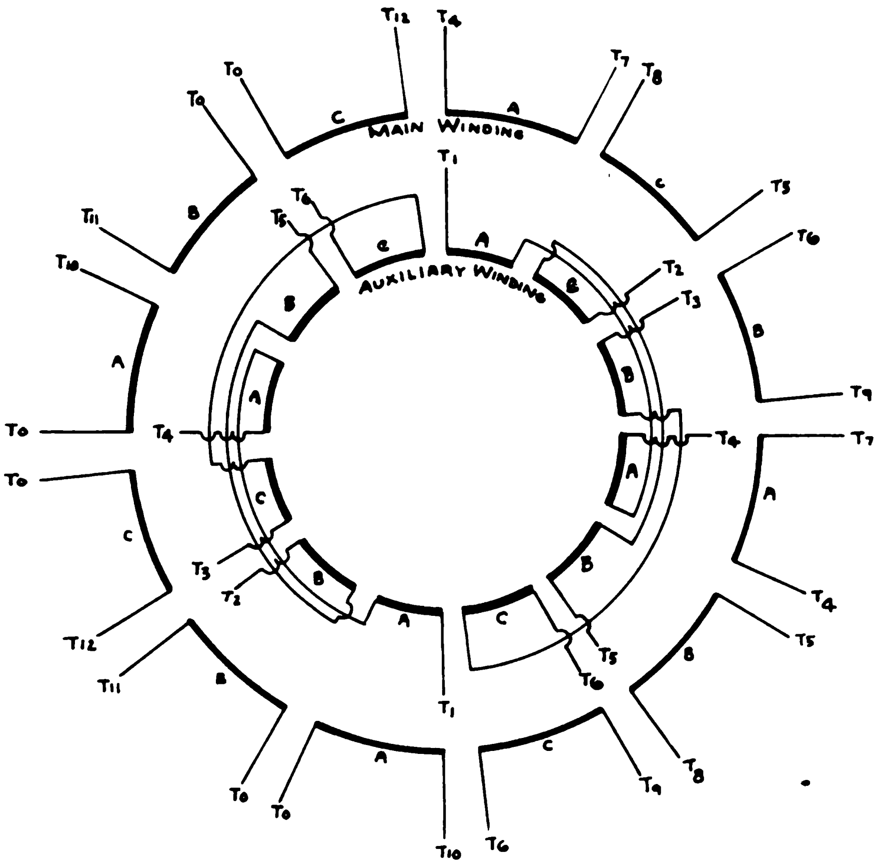


Figure 314. Stator Internal Connection Diagram.

NOTE: See Figure 315 for slot insulation details.

176. VARNISH TREATMENT OF STATOR COILS

Preheat completely wound stator 1-3/4 to 2 hours @ 250° F. Immerse while hot until all bubbling stops in clear black baking varnish. Drain well and bake at 250° F. for 9 to 12 hours. Repeat the process to give three coats. After stator has cooled apply one coat of air drying varnish.

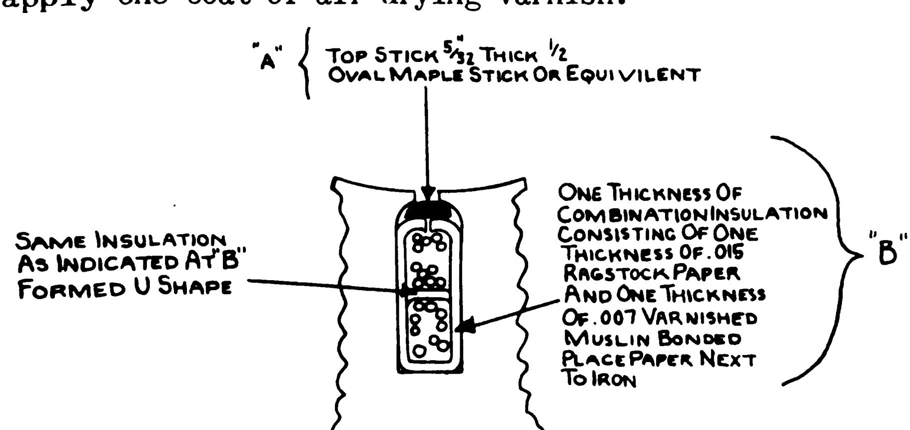


Figure 315. Cutaway View of Alternator Slot, Showing Coil and Slot Insulation.

Chapter VI

SERVICING AND MAINTENANCE OF CONTROL UNIT

177. GENERAL DESCRIPTION OF CONTROL UNIT

The generator control unit contains the devices essential to the operation of the engine and the generator. It consists of a rigid steel frame with the control panel on the front, easily removable sides and back, a fixed top cover and with open bottom. The unit is supported from the bottom by shock proofing cushions to reduce vibration from the engine. All connections to external equipment are made through the open bottom.

178. GENERAL DESCRIPTION OF PANEL EQUIPMENT

The panel equipment consists of a voltmeter and ammeter, a generator voltage regulator, an automatic air circuit breaker, synchronizing lamp equipment, a synchronizing switch, an ammeter transfer switch, the exciter field rheostat, the engine controls, indicating instruments and gauges.

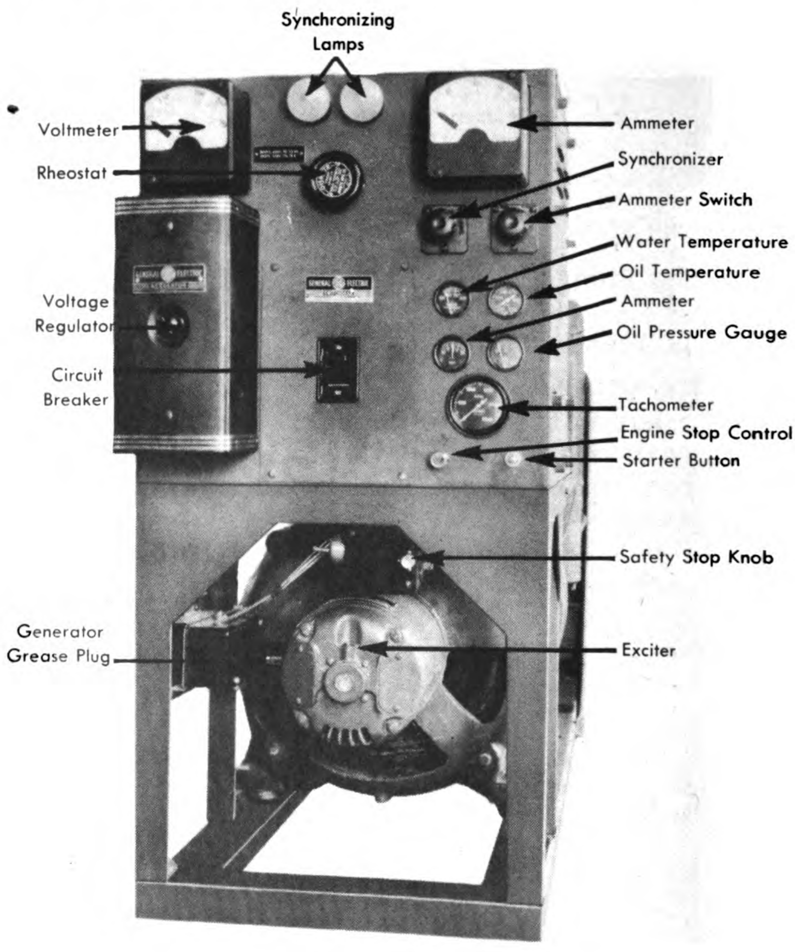


Figure 316. Generator Control Panel.

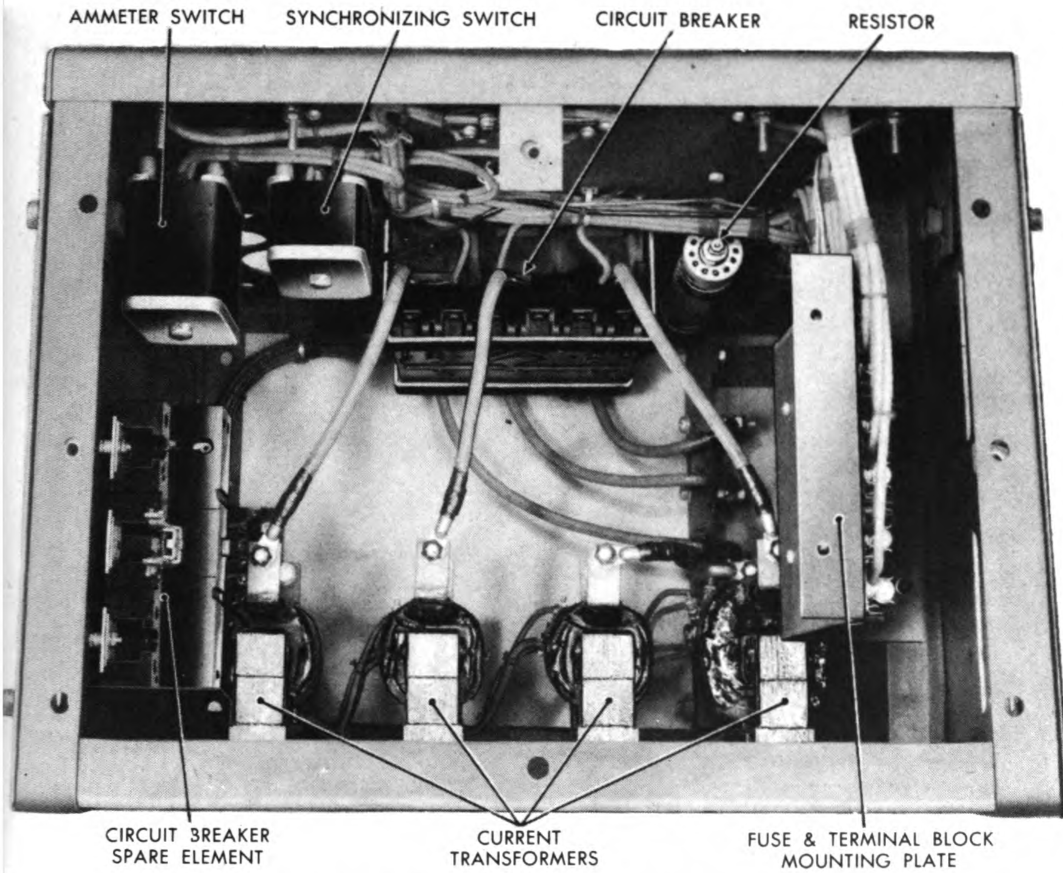


Figure 317. Control Unit - Top View.

179. GENERAL DESCRIPTION OF INTERIOR EQUIPMENT

Within the unit are three current transformers for the line ammeter and one current transformer for the voltage regulator compensation, terminal boards for main and secondary leads and the protective fuses. See Figures 317 and 318. The spare 50 A. thermal element for the air circuit breaker is mounted on the right side cover. The wiring diagram for the unit is located on the inside of the left side cover. All units are delivered with 100 A. thermal elements in the air circuit breaker for 60 cycle operation.

180. GENERAL DESCRIPTION OF OPERATION

The generator control unit is designed to control the 3 phase, 4 wire generator, which may be operated at either of two ratings as follows:

37.5 KVA, 60 cycle, 1800 R.P.M., 127/220 V.

31.3 KVA, 50 cycle, 1500 R.P.M., 230/400 V.

The change in generator voltage is made by moving connection links on the terminal board of the generator and on the terminal board within the unit and by changing the position of the slider on the resistor mounted inside the voltage regulator case. Engine speed must be adjusted separately to correspond with the desired

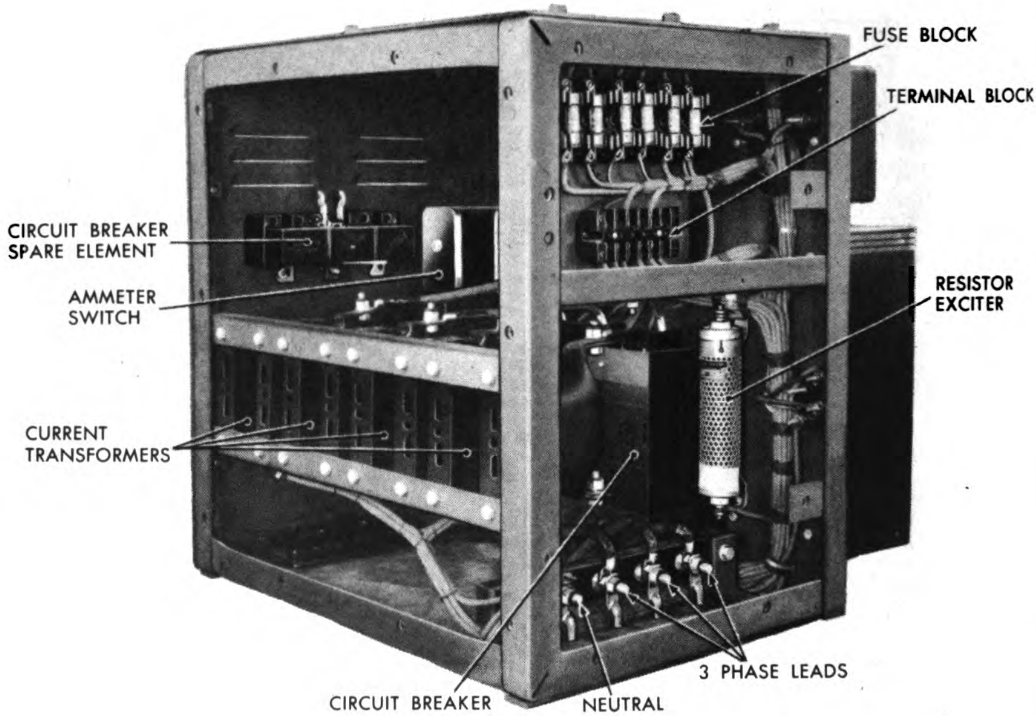


Figure 318. Side View Control Unit.

operation. Additionally, the 100 A. tripping element installed in the air circuit breaker for 60 cycle operation must be changed to the spare 50 A. tripping element when 50 cycle operation is desired. See paragraph 196.

181. REPAIRS AND PARTS REPLACEMENTS

The maintenance personnel should not attempt to make any repairs to the instruments or switches other than those indicated in the following paragraphs. If any of the instruments fail to function properly, it is better and quicker to replace the faulty instrument or switch. This is necessary because of the fine calibrations which are required and because the instruments needed for these calibrations usually are not available to the maintenance personnel.

182. OVERCURRENT PROTECTION

Each pole of the air circuit breaker is equipped with thermal and instantaneous overcurrent tripping element. The thermal element, which has been selected for operation in an ambient temperature of 50° C, is non-adjustable and provides overcurrent protection for the generator. The instantaneous element, has a tripping range adjustable from 350-1100 amperes in the case of the 100- ampere overcurrent unit, and from 175-550 amperes in the case of the 50 ampere overcurrent unit, and may be set as required for service conditions.

183. UNDERVOLTAGE PROTECTION

Each breaker is equipped with an undervoltage device having a 230 V. coil. This device functions to trip the breaker on voltage failure and is connected to operate on oil failure, high temperature of the cooling water or if the engine is shut down by means of the Bowden switch, which is mounted on the Governor - see Figure 102. The undervoltage device is calibrated to pick up at 180 V. or less to insure positive operation well below operating voltage. It will drop out on approximately 120 V., or below values ordinarily experienced in operation. Care should be given the setting of the undervoltage device when changing its mounting. When changing breaker trip elements, carefully check that the undervoltage trip pin has sufficient travel to operate the trip device when the undervoltage device is de-energized. It should be impossible to close the breaker while the undervoltage device is de-energized.

The undervoltage device armature travel has been adjusted in the factory by the positioning of the armature stop screw at the top of the device and the lower limit of travel was adjusted by the positioning of the threaded cap at the bottom of the armature pin. Some additional adjustment with respect to the tripping bar in the trip unit may be obtained by moving the entire undervoltage element assembly in the two mounting holes.

184. BOWDEN SWITCH

This switch operates to open the main circuit breaker when the governor control button is pulled all the way out. This assures that the circuit breaker is open when one unit is stopped. This is very essential when more than one unit is operated in parallel. See Figure 102.

185. HAND OPERATION OF CONTROL UNIT

If it is desired to transfer the generator to hand control of voltage from that normally supplied by the voltage regulator and the generator is running, turn the exciter field rheostat in slowly till the voltage begins to fall. The voltage adjusting rheostat then should be turned to increase the resistance after which the regulator is out of circuit and the voltage may be controlled by the exciter field alone. To return to regulator control, turn the voltage adjusting rheostat back slowly to its normal position and move the exciter rheostat in turn slowly back to its normal setting. After this operation the regulator will again operate in its former manner.

186. INSTRUMENT TRANSFORMERS

The three line transformers are single secondary transformers having a 24:1 ratio with 5A. secondary. The compensating transformer has a 24:1 ratio with 5A. mid-tap secondary to permit proper current for compensation at both voltages of operation. Lead A at the terminal board is connected to the full winding on 60 cycle operation and the mid-tap for 50 cycle operation.

The ammeter is provided with a current transformer. The current transformer used with the ammeter must have the same ratio as the transformer for which it was calibrated, as indicated by the ratio printed on the scale of the instrument. See the Wiring Diagram. In the event of a faulty instrument, it should be replaced with a new one and the faulty one returned to such a base where equipment and skill is available to make repairs. Replacements because of faulty instruments are rare.

The voltmeter is self-contained and has no external resistance. When there is no current flowing through the instruments and they are properly leveled, the needle should indicate zero. Any deviation from zero should be corrected by means of the zero setter.

CONTROL AND INSTRUMENT SWITCHES

188. AMMETER SWITCH

Figure 319 shows the moving contacts of the ammeter switch. These contacts are marked with odd numbers on the left and even numbers on the right-hand side of the switch, back view, starting with the stage next to the panel. If for any reason a contact is omitted, its corresponding number is also omitted; for instance, number 1 is always the left-hand contact of stage 1; if for any reason this contact is omitted, the numbering will start with 2 which will be the right-hand contact of stage 1. With this system of numbering, the contact number also identifies the stage; for instance, contact 9 is the left-hand contact of stage 5, unless, of course, the switch has a special numbering of contacts due to the purchaser's request.

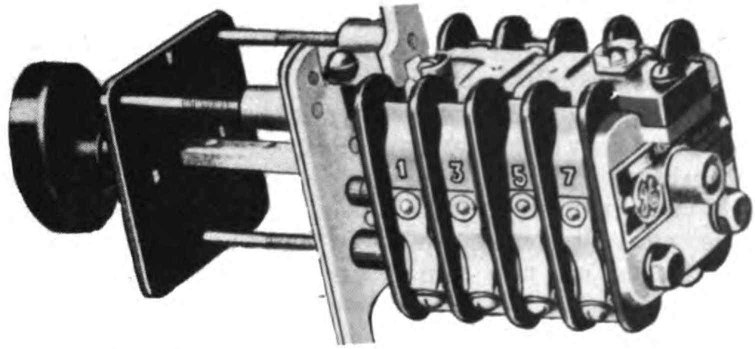


Figure 319. Ammeter Switch.

189. REPLACING CONTACTS ON AMMETER SWITCH

To remove the moving contact, in case the contacts are burned and need replacement, first remove the screw and clamping washer holding the shunt to the terminal, Figure 319; then with the contact in the open position, press in on top and pull upwards to remove. The new contact is inserted by entering the end of the moving contact support under the shoe on the moving contact and sliding the contact down until the tongue engages the notch in the support. The shunt is then fastened to the terminal by means of the clamping washer and screw. Care should be exercised to avoid creasing or kinking the shunt.

If a stationary contact requires replacements, a new contact unit should be installed by means of two round-head screws holding the stationary contact support to the front and rear supports of the switch.

If it is necessary to replace cams, the switch must be disassembled. Before starting, secure a drawing of the switch showing the cam arrangement. First remove the handle; then the fixed contact support; then loosen the tie rods through the switch but do not remove them. Slip the front support off the shaft, being careful not to pull the shaft out of the cams. Stand the switch up on the table, resting on the rear support with the tie rods and shaft extending up. Slide the shaft out just enough to remove the pin through the shaft which seats in the counter bore in the indent wheel or spring stretcher but do not slide the shaft out enough to lose the cams in the last stage. Push the shaft back and slip off the indent wheel or spring stretcher being careful to hold the shaft in so as not to misplace the cams. The first barrier may now be removed. Before removing the cams, compare their position with the cam arrangement on the drawing and be sure the drawing is understood before proceeding. Each contact stage requires two or three cams depending on whether there are one or two contacts per stage. The cam arrangement is usually shown on the drawing with vertical rows of three cams or two cams and one spacer. Under each vertical row are the contact numbers, to which the cams apply. The horizontal rows are lettered A, B, and C. The A cam is the one removed first, working from the front end of the switch, the B cam next and the C cam last. Unless otherwise stated, the position of the cams on the drawing are for the vertical switch position.

Reassemble the switch from the rear support. Put the tie rods through the rear support and place it on the table with the tie rods extending up. Put the shaft in the rear support in an angular position corresponding to the vertical switch position, or to agree with the cam arrangement on the drawing. Assemble the rear barrier and contacts. Place the C cam for the rear contacts on the shaft in the exact position shown in the cam arrangement, next the B cam and the A cam last. Continue with the next contact stage in the same manner until all the stages are assembled. Assemble the indent wheel or spring stretcher and spring. Slide the shaft out just enough to replace the pin which seats in the counterbore of the indent wheel or spring stretcher. Assemble the front support and if it is a sustained contact switch, be sure the ball and spring which engage the notches in the indent wheel are assembled before pushing the front support home. Tighten the tie rods, first making sure the barriers are all properly nested.

OPERATING GENERATOR SWITCHBOARD

190. STARTING ENGINE

NOTE: Whether or not connections of the load have been made, the circuit breaker must be in off position when starting the engine.

1. Turn the safety stop knob to on position, that is, pointed to the left. NOTE: The safety stop control is mounted at the rear of the unit underneath the control panel. See Figure 316.

2. See that the engine control marked "Stop" is positioned clear in.

3. Depress the starter button.

4. When the engine fires and continues firing, release the starter button and the engine will automatically come up to full speed of 1800 R.P.M. and 60 cycle operation. As soon as the oil pressure registers on the oil pressure gauge, the knob on the safety switch located below the switchboard cabinet will automatically turn in the downward position. This position will permit the switch to stop the engine in case of no oil pressure or high water temperature.

NOTE: If the engine temperature is low, it will be desirable to run at partial speed, from 1000 to 1200 R.P.M. until the water temperature rises to 100^{o} or 120^{o}. This may be done by holding out the engine stop control button and watching the tachometer to see that this reduced speed is maintained.

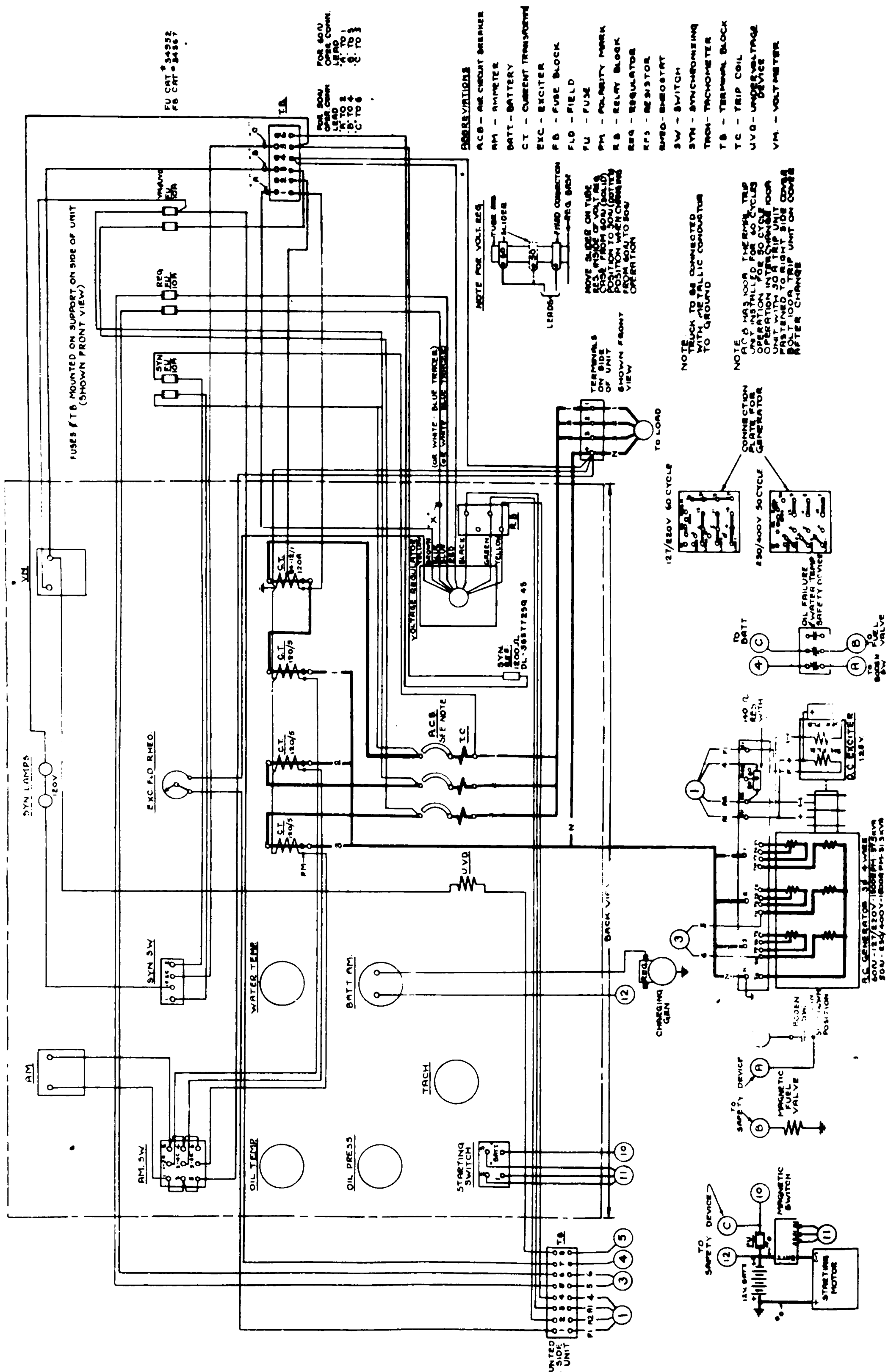


Figure 320.

NOTE: After the engine is operated at no-load for approximately 15 minutes, stop the engine and make the necessary electrical connections. Do not make connection with generator running.

Units shipped from the factory are connected for 60 cycle operation.

191. CONNECTING LOAD LEADS

In making the electrical connections, refer to the Wiring Diagram. This wiring diagram is attached to the inside of the switchboard cabinet side cover and is also shown in Figure 320 in this manual. Connect the load to terminals marked 1, 2, 3, and "N".

192. OPERATING GENERATOR SET

1. Make certain that the circuit breaker is in off position. Start the engine as outlined in paragraph 190 and permit the engine to warm up to normal.

2. Adjust the voltage regulator knob for approximately 220 volts no-load, as indicated on the voltmeter.

3. Turn the exciter field rheostat so that the pointer points to the mark on the front of the panel. See Figure 316. The unit is now ready to operate under load. With the load attached, move the breaker to the "On" position.

The generator being now connected to the external circuit, the ammeter will indicate as the load is applied. The ammeter transfer switch may be turned to each of its three positions to read the current in each phase. If single phase loads are connected, the load should be adjusted in order that each phase balances as nearly as possible. This switch should be left in the position indicating the higher current.

NOTE: The generator should not be called upon to deliver more than the rated current on one phase even though the other phases are not fully loaded.

CAUTION: This unit is provided with a safety switch lock located below the switchboard cabinet. This switch protects the unit in case of low oil pressure or high engine temperature. However, in order to permit the switch to function properly, the operating knob is turned with the arrow pointing to the left for starting. As soon as the engine starts and oil pressure registers on the gauge, the knob should automatically turn in the downward position. This will permit the switch to stop the engine in case of failure due to low oil pressure or high water temperature.

193. PARALLEL OPERATION

These generator sets are designed for parallel operation with another unit of the same type and model. When parallel operation is desired between two generator sets, it is necessary that they be synchronized. For this purpose, each unit has a pair of synchronizing lamps and a synchronizing switch. Load lead terminals on the two units to be paralleled must be connected prior to the parallel operation to the same bus. These connections should tie points 1 to 1, 2 to 2, etc. The first generator set should be started as described in paragraphs 190 and 192 for single unit operation and connected to load. The second generator should then be brought to speed and its voltage adjusted. The first set should then be considered as the running machine and the second as the incoming. Be sure before starting the engine of the incoming unit that the breaker is in off position. On the incoming panel, the synchronizing switch should be turned to the on position at which time the synchronizing lamps will be found to flash on and off at a frequency dependent upon the difference of the speed between the units.

Synchronism is determined when the frequency of these flashes diminishes to zero and the lamps are out, or dark. When this condition is reached, the two units may be connected by closing the line breaker on the incoming unit, after which the two units are parallel.

From the foregoing, it is evident that the essential necessity for correct synchronizing is the time of the closing of the incoming breaker. If the voltages are slightly apart, small cross currents will flow between the machines with no detriment to the machines and very little voltage variation, if any, in the load circuits. However, if a phase displacement exists at the time of closing the breaker of the incoming machine by reason of closing when partially out of phase, more or less severe jolts will be felt by the generators. With a little experience and care, the operator can so anticipate the breaker closing movement with the slowly oscillating lamp outages that the breaker can be closed when the lamps are dark.

After the total load has been applied, turn the knob on the voltage regulator until each unit shows the same current on the ammeter. Taking ammeter readings, make sure that the phase on each unit registers current on the same phase, as indicated by the phase switch. **Make sure that the engine stop button is pushed all the way in after synchronizing has been made.**

NOTE: If it becomes necessary to adjust the governor for synchronizing speeds, make certain that all units to be synchronized have the same speeds and voltage at no load. In making this check, permit the generator sets to operate until the temperature of each is approximately the same. Although the tachometer on these units indicates the operation at the speed indicated, this is not always accurate enough for synchronizing. In order to obtain greater accuracy, permit the units to operate at no load with one unit connected to the load bus and the synchronizing light on the other unit in the on position. This will permit the lights to blink and indicate the relative speeds of each unit. With each unit operating at no load, the synchronizing lights should blink very slowly. Adjust the governor, if necessary, on

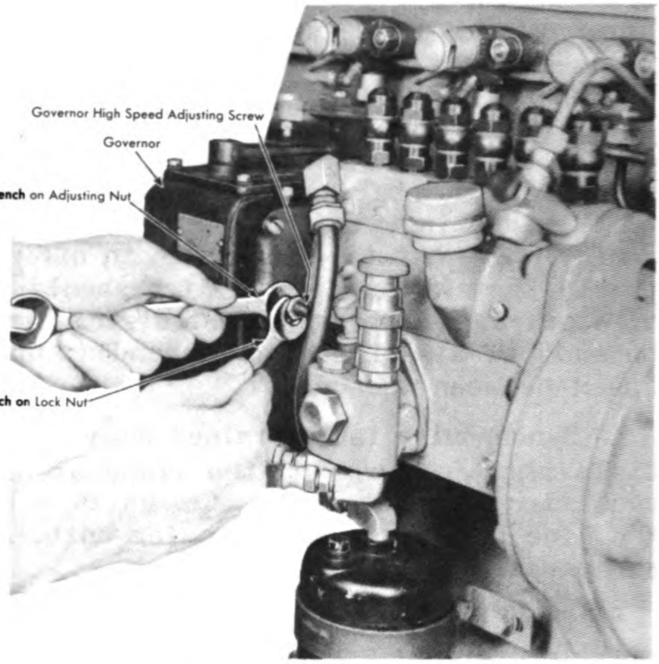


Figure 321. Adjusting Governor for Synchronization.

one of the units until this condition is obtained. To adjust the governor, loosen the locknut on the adjusting screw at the front of the governor, as shown in Figure 321. Adjust this screw until the desired synchronization is obtained. See paragraph 65.

194. DISCONNECTING PARALLEL OPERATION

When it is desired to disconnect one unit (generator set) from the line that has been operating parallel with other units, be sure the circuit breaker is first opened before attempting to stop the engine. A safety interlock is provided on the governor which is engaged by the governor lever when the stop button is pulled all the way out. This provision is made in order to make sure that the breaker is open when the engine is stopped.

195. 50 CYCLE OPERATION

If it is desired to operate the generator set on 50 cycles, it will be necessary to remove the 100 A. thermal element in the air circuit breaker and install the spare 50 A. thermal element which is mounted on the right side of the control cover.

196. PROCEDURE FOR REMOVING TRIPPING ELEMENT OF AIR CIRCUIT BREAKER

Remove the steel cover plate on panel. Remove the four holding screws on breaker cover and remove cover. Then remove the undervoltage device by the two holding screws and pass undervoltage device to the right. It will hang by its two external leads outside the breaker. Remove the three lead holding screws of the movable contacts of the breaker. Remove the breaker operating handle. Then raise the trip element slightly so as to disengage the element from the breaker and remove.

The spare element is fastened to a right side cover and, when changing elements, the unused element should be bolted to the cover.

If it is desired to remove the breaker from the unit, leads should be disconnected at the back, the undervoltage leads disconnected and withdrawn from their clips, and the front cover removed after which remove the four rear holding screws which frees the breaker from its supports.

When replacing the removable handle, care should be taken to see that the white "position" line is at the bottom or the letter "T" molded in the handle, is right side up.

The four holding screws of the front cover of the breakers should be equally and lightly tightened to avoid strains. It is important that they be progressively tightened as one would tighten the rim bolts of a car wheel. The steel cover on the panel front should be placed to give an equal clearance between it and the breaker boss before tightening.

197. CHANGEOVER FROM THE 60 CYCLE TO 50 CYCLE OPERATION (After instructions in paragraph 195 have been followed.)

1. Remove the front cover on the terminal box located on top of the alternator.

2. Change the links on the terminal board in line with the instructions on plate attached to the terminal box, or see Figure 320.

3. Remove the knob and cover from the voltage regulator. Change the slide wire terminal on the small resistor at the lower left of the regulator to position marked 50 cycles.

4. Remove the side cover from the switchboard cabinet and with the wiring diagram as a guide, reconnect wires marked "A", "B", and "C" to the position as shown in the marginal information.

This information is given at the upper right hand corner of the wiring diagram.

5. Start the engine according to the instructions in paragraph 190, making certain that the circuit breaker is in off position.

6. Loosen the locknut on the speed adjusting screw at the front of the governor as shown in Figure 307. Loosen this screw until the engine operates at 1500 R.P.M. at no load. See paragraph 65. The generator set should now be ready to operate on 50 cycles, 230 - 400 volts. All covers should be replaced and securely fastened.

198. STOPPING OPERATIONS

Move the circuit breaker to "Off" position. Pull stop control half way out to allow engine to idle a few minutes, after which pull the stop control all the way out to stop the engine.

Chapter VII

REASSEMBLY OF GENERATOR SET

199. STEPS OF REASSEMBLY

The following steps of reassembly are recommended:

1. Block up the motor approximately 18" from the floor. With a hoist hooked to the generator lifting eye, lift the generator (coupling in place) into the approximate position to assemble to the engine. NOTE: The coupling flange must go into the flywheel at the same time as the generator frame slips into the machine recess in the flywheel housing. See Figure 104.

2. Start the coupling-to-flywheel capscrews and also the flywheel housing-to-generator capscrews before tightening any of these capscrews. Tighten the flywheel-to-generator capscrews before tightening the coupling-to-flywheel capscrews. See Figure 103.

3. With the engine and generator assembled as a unit, lift them onto the mounting frame. The mounting frame should have the front support assembled to the frame and the flexible mountings in place before the engine and generator are set in place. Tighten the four generator mounting bolts and the two mounting bolts at the front of the motor.

4. Install the radiator, hoses, and braces.

5. Install the generator control unit frame.

6. Mount the generator control unit on the frame.

7. Make all the connections of the engine controls and engine instruments.

8. Wire the control unit to the generator.

9. Install the Penn safety control on the frame and connect up all wiring according to the Wiring Diagram, Figure 320.

10. Install the Bowden, or generator circuit breaker, switch on the governor shown in Figure 102 and hook it up according to the Wiring Diagram, Figure 320.

11. Install the engine safety control switch and hook it up with the solenoid safety shut off valve according to the Wiring Diagram.

12. Install the starter switch and hook up the engine wiring with the batteries according to the engine Wiring Diagram, Figure 226.

200. PREPARING GENERATOR FOR TEST RUN

1. Fill the oil pan with seven quarts of the recommended grade of lubricating oil according to the operating temperature.

2. Fill the radiator with soft, clean water or suitable anti-freeze.

3. Oil the generator and starter motor.

4. Fill the fuel injection pump housing with clean, fresh engine oil up to the full level mark and also fill the governor with clean fresh oil up to the full level mark.

5. Connect the fuel suction line to the first stage, or primary, filter and suction connection on the fuel tank. **NOTE:** The suction connection on the fuel tank is the special plug which has the pipe extending to the bottom of the tank. Connect the fuel lines according to Figure 197.

6. Connect the fuel return line from the fuel injection pump overflow to the fuel return opening. See Figure 197. **NOTE:** The fuel tank return opening should be connected to the horizontal outlet of the "T" provided in one of the fuel tank connections, and the vertical outlet of this "T" should be provided with an open extension for venting purposes.

7. Loosen the spring screw of the fuel injection pump to release the overflow check valve spring tension so pump housing can be vented. Remove the fuel return connection at the fuel pump overflow. See Figure 322. Work the hand plunger on the fuel transfer pump until the air bubbles cease coming out of the loosened connections and solid fuel appears at every stroke of the pump. **NOTE:** The hand primer must be unscrewed (turned to the left) before it can be operated. Replace the fuel return connections and screw down the hand plunger to the locked position. The engine is now ready for starting.

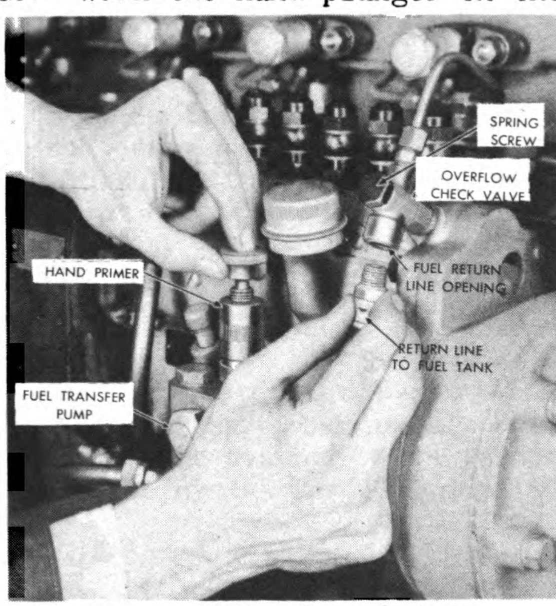


Figure 322. Fuel Return Connection.

201. TEST RUNNING ENGINE AND GENERATOR SET

Start the engine according to the instructions in paragraph 190. As soon as the engine starts, check the oil pressure. Allow the engine to run at half speed (approximately 900 R.P.M.) and check for oil, fuel, and water leaks. Bring the engine up to normal operating temperature until the water temperature rises to 100° or 120°.

Remove the rocker arm cover and adjust the valve tappets with a feeler gauge as follows: The intake clearance should be .009" and the exhaust .012". Insert the correct feeler gauge between the rocker arm and the valve stem. See Figure 323. Slowly move the feeler gauge back and forth. If the clearance is

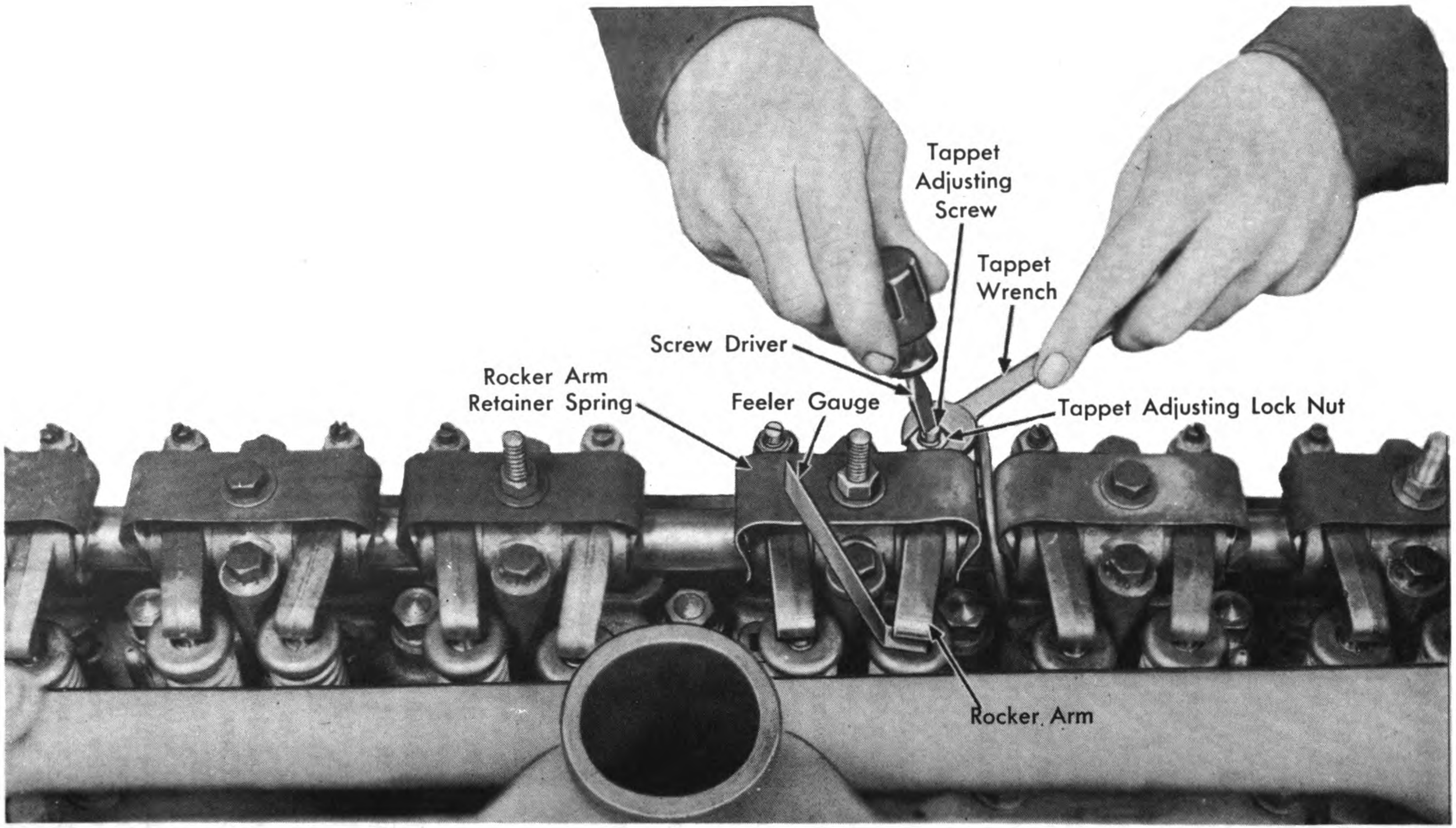


Figure 323. Adjusting the Valve Tuppets for Correct Clearances

correct, the operator will note that there is just a slight drag followed by tightness which momentarily prevents him from moving the feeler gauge. If the clearance is not correct, this will be indicated by tightness which will not permit the feeler gauge to move without a considerable drag. On the other hand, if the feeler gauge moves without any binding, the clearance is incorrect.

Run the engine for at least eight hours as follows: (a) two hours no load at 1000 R.P.M.; (b) two hours no load at 1800 R.P.M.; (c) two hours at half load; (d) two hours at 3/4 load. See the following notations for obtaining loads.

Check the water temperature safety switch by raising the temperature of the water by closing off the air circulation through the radiator. Engine will stop a few minutes after the temperature reaches 205°. See paragraph 115.

NOTE: If it becomes necessary to adjust the smoke stop in the fuel injection pump and there is no other means to hook up the generator to the load, the water barrel method of creating resistance can be used. The water barrel method is as follows:

Fill a fifty-gallon barrel with water and add salt. Obtain three sheets of scrap iron and attach to each of the three phase wires and immerse them into the water barrel approximately 12" apart. Each plate has to be equidistant in order to balance the phases. To obtain the necessary load, volts times amperes, times the square root of 3 will give the desired kilowatts. For instance, if the desired load is 36 K.W., the voltmeter should read 220 and the ammeter 94-1/2, or if the load desired is 35 K.W., the voltmeter should read 220 and the ammeter 92. For 30 K.W., the voltmeter should read 220 and the ammeter read 79. An increase or decrease in the load can be obtained by lowering or raising the three plates in the water barrel.

NOTE: Do not depend upon the tachometer for the critical adjustments of engine R.P.M. that are necessary, but use a counter and stop watch or the frequency meter. The setting at the factory for 30 K.W., at no load, is 60 to 61.5 cycles for 1800 and 1845 R.P.M. respectively.

202. TIMING THE FUEL INJECTION PUMP

To time the fuel injection pump with the engine, the following steps are necessary:

NOTE: It requires two men to time the fuel injection pump with the engine.

1. Crank the engine until the timing mark No. 1, F.P.I. (No. 1 fuel pump injects) is in the center of the timing hole of the flywheel housing. See Figure 190. **NOTE:** The No. 1 piston must be on the compression stroke when centering this timing mark in the timing hole of the flywheel housing. This can be checked

by noting that both the intake and exhaust valves of No. 1 cylinder are completely closed and have clearance between the stem and rocker arms.

2. Drain and remove the radiator. Remove the oil filler pipe. See Figure 195.

3. Remove the wire locks from the capscrews of the fuel pump gear. Slightly loosen the three capscrews so that the gear hub is free to turn. See Figure 324.

4. There are two marks on the pump housing immediately in back of the gear hub. The one is vertical and indicates the top dead center of the pump. The other is to the left of the vertical mark about 1/8 of a turn and indicates port closing or the beginning of the injection. See Figure 325. This latter mark must center in the gear hub timing hole. If necessary, turn the gear hub until this timing mark is in the center of the hole. The injection pump is now in time with the engine. Tighten the capscrews.

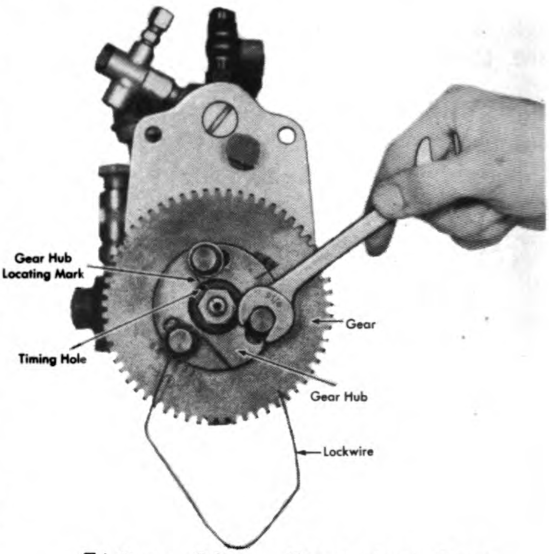


Figure 324. Removing Gear Hub Capscrews.

5. To check the timing, remove the No. 1 injection line at the fuel injection pump. Remove the No. 1 check valve at the angle connection of the fuel injection pump and replace the angle connection without the check valve. See Figure 326.

6. Turn the crankshaft flywheel backward 1/2 turn (turn to the left facing the timing gears). At this position, the fuel should run freely from the No. 1 angle connection by operating the hand primer of the fuel transfer pump.

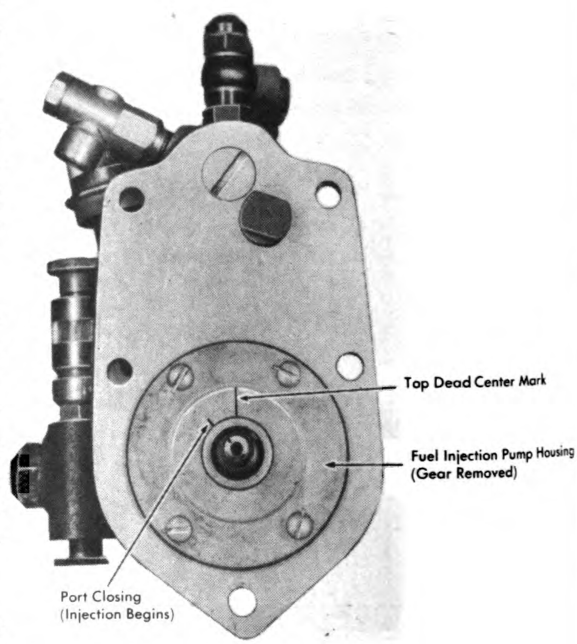


Figure 325. Timing Marks on Fuel Injection Pump Housing.

7. Crank the engine slowly in the direction of rotation (while continuing to operate the hand primer of the fuel transfer pump) until the

fuel at the open connection seeps slowly. With a small tube, as shown in Figure 327, blow gently the fuel seepage away from the opening as the engine is being slowly cranked and the hand primer being operated. By blowing the seepage away, the exact moment when the seepage stops can be observed. At the instant the fuel seepage stops, the cranking should be stopped and the timing mark No. 1 F.P.I. observed through the timing hole in the flywheel housing. This mark should be in the exact center of the hole. See Figure 190. If not the timing is either advanced or retarded. If the timing is advanced, the timing mark No. 1 F.P.I. is approaching the center of the flywheel housing timing hole. If retarded, the mark has gone past.

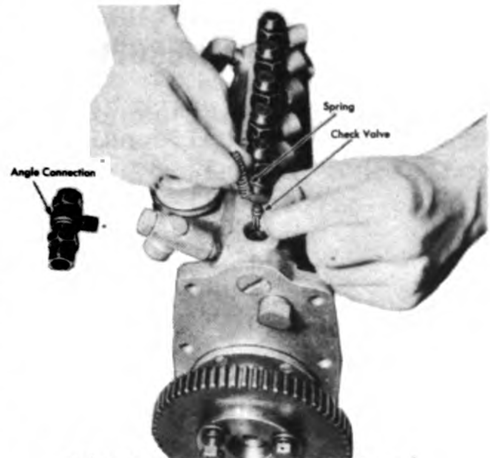


Figure 326. Removing Check Valve.

8. To reset the timing if the timing is retarded, loosen the capscrews on the gear hub and turn the hub clockwise (as shown in Figure 192) one degree mark. If timing is advanced, the gear hub should be turned counter-clockwise one degree mark.

NOTE: When turning the hub counter-clockwise, as shown in Figure 327, do not loosen the hub retaining nut. Exert just enough pressure on the wrench handle to move the hub. Tighten the capscrews and recheck the timing beginning with Step 6. It may be necessary to repeat the foregoing procedure more than once to obtain exact timing.

Fuel injection starts immediately upon port closing which occurs 32° before top dead center of No. 1 cylinder, as measured on the flywheel and marked No. 1 F.P.I.

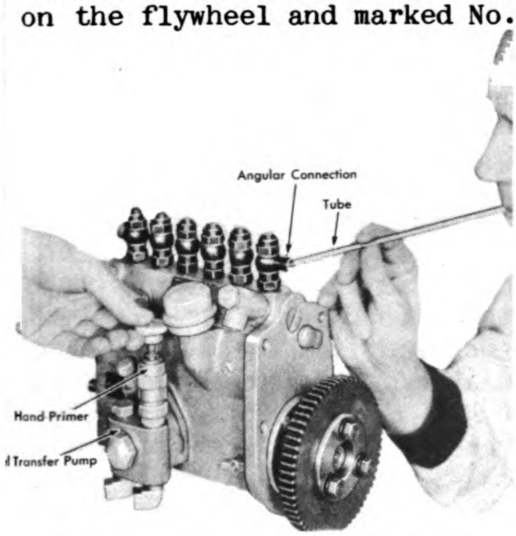


Figure 328. Blowing Seepage Away (Timing Injection Pump)

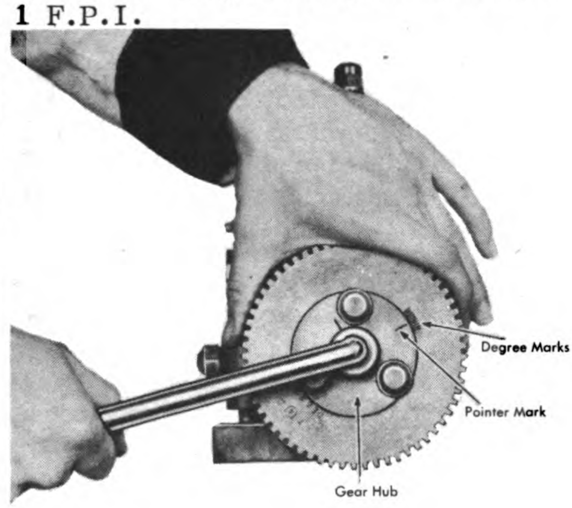


Figure 327. Turning Gear Hub with Socket Wrench.

Chapter VIII

EMERGENCY TREATMENT

A generator set which has been filled with dirt due to dust storms or other unusual conditions, or has been submerged during a flood either in salt or fresh water and is clogged with mud and foreign matter will probably require a thorough washing out, and this means a complete tear-down of the entire unit.

203. EMERGENCY TREATMENT OF ENGINE AFTER SUBMERSION IN SALT OR FRESH WATER

A complete tear-down of the engine is required, and unfortunately, proper equipment for this operation is rarely available at the scene of submersion. This brings in the element of time. Therefore, means should be taken to prevent corrosion, in so far as possible, until the time when the engine is completely dismantled and each part cleaned. The action of the air creates the corrosion; therefore, all parts of the engine should be coated as thoroughly as possible with oil to prevent the air reaching them. It is so important that the air be kept from contacting the wet steel parts that, in cases where oil is not available, it is oftentimes better to allow the engine to remain under water until some slushing medium can be obtained, provided, of course, that this can be done within a reasonable length of time.

Too much stress cannot be given to the importance of working quickly if it is expected that the engine is to be salvaged. Therefore, arrangements must be promptly made to dismantle the engine as quickly as possible and thoroughly clean and slush each part. If submersion occurred in salt water, it is recommended that as soon as the engine is dismantled, all parts other than electrical equipment be washed in hot fresh water, dried, and slushed with lubricating oil that has been heated to 180° F. Engine electrical accessories, such as starter motor and generator, should be thoroughly flushed with fresh water, dried and completely overhauled before using. When these electrical engine accessories are being overhauled, they should be visually checked for metal corrosion, the condition of all insulation determined, and all electrical circuits thoroughly tested before reassembly according to the instructions given in paragraphs 162, 163, 164 and 165. All windings that are otherwise serviceable should be baked in an oven at 140° F. for four hours before reassembly. All flexible conduits must be replaced.

A careful inspection must be made of each part salvaged to determine not only the extent of the damages caused by corrosion but also other defects caused by the sudden cooling action of the water in cases where the engine was at operating temperature at the instant prior to submersion.

204. EMERGENCY TREATMENT OF GENERATOR

Electrical apparatus which has been filled with dirt by dust storms or other unusual conditions or has been submerged during a flood and is clogged with mud and foreign matter will require a thorough washing out. In such cases, disassemble the apparatus and thoroughly wash all parts with water. Use an approved solvent to remove grease from the insulation. If water is applied to insulated parts with a hose, the pressure should not exceed 25 pounds per square inch.

205. CLEANING THE GENERATOR

The methods of cleaning insulation include: wiping off the dirt with a clean, dry cloth, blowing it out with air pressure, drawing it out with suction apparatus, removing it in various ways with solvents, and washing it out with water--sometimes hot water and a solvent are needed. The method will, of course, depend upon the conditions involved.

206. USING COMPRESSED AIR

Blowing out dirt with air at about 25 pounds pressure is usually effective, particularly when the dirt has collected in places which cannot be reached with a cloth. Do not direct compressed air against insulation until certain that it is free from moisture that may have accumulated in the air line from condensation. Too great an air pressure may loosen binding tape and blow dirt under it. Dirt blown out of a machine is likely to be drawn into others that are in operation near it. Remember the use of compressed air simply transfers the dirt from one location to others, and unless the final location is outside the operating room, very little good may be accomplished.

207. USING SOLVENTS

If the accumulation of dirt contains oil or grease, a solvent will be required to remove it. There are three types of solvents in general for this purpose.

These are petroleum distillates, such as benzine or gasoline, (not benzene or benzol, which are extremely toxic) carbon tetrachloride, and a mixture of the two.

Benzine or gasoline has the least corrosive action on the insulation varnishes and for that reason, where conditions permit, are preferable to the other solvents. Benzine, having a flash point of 100° F. or higher, is perhaps the most generally desirable. Solvents known commercially as Stoddard Solvents (described in U. S. Bureau of Standards as "Commercial Standard SC-3-28"), Cleaners' Naphtha, or Safety Type Solvents minimize the fire hazard and should be used in preference to gasoline or benzine, but ample precautions should be used to prevent fires or explosions. A mixture of 50% carbon tetrachloride and 50% benzine or 60% carbon tetrachloride and 40% gasoline is not inflammable, but the vapors mixed with the right proportion of air are explosive.

208. APPLYING SOLVENTS

In Cleaning a generator set, solvents are generally used by wiping the insulation with cloths moistened with the cleaning fluid. In such cases the solvent may be sprayed on the insulation or the insulated parts may be dipped into the solvent.

CAUTION:

When petroleum distillates are used, guard carefully against fire and explosion.

Both benzine and gasoline are very inflammable and their vapors are extremely explosive when mixed with the proper percentage of air.

Be sure there is good ventilation and minimum fire risk.

Do not allow the clothing to become saturated with the solvent. If the clothing should become saturated, it should be removed.

Always have fire extinguisher handy.

Keep metal tools from striking metal parts of the generator set.

The mechanic's shoes should not have protruding nails.

If using a hose to spray either cleaning solution or varnish, make sure that the nozzle is grounded.

When using carbon tetrachloride, guard against breathing the fumes.

Adequate ventilation should be provided when any type of solvent is used.

209. DRYING

There are three general methods of drying the insulation of windings: external heat, internal heat, and a combination of both. An effective process, where possible, is to dry the generator under vacuum while hot.

210. DRYING WITH EXTERNAL HEAT

Drying the insulation of the generator with electric heaters distributed under the ends of the winding is effective. Most convenient for this method are the space heaters. This type of heater is 3/16" thick, 1/2" wide, and depending upon their capacity, are anywhere from 12" to 43" long.

211. USING OVEN HEAT

Oven drying is particularly recommended. A good temporary oven may be made of panels of heat insulating material secured to wooden frames or they can be made of sheet iron, bricks, or concrete blocks lined with insulating material.

NOTE: The oven should be ventilated to provide air circulation and to remove moisture. Pre-heated air may be forced through the oven. Many kinds of heaters may be used if precauons are taken against fire and to keep the actual product of mbustion out of the oven.

2. DRYING WITH INTERNAL HEAT

The coil insulation may be dried by circulating current rough the windings. In this way, internal heat can be developed thout exposing the insulation to voltages that might damage during drying. There is always danger, however, of serious jury to the windings when drying the insulation in this manner nce the heat generated in the inner parts is not readily dissi-.ted; besides, coils containing moisture are most susceptible injury from overheating. Gases and vapors generated within e insulation may develop such pressure that they are forced rough the insulation, breaking the continuity of the layers or pturing the material. This means of drying should be carefully ne.

Drying should be continued until the insulation resistance s dropped to a minimum and then has increased until at least e megohm for each 1,000 volts, operating voltage, is indicated, t in no case less than one megohm, regardless of voltage. It y then be desirable to maintain the temperature at from 15 to ^{0} above the ambient until ready for operation.

In the alternating current generators, the internal heat thod of drying can be done by the short circuit method or low ltage from an external source. The short circuit method means ort circuiting the armature windings and driving the generator d applying sufficient field excitation to give somewhat less an full load armature current. When the windings are provided th imbedded temperature detectors or when temperatures are termined by the increase of resistance method, the current may adjusted to maintain an internal temperature of 85^{0} C. from e beginning of the dryout run. If the temperature indications e obtained from thermometers located on the outside of the high ltage coil insulation, several hours may elapse before maximum mperature under constant current, ventilation, and ambient mperature conditions are indicated. Since these temperatures y be from 2^{0} C. to 25^{0} C. lower than the temperatures at the ter should not exceed 65^{0} C.

In the low voltage method from an external source for drying e coil insulation, the current must be controlled so as not to ceed the full load current. When alternating current is sup-ied to the armature from an external source, the field windings ould always be short circuited.

PARTS LIST

TM5-5090

PARTS CATALOG

for

BUDA MODEL 6-DTG-317, 30 KW DIESEL-POWERED GENERATOR SET

•

Serial Nos. 12030 to 15708

U. S. Corps of Engineers Contract 56995

•

Contents

PREPARATION OF REQUISITIONS

SAMPLE COPY FOR USE IN THE PREPARATION OF REQUISITIONS

Revisions in QMC Form 400 for requisitioning spare parts are confined to new column headings. Until new forms are available all organizations are to continue using the present form and either type or write in corrections indicated in column headings.

Under revised heading "Nomenclature and Unit" list the article and the unit (ea for each; lb for pound, etc.). Under heading "Authorized or Maximum Level" list the authorized depot stock levels or organizational allowances given in Part III of the Corps of Engineers Supply Catalog. The total number on hand for each item is listed under "On Hand". In column headed "Due In" enter the total quantity previously requisitioned but not delivered. For "Initial" and "Replenishment" requisitions, the sum of "Required", "Due In", and "On Hand" should equal the "Authorized or Maximum Level".

On this page is shown a sample requisition on QMC Form No. 400 which conforms to the latest revisions. The marginal notes give instructions for preparing a requisition for spare parts for Engineer equipment. Additional information on this subject is contained in section AA-1 of Part III Engineer Supply Catalog, available from the Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio.

State PERIOD designation by use of one of the following terms:
(1) "INITIAL"—first requisition of authorized allowances.
(2) "REPLENISHMENT"—subsequent requisitions to maintain authorized allowances.
(3) "SPECIAL"—requisitions for necessary repairs not covered by allowances.

Type "SPARE PARTS" in upper right hand corner of requisition.

Give complete shipping instructions. Special instructions for packing, marking, routing, etc., should be given at the end of the requisition.

State proper nomenclature of machine, and make, model, serial number and registration number.

Prepare a separate requisition for each different machine.

State basis or authority and date delivery is required, immediately below description of machine.

Double space between items.

Group parts required under group headings as shown in manufacturers' parts catalogs (Technical Manuals).

State manufacturers' parts numbers and nomenclature descriptions accurately and completely. Do not use abbreviations.

WAR DEPARTMENT
Q. M. C. Form No. 400
Revised Apr. 6, 1921

(Sample)
REQUISITION

SPARE PARTS

To: ENGINEER SUPPLY OFFICER — No. of Sheets 1 — Sheet No. 1
COLUMBUS QUARTERMASTER DEPOT, COLUMBUS, OHIO
Requisition No. E-532-8-6-43 — Date August 16, 1943 — Period SPECIAL

SHIP TO ENGINEER PROPERTY OFFICER, PINE CAMP, NEW YORK
MARKED FOR: ENGINEER SUPPLY OFFICER, 802nd ENGINEERS BATTALION, PINE CAMP, N.Y.

Requisitioned By (show Signature, Rank, Organization, Destination. If different from "ship to" include address):
JAMES A. ROE
MAJOR, C.E.
ENGINEER PROPERTY OFFICER

Approved By:
JOHN E. DOE
COL., C.E.
EXECUTIVE OFFICER

STOCK No. MFR. No.	ARTICLES	UNIT	ON HAND AND DUE	CONSUMED	REQUIRED	APPROVED
	PARTS FOR 30 K.W. GENERATOR SET, DIESEL, BUDA MODEL 6-DTG-317					
	SERIAL NO. 15004 U.S.A. REG. NO. W-84997					
	Basis: Repair of Disabled Equipment					
	Delivery is requested by September 15, 1943.					
	BUDA ENGINE GROUP					
	Engine Serial No. 15004					
1307	Camshaft Gear Retainer	ca	0	1	1	
DE-50657	Gasket	ca	0	4	4	
DE-50864	Gasket	ca	0	4	4	
DE-52191	Fuel Filter (Primary)	ca	0	1	2	
	AMMETER (General Electric)					
8-AD-6-AB2	Ammeter (125 Amp. 24.1 ct)	ca	0	2	2	
	MAIN GENERATOR (Century Electric)					
ES-9702	Brushes	ca	0	2	4	
	*					

*Nonexpendable items such as tools must be accounted for, when requisitioned, by a statement that they have been placed on REPORT OF SURVEY or STATEMENT OF CHARGES.

Emergency requisitions sent by telephone, telegraph, or radio must always be confirmed immediately with requisition marked: "Confirming (state identifying data)."

PREPARATION OF REQUISITIONS

A Sample requisition in the correct form for submission by the Engineer 'operty Officer is shown on the opposite page.

THIS SHALL BE FOLLOWED IN MAKING OUT REQUISITIONS.

In order to eliminate duplication of work, Property Officers may authorize ganizations to prepare requisitions in final form, leaving requisition number ace blank for completion by Property Officer.

IE FOLLOWING RULES WILL BE OBSERVED CAREFULLY IN PREPARING REQUISITIONS FOR SPARE PARTS:

Prepare a separate requisition for each different machine.

Type "SPARE PARTS" in upper right hand corner of requisition form.

State PERIOD designation by use of one of the following terms:

(1) "INITIAL"—first requisition of authorized allowances.

(2) "REPLENISHMENT"—subsequent requisitions to maintain authorized allowances.

(3) "SPECIAL"—requisitions for necessary repairs not covered by allowances.

Give complete shipping instructions.

State proper nomenclature of machine, and make, model, serial number and registration number.

State basis or authority, and date delivery is required, immediately below description of machine.

Group parts required under group headings as shown in manufacturers' parts catalogs.

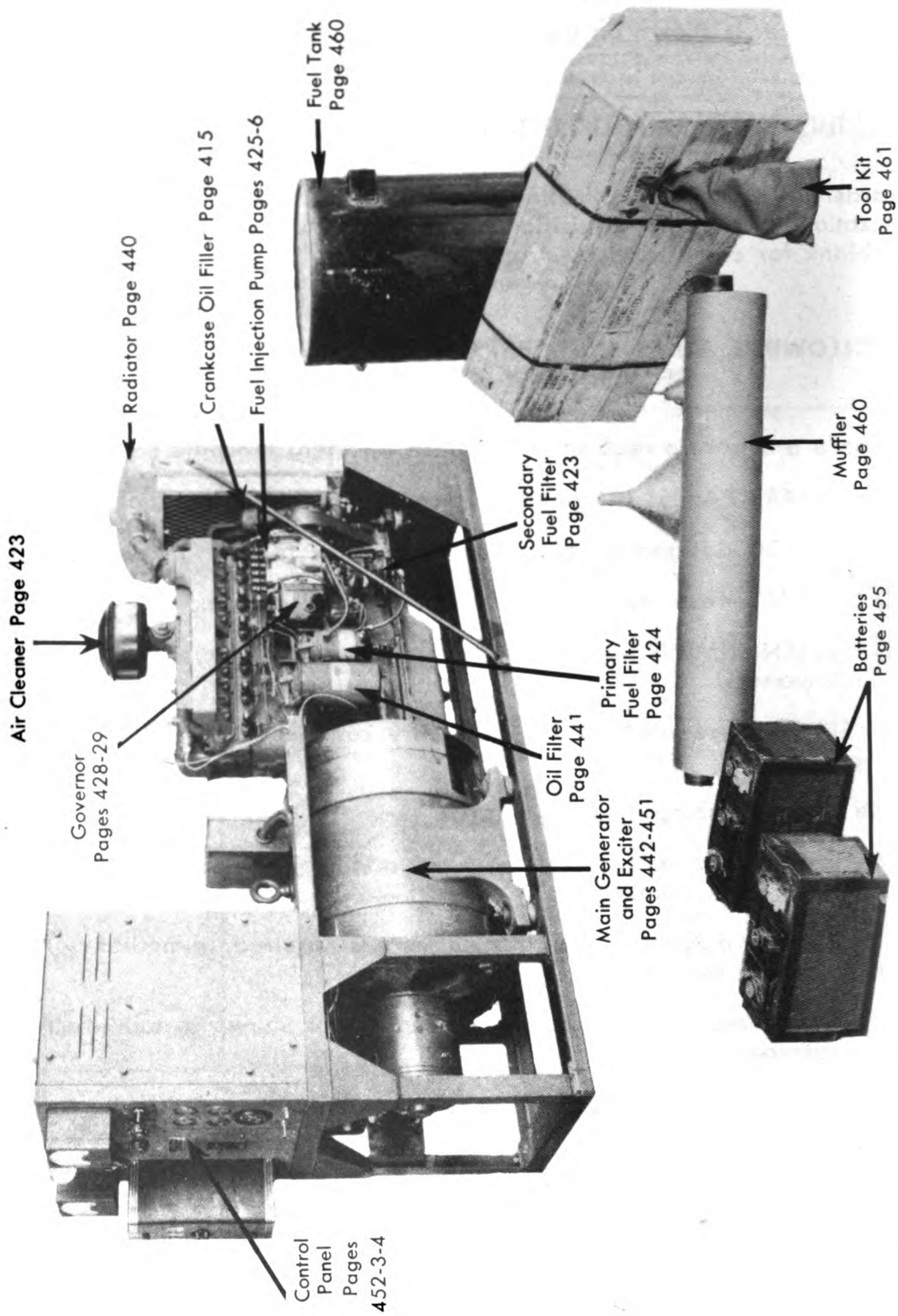
State manufacturers' parts numbers and nomenclature descriptions accurately and completely. Do not use abbreviations.

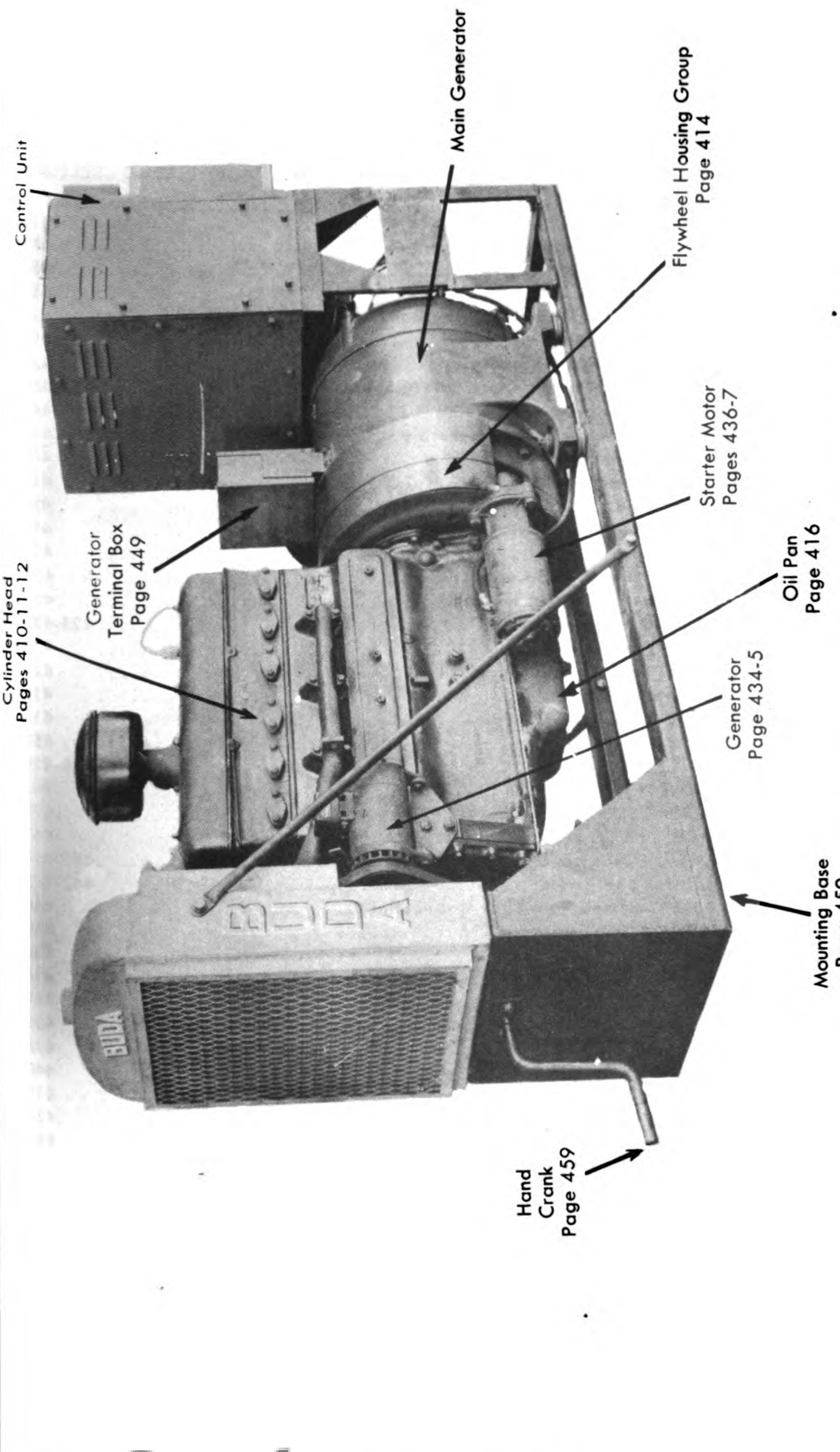
Double space between items.

Emergency requisitions sent by telephone, telegraph, or radio must always be confirmed immediately with requisition marked: "Confirming (state identifying data)."

Nonexpendable items must be accounted for.

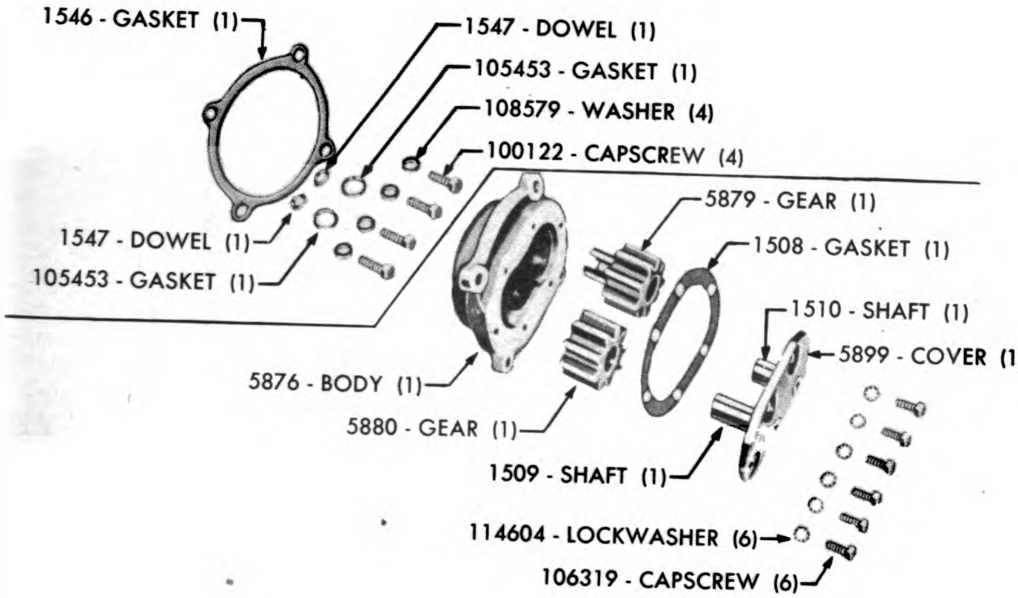
GRAPHIC INDEX
(Showing Major Assembly Parts)



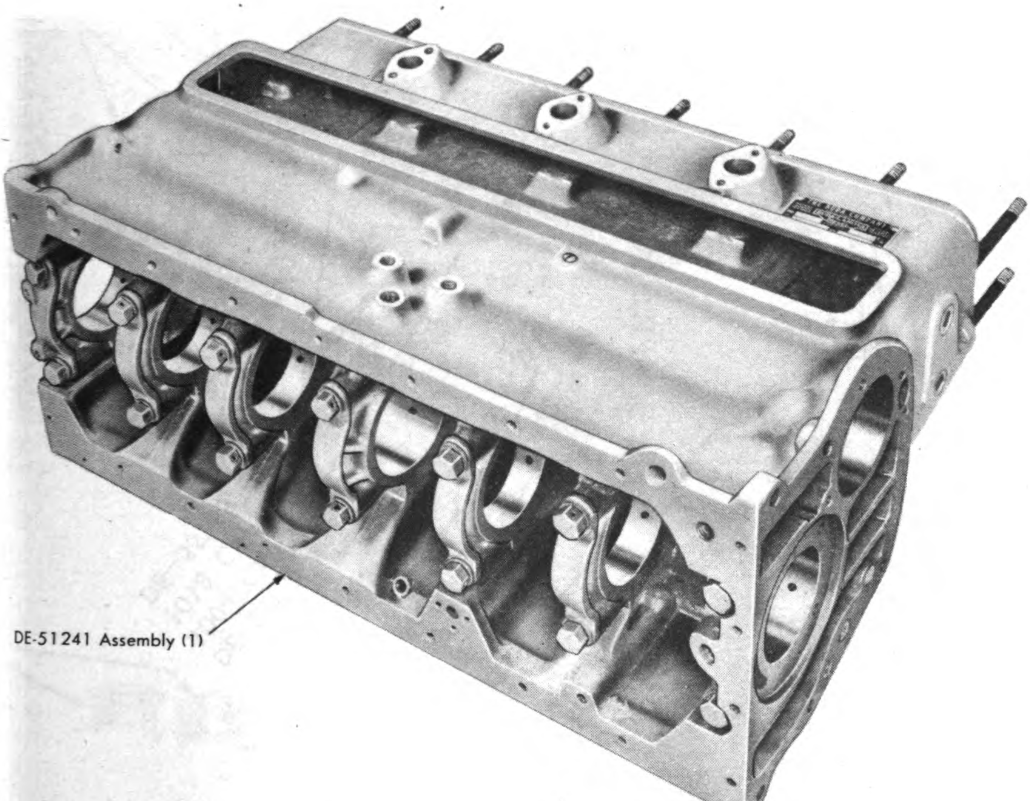


LEFT SIDE OF BUDA MODEL 6-DTG-317 GENERATOR SET

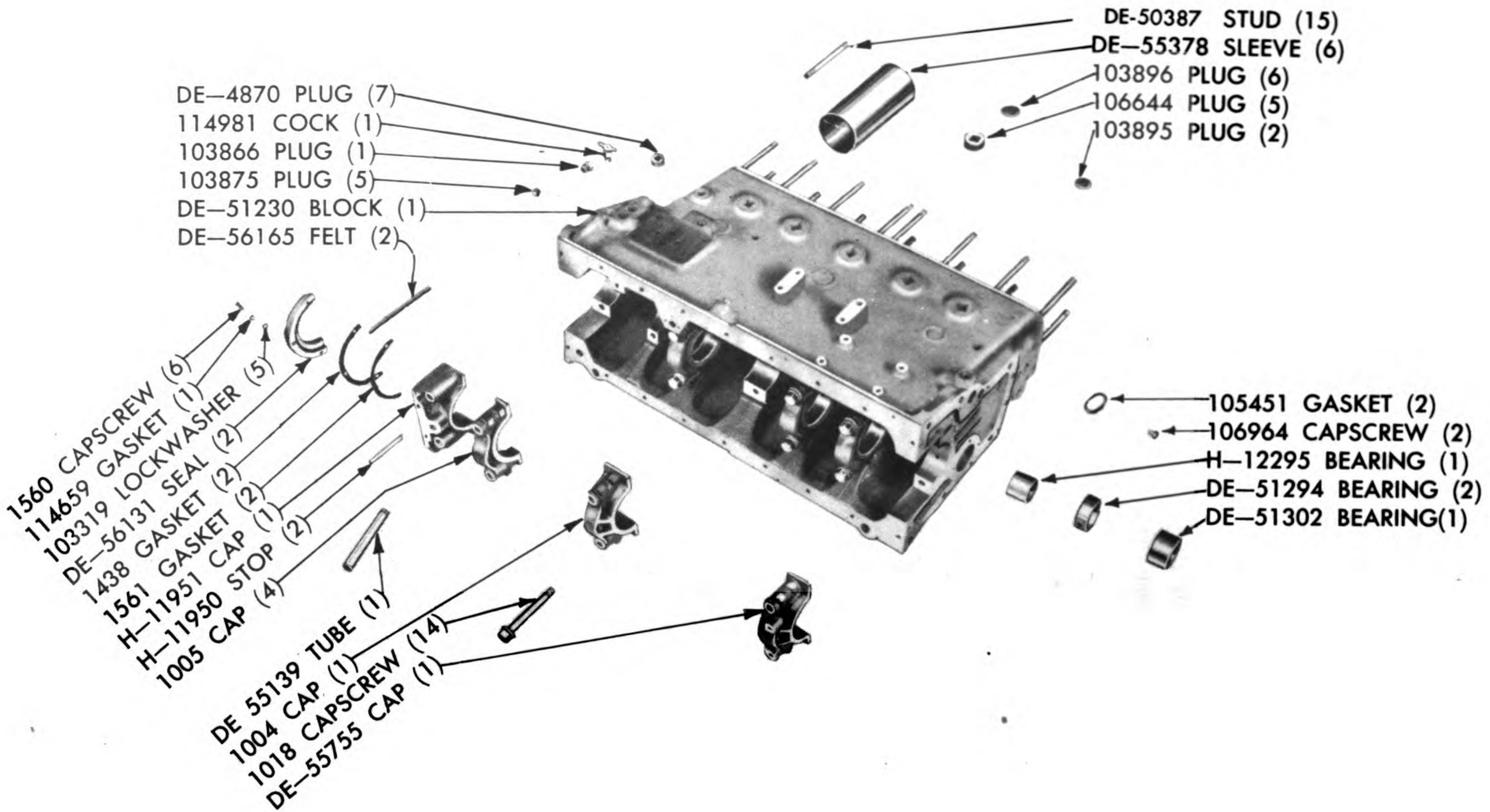
ALPHABETICAL INDEX



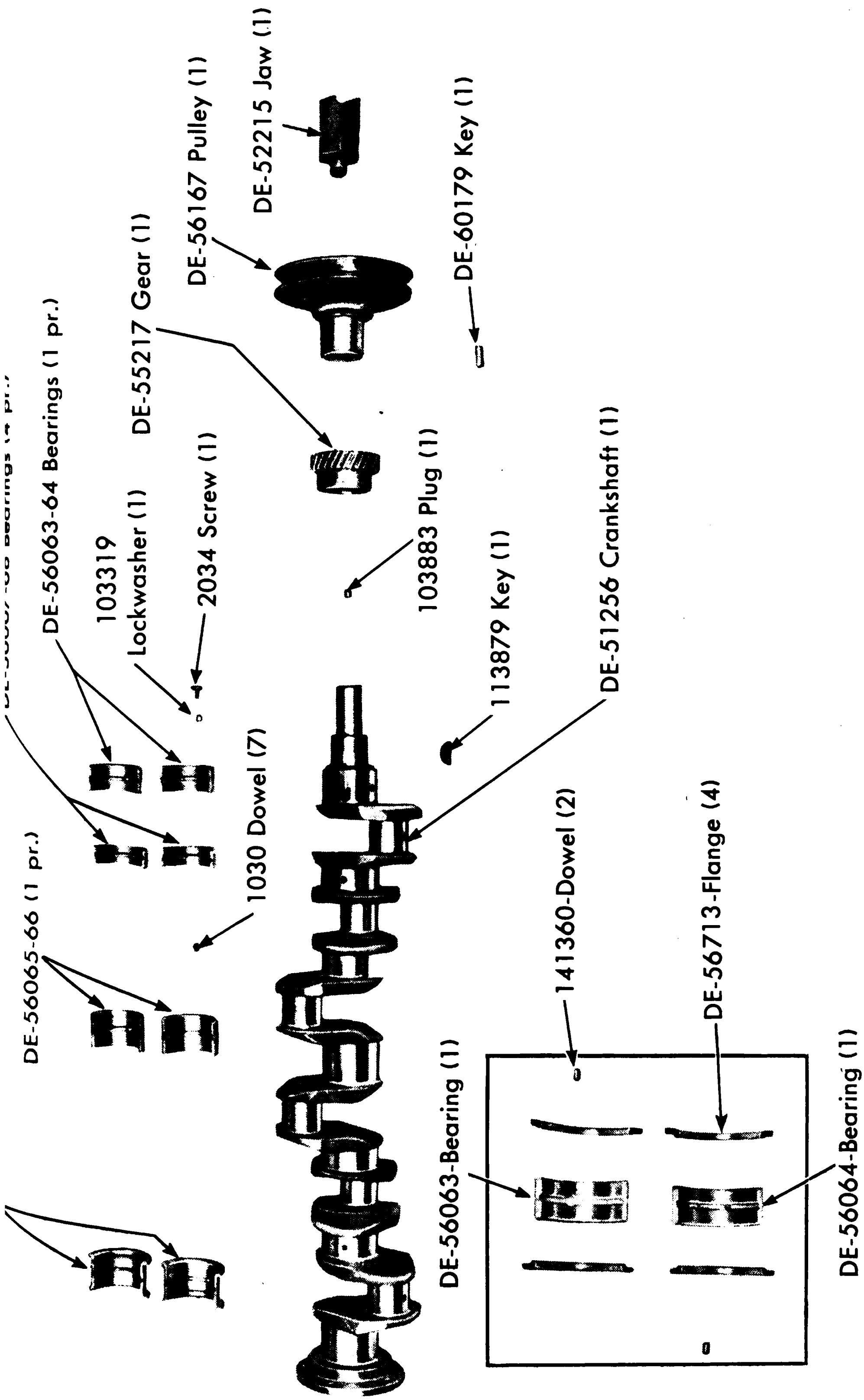
OIL PUMP ASSEMBLY
(No. 5875 includes all items to right of dividing line)



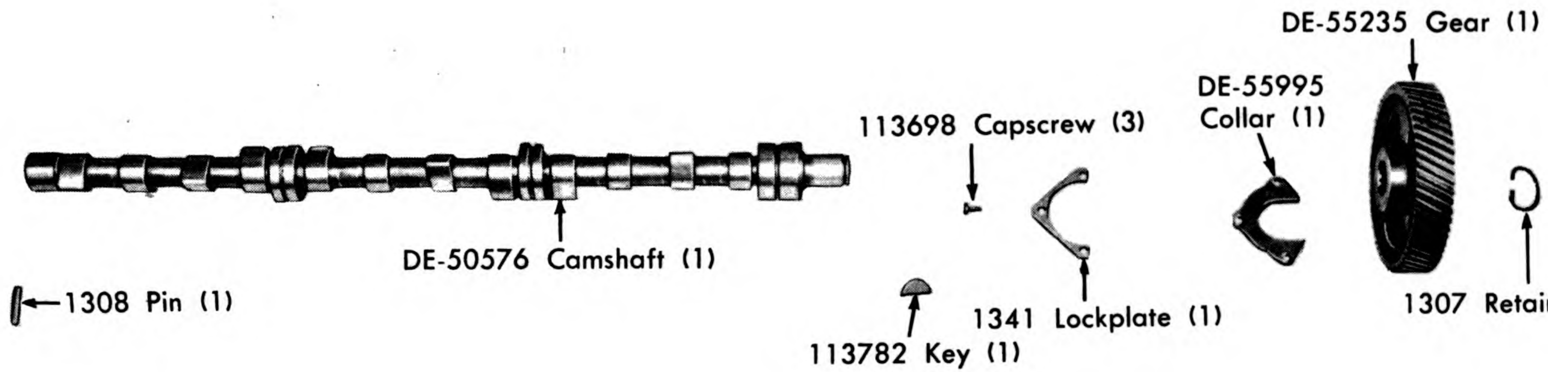
CRANKCASE AND CYLINDER BLOCK ASSEMBLY
(Exploded view of parts contained in assembly shown on page 408)



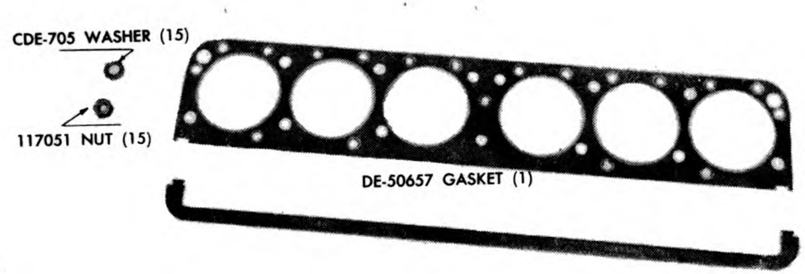
CRANKCASE AND CYLINDER BLOCK. SLEEVES AND BEARINGS

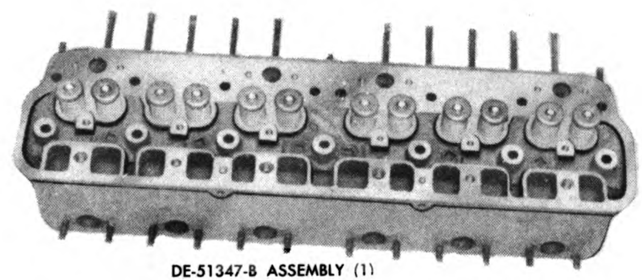


CRANKSHAFT AND BEARINGS

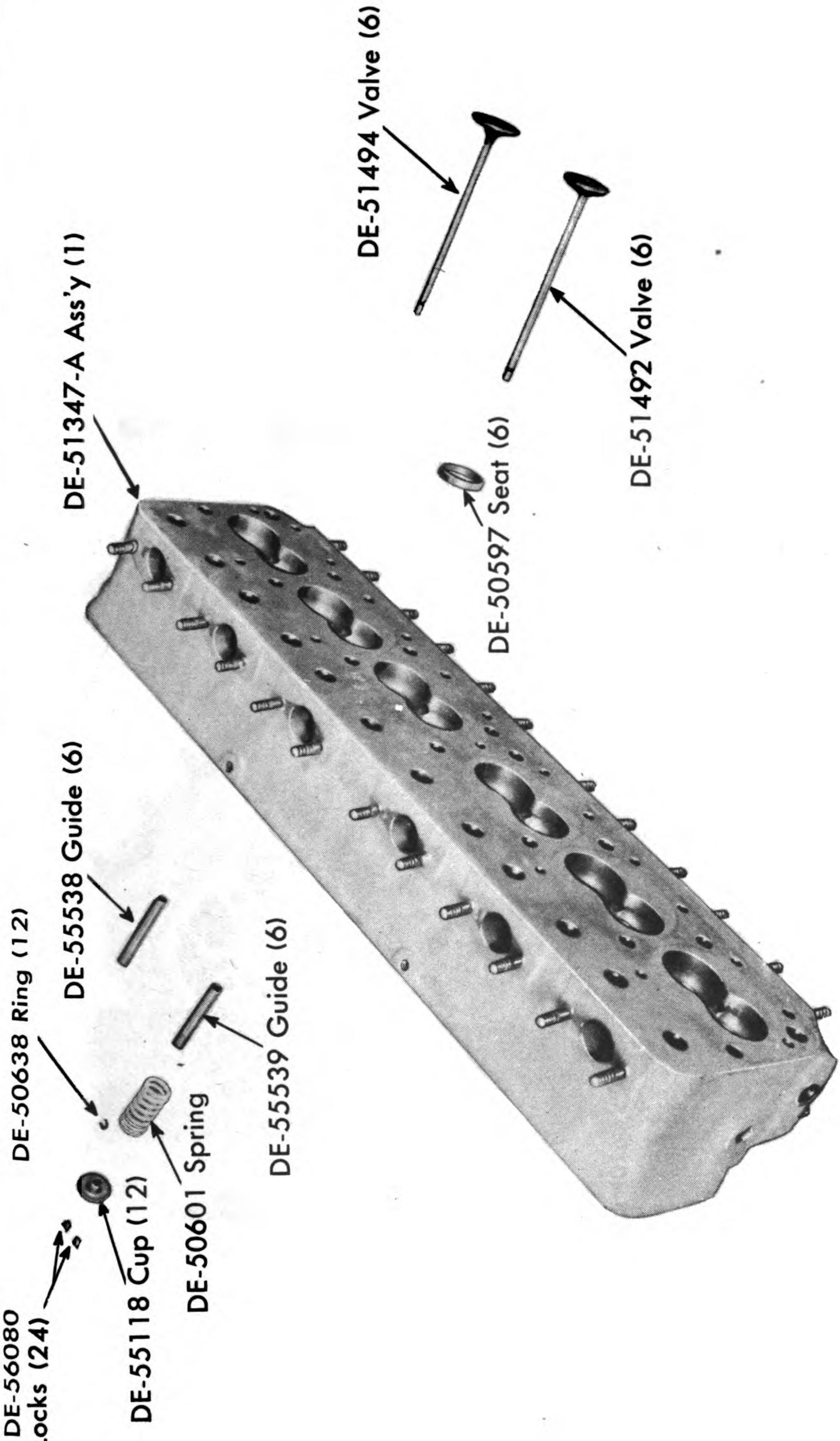


CAMSHAFT GROUP

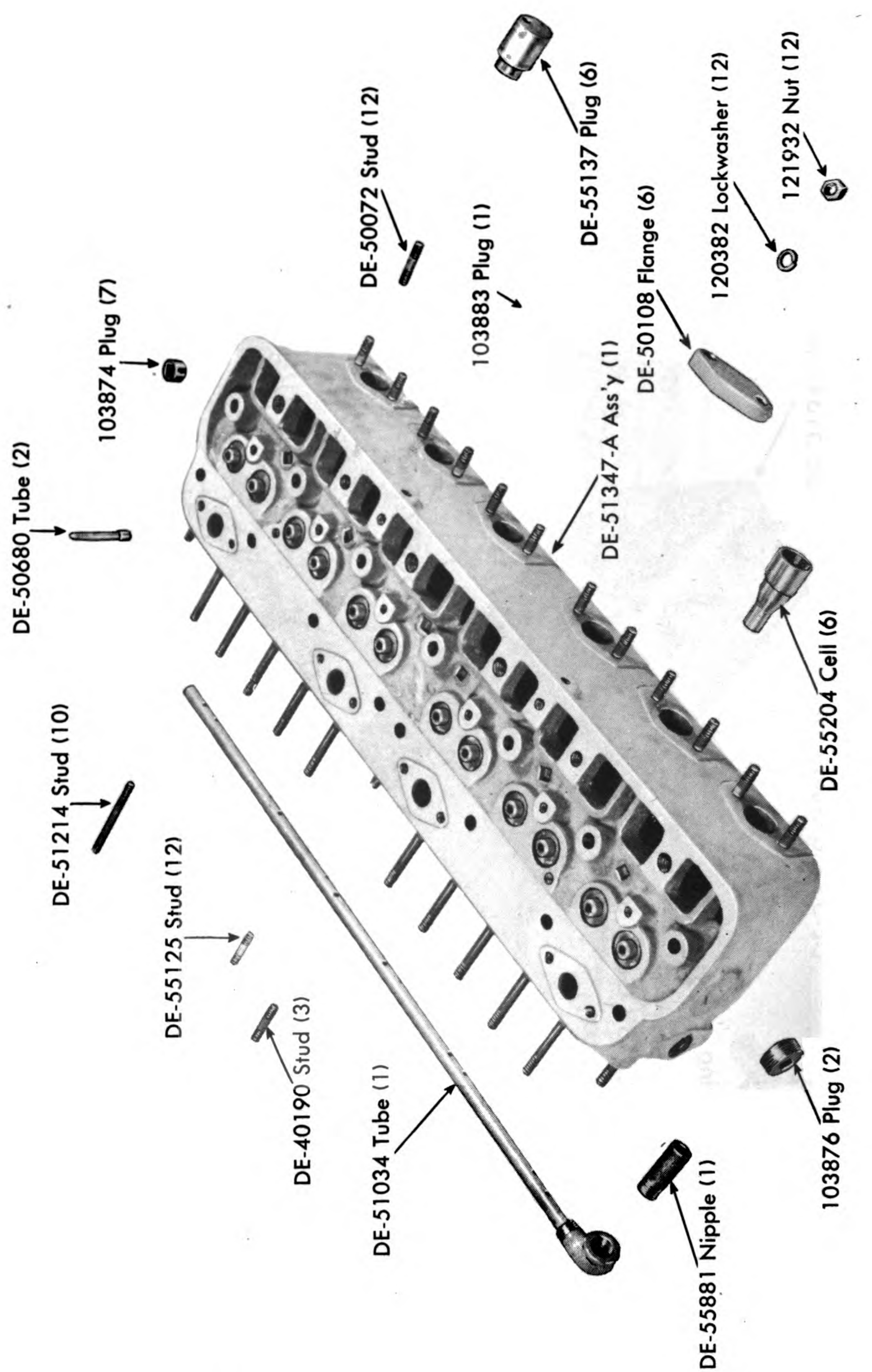




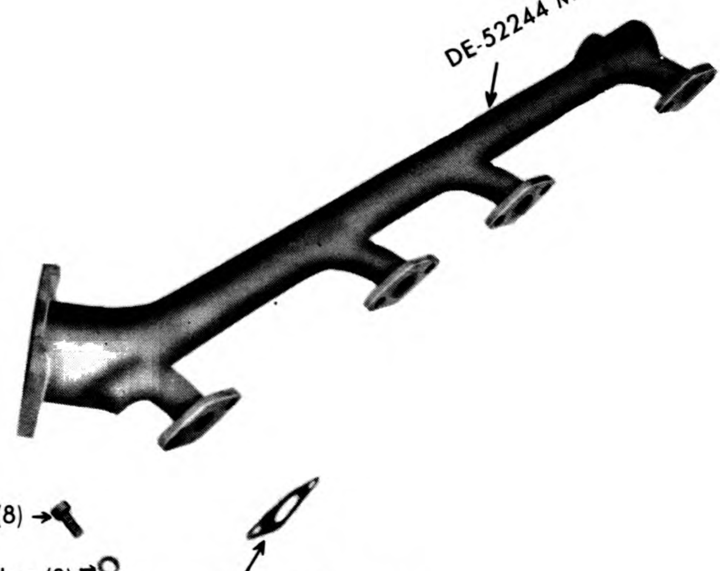
CYLINDER HEAD ASSEMBLY AND GASKETS
(For Parts Breakdown of Cylinder Head DE-51347-B see page 411)



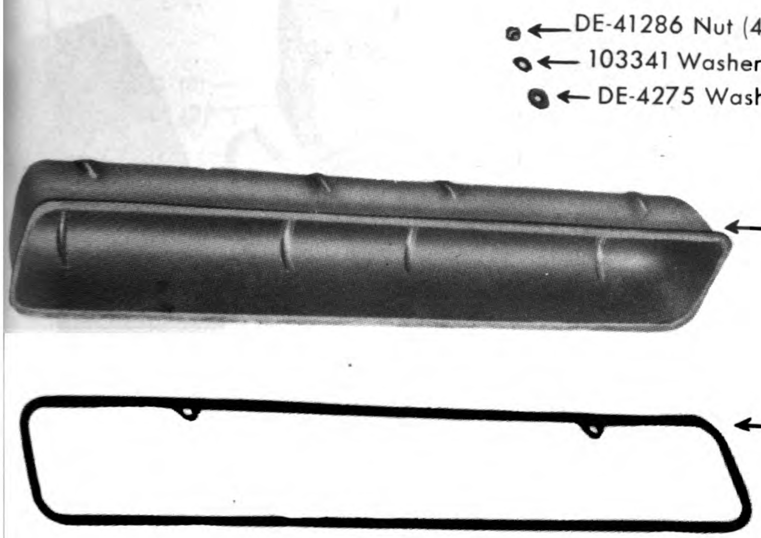
CYLINDER HEAD, VALVES AND VALVE SPRINGS



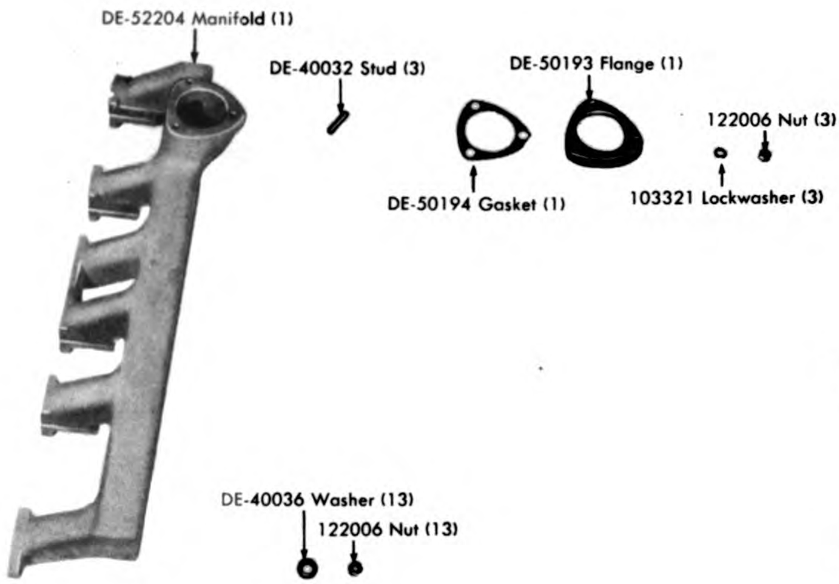
CYLINDER HEAD, ENERGY CELL, TUBES AND STUDS

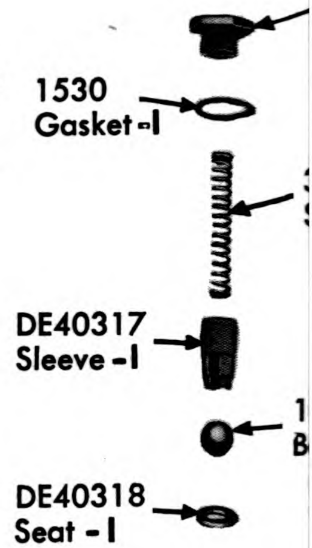


CYLINDER HEAD COVER AND GASKET



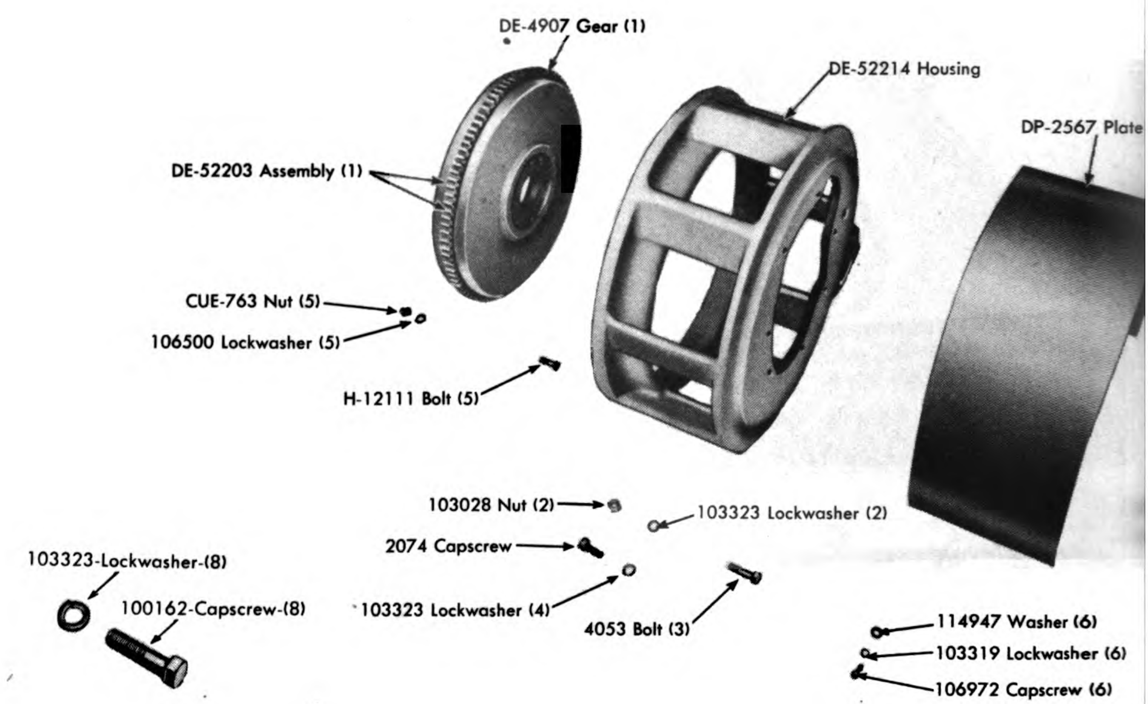
WATER OUTLET MANIFOLD



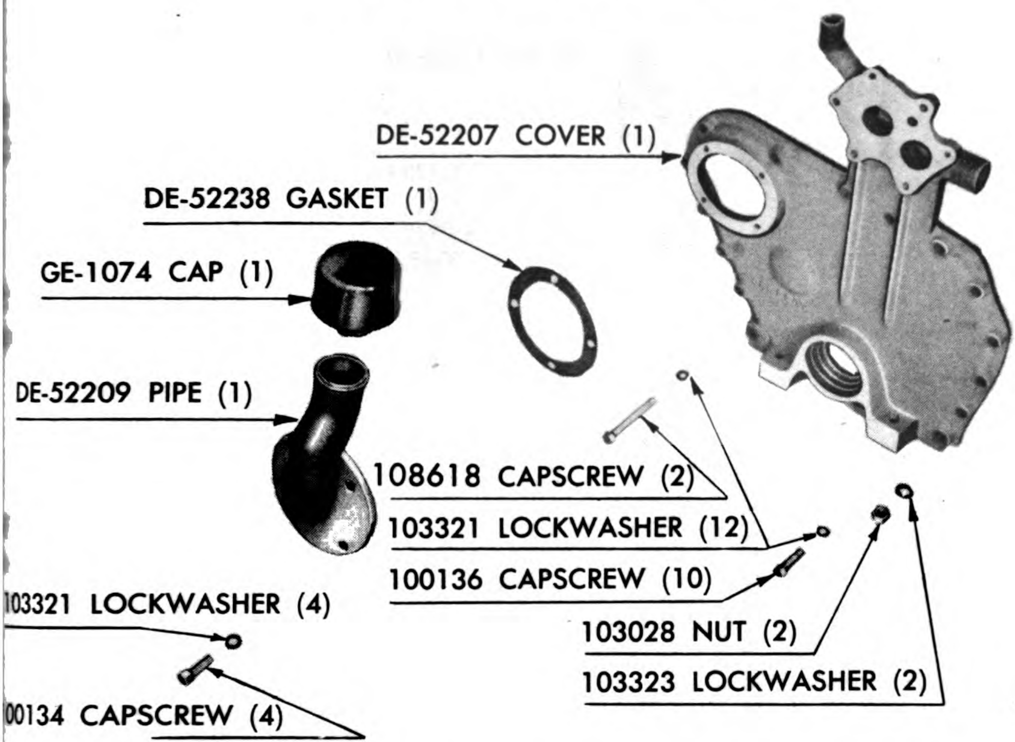


EXHAUST MANIFOLD AND GASKET

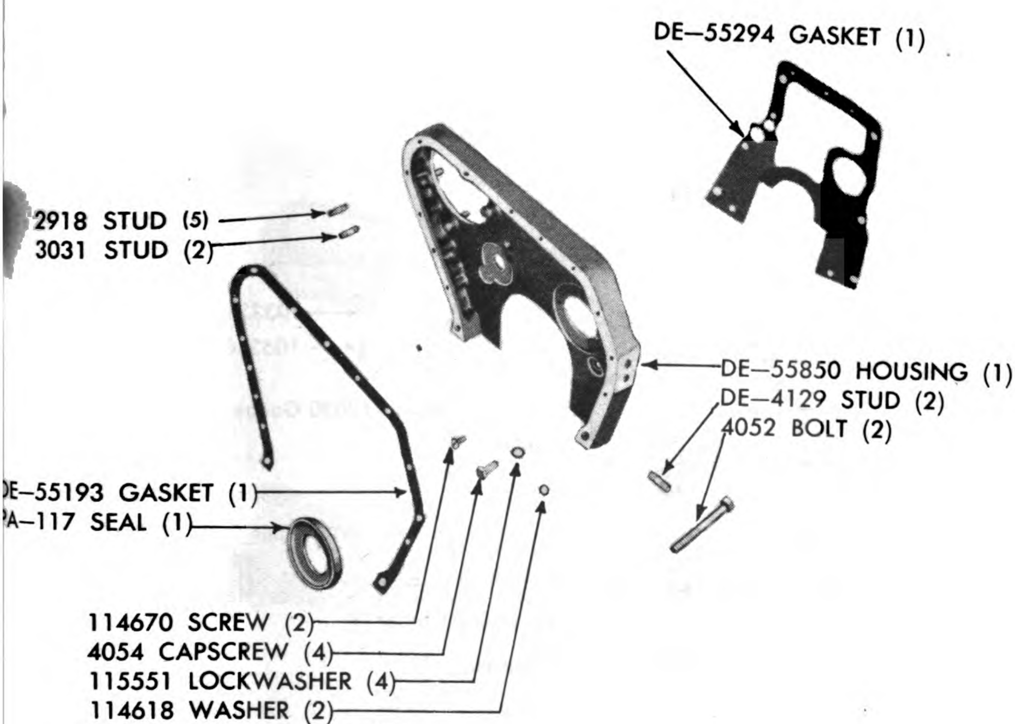
OIL PRESSURE RELIEF VALVE



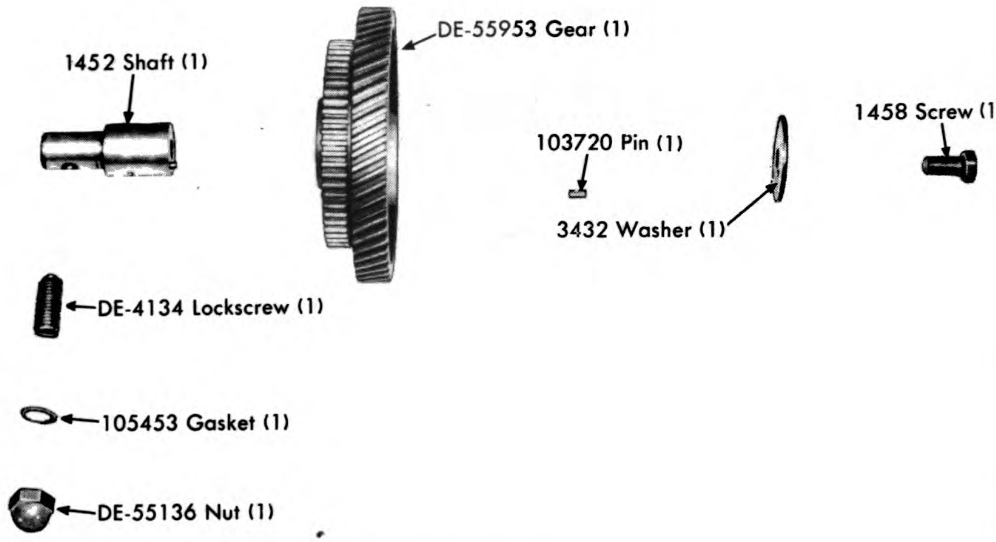
FLYWHEEL AND FLYWHEEL HOUSING GROUP



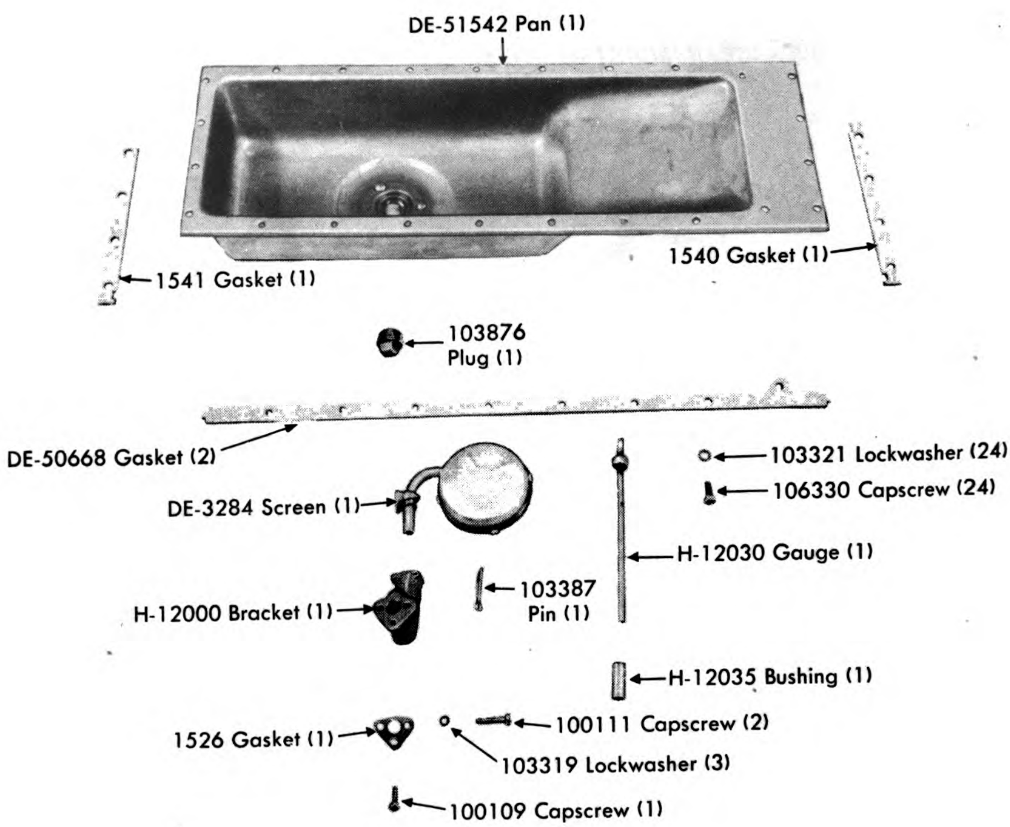
GEAR HOUSING COVER AND OIL FILLER



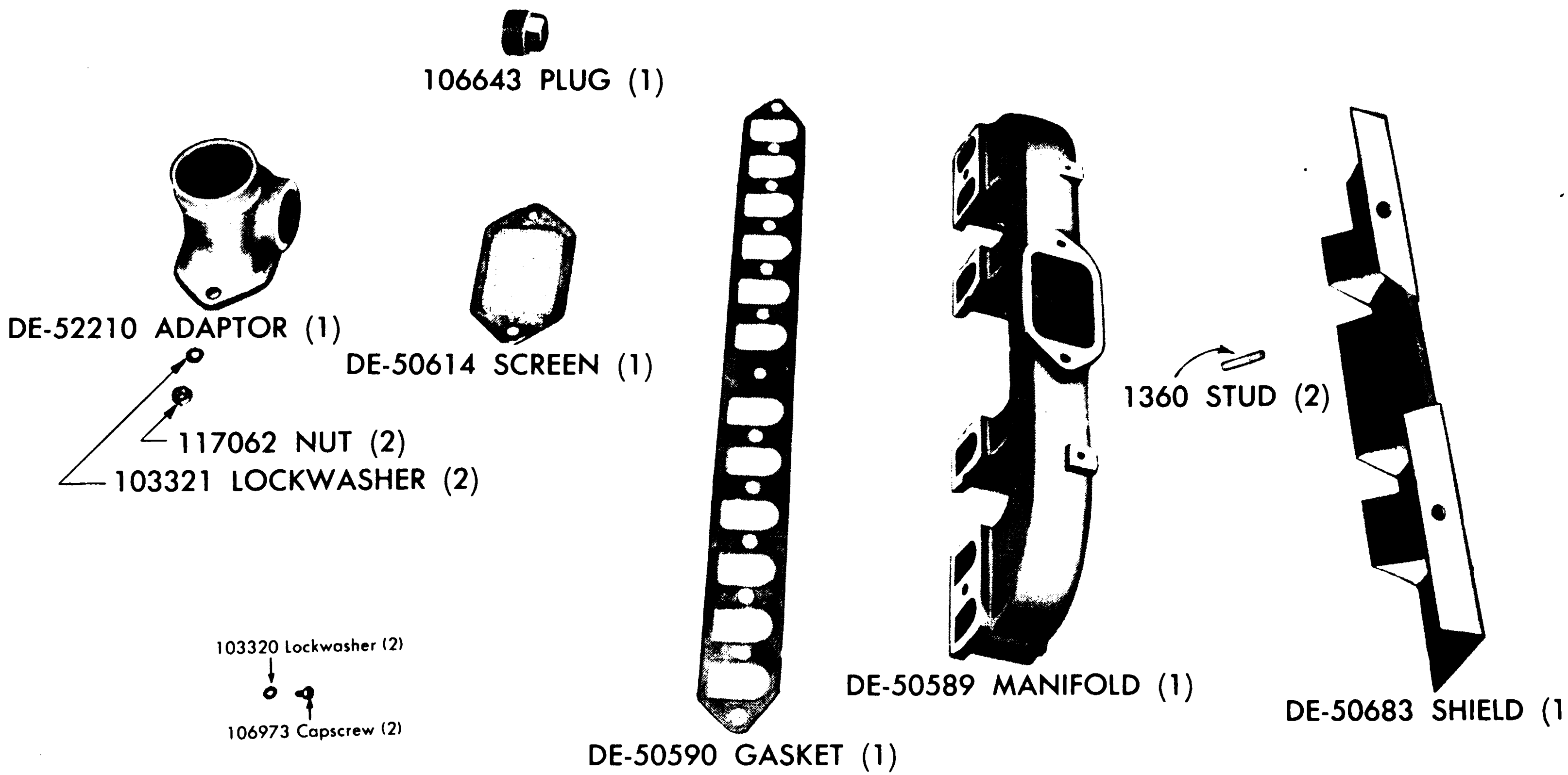
GEAR HOUSING AND GASKETS



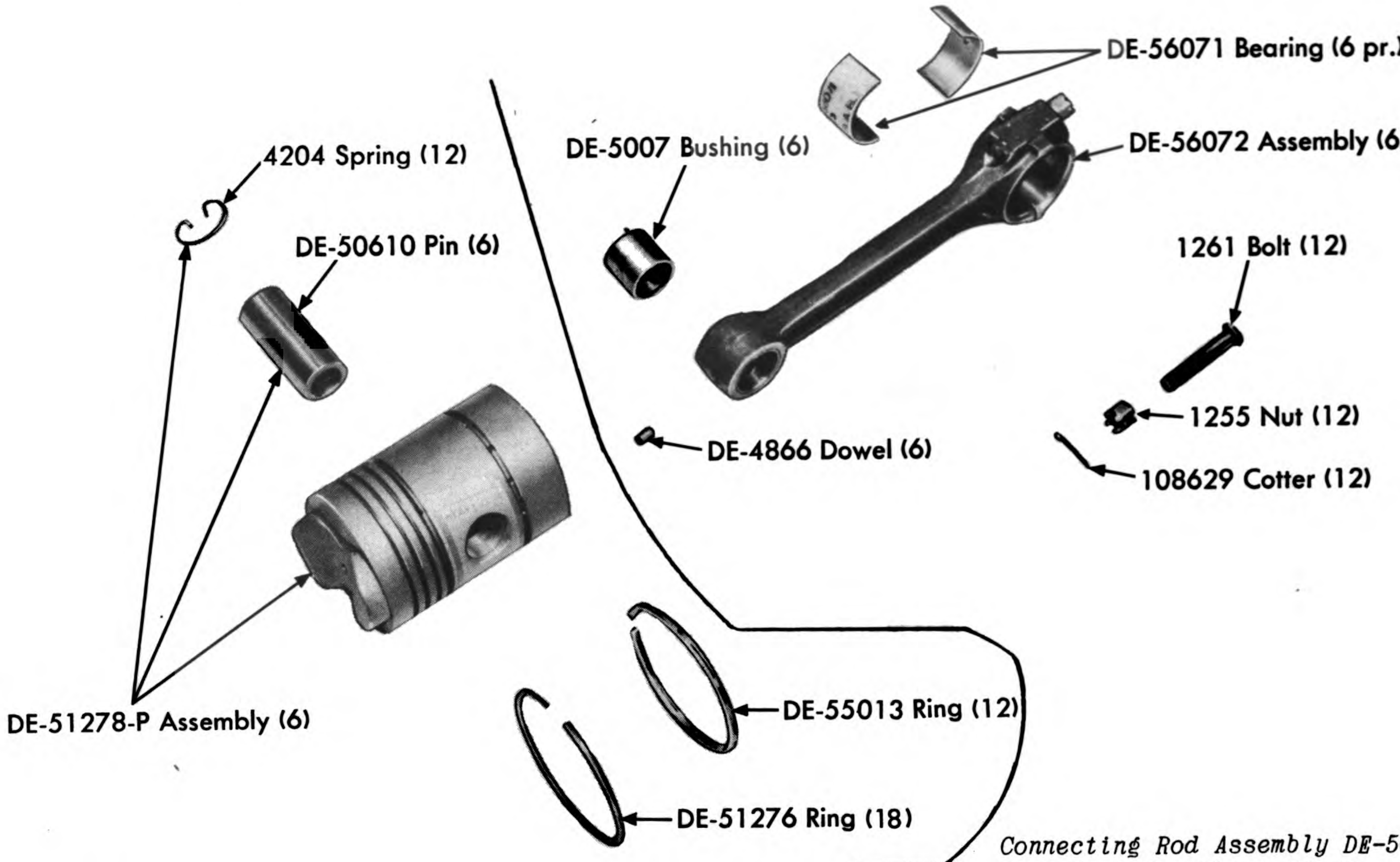
IDLER GEAR GROUP



OIL PAN, OIL FLOAT AND GASKETS



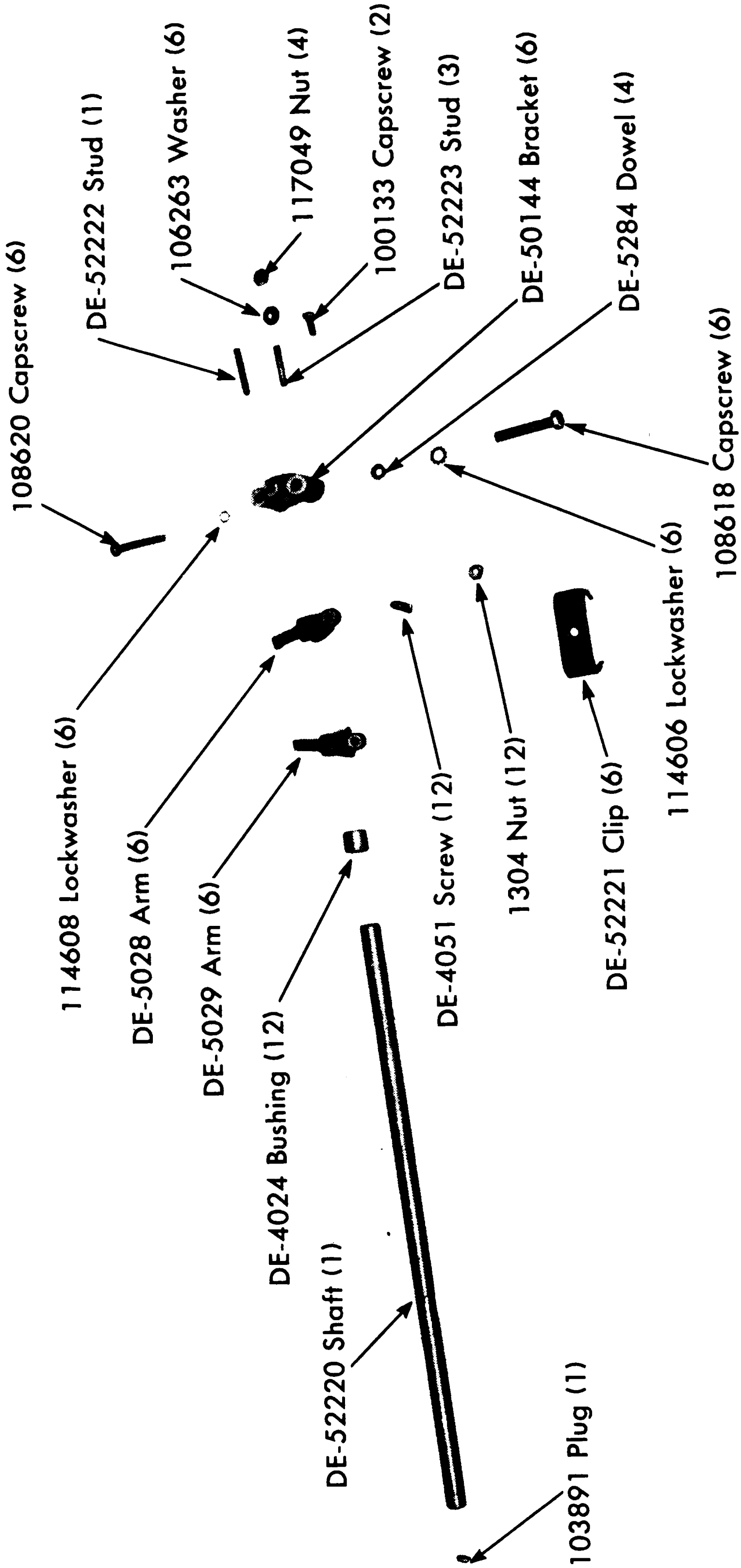
INTAKE MANIFOLD SHIELD AND ADAPTOR



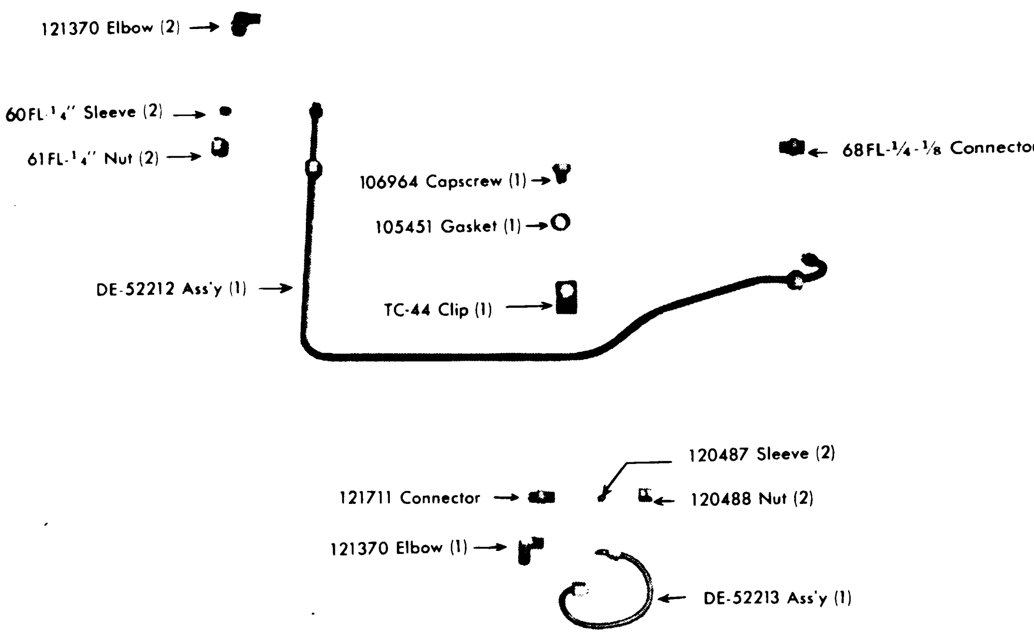
Connecting Rod Assembly DE-56072 includes above items.

Piston Assembly DE-51278-P includes above items.

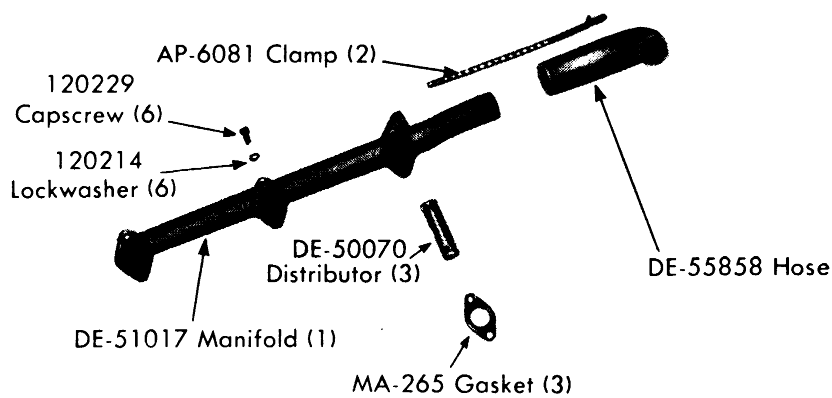
PISTON AND CONNECTING ROD ASSEMBLIES

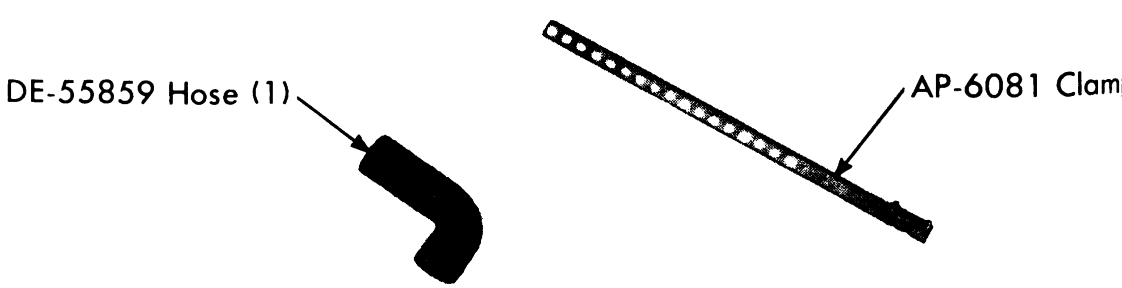


ROCKER ARM ASSEMBLY

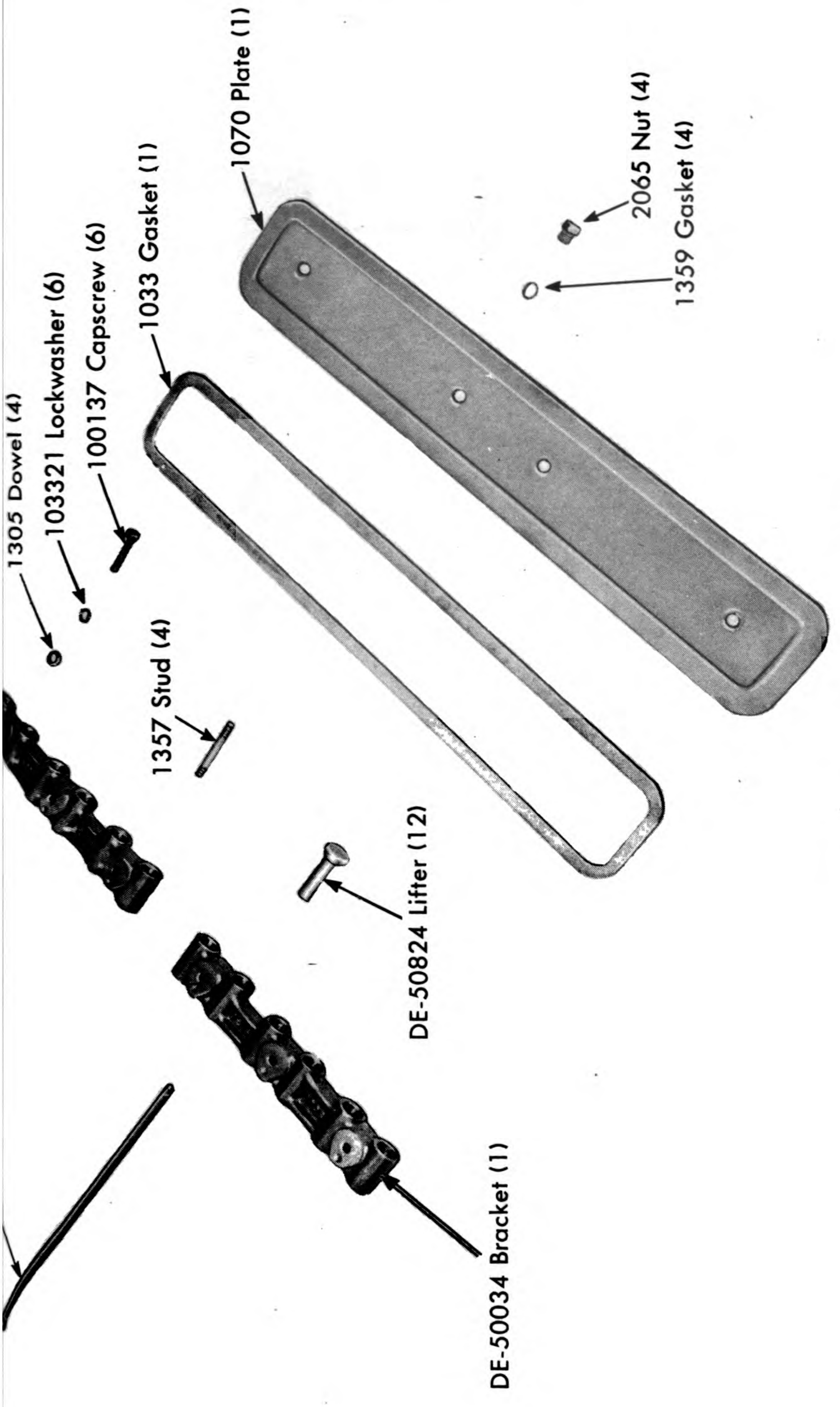


ROCKER ARM OIL LINES

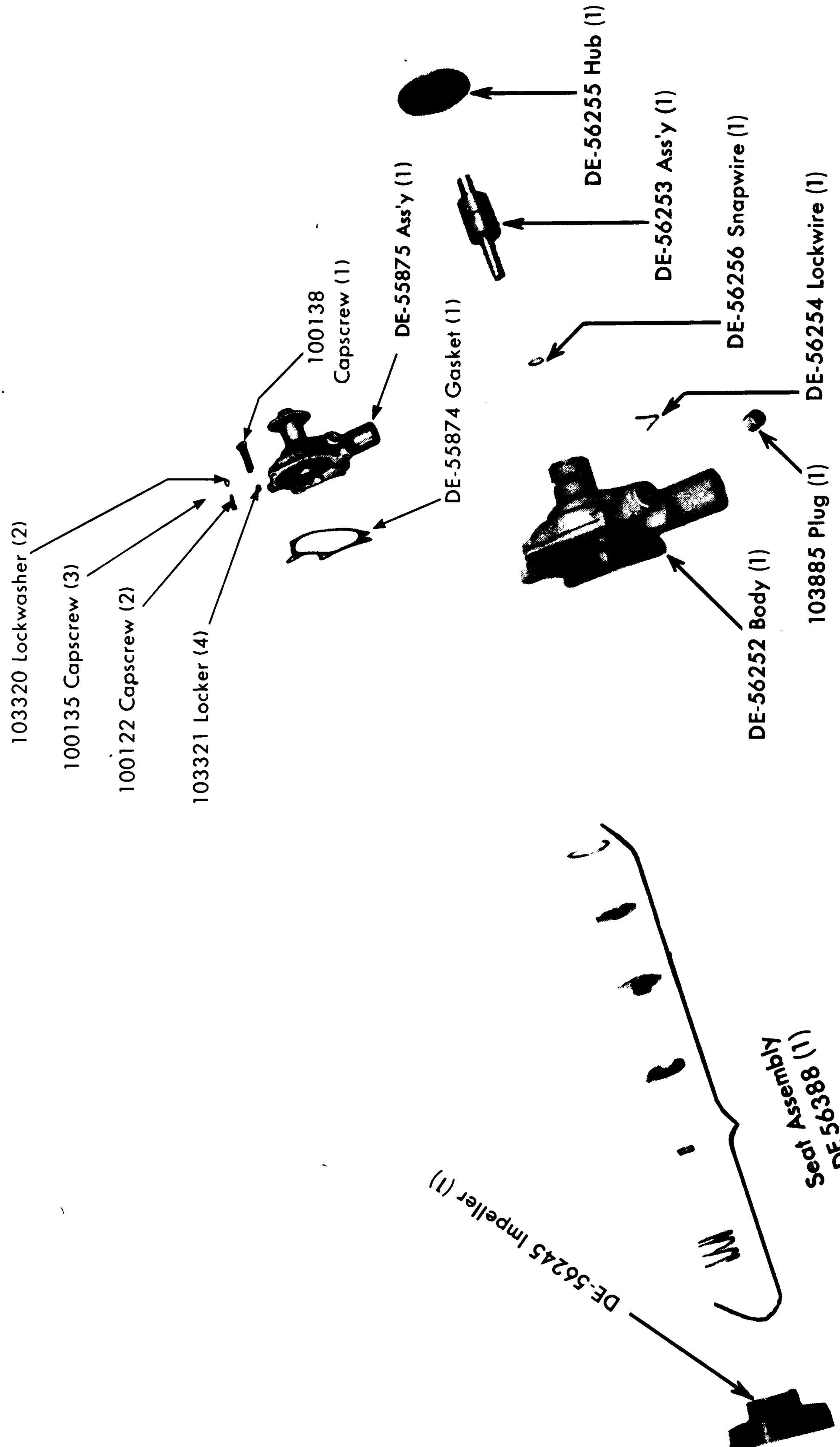




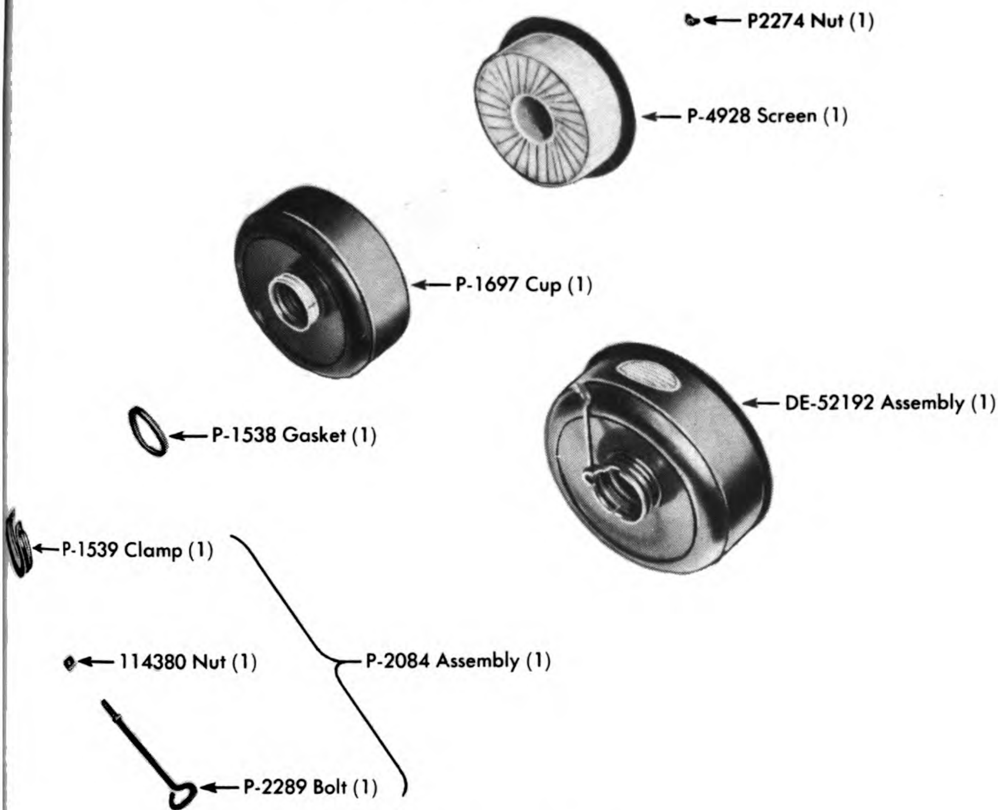
WATER INLET MANIFOLD, DISTRIBUTOR HOSE CONNECTIONS



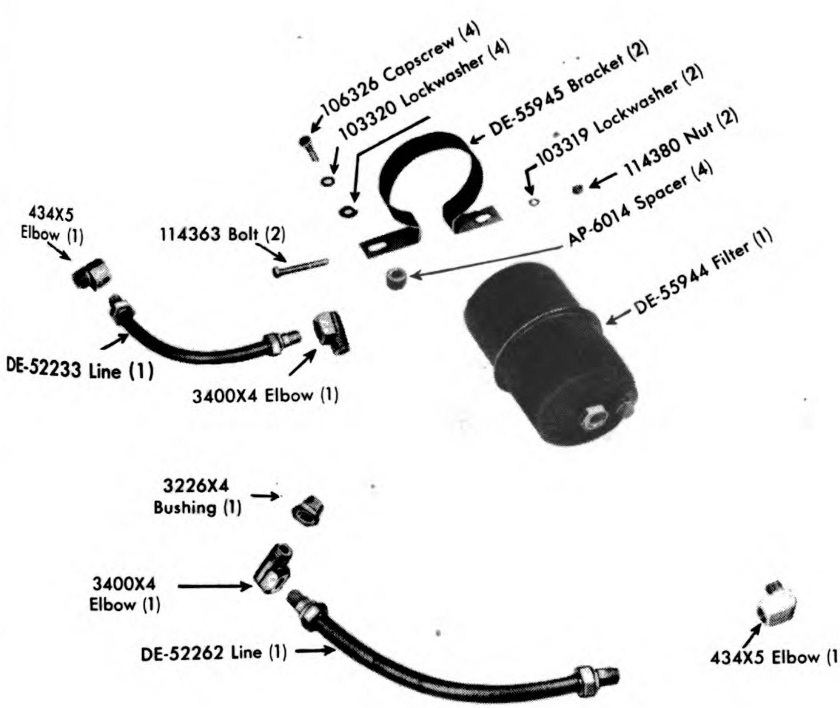
VALVE LIFTER. BRACKET AND COVER



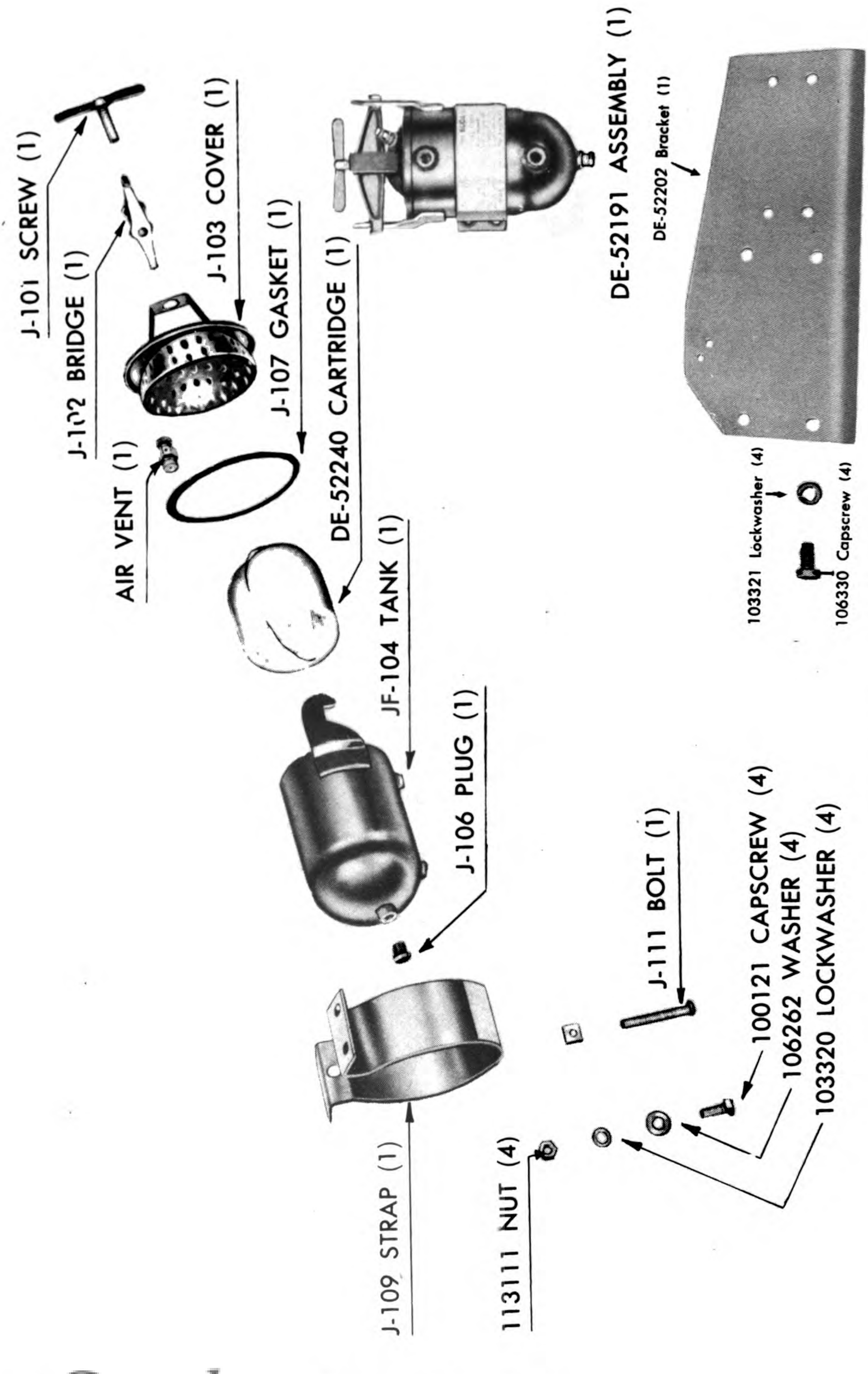
WATER PUMP GROUP
(Assembly No: DE-55875 includes all above parts with DE prefixes)

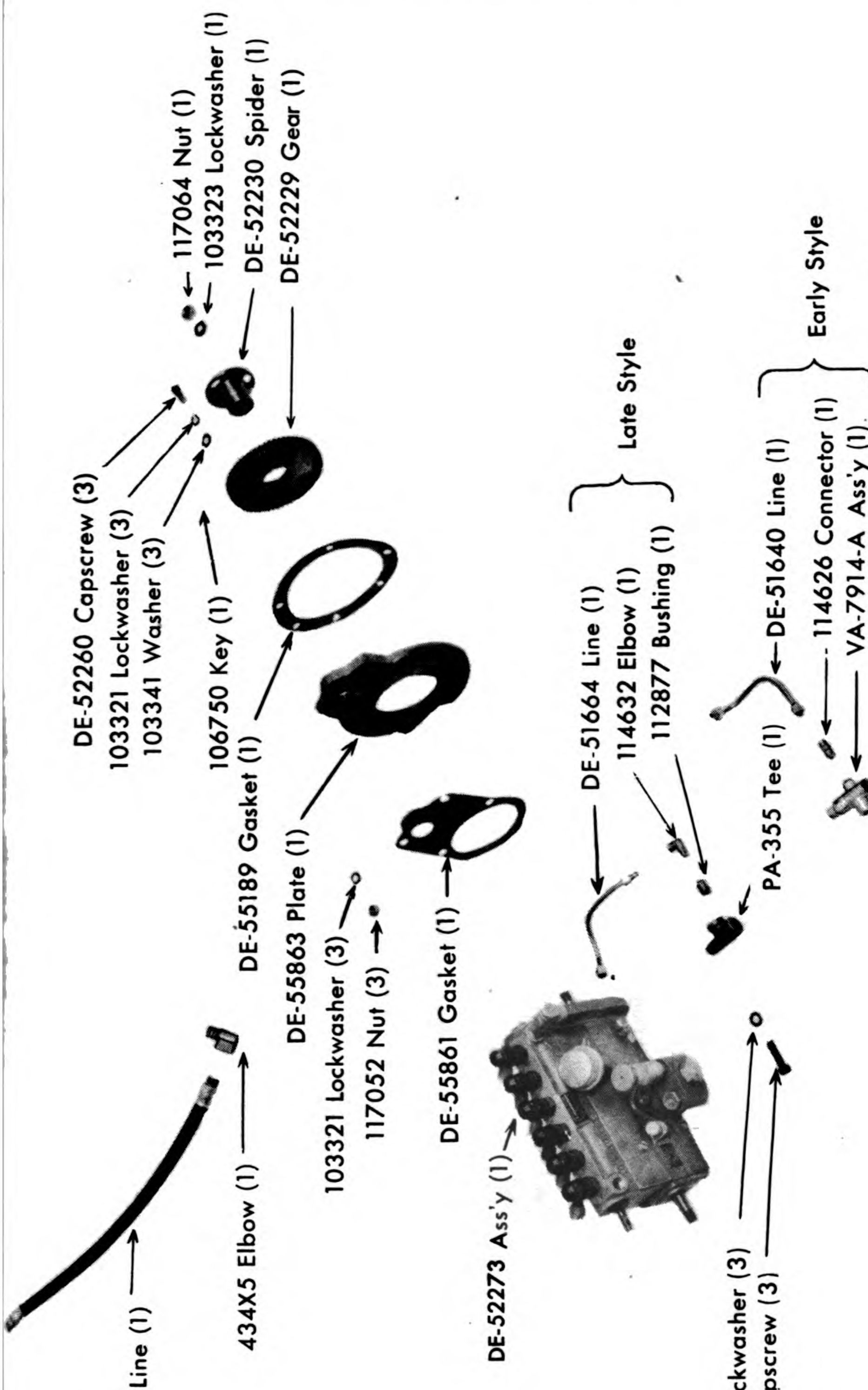


AIR CLEANER

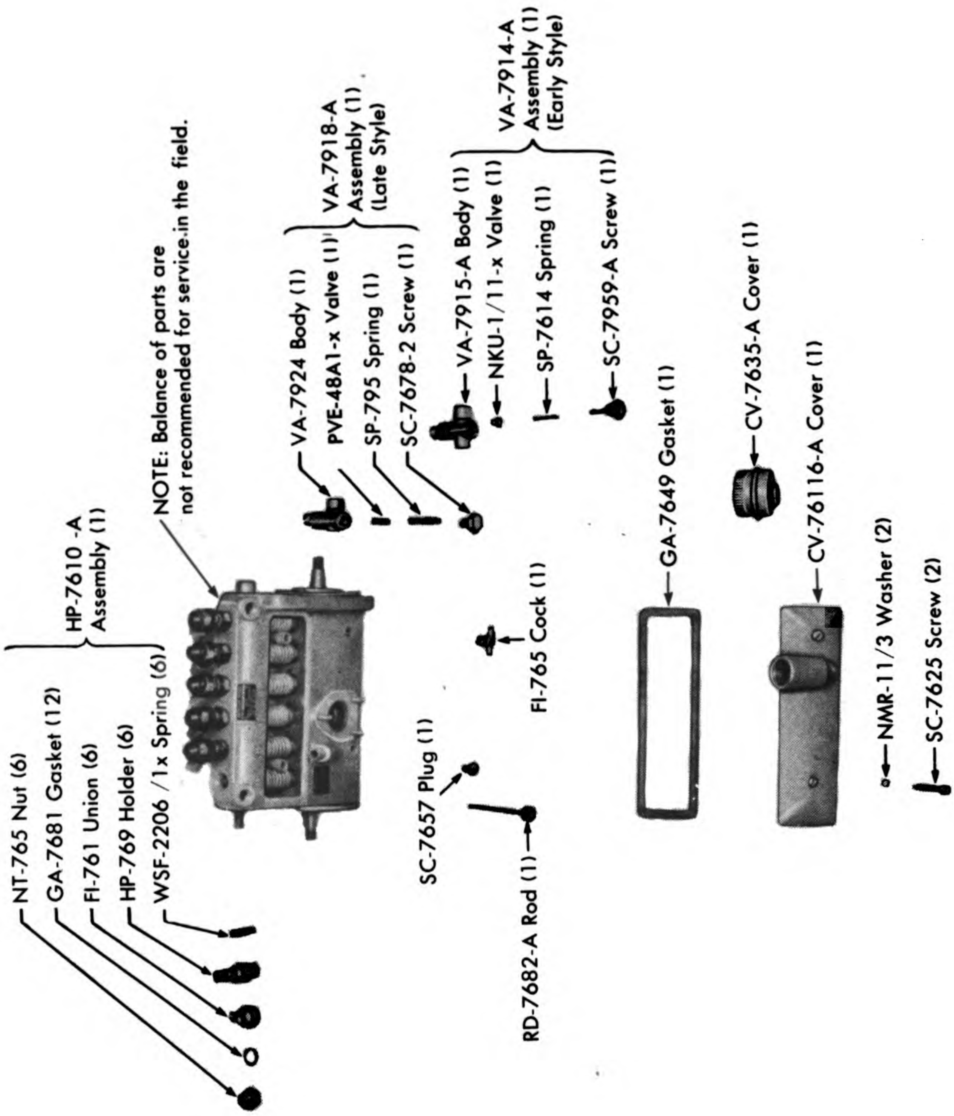


FUEL FILTER (SECONDARY) AND CONNECTIONS

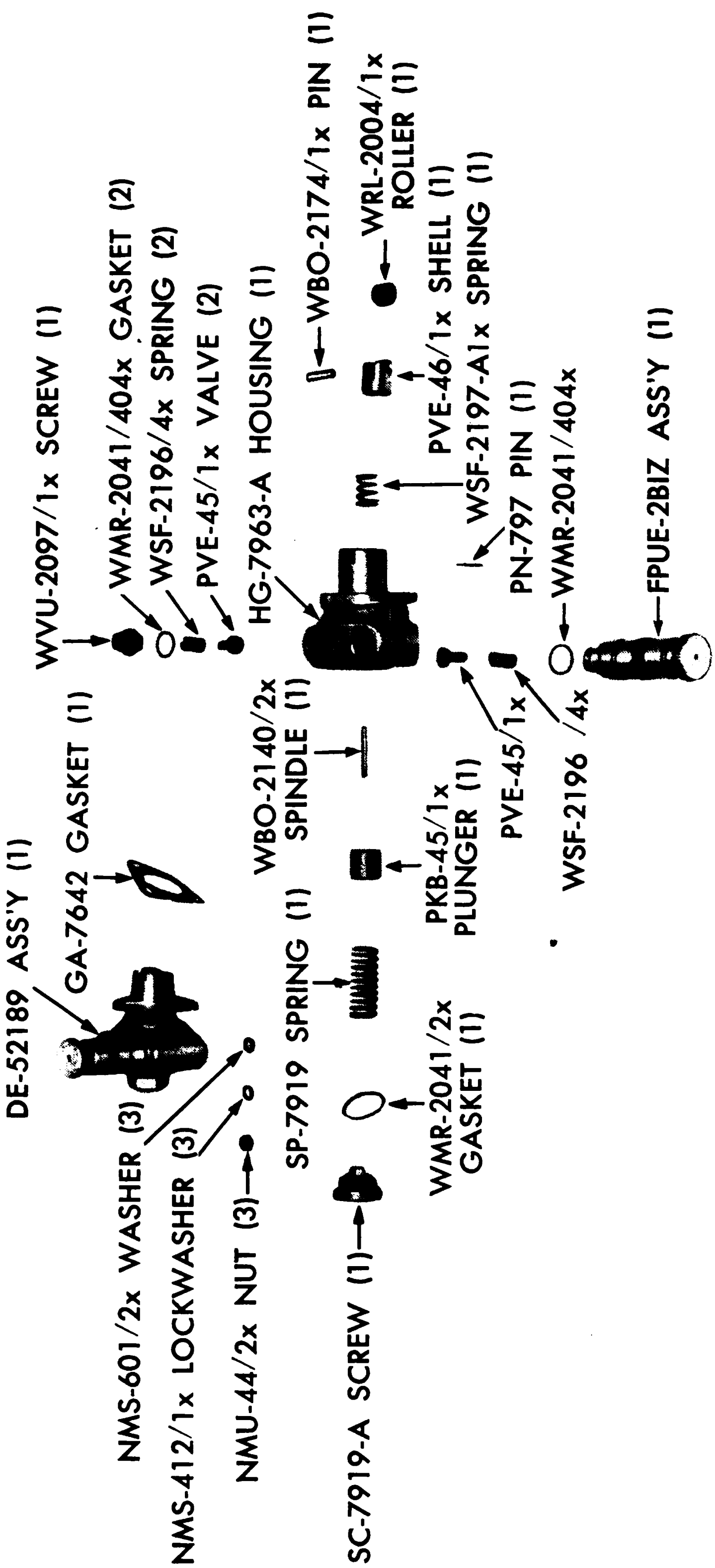

J-101 SCREW (1)
J-102 BRIDGE (1)
J-103 COVER (1)
AIR VENT (1)
J-107 GASKET (1)
DE-52240 CARTRIDGE (1)
JF-104 TANK (1)
J-106 PLUG (1)
DE-52191 ASSEMBLY (1)
DE-52202 Bracket (1)
103321 Lockwasher (4)
106330 Capscrew (4)
J-111 BOLT (1)
100121 CAPSCREW (4)
106262 WASHER (4)
103320 LOCKWASHER (4)
J-109 STRAP (1)
113111 NUT (4)



FUEL INJECTION PUMP AND DRIVE
(Exploded view of Fuel Injection Pump on page 426)

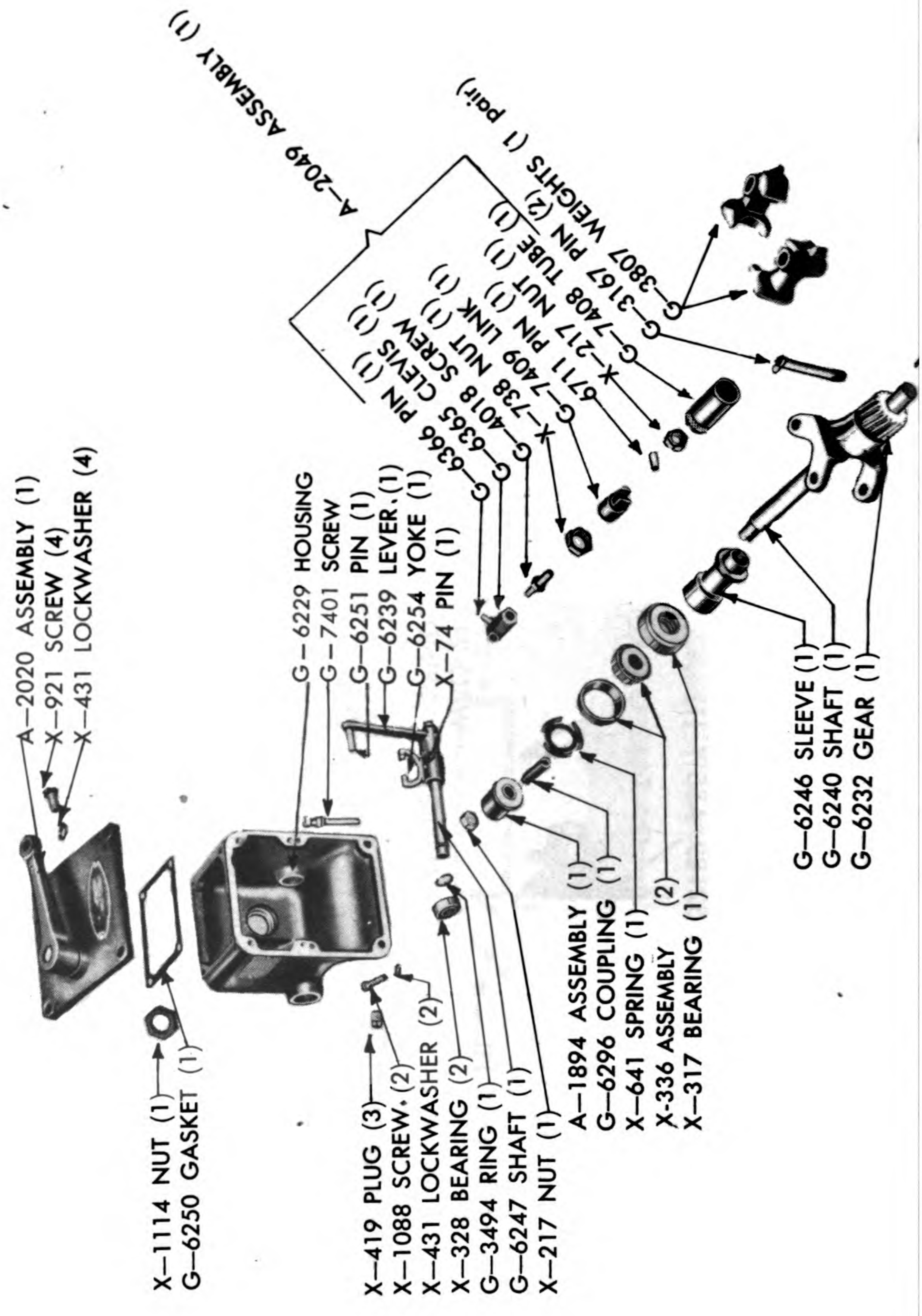


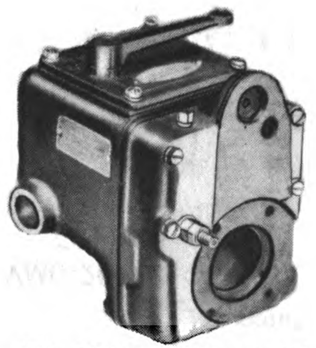
EXPLODED VIEW OF FUEL INJECTION PUMP



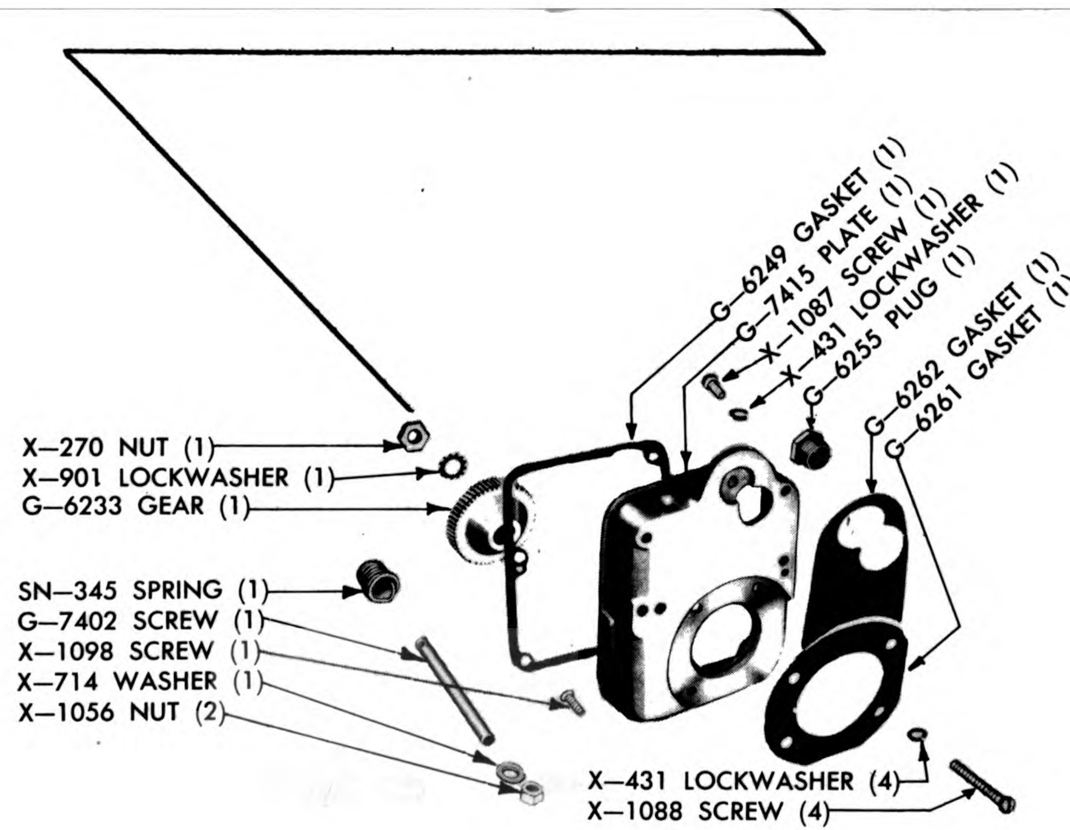
FUEL TRANSFER PUMP

GOVERNOR

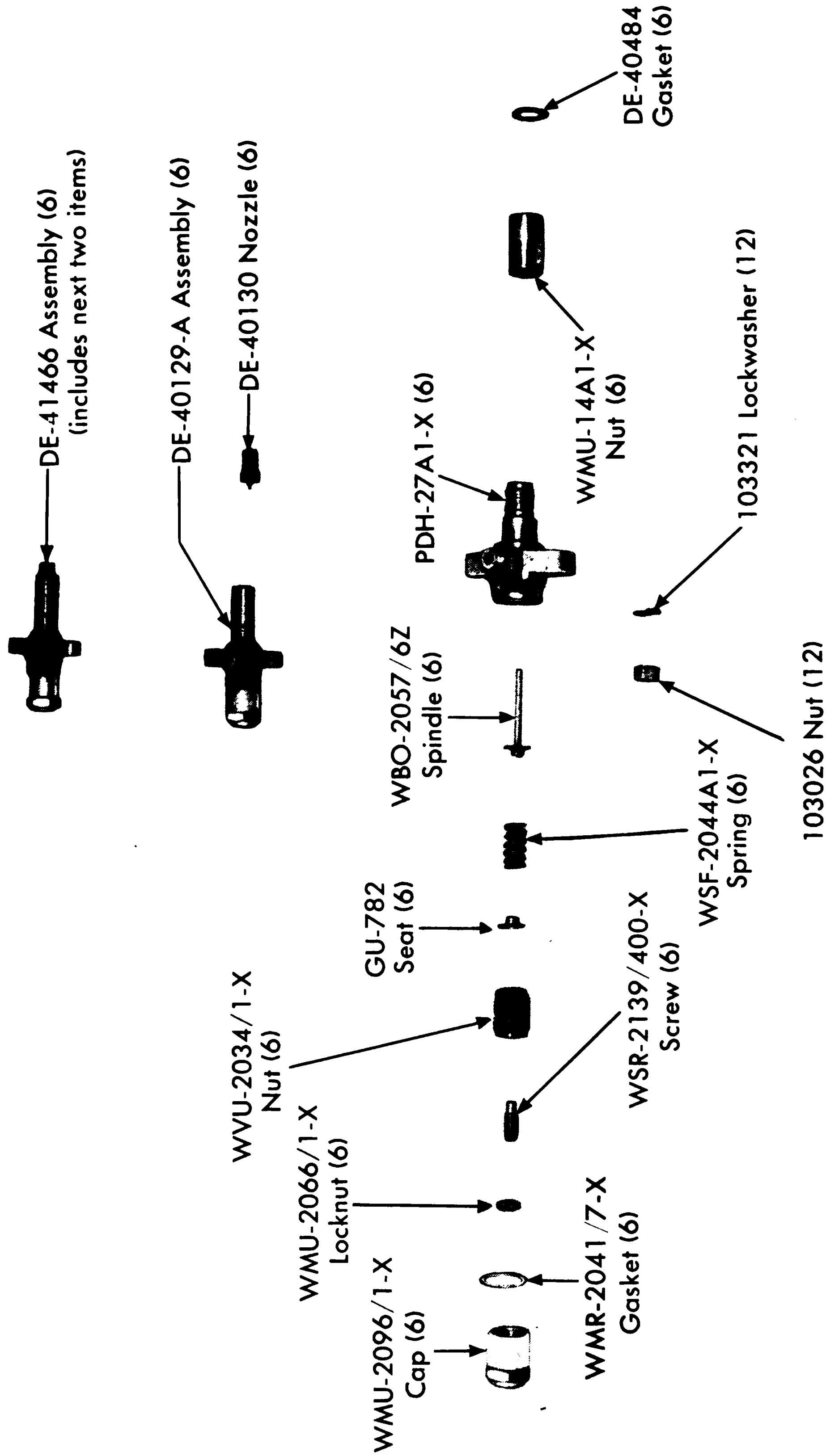

A—2020 ASSEMBLY (1)
X—921 SCREW (4)
X—431 LOCKWASHER (4)
G—6229 HOUSING
G—7401 SCREW
G—6251 PIN (1)
G—6239 LEVER (1)
G—6254 YOKE (1)
X—74 PIN (1)
X—1114 NUT (1)
G—6250 GASKET (1)
X—419 PLUG (3)
X—1088 SCREW (2)
X—431 LOCKWASHER (2)
X—328 BEARING (2)
G—3494 RING (1)
G—6247 SHAFT (1)
X—217 NUT (1)
A—1894 ASSEMBLY (1)
G—6296 COUPLING (1)
X—641 SPRING (1)
X-336 ASSEMBLY (2)
X—317 BEARING (1)
G—6246 SLEEVE (1)
G—6240 SHAFT (1)
G—6232 GEAR (1)
A—2049 ASSEMBLY (1)
G—3807 WEIGHTS (1 pair)
G—3167 PIN (2)
G—7408 TUBE (1)
X—217 NUT (1)
G—6711 PIN (1)
G—7409 LINK (1)
X—738 NUT (1)
G—4018 SCREW (1)
G—6365 CLEVIS (1)
G—6366 PIN (1)



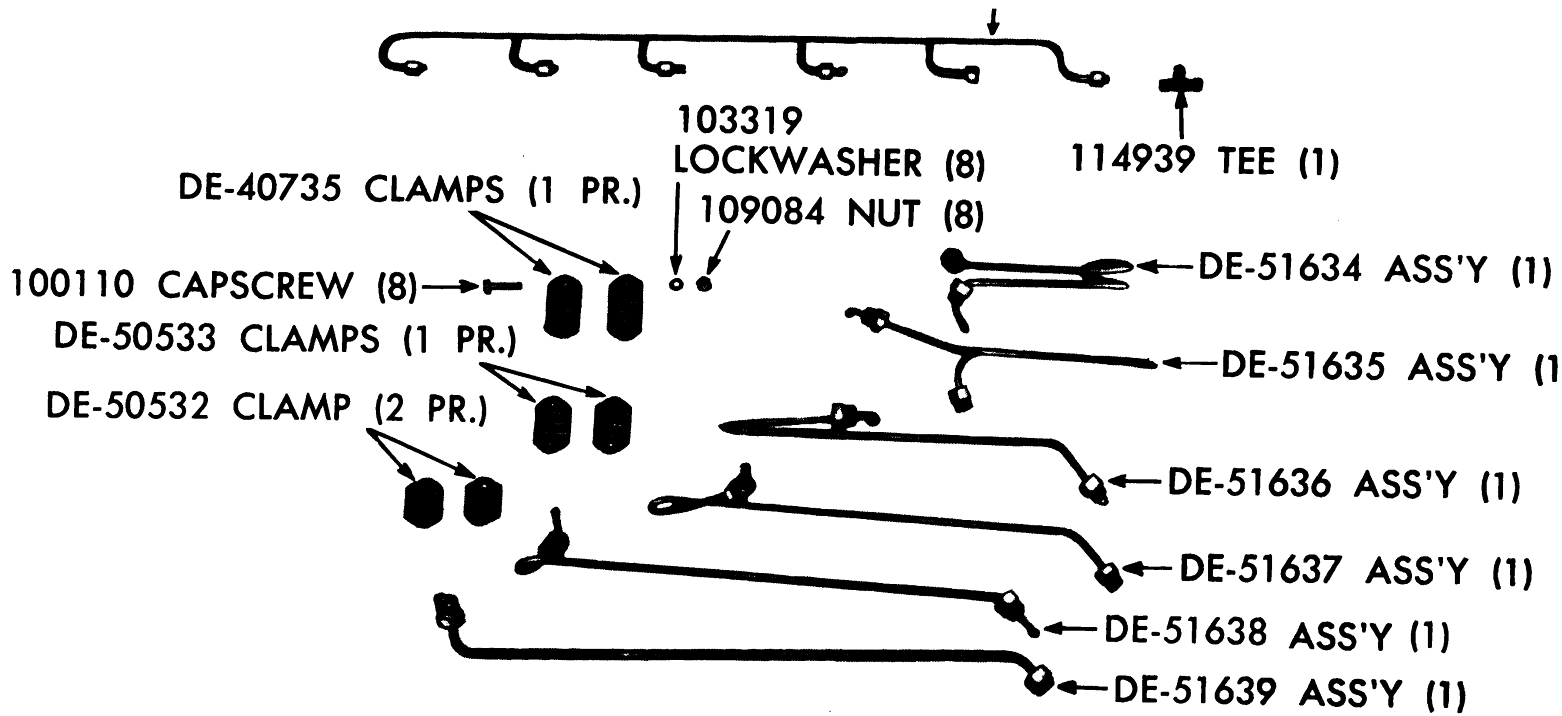
DE—52201 ASSEMBLY (1)



GOVERNOR

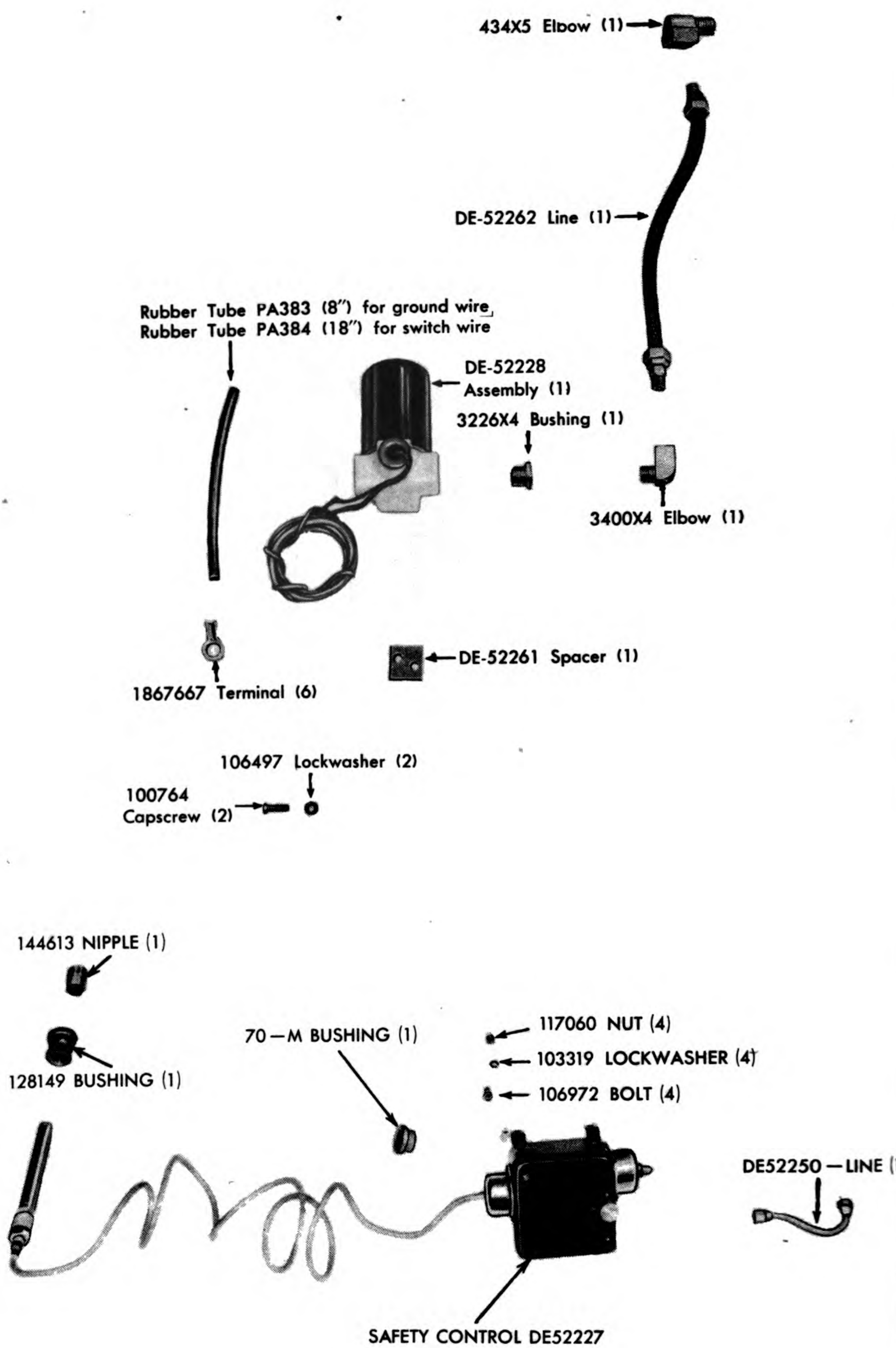


FUEL INJECTORS (NOZZLES)

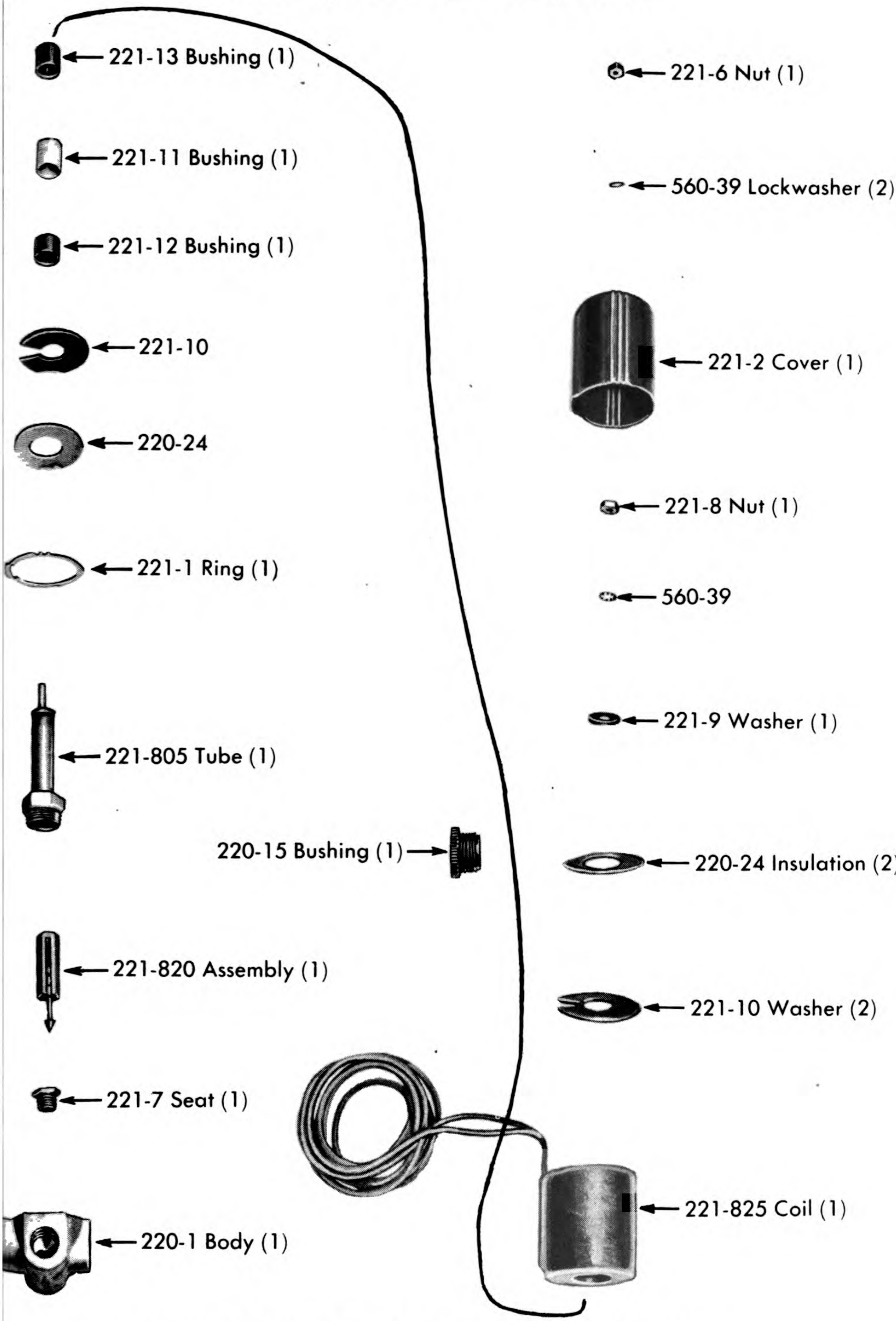


Fuel Line Straight — DE51634-S
(For any cylinder,
must be bent to fit)

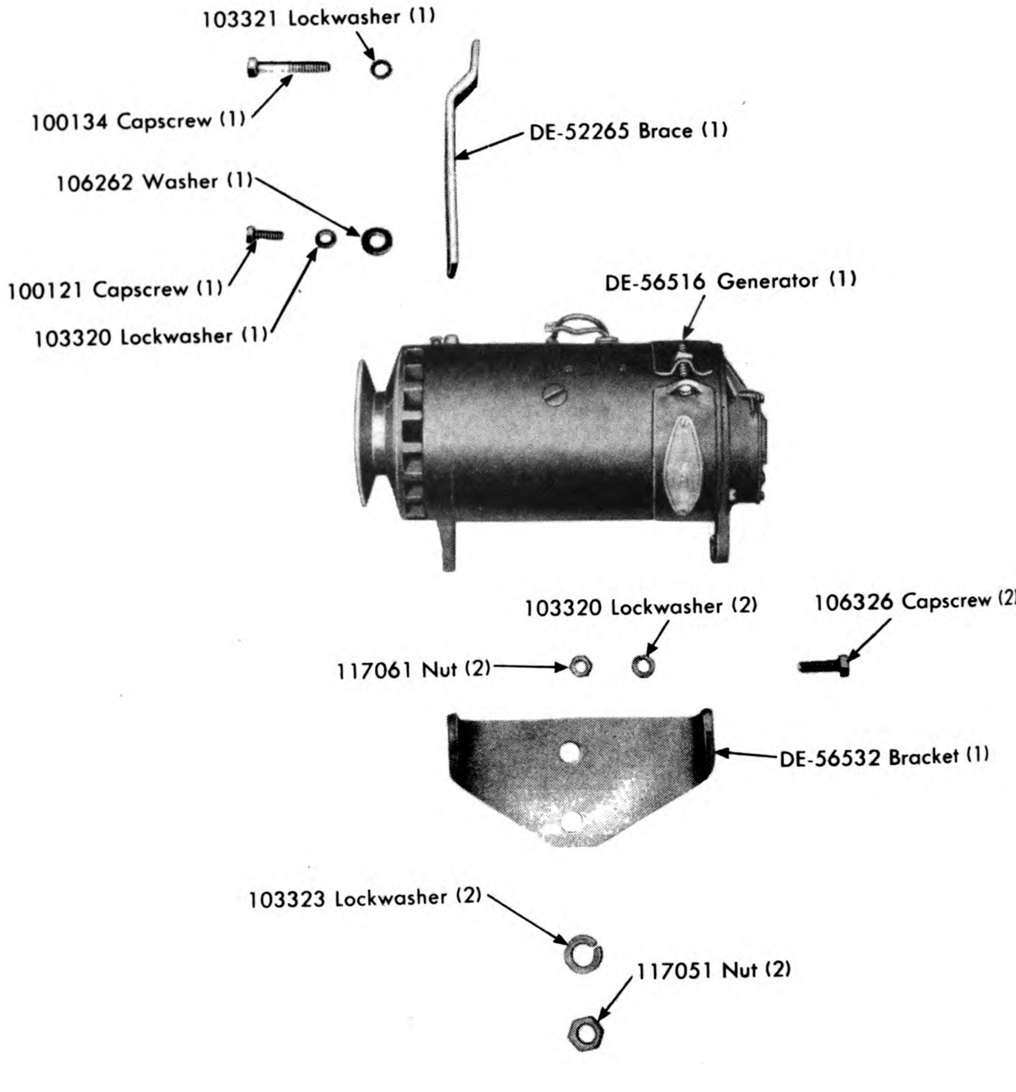
FUEL INJECTOR LINES AND RETURN LINES



ENGINE SAFETY CONTROL OR SOLENOID SAFETY SHUT-OFF VALVE

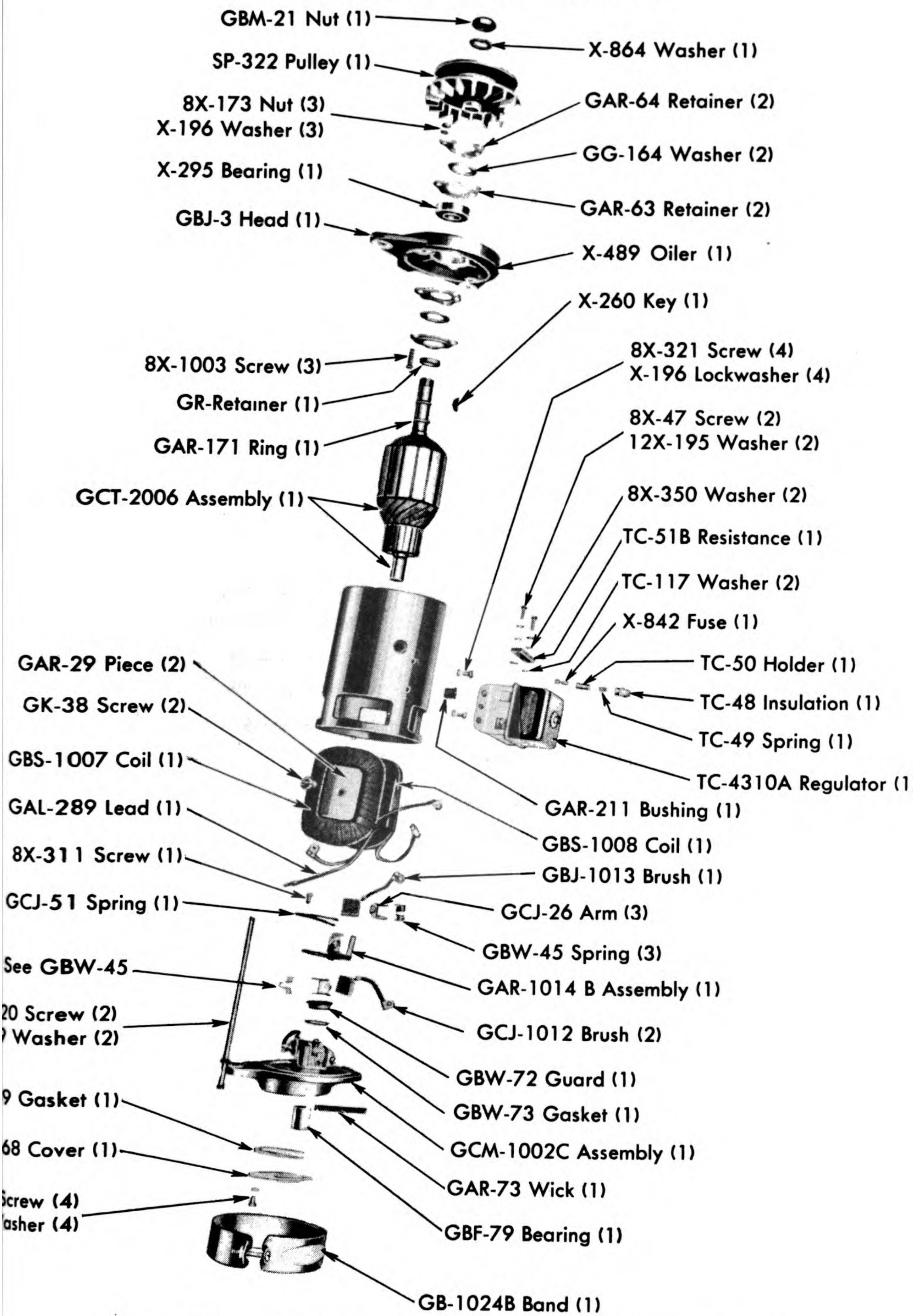


EXPLODED VIEW OF SOLENOID SAFETY SHUT-OFF VALVE
ASSEMBLY N. DE-52228

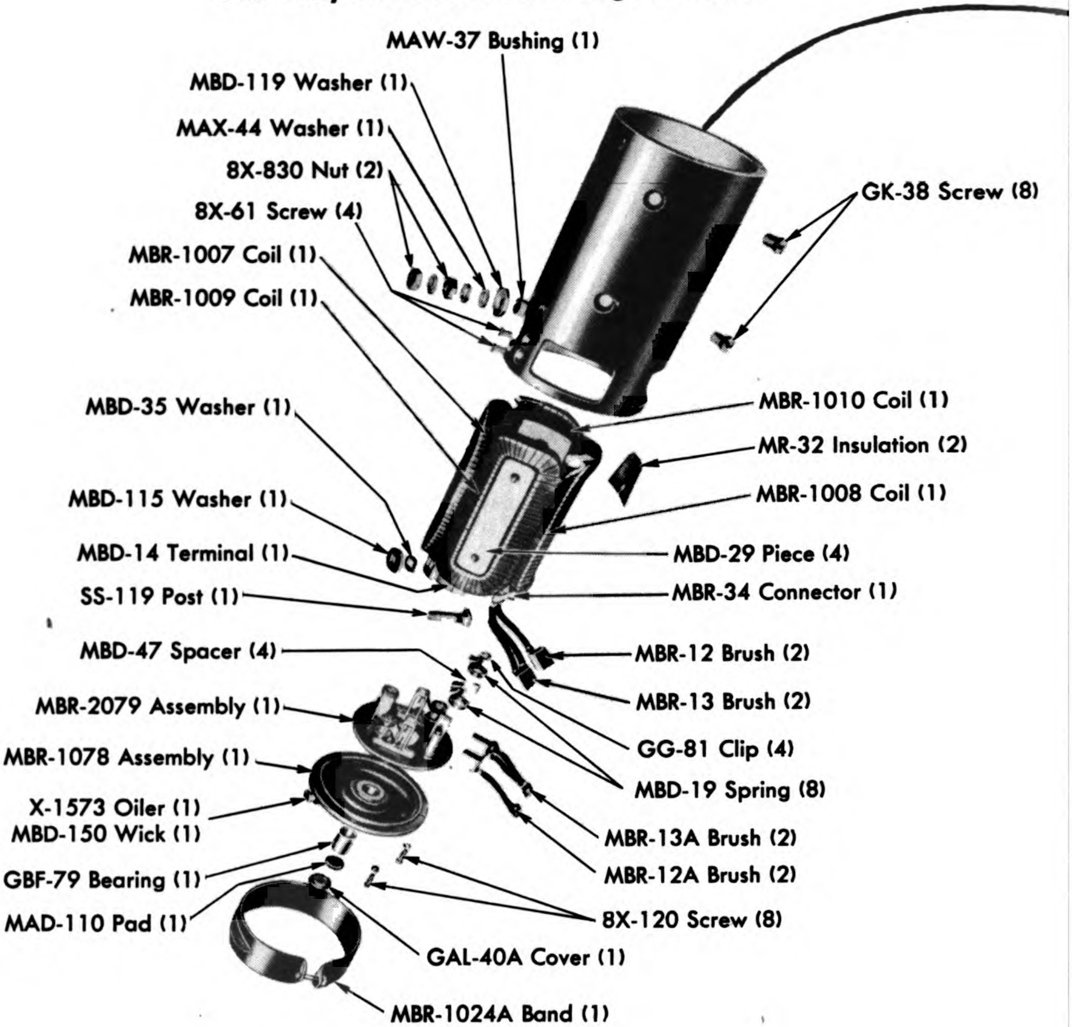


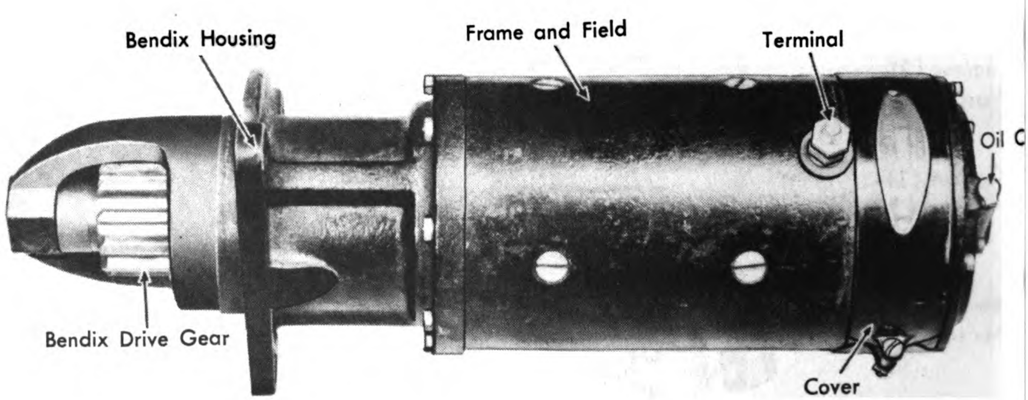
ENGINE (BATTERY CHARGING) GENERATOR AND MOUNTING PARTS

Use Only Genuine BUDA Engine Parts

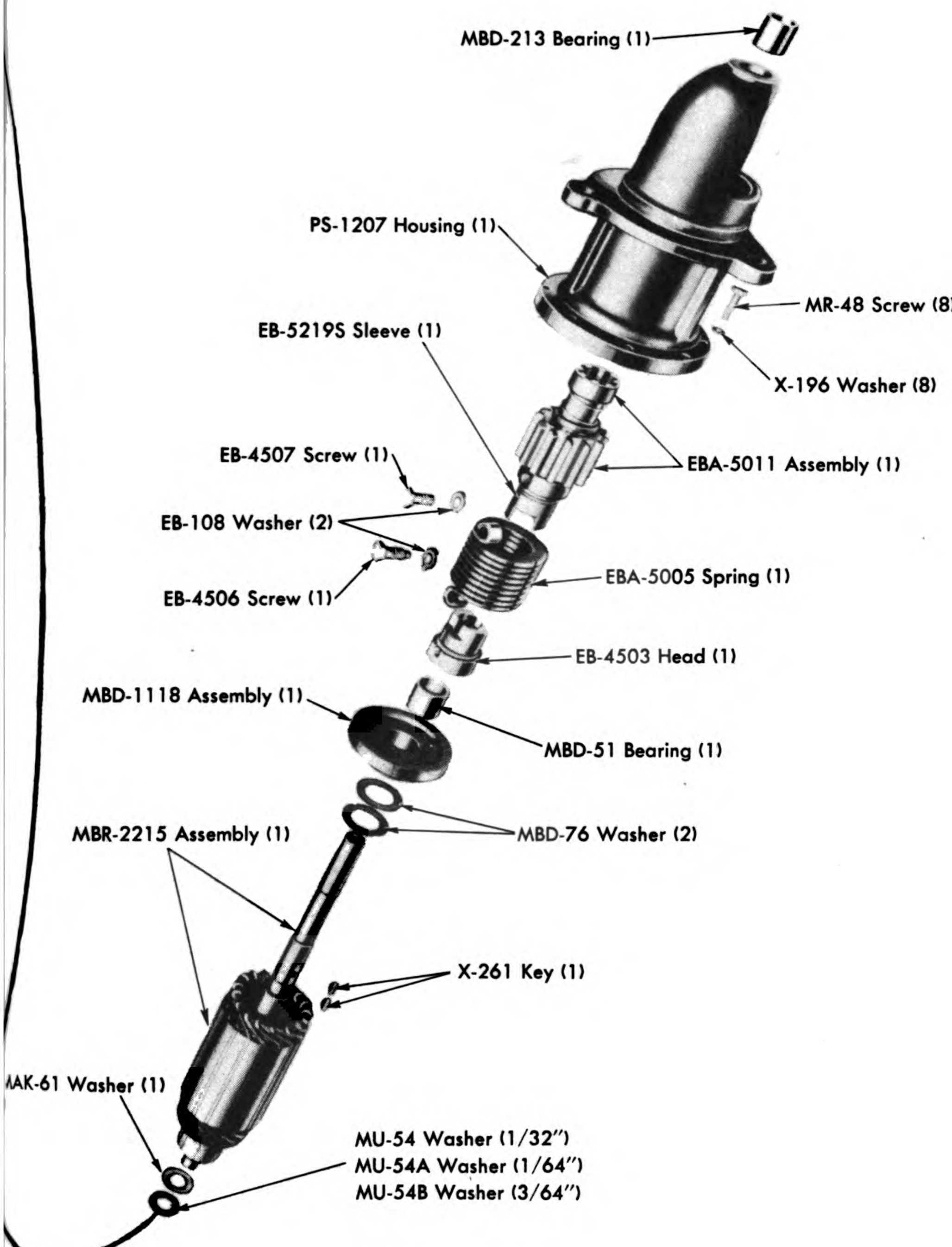


EXPLODED VIEW OF ENGINE (BATTERY CHARGING) GENERATOR
(Voltage Regulator TC-4310A is shown in place.
Exploded view of this assembly is illustrated on page 438)

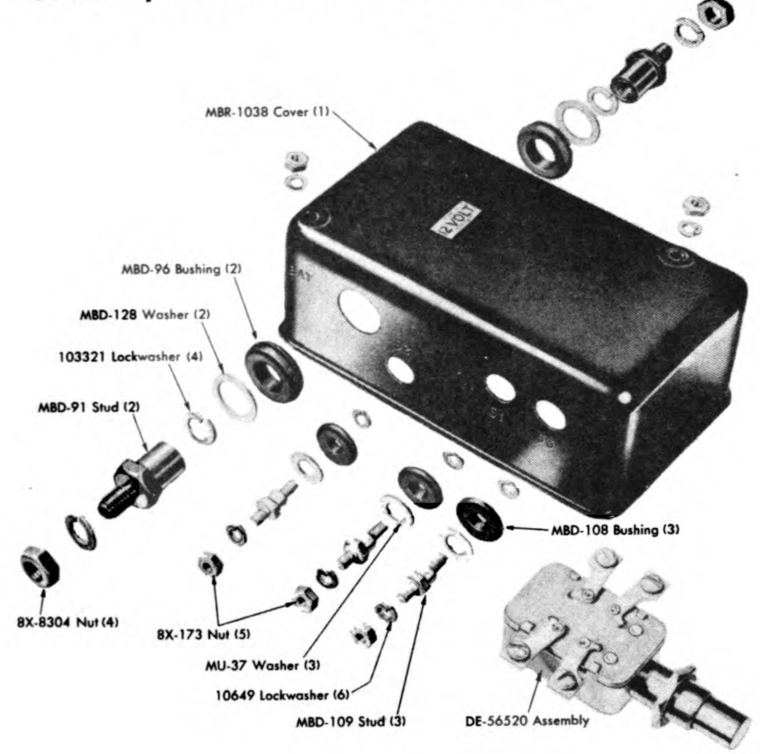


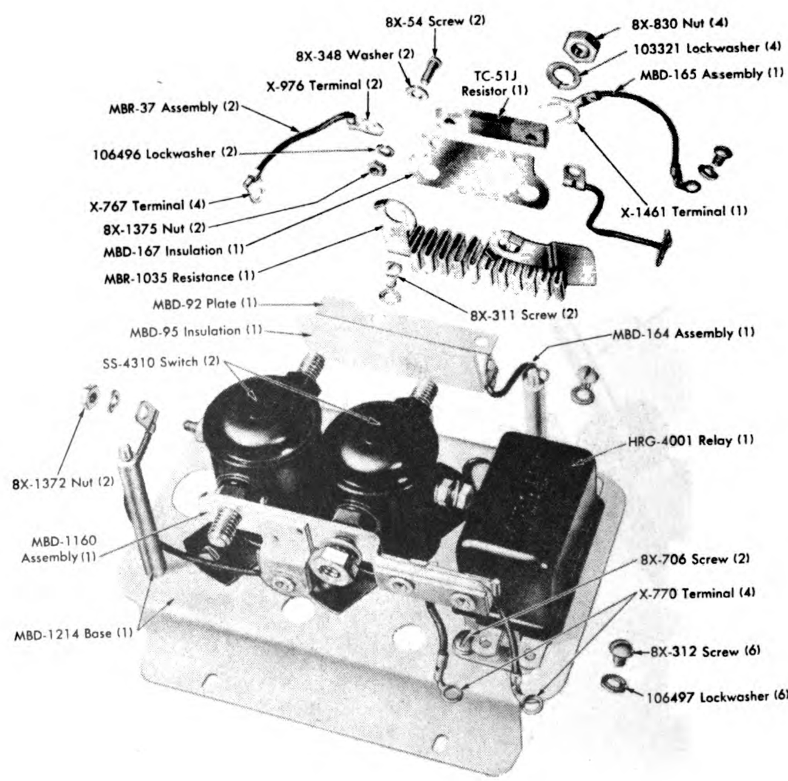


STARTER MOTOR (ASSEMBLY NO. DE-56518)

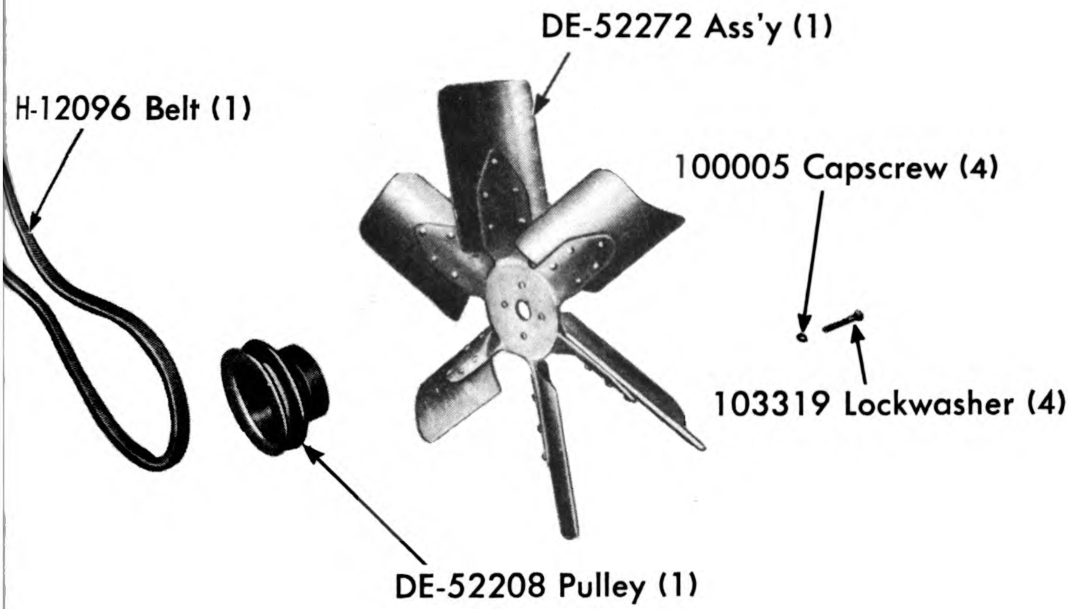


EXPLODED VIEW OF STARTER MOTOR SHOWN ABOVE AND ON PAGE 436.

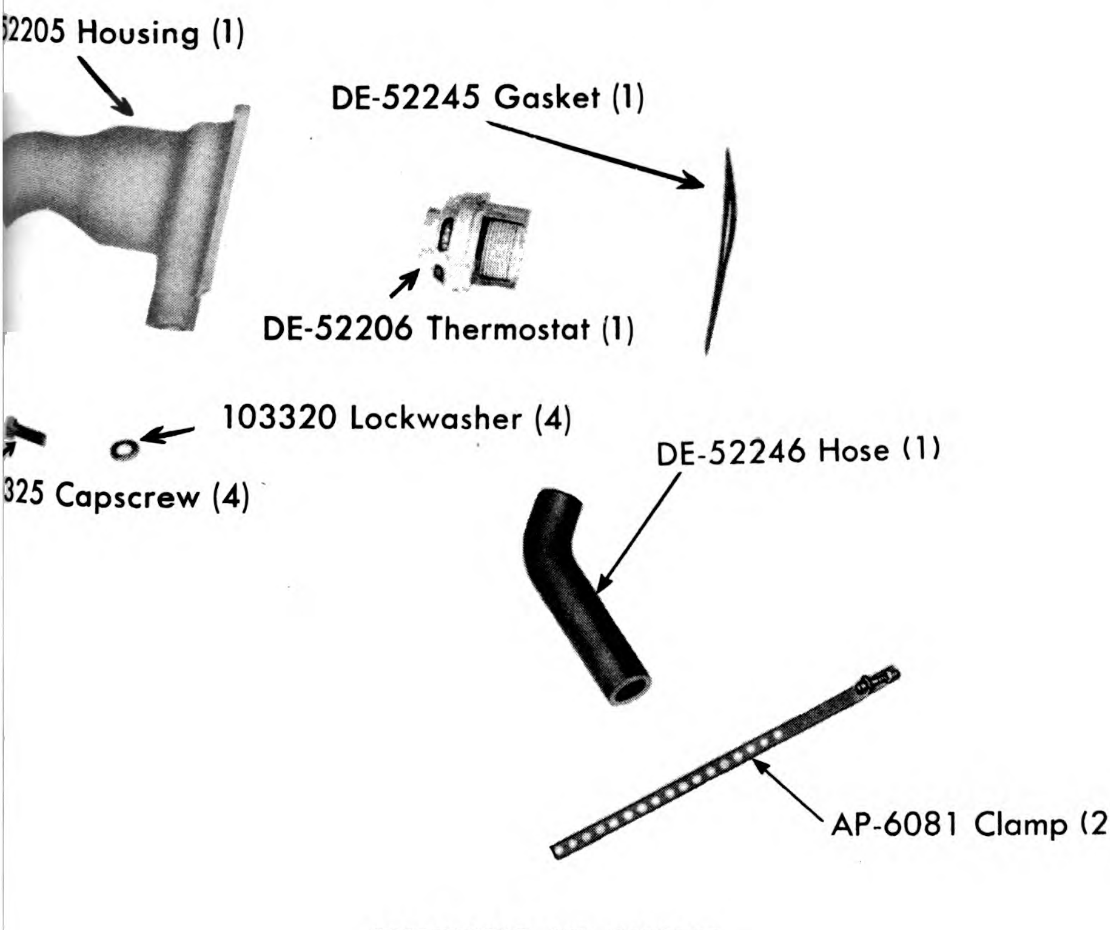




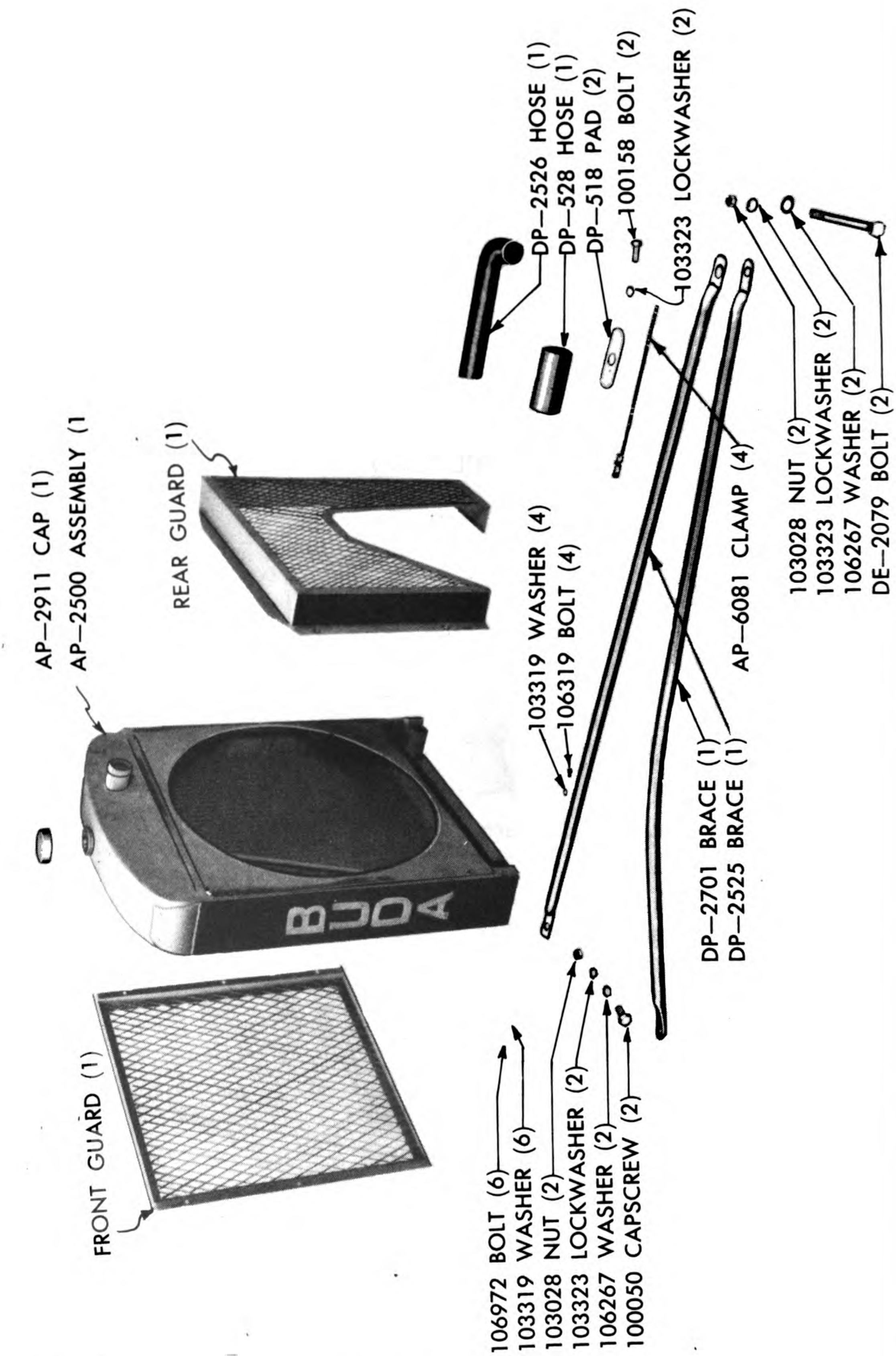
EXPLODED VIEW OF VOLTAGE REGULATOR
ASSEMBLY NO. TC-4310A

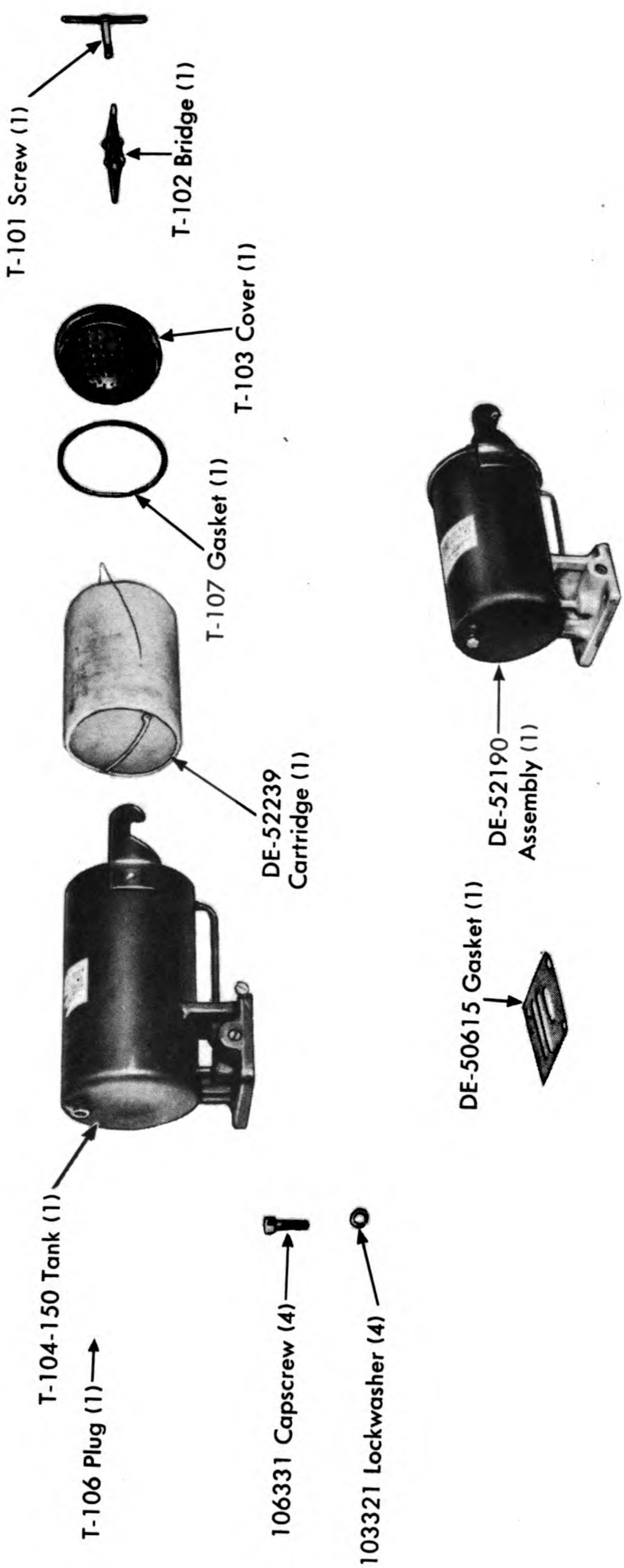


FAN, PULLEY AND FAN BELT



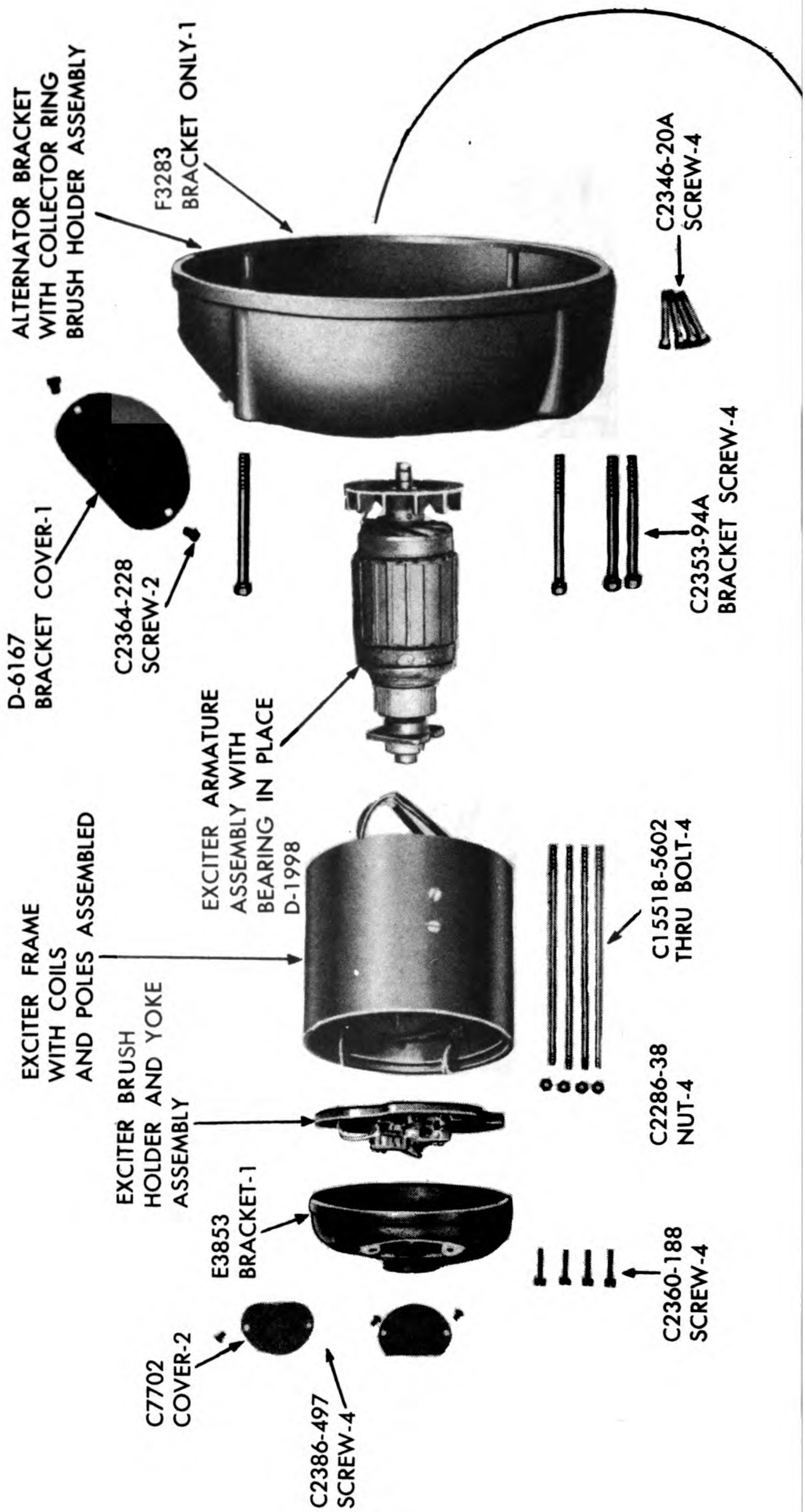
THERMOSTAT AND HOUSING
HOSE CONNECTIONS

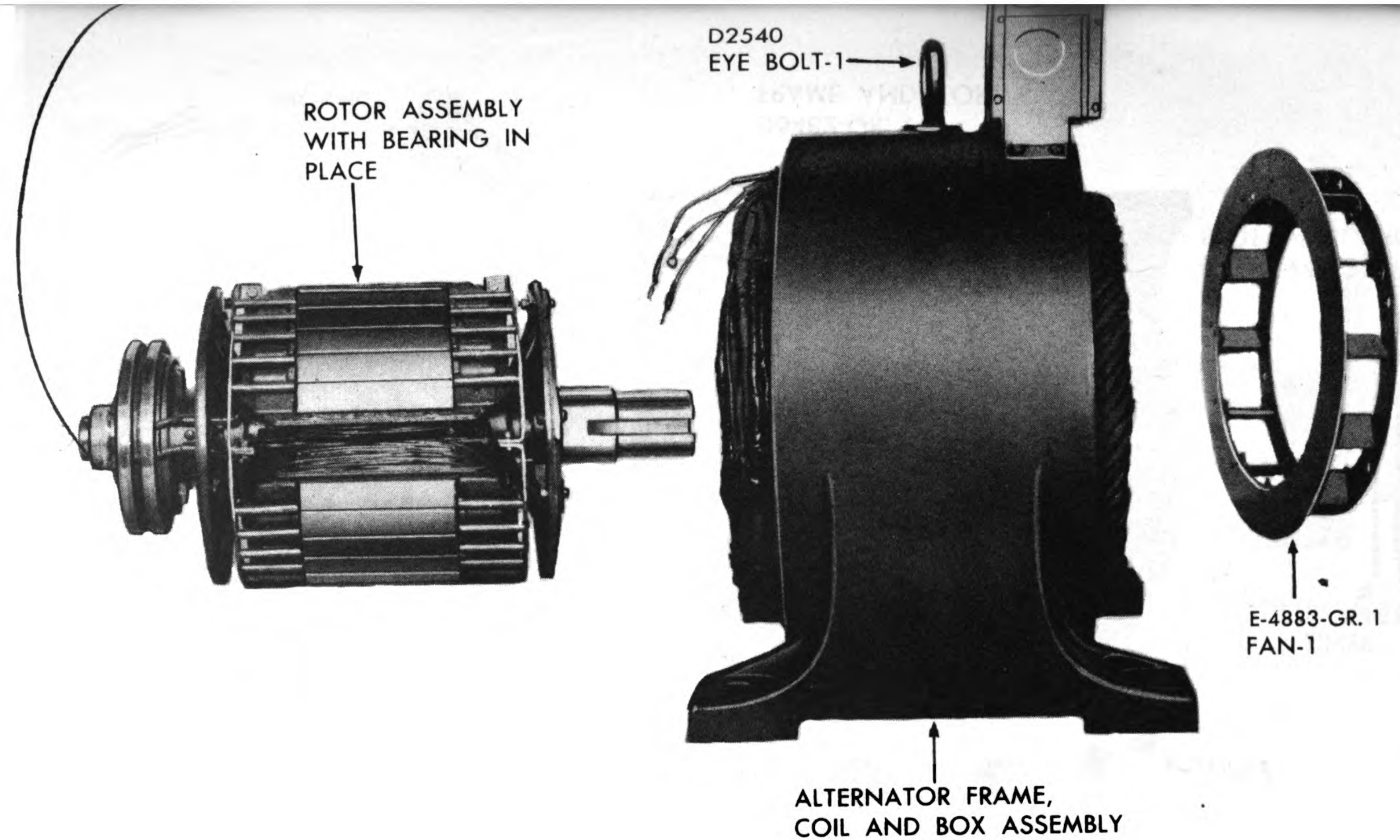

AP—2911 CAP (1)
AP—2500 ASSEMBLY (1
REAR GUARD (1)
FRONT GUARD (1)
DP—2526 HOSE (1)
DP—528 HOSE (1)
DP—518 PAD (2)
100158 BOLT (2)
103323 LOCKWASHER (2)
103319 WASHER (4)
106319 BOLT (4)
AP—6081 CLAMP (4)
103028 NUT (2)
103323 LOCKWASHER (2)
106267 WASHER (2)
DE—2079 BOLT (2)
DP—2701 BRACE (1)
DP—2525 BRACE (1)
106972 BOLT (6)
103319 WASHER (6)
103028 NUT (2)
103323 LOCKWASHER (2)
106267 WASHER (2)
100050 CAPSCREW (2)



LUBE OIL FILTER

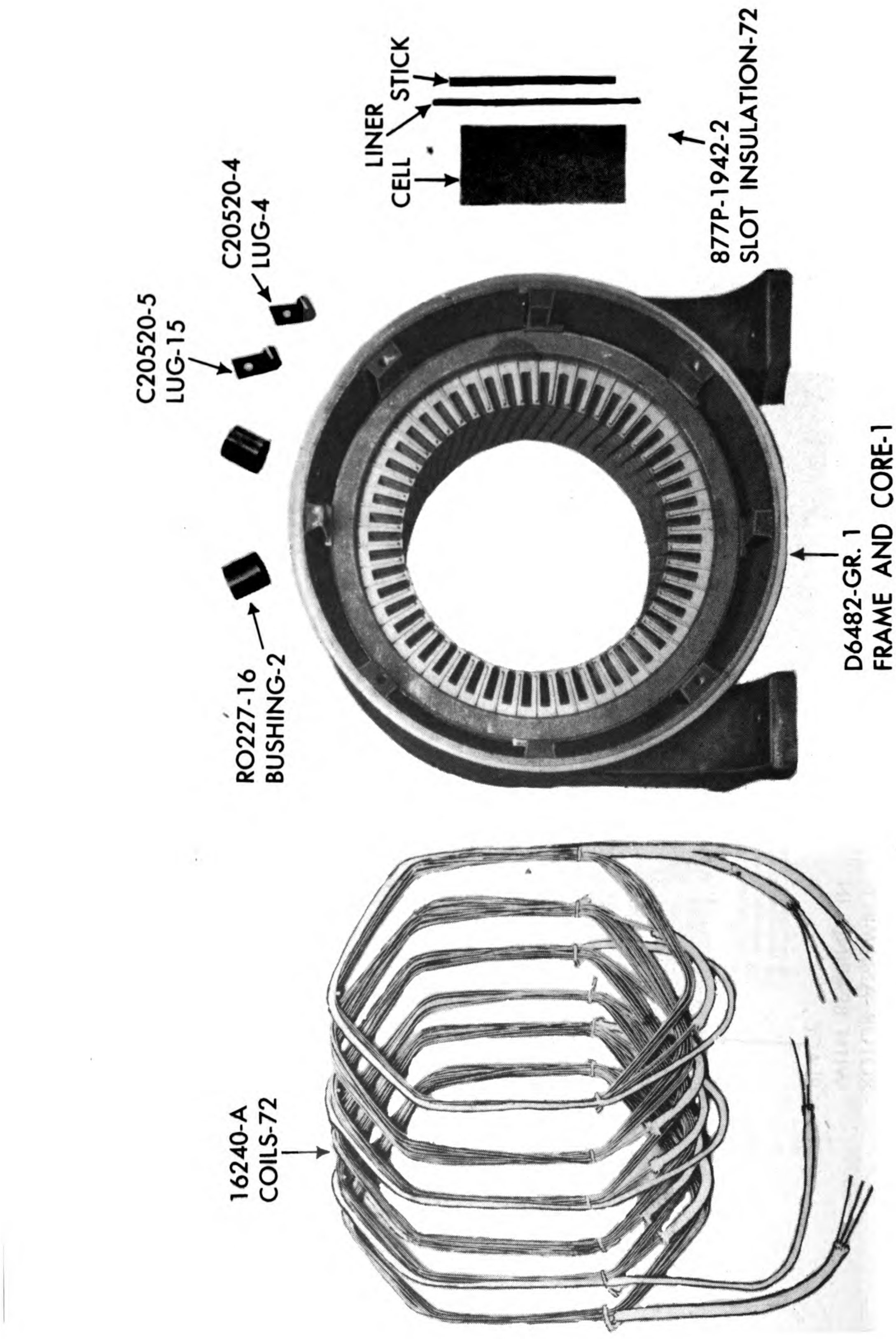
MAIN GENERATOR AND EXCITER

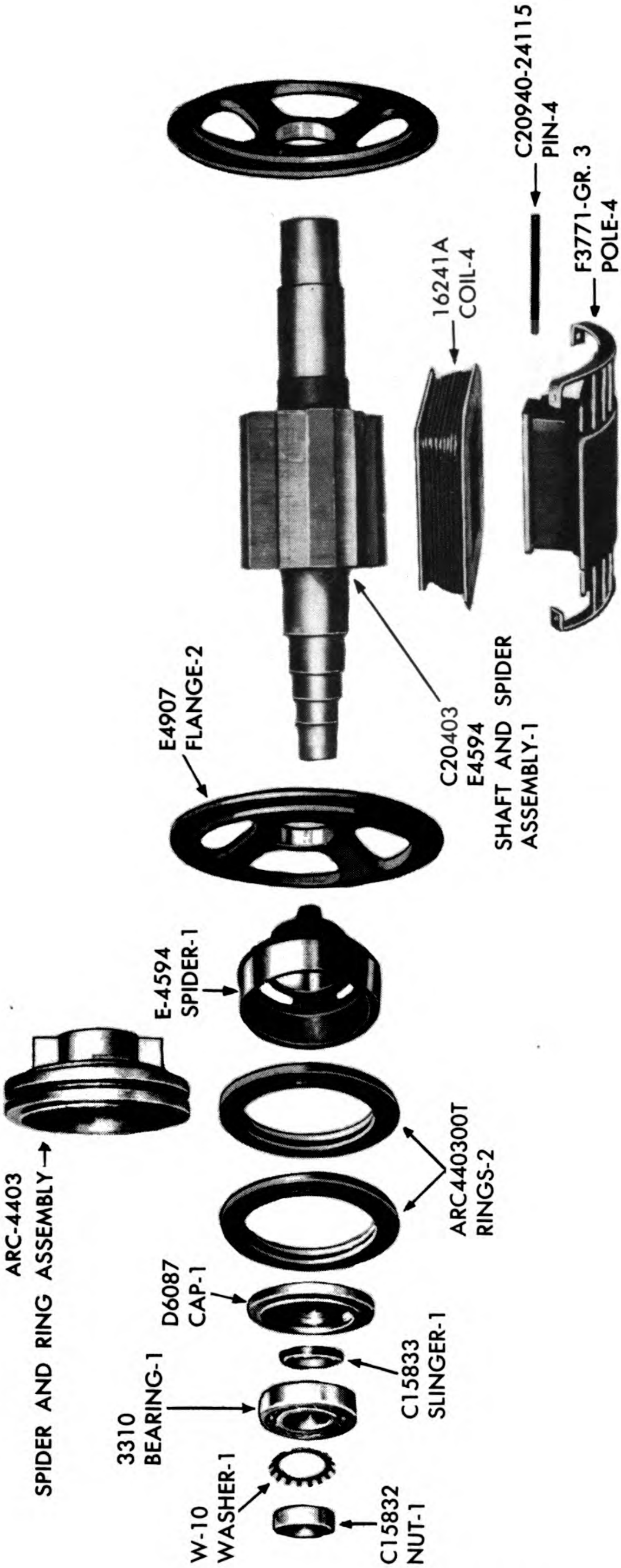




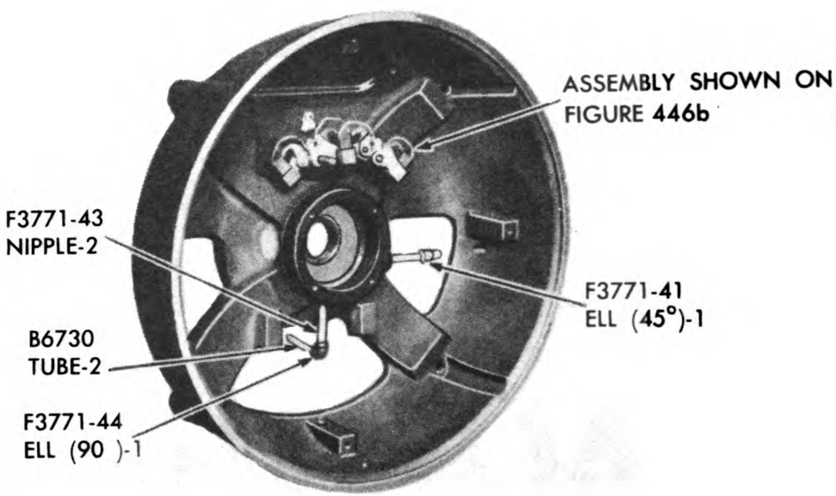
MAIN GENERATOR AND EXCITER

(For a cross-section schematic view of plain Generator and Exciter see page 451)

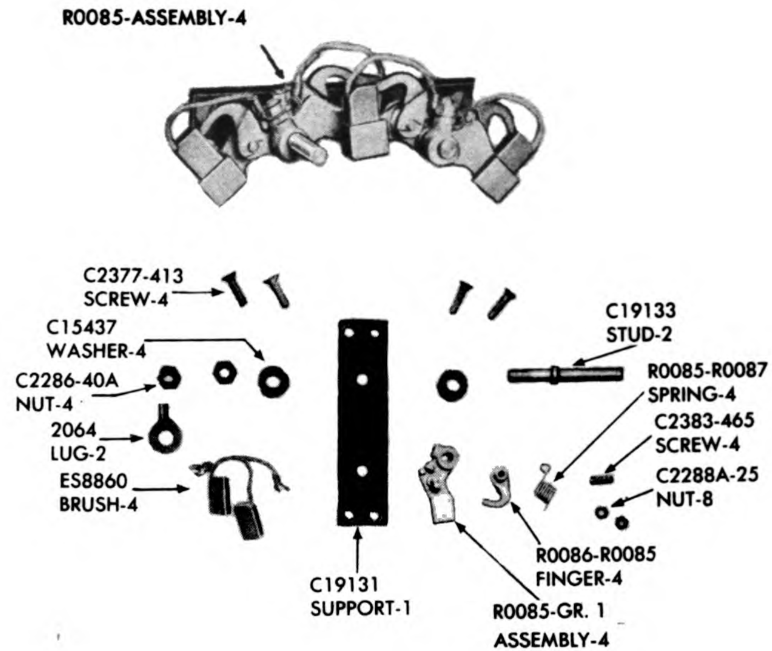

C20520-5
LUG-15
C20520-4
LUG-4
LINER
STICK
CELL
877P-1942-2
SLOT INSULATION-72
RO227-16
BUSHING-2
D6482-GR. 1
FRAME AND CORE-1
16240-A
COILS-72



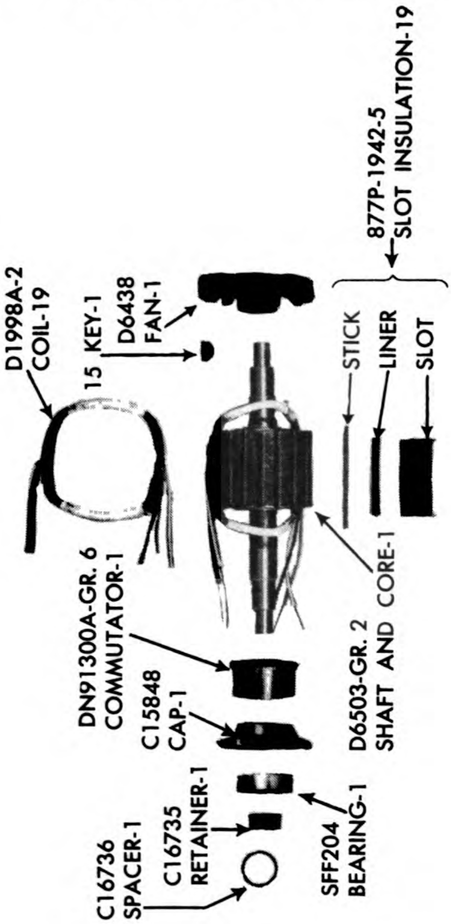
ROTOR ASSEMBLY (MAIN GENERATOR)



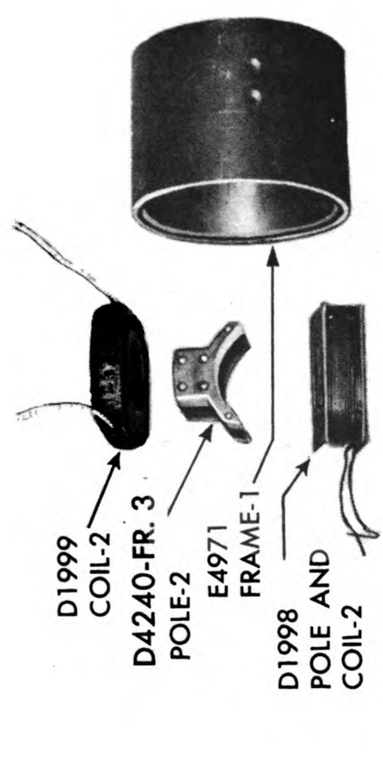
ALTERNATOR BRACKET AND BRUSH ASSEMBLY



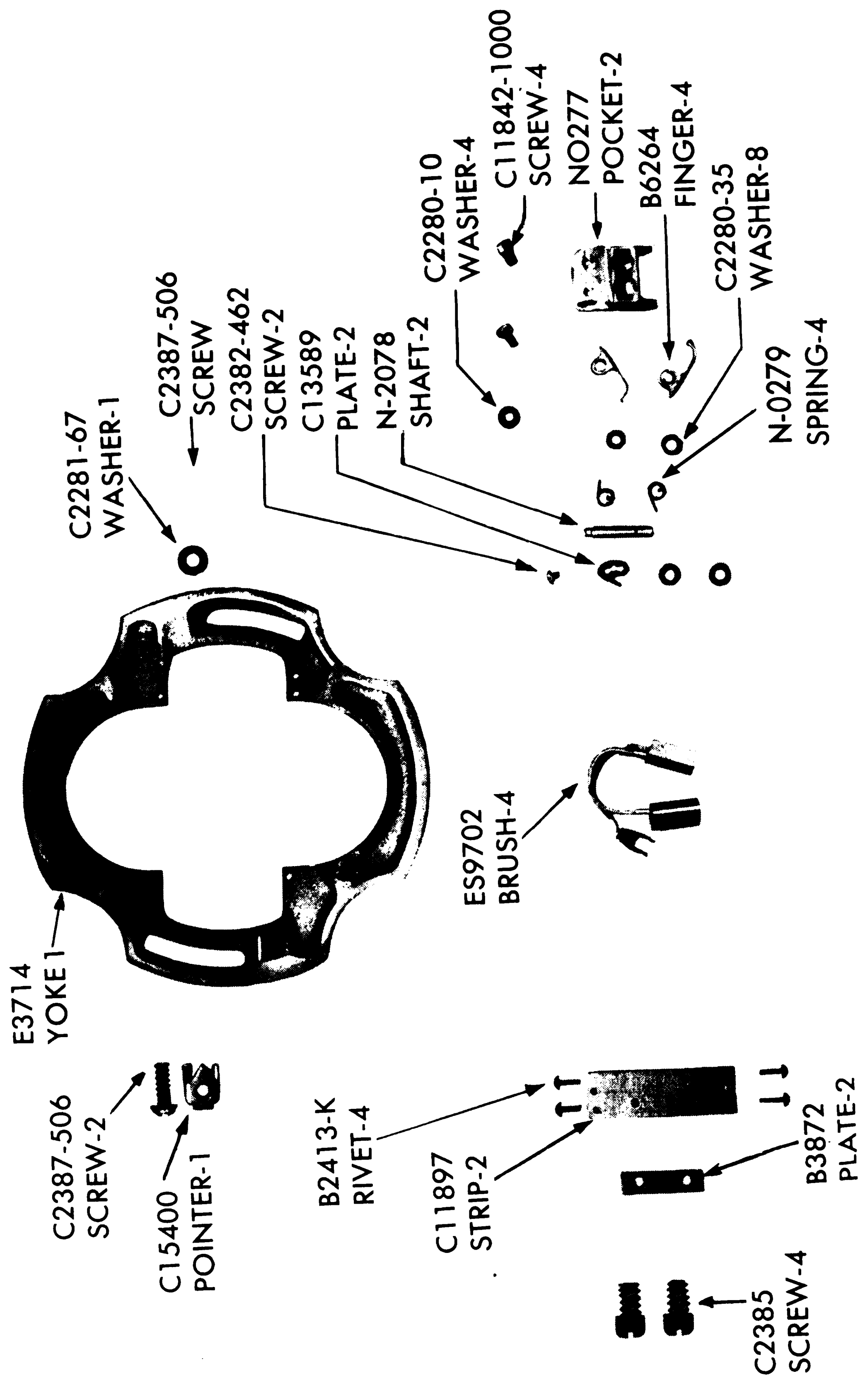
ALTERNATOR BRUSH HOLDER AND SUPPORT

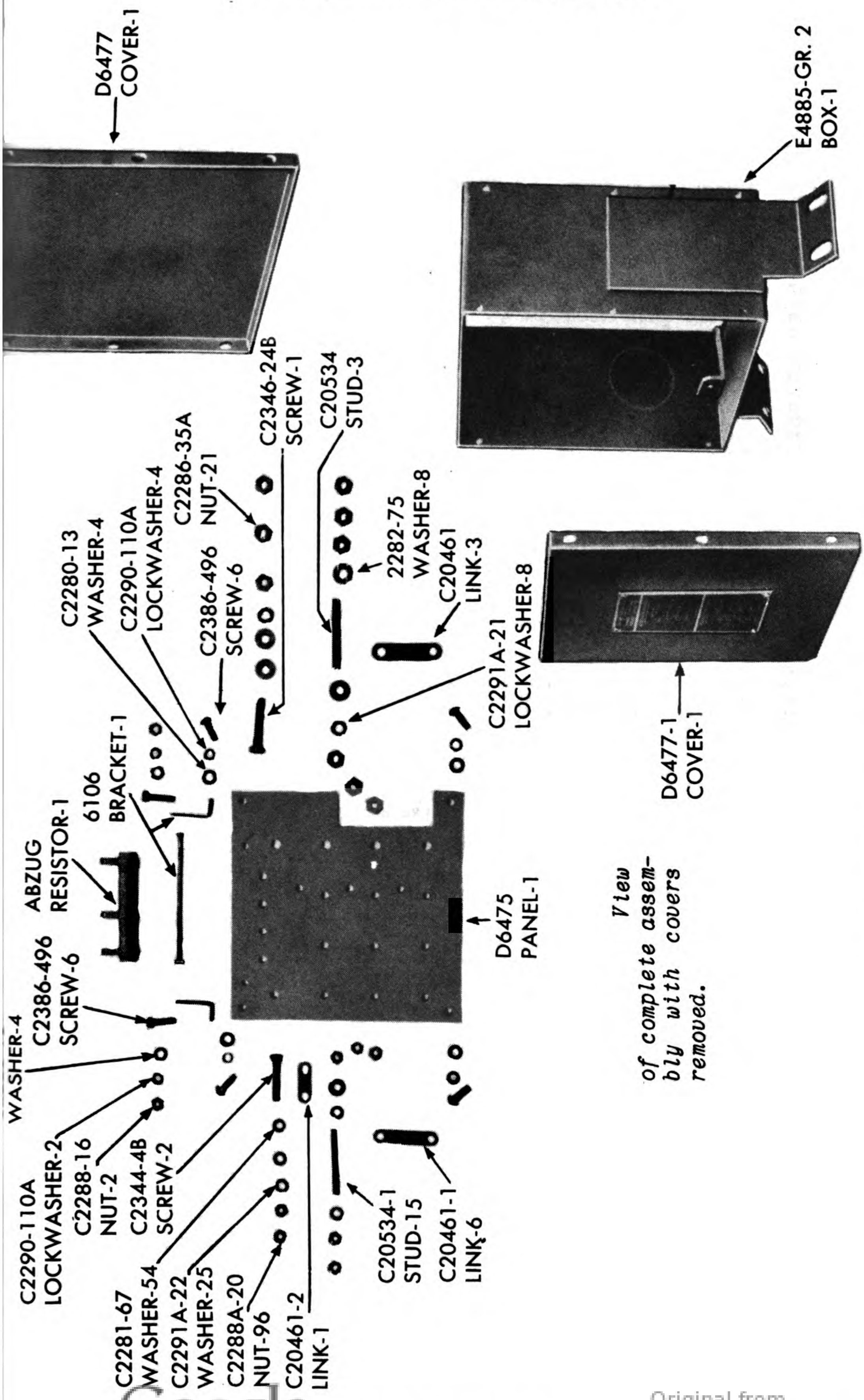


EXCITER ARMATURE ASSEMBLY



EXCITER FRAME ASSEMBLY


C2281-67
WASHER-1
C2387-506
SCREW
C2382-462
SCREW-2
C13589
PLATE-2
N-2078
SHAFT-2
C2280-10
WASHER-4
C11842-1000
SCREW-4
NO277
POCKET-2
B6264
FINGER-4
C2280-35
WASHER-8
N-0279
SPRING-4
E3714
YOKE 1
ES9702
BRUSH-4
C2387-506
SCREW-2
C15400
POINTER-1
B2413-K
RIVET-4
C11897
STRIP-2
B3872
PLATE-2
C2385
SCREW-4



STATOR LOAD PANEL CONNECTION BOX ASSEMBLY

PARTS REFERENCE INDEX TO CROSS-SECTION DRAWING SHOWING LOCATION OF VARIOI PARTS OF CENTURY ELECTRIC TYPE ARC-444 ALTERNATOR

Item No.	Name of Part	Drawing No.	Illustrated on Pa
1.	Slip Ring Assembly	ARC440300T	445
2.	Slip Ring Spider	E4595	445
3.	Alternator Pole Piece Assembly	F3771-Gr.3	445
4.	Alternator Field Coils	16241-A	445
5.	Alternator Balance Flange	E4907	445
6.	Alternator Frame and Coil Assembly	D6482 Gr. 1	443
7.	Alternator End Bracket (Front)	F3283	442
8.	Alternator End Bracket Screw (1/2-13x7/16)	C2353-94A	442
9.	Alternator Rotor Shaft	C20403-E4595	445
10.	Alternator Ball Bearing (Front) New Departure	3310	445
11.	Lead Clamp for alternator leads	C19138	
12.	Alternator Ball Bearing Lock Nut	C15832	445
13.	Alternator Shaft Grease Slinger	C15833	445
14.	Alternator Ball Bearing Lock Nut Washer	W10	445
15.	Alternator Grease Pipe Nipple (2 1/2" length) 1/8"	F3771-43	446
16.	Alternator Grease Tube	B6730	446
17.	Alternator Grease Pipe Ell (Std. 90°) 1/8"	F3771-44	446
18.	Alternator Grease Plug	B5671	446
19.	Alternator Grease Coupling Std. 1/8"		446
20.	Alternator Frame Eye Bolt	D2540	443
21.	Alternator Stator, Coils Only (1 set)	16240-A	444
22.	Lead Clamp for Exciter Leads	C19671	
23.	Lead Clamp Screw and Nut (10-32x1")	C2386-496E	
24.	Slip Ring Brush Holder Spring	R0085-R0087	446
25.	Slip Ring Brush Holder Assembly	R0085 Gr. 1	446
26.	Slip Ring Brush (1 1/8x5/8x5/16) Nat.	AYES8860	446
27.	Slip Ring Brush Holder Stud Washer	C15437	446
28.	Slip Ring Insulated Support	C19131	446
29.	Slip Ring Brush Holder Term. Lug	2064	446
30.	Slip Ring Brush Holder Stud Jam Nut	C2286-40A	446
31.	Slip Ring Brush Holder Stud	C19133	446
32.	Alternator Front Inside Bearing Cap	D6087	445
33.	Alternator Ball Bearing Cap—Cap Screw (5/16-18x2 3/4)	C2346-20A	442
34.	Alternator Ball Bearing Cap Screw Lockwasher (5/16)	C2291A-21	449
35.	Alternator End Bracket Cover	D6167	442
36.	Alternator End Bracket Cover Screw (3/8-16x1/2) Fil. Hd.	C2364-228	442
37.	Insulated Lead Grommet	C12278	
38.	Exciter Field Frame Only	E4971	447
39.	Exciter Main Pole Assembly	D4240 Gr. 3	447
40.	Exciter Commutating Pole Assembly		
41.	Exciter Main Pole Coil Only	D1999-B	447
42.	Exciter Commutating Pole & Coil Complete		
43.	Exciter Brush Holder Yoke	E3714	448
44.	Exciter Brush Holder Yoke Locking Screw	C2387-506	448
45.	Exciter Brush Holder Yoke Assembly	NO277	448
46.	Exciter Brush (1x1/2x3/8") Nat. 676	ES9702	448
47.	Exciter Brush Holder Spring	NO279	448
48.	Exciter Armature Commutator	DN91300A-Gr. 6	447
49.	Exciter Armature (Complete with winding)	D6503-Gr. 2	447
50.	Exciter Armature Shaft	C20856	447
51.	Exciter End Bracket (Front)	F3853	442
52.	Exciter End Bracket Cover	C7702	442
53.	Exciter End Bracket Cover Screw (1/4-20x1/4) Rd. Hd.	C2386-497	442
54.	Exciter End Bracket Grease Plug (1/8")	B5671	446
55.	Exciter Bearing Cap Screw Lock Washer (1/4) (Pc. 22)	C2291A-22	449
56.	Exciter Bearing Cap Screw (1/4-20x5/8") Fil. Hd.	C2360-188	442
57.	Exciter Bracket Dust Cap	B3349	
58.	Exciter Bracket Inside Bearing Cap	C15848	447
59.	Exciter Ball Bearing (Double Shield)	SFF204	447
60.	Exciter Ball Bearing Retainer	C16735	447
61.	Exciter Through (THRU) Bolt	C11518-5602	442
62.	Exciter THRU Bolt Nut (3/8") Hex. Hd.	C2286-38	442
63.	Lead Clamp Screw and Nut for Alternator Leads	C2348-1847	
64.	Exciter Armature Vent Fan	D6438	447
65.	Exciter Ball Bearing Spacer	C16736	447
66.	Exciter Shaft Key (Woodruff)	15	447
67.	Exciter Deflector (Back)	C20346	
68.	Alternator Vent Fan	E3883-Gr. 1	443
69.	Alternator Terminal Box	E4885-Gr. 2	449
70.	Alternator Panel Support Screw 10-32x3/4 Rd. Hd.	C2386-496	449
71.	Panel Support Screw Lock-Washer (1/4")	C2290-110A	449
72.	Terminal Stud (Small)	C20534	449
73.	Terminal Stud (Large)	C20534	449
74.	Terminal Screw (Large) (Brass)	C2346-24B	449
75.	Terminal Screw (Small) (Brass)	C2344-4B	449
76.	Terminal Stud Jam Nut (1/4-20) Brass	C2288A-20	449
77.	Terminal Stud Jam Nut (5/16-18) Brass	C2286-35A	449
78.	Terminal Stud Lock-Washer (1/4")	C2291A-22	449
79.	Terminal Stud Lock-Washer (5/16")	C2291A-21	449
80.	Terminal Stud Washer (Plain) (1/4")	C2281-67	449
81.	Terminal Stud Washer (Plain) (5/16")	C2282-75	449
82.	Terminal Connector Lug (Small)	C20520-5	444
83.	Terminal Connector Lug (Large)	C20520-4	444
84.	Terminal Link	C20461-1	449
85.	Terminal Link	C20461	449
86.	Terminal Link	C20461-2	449
87.	Terminal Box Cover (Front)	D6477-1	449
88.	Terminal Box Cover Screw 10-32x5/16	C2385-490	449
89.	Resistor (Ohmite) 140 ohms with 80 ohms tap	ABZUG	449
90.	Resistor mounting bracket (Ohmite)	6106	449
91.	Resistor mounting screw 10-32x3/4	C2386-496	449
92.	Terminal Box Cover (Back)	D6477	449
93.	Panel Board (Ebony Asbestos)	D6475	449
94.	Alternator Frame Lead Bushing –RO227	RO227-16	444
95.	Exciter Field Rheostat (Ohmite)	16355	
96.	Exciter Field Rheostat Knob (Ohmite)	5104	

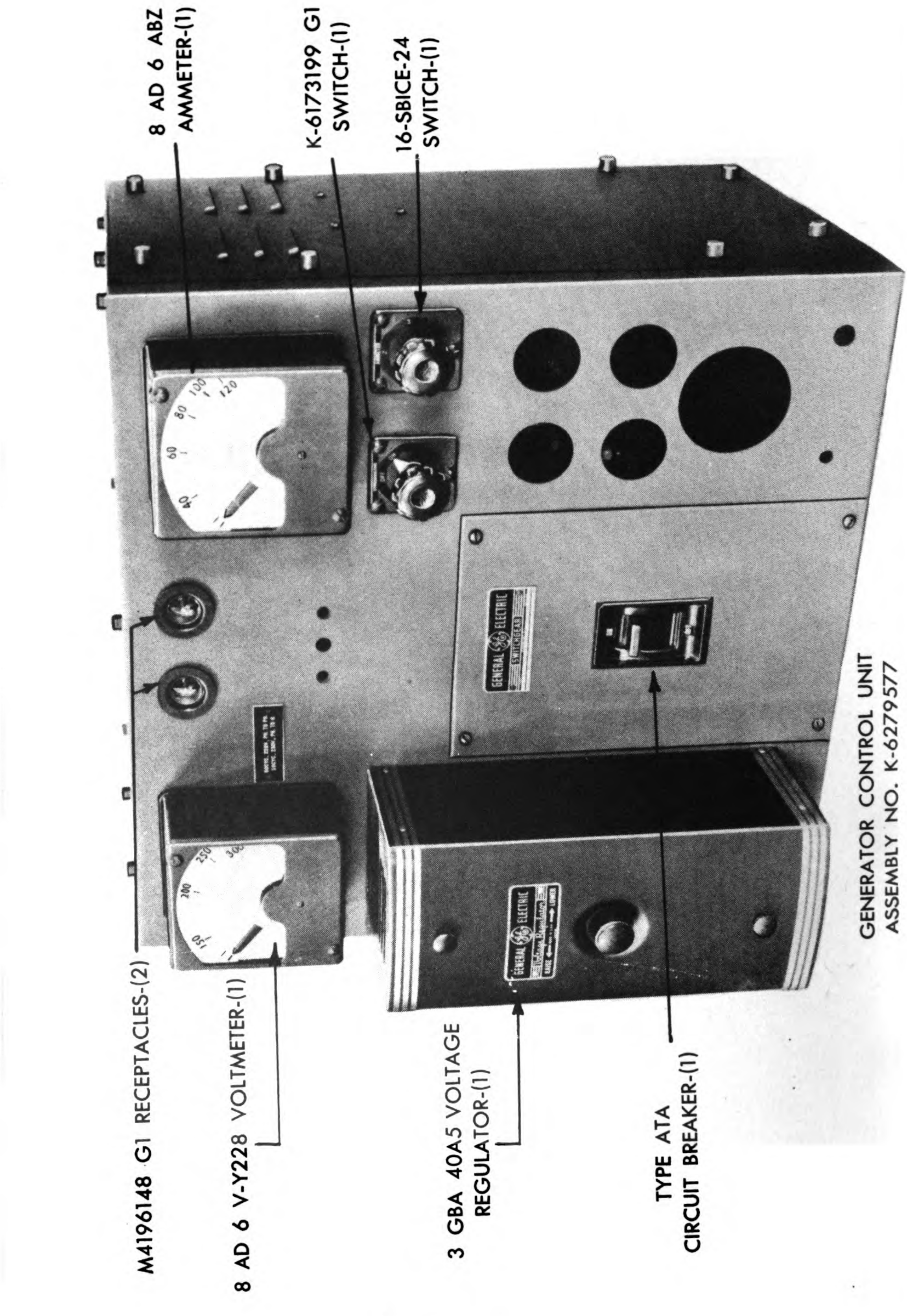
SECTIONAL VIEW OF CENTURY ELECTRIC ALTERNATOR
AND EXCITER SHOWING PART NUMBERS

PARTS REFERENCE ~~INDEX TO CROSS SECTION~~ DRAWING SHOWING LOCATION OF VARIOU

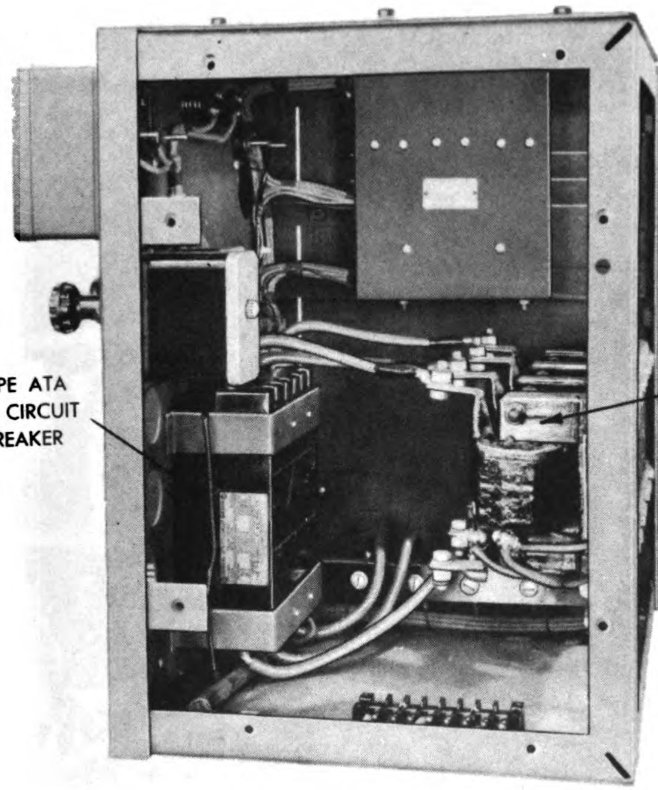
Item

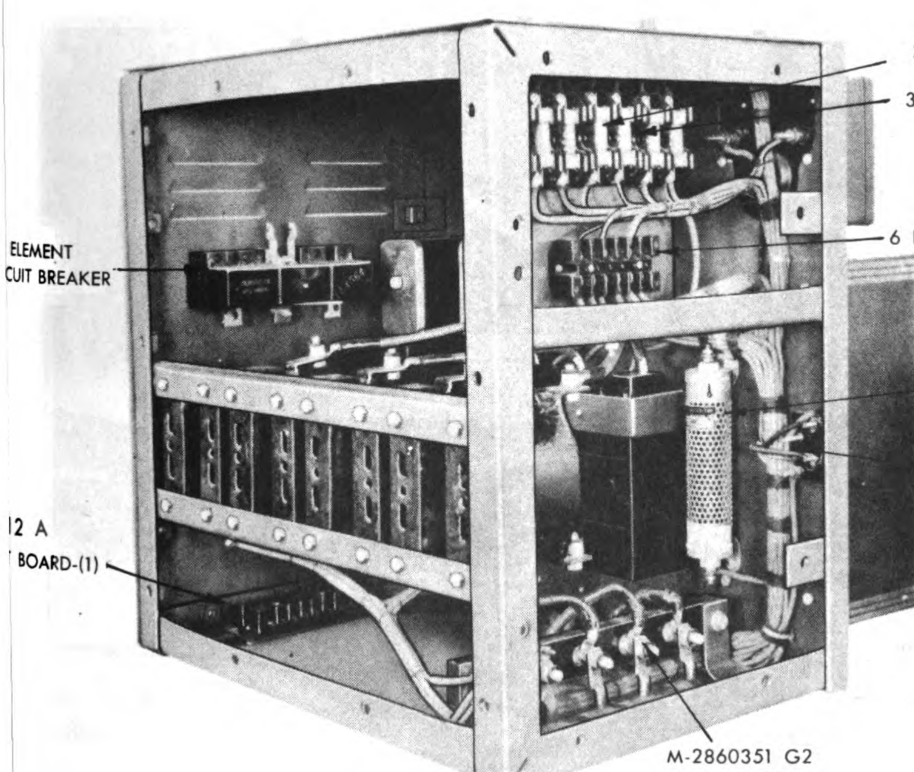
...istor (Ohmite) 140 ohms with 80 ohms tap	[illegible]	
...istor mounting bracket (Ohmite)	6106	449
...sistor mounting screw 10-32x¾	C2386-496	449
...erminal Box Cover (Back)	D6477	449
Panel Board (Ebony Asbestos)	D6475	449
Alternator Frame Lead Bushing –RO227	RO227-16	444
Exciter Field Rheostat (Ohmite)	16355	
Exciter Field Rheostat Knob (Ohmite)	5104	

SECTIONAL VIEW OF CENTURY ELECTRIC ALTERNATOR
AND EXCITER SHOWING PART NUMBERS

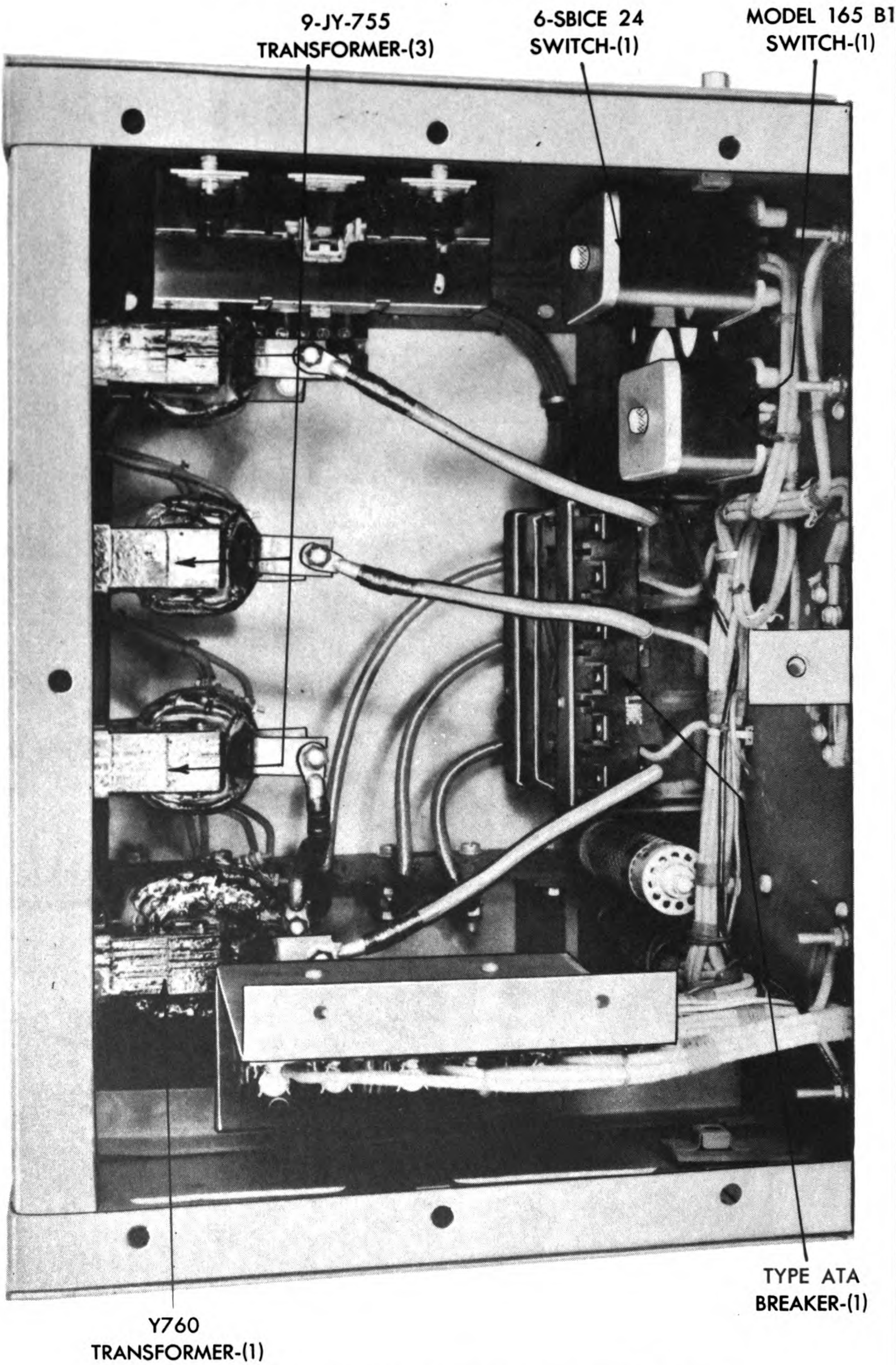


GENERATOR CONTROL UNIT
ASSEMBLY NO. K-6279577

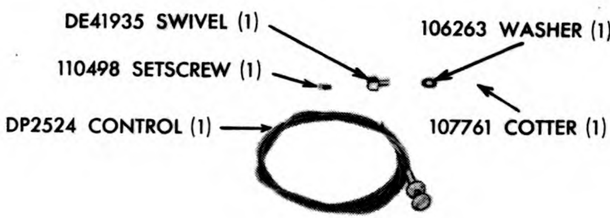


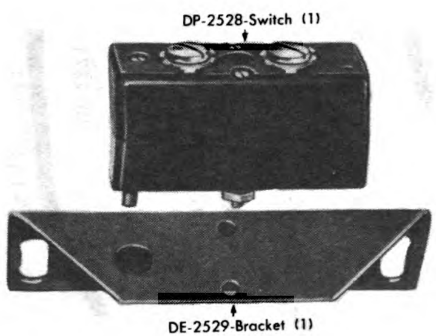


MAIN GENERATOR CONTROLS AND INSTRUMENTS

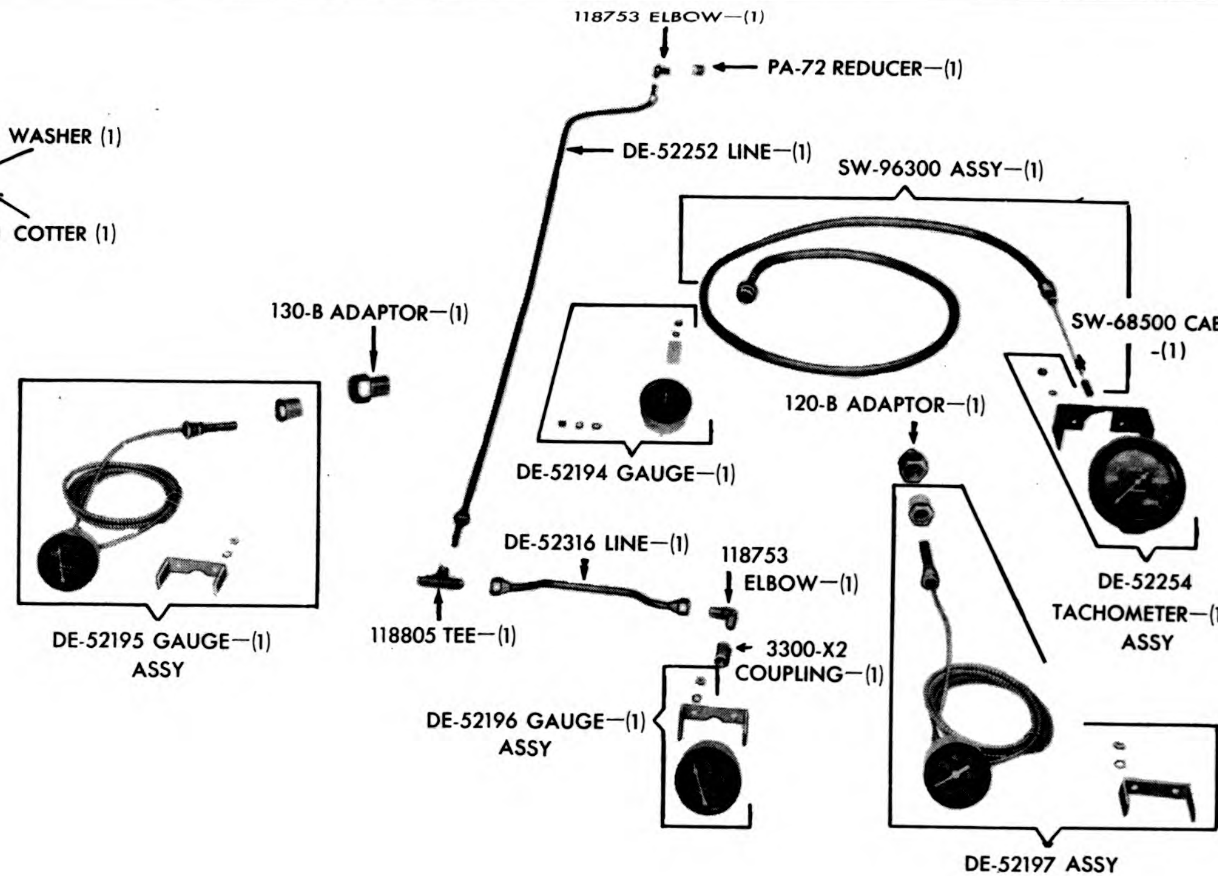


MAIN GENERATOR CONTROLS AND INSTRUMENTS

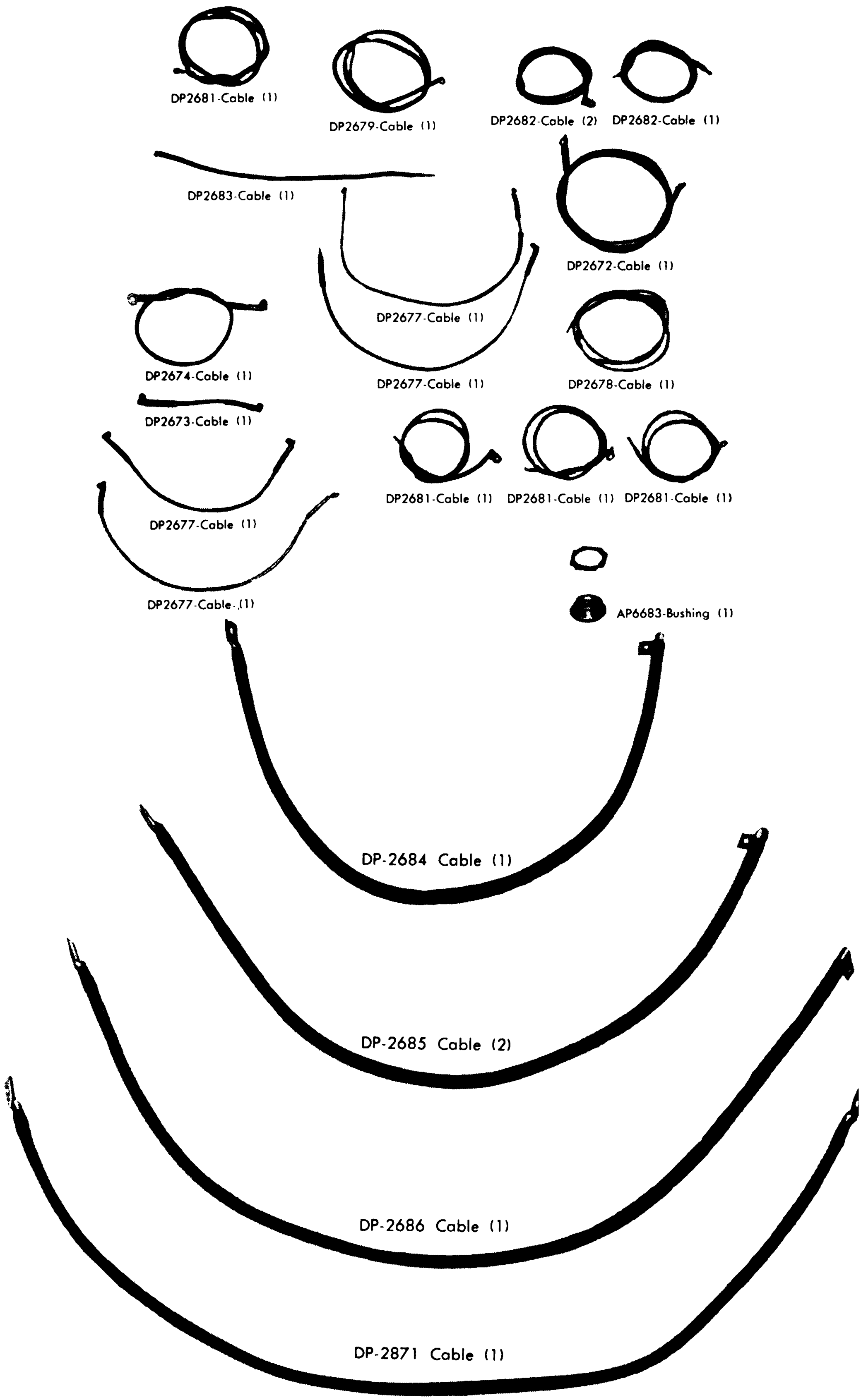




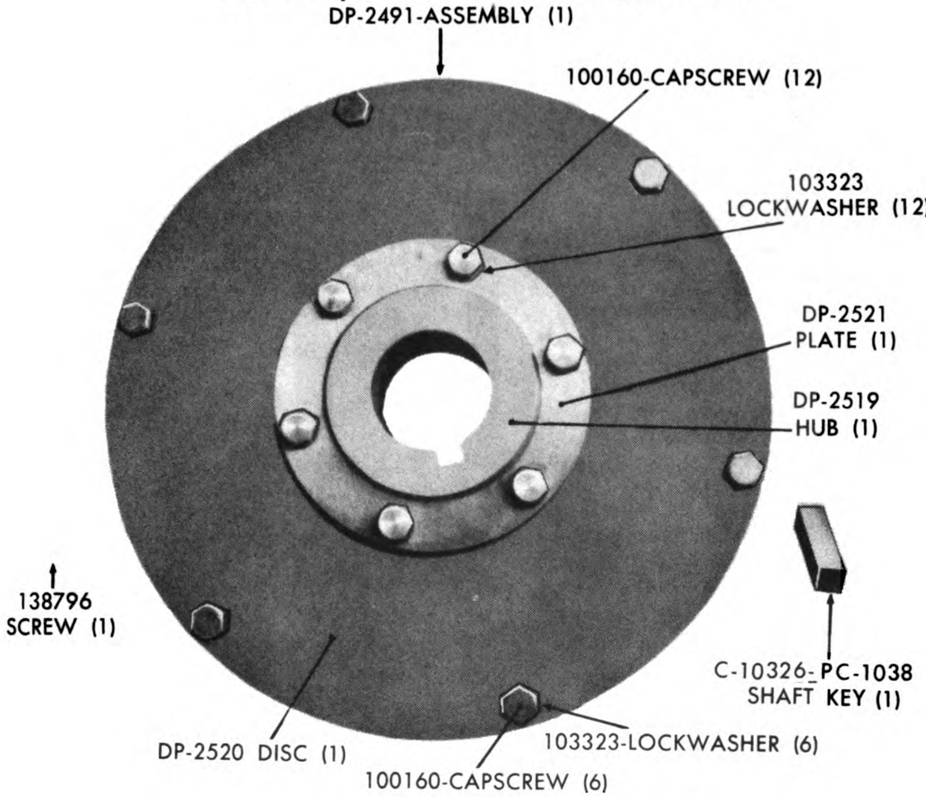
BOWDEN SWITCH
(Circuit Breaker Switch)



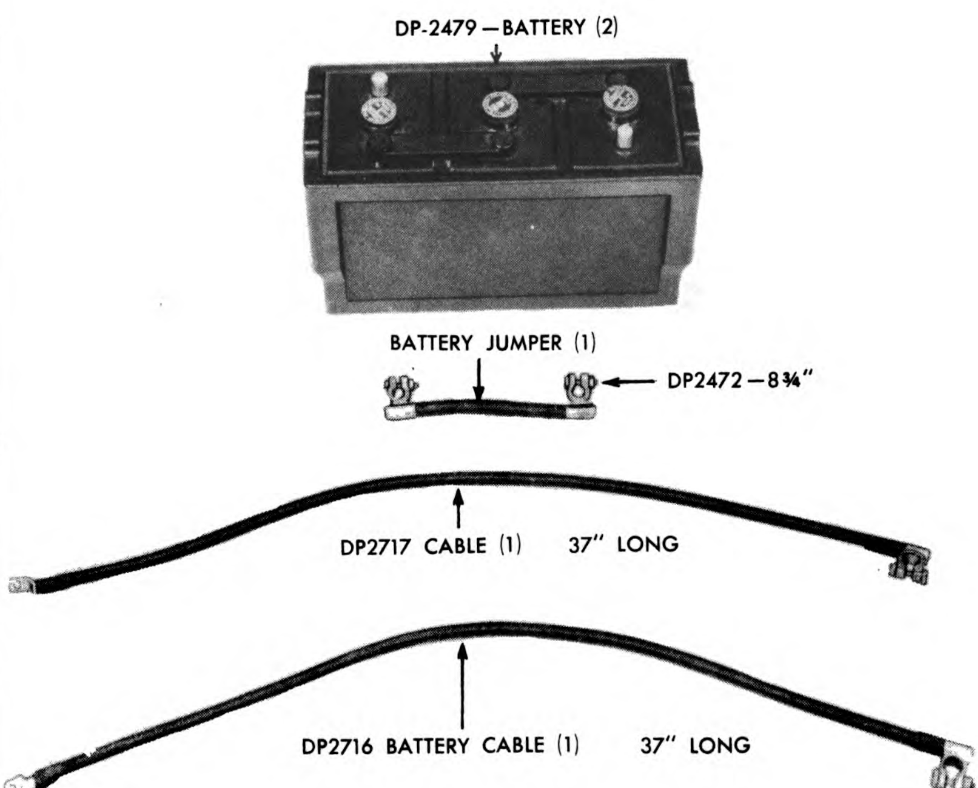
ENGINE CONTROLS AND INSTRUMENTS



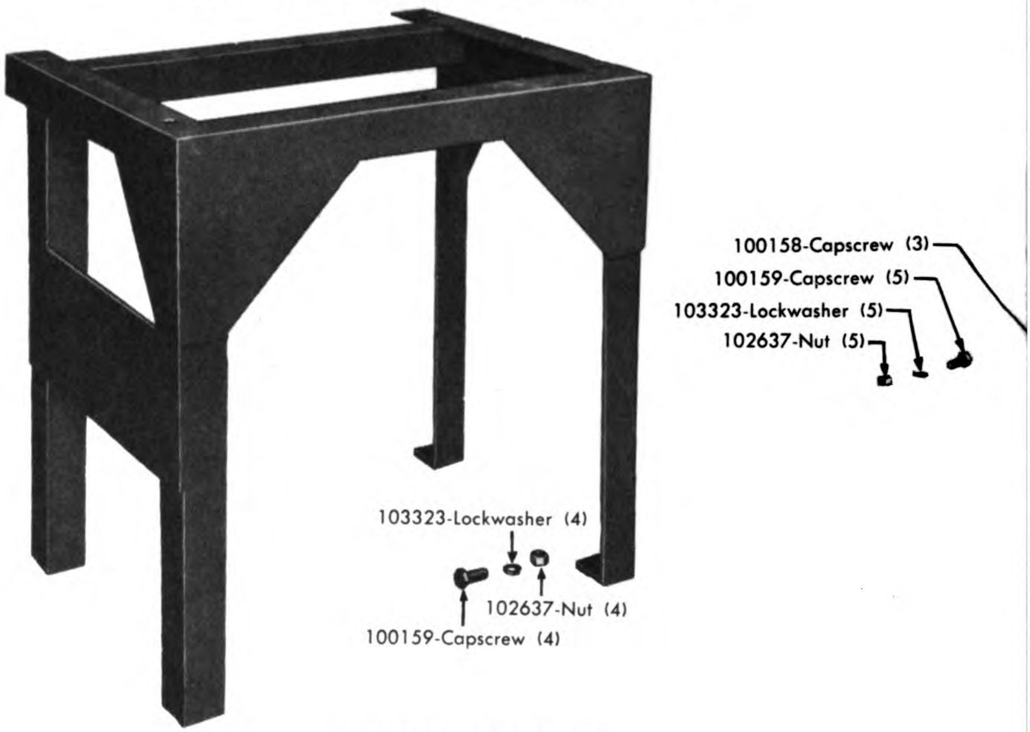
ELECTRICAL CABLES AND CONNECTIONS



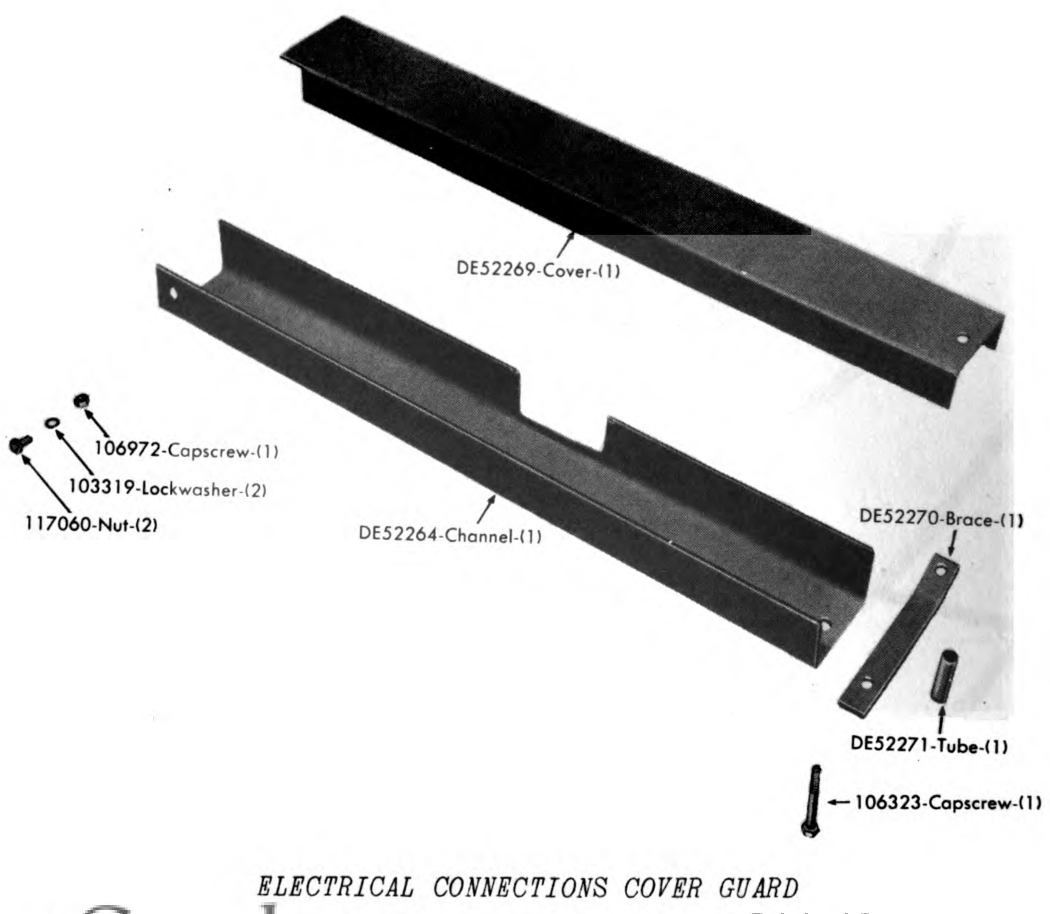
GENERATOR COUPLING



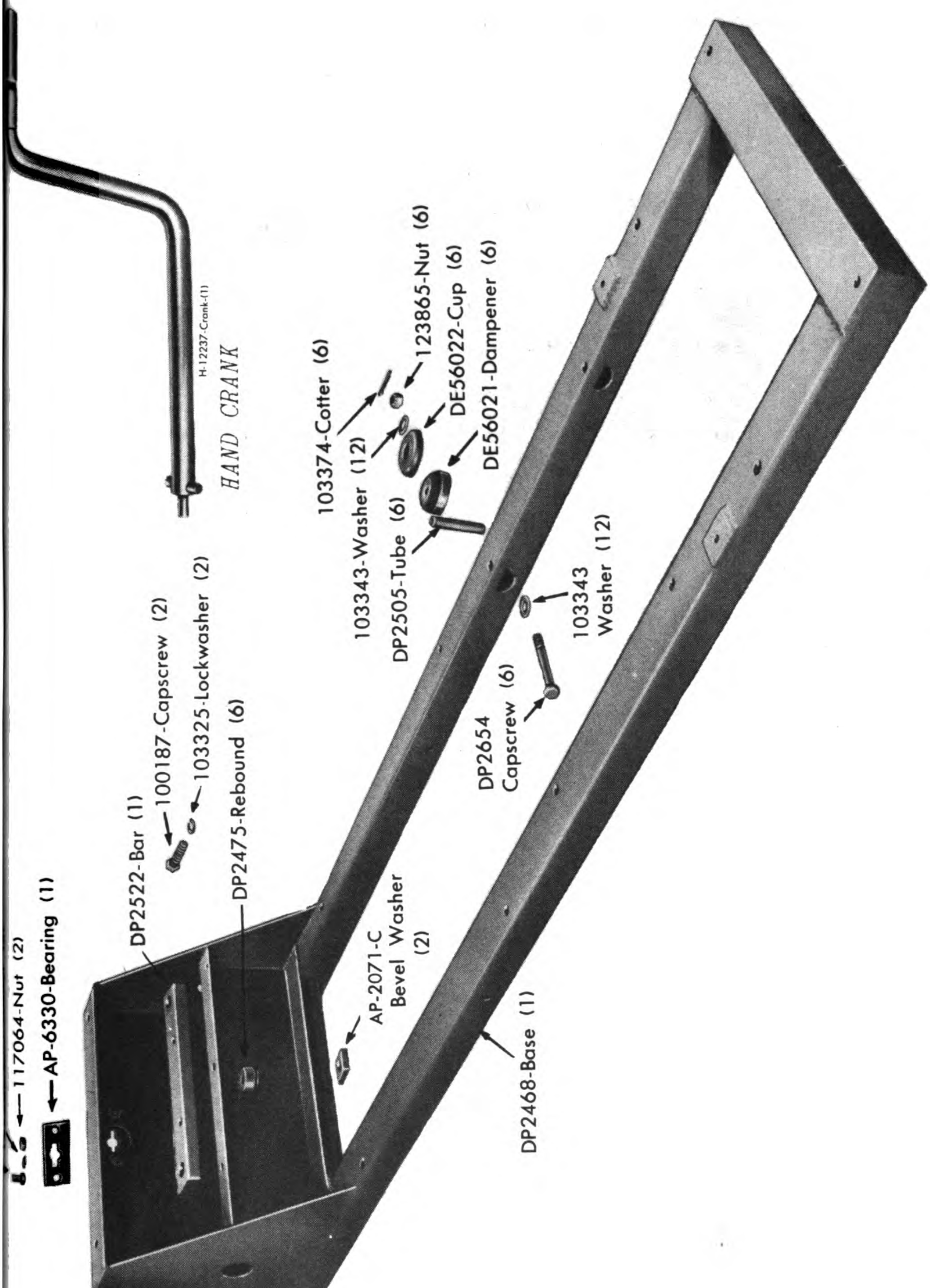
BATTERY AND CABLES



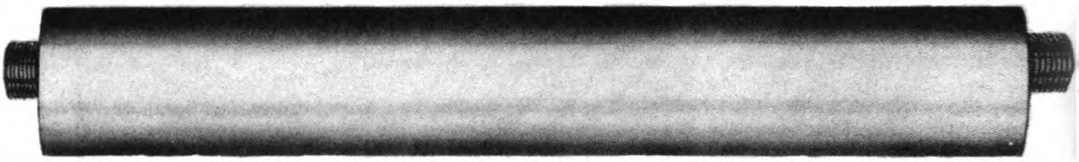
CONTROL PANEL BASE



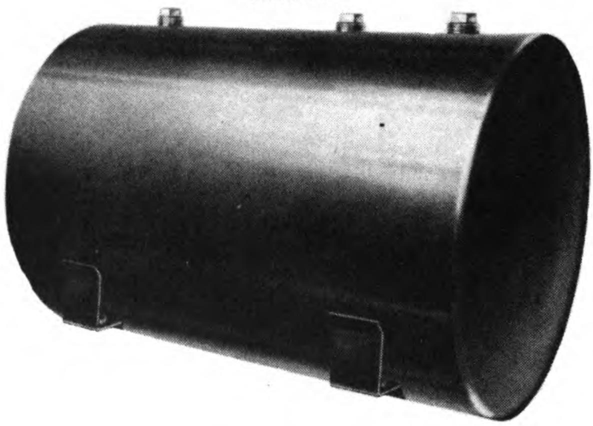
ELECTRICAL CONNECTIONS COVER GUARD



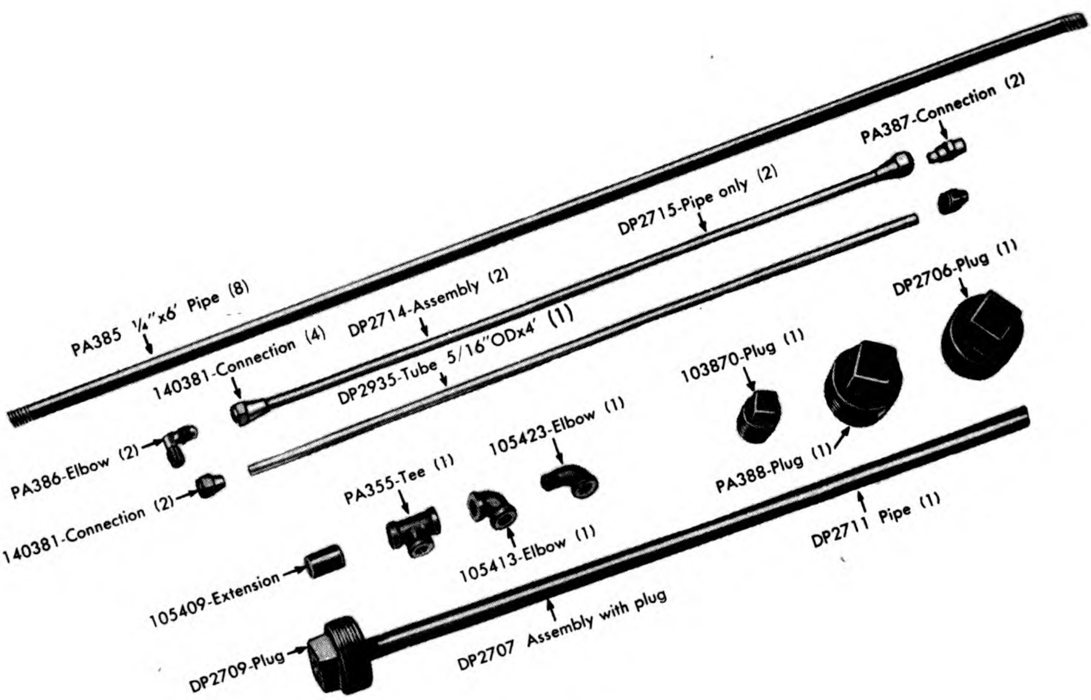
ENGINE AND GENERATOR MAIN MOUNTING BASE



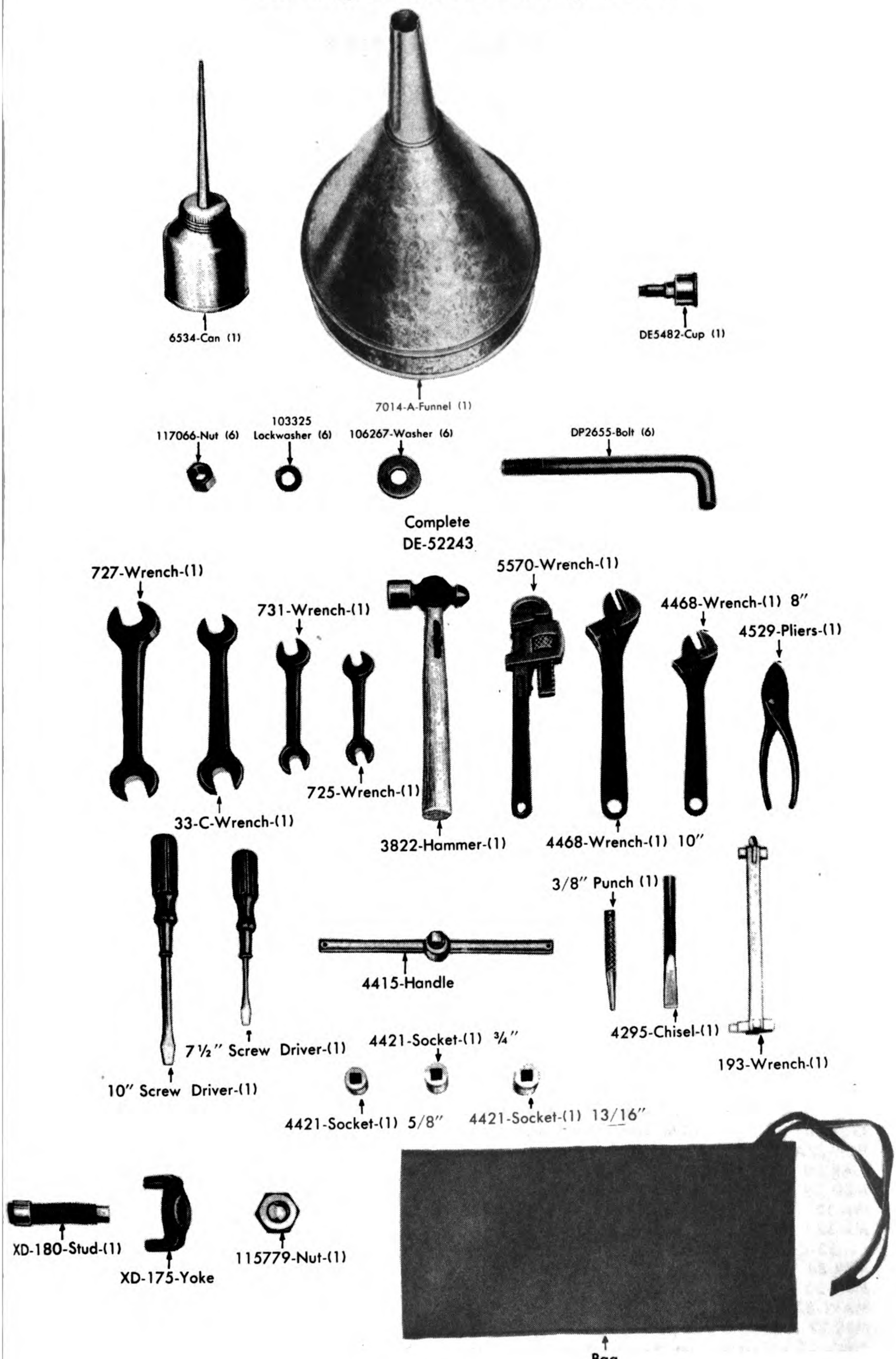
MUFFLER



FUEL TANK



FUEL TANK CONNECTIONS



TOOL KIT AND TOOLS

NUMERICAL PARTS LIST

Buda Model 6-DTG-317, 30 KW Diesel Generator Set

ENGINE SERIAL NOS. 12030 TO 15708

Buda Part Numbers are first tabulated numerically, then alphabetically by the first letters of the prefix designations.

The following list is as complete as possible at the time of printing. A number of weights of many of the parts are missing as this information was not supplied by the accessory manufacturer. All parts listed are manufactured or processed by Buda unless otherwise indicated. To save space the symbol of the accessory manufacturer was used as follows:

AL —Electric Autolite Corp., Toledo, Ohio
BO —American Bosch Corp., Springfield, Mass.
CE —Century Electric Co., St. Louis, Mo.
DN —Donaldson Co., St. Paul, Minn.
GE —General Electric Co., Bridgeport, Conn.
IB —Imperial Brass Mfg. Co., Chicago, Ill.
PES—Penn Electric Switch Co., Goshen, Indiana
PG —Pierce Governor, Anderson, Ind.
SW—Stewart-Warner Corp., Chicago, Ill.
WGB—W. G. B. Oil Clarifier, Inc., Kingston, N. Y.
YR —Young Radiator Co., Racine, Wisc.

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
*Type ATA-50	BREAKER, Air Circuit, Triple Pole with 50-ampere triple element	GE	452-454	1		$ 90.25
*Type ATA-100	BREAKER, Air Circuit, Triple Pole with 100-ampere triple element	GE	452-454	1		90.25
*	Set of contacts for 16-SB1CE-24 Ammeter Transfer Switch No. 602	GE				4.50
*	Set of contacts for 17SB1, K-6173199-G1 Synchronizing Switch No. 604	GE				3.50
*	Sets of contact parts, springs, rectifier and resistors for 3-GBA-40A5 Regulator	GE				56.00
	50-AMP. ELEMENT for Air Circuit Breaker		453	1		21.50
	100-AMP. ELEMENT for Air Circuit Breaker		453	1		21.50
NKU-1/11-X	VALVE, Fuel Return Check Valve	BO	426	1		
FPUE-2 Biz	ASSEMBLY, Hand Primer	BO	427	1		11.75
3-GBA-40A5	REGULATOR, Voltage Control Panel	GE	452	1		100.80
GBJ-3	HEAD, Drive End	AL	435	1		115.00
GR-6	COMMUTATOR, Exciter Armature (on DN-91300-A)	CE	447	1		9.60
8-AD-6-ABZ	AMMETER, 120/5-Ampere, 24:1 C.T.	GE	452	1		37.00
8-AD-6-V-Y228	VOLTMETER, 300-Volt	GE	452	1		43.30
9-JY-755	TRANSFORMER, 120-Ampere, 24:1 ratio	GE	453-454	3		16.20
W-10	WASHER, Ball Bearing Lock Nut	CE	445	1	16/per	1.60
NMR-11/3	WASHER, Fuel Pump Valve Cover	BO	426	2		.05
MBR-12	BRUSH, Starter Motor (one pigtail)	AL	436	2	25/per	.70
MBR-13	BRUSH, Starter Motor (two pigtail)	AL	436	1	15/per	.85
MBD-14	TERMINAL, Starter Motor	AL	436	1	50/per	.20
WMU-14A-1-X	NUT, Fuel Injector Nozzle	BO	430	6		2.25
15	KEY, Woodruff Exciter Shaft	CE	447	1	110/per	.50
16-SB1CE-24	SWITCH, Ammeter Transfer, No. 602	GE	452, 454	1		22.40
MBD-19	SPRING, Brush Starter Motor	AL	436	8	160/per	.07
GK-20	SCREW, Frame Generator	AL	435	2	120/per	.10
GBM-21	NUT, Generator Shaft	AL	435	1	30/per	.05
GCJ-26	ARM, Brush, Generator	AL	435	3	15/per	.02
PDH-27A1-X(6)	HOLDER, Nozzle	BO	430	6		7.25
GAR-29	PIECE, Pole, Generator	AL	435	2	¾	.37
MBD-29	PIECE, Pole, Starter Motor	AL	436	4	½	.50
GR-32	RETAINER, for Battery Generator	AL	435	1		.02
MR-32	INSULATION, Lead, Starter Motor	AL	436	2		.01
33-C	WRENCH, Double End, 1x15/16"		461	1		.36
MBR-34	CONNECTOR, Brush, Starter	AL	436	1		.20
MBD-35	WASHER, Pole Piece-Fiber, Starter	AL	436	1		.12
MAW-37	BUSHING, Insulating, Starter	AL	436	1	500/per	.03
MBR-37	ASSEMBLY, Cable, Voltage Reg.	AL	438	2		.05

*No numbers were given these part numbers by General Electric Co.

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
U-37	WASHER, Terminal Stud	AL	438	3		$ .01
K-38	SCREW, Pole Piece Starter	AL	436	8		.01
AX-44	WASHER—⅜″ Steel	AL	436	1		.01
C-44	CLIP, Rocker Arm Oil Lines		420	1	20/per	.10
MU-44/2X	NUT, Fuel Transfer Pump	BO	427	3		.05
GBW-45	SPRING, Brush, Generator	AL	435	1	300/per	.05
KB-45/1X	PLUNGER, Transfer Pump	BO	427	1		1.25
VE-45/1X	VALVE, Transfer Pump	BO	427	2		.45
VE-46/1X	SHELL, Transfer Pump	BO	427	1		1.90
X-47	SCREW, Voltage Regulator	AL	435	2	300/per	.05
BD-47	SPACER, Brush Holder, Starter	AL	436	1		.10
R-48	SCREW, Starter Housing	AL	437	8		.07
VE-48A-1-X	VALVE, Fuel Injection Pump	BO	426	1		.25
C-48	INSULATION, Fuse, Generator	AL	435	1	5000/per	.01
C-49	SPRING, Fuse Holder, Generator	AL	435	1	1100/per	.01
C-50	HOLDER, Fuse Holder, Generator	AL	435	1	60/per	.03
50	AMP ELEMENT FOR AIR CIRCUIT BREAKERS	GE	453			
GCJ-51	SPRING, Retaining	AL	435	1		.07
MBD-51	BEARING, Absorbent Bronze	AL	437	1		.45
TC-51-B	RESISTANCE, Carbon	AL	435	1	75/per	.15
BX-54	SCREW, Voltage Regulator	AL	438	2		.05
MU-54	WASHER (1/32″) Thrust,	AL	437	1	750/per	.01
MU-54-A	WASHER (1/64″), Thrust	AL	437	1	450/per	.01
MU-54-B	WASHER (3/64″), Thrust	AL	437	1	200/per	.01
60 FL	SLEEVE, Rocker Arm Rubber, ¼″		420	2	200/per	.06
61 FL	NUT, Rocker Arm, ¼″		420	2	40/per	.08
MAK-61	WASHER, Steel, Starter Motor	AL	437	1		.01
BX-61	SCREW, Flat Head, Starter	AL	436	4		.05
GAR-64	RETAINER, Bearing	AL	435	2	25/per	.04
68 FL	CONNECTOR, Rocker Arm, ¼-⅛″		420	1	20/per	.28
GBW-69	GASKET, Generator Cover	AL	435	1	650/per	.01
70-M	BUSHING, Solenoid Safety Valve	PES	432	1	20/per	.30
GBW-72	GUARD, Oil, Generator	AL	435	1	110/per	.05
PA-72	REDUCER, Oil Line, ⅛x⅜″ pipe, threaded.		455	1	1000/per	.25
GAR-73	WICK, Oil, Generator	AL	435	1	250/per	.03
GBW-73	GASKET, Oil Retaining, Generator	AL	435	1	5000/per	.01
X-74	PIN, Taper Governor	PG	428	1	300/per	.07
MBD-76	WASHER, Thrust, Starter	AL	437	2		.15
GBF-79	BEARING, Absorbent Bronze, Generator	AL	435	1	35/per	.15
GG-81	CLIP, Brush Holder, Starter	AL	436	4		.01
OO-85-GR-1	ASSEMBLY, Slip Ring Brush Holder	CE	446	4	¼	13.60
OO-85-ROO87	SPRING, Slip Ring Brush Holder	CE	446	4	160/per	.40
OO-86-ROO85	FINGER, Slip Ring Brush Holder	CE	446	4	40/per	1.60
BD-91	STUD, Terminal, Voltage Regulator	AL	438	2		.85
BD-92	PLATE, Clamp, Voltage, Regulator	AL	438	1		.12
BD-95	INSULATION, Connector, Voltage, Regulator	AL	438	1		.40
BD-96	BUSHING, Insulating Stud, Voltage Regulator	AL	438	2		.30
-101	SCREW, Fuel Filter Bridge	WGB	424	1	⅛	.45
-101	SCREW, Lube Oil Filter Bridge	WGB	441	1	⅛	.45
-102	BRIDGE, Lube Oil Filter	WGB	441	1	⅜	1.00
-102	BRIDGE, Fuel Filter	WGB	424	1	⅜	.90
-103	COVER, Fuel Filter	WGB	424	1	1	2.80
-103	COVER, Lube Oil Filter	WGB	441	1	1	3.40
F-104	TANK, Fuel Filter	WGB	424	1	3¼	5.10
-104-150	TANK AND CASTING, Lube Oil Filter	WGB	441	1	8	19.75
-106	PLUG, Fuel Filter Drain	WGB	424	1	30/per	.11
-106	PLUG, Lube Oil Filter Drain	WGB	441	1	30/per	.11
-107	GASKET, Fuel Filter Cover	WGB	424	1	200/per	.10
-107	GASKET, Lube Oil Filter Cover	WGB	441	1	150/per	.15
EB-108	WASHER, Lock, Bendix Screw	AL	437	2	180/per	.01
MBD-108	BUSHING, Rubber Terminal Stud, Voltage Regulator	AL	438	3		.45
-109	STRAP, Fuel Filter Bracket	WGB	424	1	1	.68

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
MBD-109	STUD, Terminal Voltage Regulator	AL	438	3		$ .1
MAD-110	PAD, Felt, Bearing Cover, Starter	AL	436	1		.0
J-111	BOLT, Fuel Filter Draw	WGB	424	1	100/per	.1
MBD-115	WASHER, Insulating, Pole Piece	AL	436	1		.1
PA-117	SEAL, Front End Gear Housing Oil		415	1		.8
TC-117	WASHER, Insulating, Resistance-Gen.	AL	435	2	2500/per	.0
MBD-119	WASHER, Insulating, Starter	AL	436	1		.1
SS-119	POST, Terminal, Starter	AL	436	1		.1
8X-120	SCREW, Filister Head, Starter	AL	436	8		.0
120-B	ADAPTOR, Oil Temp. Gauge, ½x⅜"	IB	455	1		.5
MBD-128	WASHER, Plain Steel, Voltage Regulator	AL	438	2		.1
130-B	ADAPTOR, Water Temp. Gauge, ½x½"	IB	455	1		.5
MBD-150	WICK, Starter	AL	436	1		.1
GG-164	WASHER, Felt Generator	AL	435	2		.0
MBD-164	ASSEMBLY, Lead, Voltage Regulator	AL	438	1		.0
MBD-165	ASSEMBLY, Lead, Voltage Regulator	AL	438	1		.1
165-B1	SWITCH, Voltmeter	GE	454	1		19.2
MBD-167	INSULATION, Resistor Support, Voltage Regulator	AL	438	1		.2
GAR-171	RING, Snap, Generator Shaft	AL	435	1		.0
8X-173	NUT, Hex, Generator	AL	435	3		.0
XD-175	YOKE, Air Cell Puller		461	1		.6
XD-180	STUD, Air Cell Puller		461	1		1.0
193	WRENCH, Plug		461	1		1.2
12X-195	WASHER, Lock, Brush Lead, Generator	AL	435	2	1600/per	.0
X-196	LOCKWASHER, Generator	AL	435	4	800/per	.0
X-196	WASHER, Generator	AL	435	3	800/per	.0
X-196	LOCKWASHER, Terminal Stud, Voltage Regulator	AL	438	6		.0
X-199	WASHER, Generator	AL	435	2	400/per	.0
SFF-204	BEARING, Exciter Ball (double shield)	CE	447	1	¼	2.6
GAR-211	BUSHING, Insulating, Generator	AL	435	1	500/per	.0
MBD-213	BEARING, Starter Motor	AL	437	1		.3
X-217	NUT, Lock, Governor	PG	428	1		.0
220-1	BODY, Brass Valve Assembly	PES	433	1		3.5
220-15	BUSHING, Insulating	PES	433	1		.0
220-24	WASHER, Insulation	PES	433	2		.01
221-1	RING, Safety Shut-off Valve	PES	433	1		.1
221-2	COVER, Safety Shut-off Valve	PES	433	1		.4
221-6	NUT, Cover	PES	433	1		.0
221-7	SEAT Orifice, 7/32"	PES	433	1		.23
221-9	WASHER, Safety Shut-off Valve	PES	433	1		.07
221-10	WASHER, End, Safety Shut-off Valve	PES	433	2		.0
221-11	BUSHING, Spacer, Brass	PES	433	1		.08
221-12	BUSHING, Spacer, Steel	PES	433	1		.04
221-13	BUSHING, Spacer, Steel	PES	433	1		.04
221-805	TUBE, Sealing Assembly	PES	433	1		1.6
221-820	ASSEMBLY, Valve Needle	PES	433	1		2.2
221-825	COIL, 12 V. D. C.	PES	433	1		3.0
RO-227-16	BUSHING, Alternator Frame Lead	CE	444	2	32/per	1.0
X-260	KEY, Woodruff Generator	AL	435	1	250/per	.0
X-261	KEY, Woodruff Generator	AL	437	1	180/per	.0
MA-265	GASKET, Water Inlet or Outlet Manifold		413	4	100/per	.0
X-270	NUT, Metric, 12-1¾	PG	429	2		.90
N-0277	POCKET, Exciter Brush Holder	CE	448	2	¼	2.88
N-0278	SHAFT, Exciter Brush Holder	CE	448	2	40/per	.48
N-O-279	SPRING, Exciter Brush Holder	CE	448	4	160/per	.32
GAL-289	LEAD, C. B. Assy. Gen. Field Coil	AL	435	1		.09
X-295	BEARING, Generator	AL	435	1	⅛	2.10
8X-311	SCREW, Voltage Regulator	AL	438	2		.05
8X-312	SCREW, Voltage Regulator	AL	438	6		.05
X-317	BEARING, No. 603 Nice Governor	PG	428	1		1.30
8X-321	SCREW, Generator	AL	435	4	220/per	.05

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
-322	PULLEY, Drive Generator	AL	435	1		$ 1.20
328	BEARING, Governor	PG	428	2		.50
336	ASSEMBLY, Bearing, Governor	PG	428	2		1.20
-345	SPRING, Governor	PG	429	1		.47
-348	WASHER, Special Voltage Regulator	AL	438	2		.05
-350	WASHER, Plain, Voltage Regulator	AL	435	2	2000/per	.05
-355	TEE, Wrought Iron Service, ¼"	BO	425	1		.28
-383	TUBE, Rubber (for ground wire) 8"	PES	432	8		.15
-384	TUBE, Rubber (for switch wire) 18"	PES	432	8		.35
-385	PIPE, ¼" x 6', Fuel Tank Line		460	8		.30
-386	ELBOW, Fuel Tank Line		460	2		.15
-387	CONNECTION, Fuel Tank Line		460	2		.30
-388	PLUG, Fuel Tank		460	1		.25
MS-412/1X	LOCKWASHER, Fuel Transfer Pump	BO	427	3		.05
-419	PLUG, Oil (Fordson) Governor	PG	428	3		.06
-431	LOCKWASHER, Governor	PG	429	1		.03
34X5	ELBOW, Fuel Filter		423	1		.38
-489	OILER, Generator	AL	435	1	275/per	.05
P-518	PAD, Radiator Shim	YR	440	2		.75
P-528	HOSE, Radiator Inlet	YR	440	1	⅝	.65
560-39	LOCKWASHER, Safety Shut-off Valve	PES	433	2		.01
MS-601/2X	WASHER, Fuel Transfer Pump	BO	427	3		.05
-641	SPRING, Bearing Adjusting, Gov.	PG	428	1		.05
DE-705	WASHER, Cylinder Head Stud		410	15		.04
X-706	SCREW, Bdg. Hd., Voltage Regulator	AL	438	2		.05
-714	WASHER, Plain, Governor	PG	429	1		.04
725	WRENCH, Double End		461	1		.18
727	WRENCH, Double End		461	1		.20
731	WRENCH, Double End		461	1		.30
-738	NUT, Governor, Hex. ⅝"-18	PG	428	1		.10
-760 (Spec. No. 3195911)	TRANSFORMER, 120-Ampere, 12/24:1	GE	453	1		21.50
-761	UNION, Fuel Injection Pump	BO	426	6		.90
UE-763	NUT, Flywheel		414	5		.05
-765	COCK, Fuel Injection Pump	BO	426	1		.35
T-765	NUT, Fuel Injection Pump	BO	426	6		.40
-767	TERMINAL, Voltage Regulator	AL	438	2		.05
P-769	HOLDER, Fuel Injection Pump	BO	426	6		1.00
-770	TERMINAL, Voltage Regulator	AL	438	6		.05
U-782	SEAT, Fuel Injection Nozzle	BO	430	6		.25
P-795	SPRING, Fuel Injection Pump	BO	426	1		.15
N-797	PIN, Fuel Transfer Pump	BO	427	1		.05
X-830	NUT, Hex, Voltage Regulator	AL	438	4		.05
-842	FUSE, Generator	AL	435	1	4000/per	.05
-864	WASHER, Generator	AL	435	1	60/per	.05
77P-1942-2	SLOT INSULATION, Main Generator	CE	444	72	20/per	.32
X-888	SCREW, Filter Head, Generator	AL	435	4	325/per	.05
-901	LOCKWASHER, Shakeproof, Governor	PG	429	1	480/per	.10
-921	SCREW, Filter Head, Governor	PG	428	4	50/per	.40
-976	TERMINAL, Voltage Regulator	AL	438	2	30/per	.05
CM-1002C	ASSEMBLY, C. E. Head Post, Generator	AL	435	1	2	2.25
X-1003	SCREW, Round Head, Generator	AL	435	3	150/per	.05
1004	CAP, Crankshaft Center Bearing		408	1	3	2.00
1005	CAP, Crankshaft Intermediate Bearing		408	4	2½	1.75
BS-1007	COIL, Left Field, Generator	AL	435	1	⅞	1.25
BR-1007	COIL, Left Field, Starter	AL	436	1	⅜	1.65
BS-1008	COIL, Right Field, Generator	AL	435	1	1	1.25
BR-1008	COIL, Left Field Starter	AL	436	1	⅜	1.65
-1008	SCREW, Filter Head	PG	428	2	100/per	.05
BR-1009	COIL, Right Field, Starter	AL	436	1	⅜	1.65
BR-1010	COIL, Right Field, Starter	AL	436	1	⅜	1.65
CJ-1012	BRUSH, Main, Generator	AL	435	2	45/per	.25
BJ-1013	BRUSH, Third, Generator	AL	435	1	40/per	.25

Use Only Genuine BUDA Engine Parts

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
GAR-1014-B	ASSEMBLY, Brush Holder Plate Part, Generator	AL	435	1	1	$.
1018	CAPSCREW, Crankshaft Bearing Cap		408	14	¼	.
MBR-1024-A	BAND, Starter	AL	436	1	¼	.
GBW-1024-B	BAND, Generator	AL	435	1	¼	.
1030	DOWEL, Crankshaft Bearing		409	7	40/per	.
1033	GASKET, Valve Cover		421	1	20/per	.
MBR-1035	RESISTANCE, Voltage Regulator	AL	438	1	100/per	.
MBR-1038	COVER, Voltage Regulator	AL	438	1	5/per	1.
X-1056	NUT, Hex. Drive Head, Governor	PG	429	2	100/per	.
GBW-1068-B	COVER, C. E. Cap, Volt. Regulator	AL	435	1	¾	.
1070	PLATE, Vqlve Cover		421	1	2½	1.
GE-1074	CAP, Oil Filler Pipe		418	1	½	1.
MBD-1078	ASSEMBLY, End Plate, Starter	AL	436	1	⅝	10.
X-1087	SCREW, Filter Head, Governor	PG	429	1	100/per	.
X-1088	SCREW, Filter Head, Governor	PG	429	2	40/per	.
X-1089	SCREW, Governor	PG	429	4	50/per	.1
1112	BOARD, Terminal, 6-Point	GE	453	1		1.1
1112-A	BOARD, Terminal, 8-Point	GE	453	1		1.9
X-1114	NUT, Governor	PG	428	1	300/per	.6
MBD-1118	ASSEMBLY, Intermediate Bearing, Starter	AL	437	1	¼	2.5
MBD-1160	ASSEMBLY, Terminal Connector, Voltage Regulator	AL	438	1	15/per	1.8
PS-1207	HOUSING, Bendix Drive, Starter	AL	437	1	5	14.0
MBD-1214	BASE, Voltage Regulator	AL	438	1	½	.8
1255	NUT, Connecting Rod		418	12	30/per	.0
1261	BOLT, Connecting Rod		418	12	⅛	.2
1304	NUT, Rocker Arm Adjusting Screw		419	12	45/per	.0
1305	DOWEL, Valve Lifter		421	4	16/per	.0
1307	RETAINER, Camshaft Gear		410	1	30/per	.0
1308	PIN, Camshaft Pump Drive		410	1	50/per	.2
1341	LOCKPLATE, Camshaft Thrust Collar		410	1	30/per	.0
1357	STUD, Valve Cover		421	4	15/per	.0
1359	GASKET, Valve Cover		421	4	100/per	.0
1360	STUD, Intake Manifold		417	2	30/per	.0
8X-1372	NUT, Hex. Voltage Regulator	AL	438	2	100/per	.0
1438	GASKET, Oil Seal Crankshaft Rear Bearing		408	2	200/per	.0
1452	SHAFTS, Idler Gear		416	1	1	2.5
1458	SCREW, Idler Gear		416	1	23/per	.1
X-1461	TERMINAL, Voltage Regulator	AL	438	1	200/per	.0
1508	GASKET, Oil Pump Cover		407	1	200/per	.0
1509	SHAFT, Oil Pump Idler		407	1	1	.6
1510	SHAFT, Oil Pump Drive		407	1	1	.6
1521	PLUG, Oil Pan Drain			1	¼	.6
1526	GASKET, Floto Bracket		416	1	30/per	.0
1535	PIN, Oil Pump Body			1	100/per	.0
P-1538	GASKET, Air Cleaner	DN	423	1	20/per	.0
P-1539	CLAMP, Air Cleaner	DN	423	1	⅛	.2
1540	GASKET, Oil Pan Front		416	1	60/per	.0
1541	GASKET, Oil Pan, Rear		416	1	60/per	.0
1546	GASKET, Oil Pump to Case		407	1	200/per	.0
1547	DOWEL, Oil Pump to Case		407	2	50/per	.0
1560	CAPSCREW, Oil Seal		408	6	100/per	.0
1561	GASKET, Oil Seal Crankshaft Rear Bearing		408	2	200/per	.0
1565	LOCKWIRE, Fuel Injection Pump Driven Spider			1		.02
X-1573	OILER, End Bearing, Starter	AL	436	1	100/per	.25
P-1697	CUP, Air Cleaner	DN	423	1	1½	1.98
A-1894	ASSEMBLY, Shaft, Governor (including weights and pins)	PG	428	1	1¼	4.00
D-1998	ARMATURE, Exciter (complete with winding)	CE	442	1		163.20
D-1998	POLE and COIL, Commutating Exciter	CE	447	2		15.20
D-1998-A-2	COIL, Exciter Armature	CE	447	19	⅜	

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
-1999-B	COIL, Exciter Main Pole (only)	CE	447	2	2	$14.40
RL-2004/1X	ROLLER, Fuel Transfer Pump	BO	427	1	20/per	.40
CT-2006	ASSEMBLY, Armature, Generator	AL	435	1	5	8.00
-2020	ASSEMBLY, Governor Lid	PG	428	1	1	7.08
2034	SCREW, Front Bearing Retainer		409			.10
VU-2034/1-X	NUT, Fuel Injection Nozzle	BO	430	6	⅛	.85
MR-2041/-7X	GASKET, Fuel Injection Nozzle	BO	430	1	200/per	.05
MR-2041/404-X	GASKET	BO	427	2	200/per	.05
SF-2044/A1-X	SPRING, Fuel Injection Nozzle	BO	430	6	30/per	.65
BO-2057/6Z	SPINDLE, Fuel Injection Nozzle	BO	430	6		.60
2064	LUG, Slip Ring Brush Holder Terminal	CE	446	2	160/per	.32
2065	NUT, Valve Cover		421	4	20/per	.08
MV-2066/1-X	LOCKNUT, Fuel Injection Nozzle	BO	430	6		.10
P-2071-C	WASHER, Bevel			2		.08
2074	CAPSCREW, Flywheel Housing		414	4		.08
E-2079	BOLT, Radiator Brace, ½″—20x4⅞″		440	2	¼	.20
BR-2079	ASSEMBLY, Brush Holder, Starter	AL	436	1		6.30
-2084	ASSEMBLY, Clamp, Air Cleaner	DN	423	1	¼	.38#
MV-2096/1-X	CAP, Fuel Injection Nozzle	BO	430	6		.45
VV-2097/1X	SCREW, Fuel Transfer Pump	BO	427	1		.90
SR-2139/400-X	SCREW, Fuel Injection Nozzle	BO	430	6		.15
BO-2140/2X	SPINDLE, Fuel Transfer Pump	BO	427	1		.75
BO-2174/1X	PIN, Fuel Transfer Pmup	BO	427	1		.25
SF-2196/4X	SPRING, Fuel Transfer Pump	BO	427	2		.10
SF-2197/A1X	SPRING, Fuel Transfer Pump	BO	427	1		.25
SF-2206/1X	SPRING, Fuel Injection Pump	BO	426	6		.25
BR-2215	ASSEMBLY	AL	437	1		36.00
-2274	NUT, Air Cleaner	DN	423	6	60/per	.02#
-2280-10	WASHER, Insulated Exciter Brush Holder	CE	448	4	200/per	.16
-2280-13	WASHER, Panel	CE	449	4	350/per	.16
-2280-35	WASHER, Exciter Brush Holder	CE	448	4	400/per	.16
-2281-67	WASHER, Exciter Brush Holder and Yoke	CE	448	4	300/per	.16
-2281-67	WASHER, Terminal Stud, (Plain) (¼″)	CE	449	34	300/per	.16
-2282-75	WASHER, Terminal Stud, ((Plain) (5/16″)	CE	449	8	150/per	.16
-2286	BOLT, (Thru) ⅜″ Hex. Head	CE	449	4	160/per	.32
-2286-35-A	NUT, Terminal Stud Jam, 5/16″—18 (Brass)	CE	449	21	32/per	.32
-2286-38	NUT, Exciter (Thru) Bolt, ⅜″ Hex. Head	CE	442	4	160/per	.20
-2286-40-A	NUT, Alternator Brush Holder Stud	CE	446	4	80/per	.24
-2288-A-20	NUT, Terminal Stud Jam, ¼″—20 (Brass)	CE	449	96	100/per	.32
-2288-A-25	NUT, Alternator Brush Holder	CE	446	4	200/per	.16
-2289	BOLT, Air Cleaner	DN	423	1	12/per	.13#
-2290-B	LOCKWASHER, Exciter (Thru) Bolt, ⅜″, PC12.	CE	449	4	280/per	.32
-2291	LOCKWASHER, Terminal Stud, 5/16″	CE	449	4	400/per	.16
-2291-A	LOCKWASHER, Panel Support, Screw, ¼″	CE	449	4	540/per	.16
-2291-A	LOCKWASHER, Bearing Capscrew, ¼″, PC22	CE	449	4	540/per	.32
-2291-A	LOCKWASHER, Alternator Ball Bearing Capscrew, 5/16″	CE	449	4	400/per	.32
C-2291-A-21	LOCKWASHER, Terminal Stud, 5/16″	CE	449	21	400/per	.16
C-2291-A-22	WASHER, Terminal Stud, ¼″	CE	449	25	540/per	.16
C-2344-4-B	SCREW, Terminal (Small) (Brass)	CE	449	2	20/per	.32
C-2346-20-A	CAPSCREW, Alternator Ball Bearing Cap, 5/16″—18x2¾″	CE	442	4	16/per	.50
C-2346-24-B	SCREW, Terminal (Large) (Brass)	CE	449	1	16/per	.32
C-2351	LOCKWASHER, Alternator Bracket Screw, 7/16″	CE	442	2	200/per	1.00
C-2353-94-A	SCREW, Alternator End Bracket, ½″—13x 7/16″	CE	442	4	½	.40
C-2360-188	SCREW, Exciter Bearing Cap, ¼″—20x⅝″, Fillister Head	CE	442	4	48/per	.32
C-2364-228	SCREW, Alternator End Bracket Cover, ⅜″—16x½″, Fillister Head	CE	442	2	16/per	.32
2377-413	SCREW, Alternator Brush Holder	CE	446	4	130/per	.16
C-2382-462	SCREW, Exciter Brush Holder	CE	448	2	300/per	.16

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
C-2383-465	SCREW, Alternator Brush Holder..........	CE	446	4	200/per	$ .1
C-2385-490	SCREW, Terminal Box Cover, 10—32x5⁄16"..	CE	449	12	280/per	.1
C-2385-492A	SCREW, Exciter Brush Holder Yoke Locking..	CE	448	2	200/per	.3
C-2386-496	SCREW, Resistor Mounting, 10—32x¾"...	CE	449	2	200/per	.1
C-2386-496E	SCREW and NUT, Lead Clamp, 10—32x1".	CE		1	180/per	.3
C-2386-497	SCREW, Exciter End Bracket Cover, ¼"—20x¼", Round Head..................	CE	442	6	130/per	.3
C-2387-506	SCREW, Panel Support, ¼"—20x¾" Round Head..........................	CE	448	4	64/per	.3
B-2413-K	RIVET, Exciter for Strip, C-11897..........	CE	448	8	200/per	.0
DP-2468	ASSEMBLY, Engine Base..................		459	1		60.0
DP-2472	CABLE, Battery-Jumper, 8¾" long.........		457	1		2.5
DP-2475	REBOUND, Vibration Dampener...........		459			2.0
DP-2478	TANK, Fuel (85 Gallons).................		460	1		32.5
DP-2479	BATTERY, One Set Globe Union 12-Y......		457	2		Appl
DP-2491	ASSEMBLY, Generator Coupling...........		457	1		17.0
DP-2493	GENERATOR, Main, Single Bearing (30 K.W. Spec. No. 6971)......	CE	451	1		Appl
DP-2500	ASSEMBLY (Young) 3697C................		440	1		187.5
DP-2505	TUBE, Vibration Dampener Spacer.........		459	6		.3
DP-2508	ASSEMBLY, Control Panel Base............		458	1		30.0
DP-2519	HUB, Generator Coupling................		457	1		10.0
DP-2520	DISC, Generator Cplg., Hub Driving.......		457	1		4.2
DP-2521	PLATE, Generator Coupling, Hub Screw.....		457	1		2.3
DP-2522	BAR, Cross............................		459	1		2.9
DP-2523	PANEL, Control (Gen. Elec.)..............	GE		1		Appl
DP-2524	CONTROL, Governor Stop...............	GE	455	1		1.0
DP-2525	BRACE, Radiator......................		440	1	¼	2.0
DP-2526	HOSE, Radiator Outlet..................		440	1	¼	.9
DP-2528	SWITCH, General Circuit Breaker.........	GE	455	1		3.4
DP-2529	BRACKET, General Circuit Breaker Switch...	GE	455	1		1.3
D-2540	BOLT, Alternator Frame Eye.............	CE	443	1		8.00
DP-2557	MUFFLER-MAREMOUNT (Unmounted).......		460	1		25.00
DP-2567	PLATE, Flywheel.......................		414	1		8.50
DP-2654	CAPSCREW, Vibration Dampener, ½"—13x4¼".........................		459	6	¼	.25
DP-2655	BOLT, Engine Sub-Base Anchor (shipped unmounted).........................		461	6		.65
DP-2657	GUARD, Main Generator................		456	1		1.90
DP-2672-5-6-8	CABLE, Leads, Starter, Armoured..........	GE	456	1		7.65
2673-4-7-9	CABLE................................		456	4		6.80
DP-2680	WIRE LEAD, No. 14 Starter.............			1		2.00
DP-2681-2-3-4-5-6	CABLE................................		456	1		12.30
DP-2701	BRACE, Radiator......................		440	1	3¼	2.10
DP-2706	PLUG, Fuel Tank......................		460	1		.60
DP-2707	ASSEMBLY, with Plug, Fuel Tank Outlet.....		460	1		1.20
DP-2709	PLUG, Fuel Tank Outlet.................		460			.65
DP-2711	PIPE, Fuel Tank Outlet		460	1		.60
DP-2714	ASSEMBLY, Fuel Line (engine to iron pipe)..		460	3		.90
DP-2715	PIPE Only, Fuel Line (engine to iron pipe)..		460	1		.35
DP-2716	CABLE BATTERY, Positive, 37" long........		457	1		1.20
DP-2717	CABLE, Battery—Negative...............		457	1		1.20
DP-2871	CABLE, Starter, 50-½" long with two terminal lugs for No. 0—Wire S-150-A.....	GE	456	1		2.90
A-2911	CAP, Radiator (M7).....................		440	1	¼	1.25
2918	STUD, Fuel Pump Drive..................		415	2		.08
2928	GUARD, Front (Radiator)................			1		17.00
DP-2935	TUBE, 5⁄16" ODx4'......................		460	1		.45
G-3167	PIN, Weight...........................	PG	428	2		.20
3226X4	BUSHING, Fuel Filter...................		423	2		.19
F-3283	BRACKET, Alternator End (Front)...........	CE	442	1	99	128.00
DE-3284	SCREEN, Floto.........................		416	1	½	1.30
3300-X2	COUPLING, ⅛"........................	GE	455	1		.16

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
3310	BEARING, Alternator Ball (Front), New Departure	CE	445	1	2½	$14.40
E-3349	CAP, Exciter Bracket Dust	CE		1	100/per	.32
3400 X 4	ELBOW, Fuel Filter		423	4		.27
3432	WASHER, Thrust Idler Gear		416	1	¼	.30
G-3494	RING, Control Snap	PG	428	1		.06
3545	SPRING, Oil Pressure Relief Valve (Gr. 2 Plain)		414	1	64/per	.05
E-3714	YOKE, Brush Holder Exciter (E-4778)	CE	448	1	1¾	10.90
E-3771-41	COUPLING, Alternator Grease (std.) ⅛"			1		.50
E-3771-43	NIPPLE, Alternator Grease Pipe (2½") ⅛"	CE	446	2	10/per	.80
E-3771-44	ELL (90°), Alternator Grease Pipe	CE	446	1	12/per	.50
E-3771-Gr. 3	ASSEMBLY, Alternator Pole Piece	CE	445	4	15	24.00
G-3807	WEIGHTS (1 pair)	PG	428	2		1.40
3822	HAMMER		461	1		.36
E-3853	BRACKET, Exciter End (Front)	CE	442	1	5½	6.75
E-3883-Gr. 1	FAN, Alternator Vent	CE	443	1	15	24.00
HRG-4001	RELAY, Horn	AL	438	1		3.50
G-4018	SCREW, Conn. Kink Adjusting	PG	428	1		2.20
DE-4024	BUSHING, Rocker Arm		419	12		.20
4045	COCK, Radiator Drain, ¼" I.P.S.			1		.40
DE-4051	SCREW, Rocker Arm Adjusting		419	12	20/per	.40
4052	BOLT, Front End Gear Housing Dowel		415	2	¼	.30
4053	BOLT		414	3		.24
4054	CAPSCREW, Front End Gear Housing		415	4		.12
DE-4129	STUD, Generator Bracket, 1$\frac{9}{16}$"		415	2		.14
DE-4134	LOCKSCREW, Idler Gear		416	1	⅛	.20
4204	SPRING, Piston (Zollner) Pin Retainer		418	12		.08
D-4240-Gr. 3	ASSEMBLY, Exciter Main Pole	CE	447	2	4	12.80
DE-4275	WASHER, Cylinder Head Cover Stud (Lower)		413	4		.06
4295	CHISEL		461	1		.30
SS-4310	SWITCH, Solanoid, Voltage Reg.	AL	438	2		10.50
TC-4310-A	REGULATOR, Generator Voltage	AL	435	1		5.50
4415	HANDLE, Socket Wrench T		461	1		1.20
4421	SOCKET, ¾" Wrench		461	1		.85
DE-4439	SCREWS, Governor	PG		4		.20
4468	WRENCH, 10" Crescent Type		461	1		1.40
EB-4503	HEAD, Driving Bendix Starter	AL	437	1		1.00
EB-4506	SCREW, Driving Head Spring, Bendix Starter	AL	437	1		.15
EB-4507	SCREW, Driving Shaft Spring, Bendix Starter	AL	437	1		.12
EB-4529	PLIERS, Combination		461	1		.25
E-4595	SPIDER, Slip Ring	CE	445	1	7	19.20
E-4778	YOKE, Exciter Brush Holder	CE		1		10.90
DE-4866	DOWEL, Connecting Rod Bearing		418	6		.06
DE-4870	PLUG, Cylinder Pipe, ⅜"		408	7	16/per	.06
E-4883-Gr. 1	FAN, Alternator Vent			1		24.00
E-4885-Gr. 2	BOX, Alternator Terminal	CE	449	1	5	8.00
DE-4907	GEAR, Flywheel		414	1		4.50
E-4907	FLANGE, Alternator Balance	CE	445	2	8¼	11.20
P-4928	SCREEN, Air Cleaner		423	1		.88#
E-4971	FRAME, Exciter Field (only)	CE	447	1	28	48.00
EBA-5005	SPRING, Bendix Drive, Starter	AL	437	1		2.40
DE-5007	BUSHING, Connecting Rod		418	6		1.50
EBA-5011	ASSEMBLY, Bendix, Starter	AL	437	1		10.50
DE-5028	ARM, Rocker, with Bushings (front)		419	6	½	2.50
DE-5029	ARM, Rocker, with Bushing (rear)		419	6		2.50
5104	KNOB, Exciter Field Rheostat (Ohmite)	CE		1	2	6.40
EB-5219S	SLEEVE, Bendix, Starter	AL	437	1		.50
DE-5284	DOWEL, Rocker Arm Bracket		419	4		.10
DE-5476	LOCKWIRE, Crankshaft Bearing Cap			7		.02
DE-5482	CUP, Tool Kit Grease, ⅛" P.T.		461	1		.60
5529	CAP, Pressure Relief Valve		414	1	⅛	.20
5570	WRENCH, Pipe		461	1		1.50
B-5671	PLUG, Exciter End Bracket Grease, ⅛"	CE	446	1	56/per	.32

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
B-5761	PLUG, Alternator Grease	CE		3		$ .5
5875	ASSEMBLY, Oil Pump			1	5	14.5
5876	BODY, Oil Pump		407	1	2½	4.7
5877	COVER, Oil Pump			1	1	2.7
5879	DRIVER, Oil Pump Gear		407	1	½	2.5
5880	GEAR, Oil Pump Idler		407	1	½	2.5
AP-6014	SPACERS, Fuel Filter Bracket		423	4	16/per	.2
AP-6081	CLAMPS, Bypass Hose		439	2		.0
D-6087	CAP, Alternator, Front Inside Bearing	CE	445	1	2½	13.6
"ABZUG"	RESISTOR (Ohmite) 140 ohms with 80 ohms top	CE	449	1	⅛	6.4
6106	BRACKET, Resistor Mounting (Ohm.)	CE	449	2	⅛	1.6
D-6167	COVER, Alternator End Bracket	CE	442	1	⅝	1.0
G-6229	HOUSING	PG	428	1		15.5
G-6232	GEAR	PG	428	1		1.0
G-6233	GEAR, Governor Driver	PG	429	1		3.5
G-6239	LEVER, Throttle	PG	428	1		2.2
G-6240	SHAFT, Spider	PG	428	1		3.5
G-6246	SLEEVE	PG	428	1		2.9
G-6247	SHAFT, Rocker	PG	428	1		.7
G-6249	GASKET, Body	PG	429	1		.1
G-6250	GASKET, Lid	PG	428	1		.0
G-6251	PIN, Throttle Lever	PG	428	1		.9
G-6254	YOKE, Rocker	PG	428	1		1.1
G-6255	PLUG, Fuel Screw	PG	429	1		1.8
G-6261	GASKET, Pump Register Plate	PG	429	1		.2
B-6264	FINGER, Exciter Brush Holder	CE	448	4	200/per	1.6
G-6296	COUPLING, Tachometer Shaft	PG	428	1		.8
AP-6330	BEARING, Engine Base Crank, $\frac{3}{16}$" plt.		459	1		.2
G-6365	CLEVIS, Throttle, R. H.	PG	428	1		1.2
G-6366	PIN, Throttle Conn. Clevis Stop	PG	428	1		.4
D-6438	FAN, Exciter Armature Vent	CE	447	1	1½	1.6
D-6475	BOARD, Panel (Ebony Asbestos)	CE	449	1	2¼	6.4
D-6477	COVER, Terminal Box (back)	CE	449	1	2½	1.6
D-6477-1	COVER, Terminal Box (front)	CE	449	1	2½	1.6
D-6482-Gr. 1	ASSEMBLY, Alternator Frame and Coil	CE	443	1	523	320.00
D-6503-Gr. 2	SHAFT AND CORE, Exciter Armature	CE	447	1	12½	48.00
6534	CAN, Oil		461	1		.24
AP-6683	BUSHING, Cable	CE	456	1		2.75
G-6711	PIN, Smoke Stop Link	PG	428	1		.30
B-6730	TUBE, Alternator Grease	CE	446	2	10/per	.50
7014-A	FUNNEL		461	1		2.50
G-7401	SCREW, Governor Surge	PG	428			1.50
G-7402	SCREW, Spring Adjusting	PG	429	1		1.80
G-7408	TUBE, Smoke Stop	PG	428	1		1.50
G-7409	LINK, Smoke Stop	PG	428	1		1.80
G-7415	PLATE, Body Flange	PG	429	1		8.20
HP-7610-A	ASSEMBLY, Fuel Injection Pump	BO	426	1		2.50
SP-7614	SPRING, Fuel Injection Pump	BO	426	1		.30
SC-7625	SCREW, Fuel Injection Pump	BO	426	2		.10
CV-7635-A	COVER, Fuel Injection Pump	BO	426	1		1.40
GA-7642	GASKET, Fuel Transfer Pump	BO	427	1		.05
GA-7649	GASKET, Fuel Injection Pump	BO	426	1		.10
SC-7657	PLUG, Fuel Injection Pump	BO	426	1		.10
SC-7678-2	SCREW, Fuel Injection Pump	BO	426	1		.40
GA-7681	GASKET, Fuel Injection Pump	BO	426	12		.10
RD-7682-A	ROD, Fuel Injection Pump	BO	426	1		.85
C-7702	COVER, Exciter End Bracket	CE	442	2	⅛	1.00
VA-7914-A	ASSEMBLY, Fuel Return Check Valve (early style)	BO	425	1		5.50
VA-7915-A	BODY, Fuel Injection Pump	BO	426	1		4.20
VA-7918-A	ASSEMBLY, Fuel Return Check Valve (late style)	BO	426	1		3.70

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
SP-7919	SPRING, Fuel Transfer Pump	BO	427	1		$ 1.25
SC-7919-A	SCREW, Fuel Transfer Pump	BO	427	1		.45
VA-7924	BODY, Fuel Injection Pump (Overflow Valve)	BO	426	1		2.90
SC-7959-A	SCREW, Fuel Injection Pump	BO	426	1		.95
HG-7963-A	HOUSING, Fuel Transfer Pump	BO	427	1		8.50
BX-8304	NUT, Terminal Voltage Regulator		438	4		.05
BS-8860	BRUSH, Slip Ring (1⅛"x⅝"x5/16") Nat. Ay.	CE	446	4	48/per	1.00
9117	STUD, Fuel Injection Pump			2		1.08
BS-9702	BRUSH, (1"x½"x⅜") Nat. 676	CE	448	4	32/per	.80
C-10326-PC-1038	SHAFT KEY, Generator Coupling, Hub, ⅝" sq. x 3 1/16"		457	1		1.60
H-10350	ASSEMBLY, Exciter Brush Holder Yoke			2		2.90
H-11141	PLUG, Oil Pump Drive Gear			1		.10
C-11518-5602	BOLT, Exciter Through (Thru)	CE	442	4	¼	.32
C-11680	ASSEMBLY, Exciter Commutating Pole			2		19.20
C-11842-1000	SCREW, Exciter Brush Holder	CE	448	4	200/per	.16
C-11897	STRIP, Exciter Brush Holder and Yoke	CE	448	2	40/per	.80
H-11950	STOP, Oil Seal		408	2	64/per	.15
H-11951	CAP, Crankshaft Rear Bearing		408	1	3¾	3.85
H-12000	BRACKET, Oil Pan Floato		416	1	1¼	2.85
H-12030	GAUGE, Oil Level		416	1	⅛	.50
H-12035	BUSHING, Oil Level Gauge		416	1	16/per	.30
H-12096	BELT, Fan Blade		439	1		2.25
H-12111	BOLT, Flywheel		414	5		.16
H-12237	CRANK, Hand		459	1		3.50
C-12278	GROMMET, Insulated Lead	CE		1	160/per	.65
H-12295	BEARING, Camshaft Rear		408	1	¼	.70
C-13589	PLATE, Exciter Brush Holder	CE	448	2	300/per	.16
C-15400	POINTER, Exciter Brush Holder and Yoke	CE	448	1	80/per	.32
C-15432	NUT, Slip Ring Brush Holder Stud Jam	CE	446	4	80/per	.25
C-15437	WASHER, Slip Ring Brush Holder Stud	CE	446	4	30/per	1.00
C-15832	NUT, Alternator Ball Bearing Lock	CE	445	1	½	1.60
C-15833	SLINGER, Alternator Shaft Greased	CE	445	1	¼	1.60
C-15848	CAP, Exciter Bracket Inside Bearing	CE	447	1	¾	1.00
16240-A	COILS, Alternator Stator (Only) (1 Set)	CE	444	72	59½	290.00
16241-A	COILS, Alternator Field	CE	445	4	16	38.40
16355	RHEOSTAT, Exciter Field (Ohmite)	CE		1	8	24.00
C-16735	RETAINER, Exciter Ball Bearing	CE	447	1	16/per	.32
C-16736	SPACER, Exciter Ball Bearing	CE	447	1	25/per	1.45
C-19131	SUPPORT, Slip Ring Insulated	CE	446	1	¼	3.20
C-19133	STUD, Slip Ring Brush Holder	CE	446	2	¼	1.60
C-19671	CLAMP, Lead, for Exciter Leads	CE		2	60/per	.50
C-20346	DEFLECTOR, Exciter (back)	CE		1	¼	1.30
C-20403	SHAFT, Alternator Rotor	CE	445	1		120.00
C-20461	LINK, Terminal	CE	449	3	16/per	1.30
C-20461-1	LINK, Terminal	CE	449	6	16/per	1.00
C-20461-2	LINK, Terminal	CE	449	1	25/per	1.30
C-20520-4	LUG, Terminal Connector (Large)	CE	444	4	25/per	1.00
C-20520-5	LUG, Terminal Connector (small)	CE	444	15	35/per	1.00
C-20534	STUD, Terminal (large)	CE	449	3	16/per	1.00
C-20534-1	STUD, Terminal (small)	CE	449	15	20/per	1.00
C-20856	SHAFT, Exciter Armature	CE	447	1		16.00
C-20940-24115	PIN, Main Generator Pole Piece	CE	445	4	¼	1.60
34367	BLOCK, Fuse, 250-Volt, No. 1116	GE	453	3		.75
34952	FUSE, 250-Volt, 10-Ampere, No. 1202	GE	453	6		.10
DE-40032	STUD, Exhaust Manifold		414	3	20/per	.16
DE-40036	WASHER, Exhaust Manifold Stud		414	13	24/per	.15
DE-40038	PLATE, Valve Cover Name			1		.30
DE-40129-A	ASSEMBLY, Nozzle (Bosch)	BO	430	6	1⅛	15.20†
DE-40130	NOZZLE (Bosch)	BO	430	6	12/per	11.00†
DE-40164	STUD, Exhaust Manifold (long) 3 5/16" Ga.-Hght.			10		.12
DE-40190	STUD, Intake and Exhaust Manifold		412	3		.08

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
DE-40317	SLEEVE, Oil Pressure Relief Valve		414	1	18/per	$ .2
DE-40318	SEAT, Oil Pressure Relief Valve		414	1		.3
DE-40484	GASKET, Fuel Injection Nozzle	BO	430	6		.1
DE-40735	CLAMPS, Fuel Injection Return Lines (1 pr.)	BO	431	2		.3
DE-41286	NUT, Cylinder Head Stud, ⅜"—24 Acorn		413	4		.0
DE-41466	ASSEMBLY, Nozzle Holder	BO	430	6	1¼	29.2
DE-41935	SWIVEL, Governor Stop Control	GE	455	1	2	.8
DE-50005	BRACKET, Valve Lifter		421			6.6
DE-50016	GASKET, Cylinder Head Cover		413	1		.3
DE-50034	BRACKET, Valve Lifter		421	1	2	6.6
DE-50070	DISTRIBUTOR, Water Inlet Manifold		420	3		.4
DE-50072	STUD, Air Cell Retainer Flange		412	12		.1
DE-50108	FLANGE, Air Cell Retainer		412	6	½	.4
DE-50144	BRACKET, Rocker Arm		419	6	1	2.2
DE-50164	GASKET, Air Cleaner			1	10/per	.0
DE-50193	FLANGE, Exhaust Manifold Outlet		414	1		1.9
DE-50194	GASKET, Exhaust Manifold Outlet Flange		414	1		.2
DE-50387	STUD, Cylinder Head		408	15	⅜	.3
DE-50532	CLAMP, Fuel Injection (2 prs.)		431	4		.2
DE-50533	CLAMPS, Fuel Injection Line		431	1		.2
DE-50576	CAMSHAFT		410	1	20	38.5
DE-50589	MANIFOLD, Intake		417	1	21	22.0
DE-50590	GASKET, Exhaust Manifold		417	1	4¾	.8
DE-50597	SEAT		411	6		2.0
DE-50601	SPRINGS, Inlet Valve		411	6	⅛	.3
DE-50610	PIN, Piston (Zollner)		418	6	⅝	1.1
DE-50614	SCREEN		417	1		19.0
DE-50615	GASKET, Lube Oil Filter		441	1		.0
DE-50638	RINGS, Inlet Valve		411	6		.0
DE-50657	GASKET, Cylinder Head (major side)		410	1	½	1.7
DE-50668	GASKET, Pan Side		416	2		.1
DE-50680	TUBE, Cylinder Head Cover		412	2	32/per	.2
DE-50683	SHIELD, Intake Manifold		417	1	1¾	2.2
DE-50814	CLUSTER, Valve Lifter (front)			1	4¾	16.2
DE-50824	LIFTER, Valve		421	12	⅜	1.6
DE-50864	GASKET, Cylinder Head (minor side)		410	1	32/per	1.6
DE-51017	MANIFOLD, Water Inlet		420	1	4¾	3.5
DE-51033-A	HEAD, Cylinder (Includes head, valve and guides)			1	115	165.0
DE-51033-B	HEAD, Cylinder (Includes valves and springs)			1	115	190.0
DE-51034	TUBE, Cylinder Head Water Distributor		412	1	⅜	4.7
DE-51151	GASKET, Nozzle Holder			6		.1
DE-51214	STUD, Cylinder Head		412	10		.1
DE-51230	BLOCK, Cylinder and Crankcase		408	1		250.00
DE-51241	ASSEMBLY, Cylinder and Crankcase		407	1	295	250.00
DE-51252	MANIFOLD, Nozzle Drip Line			1	⅜	1.50
DE-51256	CRANKSHAFT (Tocco Hardened)		409	1	81	90.00
DE-51276	RING, Piston (Zollner) Top		418	6	16/per	.20
DE-51278	ASSEMBLY (Zollner)		418	6		11.60
DE-51294	BEARING, Camshaft Center		408	2	¼	.45
DE-51347-A	ASSEMBLY, Cylinder Head		411-412	1		165.00
DE-51492	VALVE, Exhaust		411	6	¼	1.10
DE-51494	VALVE, Intake		411	6		.80
DE-51542	PAN, Oil		416	1	15	$10.0
DE-51634-5-6-7-8-9	ASSEMBLY, Fuel Injection		431	1	2	4.40
DE-51640	LINE, Fuel Injection		425	1	¼	.80
DE-51664	LINE, Fuel Nozzle Drip Manifold Extension		425	1	8/per	.60
DE-52152	MANIFOLD, Fuel Injection and Return Lines		431	1	1	3.25
DE-52189	ASSEMBLY, Fuel Transfer Pump	BO	427	1	3	31.70
DE-52190	ASSEMBLY, Lube Oil Filter	WGB	441	1	12	26.50
DE-52191	ASSEMBLY, Fuel Oil Filter (Primary)	WGB	424	1	4¾	11.00
DE-52192	ASSEMBLY, Air Cleaner	DN	423	1	4	4.50
DE-52194	AMMETER	GE	455	1	3	1.75

Use Only Genuine BUDA Engine Parts

Buda Part No.	DESCRIPTION	Mfr.	Illus. on Page	Amt. Req.	Weight Lbs.	Price Each
DE-55125	STUD, Nozzle Holder		412	12		$ .08
DE-55136	NUT, Idler Gear		416	1	10/per	.16
DE-55137	PLUG, Air Cell		412	6	⅜	.55
DE-55139	TUBE, Oil		408	1	¼	.12
DE-55189	GASKET, Fuel Injection Pump Adaptor Plate	BO	425	1		.05
DE-55193	GASKET, Gear Cover		415	1		.25
DE-55204	ASSEMBLY, Air Cell		412	6	⅜	2.25
DE-55217	GEAR, Crankshaft		409	1	2	3.85
DE-55235	GEAR, Camshaft		410	1	5½	5.30
DE-55294	GASKET, Front End Gear Housing		415	1		.20
DE-55378	SLEEVE, Cylinder		408	6	2¾	11.00
DE-55538	GUIDE, Inlet Valve		411	6	⅛	.30
DE-55539	GUIDE, Exhaust Valve		411	6	⅛	
DE-55554	ROD, Push		411	1		.40
DE-55555	END, Push Rod (upper)		411	1		.25
DE-55557	TUBE, Push Rod		421	12	⅜	1.95
DE-55755	CAP, Crankshaft Front Bearing		408	1	2¾	2.75
DE-55850	HOUSING, Front End Gear		415	1	19	24.00
DE-55858	HOSE, Water Inlet Manifold 90° Elbow		420	1		.65
DE-55859	HOSE, Water Inlet Manifold		420	1	⅛	.45
DE-55861	GASKET, Fuel Injection Pump	BO	425	1		.12
DE-55863	PLATE, Fuel Injection Pump Adaptor	BO	425	1	3¾	7.50
DE-55874	GASKET, Water Pump Pulley Hub		422	1		.08
DE-55872	ASSEMBLY, Water Pump		422	1	4¾	20.00
DE-55881	NIPPLE, Water Distributor Tube Hose		412	1	⅛	.10
DE-55944	FILTER, Fuel	BO	423	1	2½	5.00†
DE-55945	BRACKET, Fuel Filter		423	2	⅜	.95
DE-55953	ASSEMBLY, Idler Gear (includes DE-55933 Idler Gear and 3430 Bushing)		416	1	8¼	14.50
DE-55995	COLLAR, Camshaft Thrust		410	1	¼	.50
DE-56021	DAMPENER, Vibration		459	6		1.40
DE-56022	CUP, Vibration Dampener		459	6		1.50
DE-56063-64	BEARING Crankshaft Front (upper and lower)		409	1	½	8.00
DE-56065-66	BEARING, Center Main (upper and lower)		409	1 pr.	¾	Price per Pair 10.40
DE-56067-68	BEARING, Intermediate Main (upper and lower)		409	4 prs.	¾	7.00
DE-56069-70	BEARING, Rear Main (upper and lower)		409	1 pr.	¾	21.00
DE-56071	BEARING, Connecting Rod		418	6	10/per	2.90
DE-56072	ASSEMBLY, Connecting Rod		418	6	3¼	20.00
DE-56080	LOCKS, Inlet Valve		411	6 prs.	100/per	.05
DE-56131	SEAL, Rear Bearing Oil (upper and lower)		408	2	1¼	1.25
DE-56165	FELT, Valve Cover		408	2		.08
DE-56167	PULLEY, Fan Drive		409	1	5	7.00
DE-56245	IMPELLER, Water Pump		422	1		2.25
DE-56246	RING, Water Pump Seal Clamp		422	1		.15
DE-56247	SPRING, Water Pump Seal		422	1		.20
DE-56248	GUIDE, Water Pump Seal Spring		422	1		.10
DE-56249	SEAL, Water Pump Flexible		422	1		.35
DE-56250	WASHER, Water Pump Seal Carbon		422	1		.35
DE-56251	WIRE, Water Pump Seal Spring		422	1		.06
DE-56252	BODY, Water Pump		422	1	4	8.25
DE-56253	ASSEMBLY, Water Pump Shaft and Bearing		422	1		4.00
DE-56254	LOCKWIRE, Water Pump Shaft		422	1		.08
DE-56255	HUB, Water Pump Pulley		422	1		2.00
DE-56256	SNAPWIRE, Water Pump Oil Slinger		422	1		.10
DE-56388	ASSEMBLY, Water Pump Seal		422	1		1.30
DE-56516-R	GENERATOR, 12-Volt, 100-Watt, GDB-4804-D	AL	434	1	22	47.50#
DE-56518	STARTER, 12-Volt Autolite, MBR-4003	AL	436	1		175.00#
DE-56519	SWITCH, Starter, MBR-3214	AL	Not illus.	1		50.00#
DE-56520	ASSEMBLY, Starter Push, XA-572	AL	438	1		6.25
DE-56532	BRACKET, Generator		434	1	1	3.00
DE-60179	KEY, Fan Drive Pulley		409	1	30/per	.15

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
DE-52195	GAUGE, Assembly Water Temperature		455	1	1	$ 3.55
DE-52196	GAUGE, Oil Pressure		455	1	1	2.00
DE-52197	GAUGE, Oil Temperature	GE	455	1	1	3.55
DE-52198	COVER, Cylinder Head		413	1	6	4.00
DE-52201	ASSEMBLY, Governor	PG	429	1	9½	48.00
DE-52202	BRACKET, Fuel Filter and Solenoid Valve		424	1	2¾	1.40
DE-52203	ASSEMBLY, Flywheel		414	1	96	40.00
DE-52204	MANIFOLD, Exhaust		414	1	30	30.00
DE-52205	HOUSING, Thermostat		439	1	4¾	2.00
DE-52206	THERMOSTAT		439	1	¼	1.90
DE-52207	COVER, Front End Gear Housing		415	1	28	21.00
DE-52208	PULLEY, Water Pump		439	1	4	5.50
DE-52209	PIPE, Oil Filler		415	1	3¾	3.50
DE-52210	ADAPTOR, Air Cleaner		417	1	2½	2.00
DE-52211	ASSEMBLY, Rocker Arm Cluster		420	1	10	60.00
DE-52212	ASSEMBLY, Rocker Arm Oil Line (Crankcase to Cylinder Head)		420	1	1	1.00
DE-52213	ASSEMBLY, Rocker Arm Oil Line (Cylinder Head to Rocker Arm Shaft)		420	1	⅛	.80
DE-52214	HOUSING, Flywheel		414	1	132	65.00
DE-52215	JAW, Starting Crank		409	1	2	2.75
DE-52220	SHAFT, Rocker Arm		419	1	4½	6.50
DE-52221	CLIP, Rocker Arm Shaft Spring		419	6	15/per	.20
DE-52222	STUD, Rocker Arm Shaft Lock		419	1	14/per	.20
DE-52223	STUD, Rocker Arm and Cylinder Head Cover		419	3	15/per	.30
DE-52227	CONTROL, Safety (Penn Electric)	PES	432	1	3	29.50
DE-52228	ASSEMBLY, Solenoid (221-E-0314)	PES	432	1	2½	12.75
DE-52229	GEAR, Fuel Injection Pump Drive		425	1	2¾	7.50
DE-52230	SPIDER, Fuel Injection Pump Driven		425	1	¾	3.50
DE-52233	ASSEMBLY, Fuel Line (Bosch Filter to Transfer Pump, 8⅞")		425	1	5/per	1.75
DE-52235	ASSEMBLY, Fuel Line (Fillter to Transfer Pump)		425	1	7/per	1.75
DE-52238	GASKET, Oil Filler Pipe		415	1	30/per	.05
DE-52239	CARTRIDGE, Lube Oil Filter	WGB	441	1		1.60
DE-52240	CARTRIDGE, Fuel Filter (Primary)	WGB	424	1	½	.75
DE-52243	TOOL KIT		461	1	11	15.00
DE-52244	MANIFOLD, Water Outlet		413	1	10	7.00
DE-52245	GASKET, Thermostat		439	1	50/per	.05
DE-52246	HOSE, By-Pass		439	1	¼	.35
DE-52250	ASSEMBLY, Oil Pressure Line to Safety Control		432	1	8/per	1.85
DE-52251	LINE, Oil Pressure, ¼" OD x 16" long			1	5/per	1.65
DE-52252	ASSEMBLY, Oil Line—Gauge to Crankcase	GE	455	1	⅜	.95
DE-52253	LINE, Oil Pressure Gauge, ¼" ODx72" long		Not illus.	1	⅛	2.25
DE-52254	TACHOMETER, Assembly	GE	455	1	1¼	14.00
DE-52255	LINE, Rocker Arm Oil, ¼" ODx2' long		Not illus.	1	¼	1.75
DE-52260	CAPSCREW, Fuel Injection Driven Spider Pump, ⅜"—24 x ⅞"		425	3	20/per	.15
DE-52261	SPACER, Solenoid Fuel Valve		432	1	25/per	.20
DE-52262	ASSEMBLY, Fuel Line (Bosch Filter to Solenoid)		423	1	⅜	1.75
DE-52264	CHANNEL, Conduit		458	1		2.50
DE-52265	BRACE, Generator Adjusting		434	1	½	2.40
DE-52269	COVER, Conduit Channel		458	1		3.25
DE-52270	BRACE, Conduit Channel Cover		458	1		.60
DE-52271	TUBE, Conduit Channel Spacer		458	1		.05
DE-52272	ASSEMBLY, Fan Blade (4820-DX)		439	1	6½	3.25
DE-52273	PUMP, Bosch Fuel Injection	BO	425	1	19	298.25
DE-52304	LINE, Fuel Injection Pump Straight		Not illus.	1		4.40
DE-52310	KIT, Gasket		Not illus.	1		10.35
DE-52316	LINE, Oil	GE	455	1		.45
DE-55013	RING, Piston-Zollner Oil Control		418	12	15/per	.50
DE-55118	CUP, Valve Spring		411	6	15/per	.10

Use Only Genuine BUDA Engine Parts

Buda Part No.	DESCRIPTION	Mfr.	Illust. on Page	Amt. Req.	Weight Lbs.	Price Each
SW-68500	CABLE, Tachometer	SW	455	1		$ 3.75
CV-76116-A	COVER, Fuel Injection Pump		426	1		2.70
DN-91300-A GR. 6	COMMUTATOR, Exciter Armature	CE	447	1	1¾	9.60
SW-96300	ASSEMBLY, Tachometer—5 feet		455	1		4.75
100005	CAPSCREW, Fan Blade, ¼"—28x¾"		439	4	110/per	.04
100050	CAPSCREW, Radiator Brace, ½"—20x1"		440	2	10/per	.06
100109	CAPSCREW, ¼"—20x¾"		416	3	60/per	.04
100110	CAPSCREW, Fuel Injection and Return Lines		431	8		.04
100111	CAPSCREW, Floto Bracket, ¼"—20x1¼"		416	2	45/per	.04
100121	CAPSCREW, 5/16"—18x¾"		424	9	50/per	.04
100122	CAPSCREW, Water Pump, 5/16"—18x1"		422	2	30/per	.04
100133	CAPSCREW, ⅜"—16—¾"		415	10	25/per	.04
100134	CAPSCREW, ⅜"—16—1"		415	4	20/per	.04
100135	CAPSCREW, ⅜"—16—1¼"		422	8	20/per	.04
100136	CAPSCREW, Front End Gear Housing, ⅜"—16x1½"		415	11	15/per	.06
100137	CAPSCREW, Valve Lifter, ⅜"—16x1¾"		421	6	15/per	.06
100138	CAPSCREW, Water Pump, ⅜"—16x2"		422	1	12/per	.06
100158	BOLT, ½"—13x1"		440, 458	7	10/per	.06
100159	CAPSCREW, ½"—13x1¼"		458	14	⅛	.06
100160	CAPSCREW, Generator Coupling Screw Plate		457	12	⅛	.08
100162	CAPSCREW, Main Generator Single Bearing, ½"—13x2" (to B.H.)		414	8	⅛	.08
100183	CAPSCREW, Starter, ⅝"—11x1¼"		Not illustrated	3	¼	.08
100187	CAPSCREW (Engine to Base), ⅝"—11x2½"		459	2		.12
100764	CAPSCREW, Solenoid Valve, 10—32x½"		432	2		.04
102637	NUT, Control Panel, ½"—13		458	5	15/per	.04
103026	NUT, Nozzle Holder Gasket, ⅜"—24		430	12	65/per	.02
103028	NUT, Front End Gear Housing Dowel Bolt, ½"		414	2	25/per	.04
103028	NUT, Cylinder, ½"—20		400	6	28/per	.04
103028	NUT, Air Cleaner Stud		440	2	28/per	.04
103319	LOCKWASHERS, ¼"		409,414,440	25	500/per	.01
103320	LOCKWASHERS, 5/16"		422	19	300/per	.01
103321	LOCKWASHERS, ⅜"		414,424,441	94	200/per	.01
103323	LOCKWASHERS, ½"		414	56	75/per	.01
103325	LOCKWASHERS, ⅝"		459	11	40/per	.02
103341	WASHERS, ⅜"		413	7		.01
103343	WASHER, Vibration Dampener Cap-screw (plain) ½"		459	12		.04
103374	PIN, Vibration Dampener Cotter, 3/32"x1"		459	6	200/per	.01
103387	PIN, Floto Assembly Cotter, ⅛"x1½"		416	1	150/per	.01
103720	PIN, Idler Gear, 3/16" dia.x½"		416	1	64/per	.04
103866	PLUG, Cylinder Pipe, ⅜" sq. hd.		408	1	30/per	.04
103870	PLUG, Cylinder Pipe, ¼" sq. hd.		460	1	30/per	.04
103874	PLUG, Cylinder Head Pipe, ½"		412	7	15/per	.08
103875	PLUG, Cylinder Head, ¾" countersunk		408	5	¼	.10
103876	PLUG, 1" Square Head		412	3	¼	.16
103883	PLUG, Crankshaft Pipe, ⅛" slotted headless		409, 412	1	100/per	.02
103885	PLUG, Water Pump Pipe		422	1	100/per	.04
103891	PLUGS, ⅝"		419	3	10/per	.04
103892	PLUG, Oil Pump Welch		408	1	40/per	.04
103895	PLUG, Cylinder Expansion, 1¼"		408	2	30/per	.04
103896	PLUG, Cylinder Expansion, 1½"		408		15/per	.06
104924	BALL, Oil Pressure Relief Valve, ⅝" diameter		414	1	20/per	.06
105409	EXTENSION, Fuel Tank Line		460	1		.16
105413	ELBOW, 90° ¼" Fuel Tank		460	1	20/per	.25
105423	ELBOW, ¼" 90° Female Fuel Tank		460	1	20/per	
105451	GASKET, Rocker Arm Oil Lines		420	1		.04
105453	GASKET, ⅝" ID x 15/16" OD		416	3	320/per	.04
105455	GASKET, Oil Pressure Valve Cap-screw, 11/16" ID x 1" OD		Not illus	2	300/per	.04
106261	WASHER, Main Generator Guard (plain) ¼"		Not illus	6	400/per	.04

Buda Part No.	DESCRIPTION	Mfr.	Illus. on Page	Amt. Req.	Weight Lbs.	Price Each
106262	WASHER, Generator Adjusting Brace (flat) 5/16"		424	6	200/per	$ .01
106263	WASHER, Rocker Arm Shaft	GE	455	6	200/per	.04
106263	WASHER, Governor Stop Control (flat)		455	1	300/per	.04
106265	WASHER, Radiator Brace (flat) 1/2"		Not illus.	4	100/per	.04
106267	WASHER, Anchor Bolt (plain) 5/8"		440	6	40/per	.04
106319	BOLT, 1/4"—20 x 5/8"		440	10	60/per	.04
106323	CAPSCREW, Conduit Channel Spacer Tube, 1/4"—20x2 1/4"		458	1	25/per	.05
106325	CAPSCREW, Thermostat, 5/16"—18 7/8"		439	4	33/per	.04
106326	CAPSCREW, Generator, 5/16"—18x1 1/8"		423	24	28/per	.04
106330	CAPSCREW, 3/8"—16x7/8"		424	28	22/per	.04
106331	CAPSCREW, Lube Oil Filter, 3/8"—16x1 1/8".		441	4	20/per	.04
106496	LOCKWASHER, No. 8	AL	438	2		.01
106497	LOCKWASHERS, No. 10		432	6	250/per	.01
106500	LOCKWASHER, Flywheel Bolt		414	5	100/per	.02
106643	PLUG, Air Cleaner Pipe, 1 1/2"		417	1	1/8	.16
106644	PLUG, Cylinder Pipe, 1 1/4"		408	5	1/4	.15
106750	KEY, Driven Spider (Woodruff) 5/8"x1/4"		425	1	200/per	.02
106964	CAPSCREW, Rocker Arm Oil Lines		420	1		.06
106972	BOLT, Radiator		440	6	70/per	.04
106973	CAPSCREW, Intake Manifold, 5/16"—18x1 1/2"		417	2	23/per	.04
107761	COTTER, Governor Stop Control	GE	455	1		.01
108579	LOCKWASHER, Oil Pump to Case Screws		407	4	40/per	.02
108618	CAPSCREW, Gear Housing Cover		415	2		.06
108618	CAPSCREW, Rocker Arm Bracket		419	8	1/8	.06
108620	CAPSCREW, Rocker Arm Bracket, 1/2"x2 3/4".		419	6	5/per	.08
108629	COTTER, Connecting Rod		418	12		.01
109084	NUT, Fuel Injection and Return Lines		431	8		.02
110498	SETSCREW, Governor Stop Control	GE	455	1		.02
110501	BOLTS, Vibration Dampener, No. 10—24x 5/8"		Not illus.	4		.04
110633	NUTS, Vibration Dampener Bolt, No. 10—24		Not illus.	4		.01
112877	BUSHING, Reducing, 1/4" to 1/8"		425	1		.12
113111	NUT, Fuel Filter Lcokwasher, 5/16"—18		424	4	100/per	.02
113698	CAPSCREW, Camshaft Thrust Collar, 1/4"—28x1/2"		410	3	85/per	.04
113782	KEY, Camshaft Gear		410	1	50/per	.04
113879	KEY, Crankshaft Gear, 5/16"x1 1/4 (Woodruff)		409	1	20/per	.04
114363	BOLT, Fuel Filter Strap		423	2		.08
114380	NUT, Fuel Filter and Air Cleaner		423	3		.02
114604	LOCKWASHER, Oil Pump Cover Screw Star.		407	6		.01
114606	LOCKWASHER, Rocker Arm Bracket Capscrew, 3/8" Ext. Tooth		419	6		.02
114608	LOCKWASHER, Rocker Arm Bracket Capscrew, 1/2" Ext. Tooth		419	6		.02
114618	WASHER, Countersunk, 3/8"		415	2		.01
114626	CONNECTOR, Nozzle Drip Line Manifold, 1/4" Tube, 1/4" pipe thread		425	1		.12
114627	NUT, Nozzle Drip Line Manifold, 1/4" Tube		Not illus.	8		.04
114628	SLEEVES, Nozzle Drip Line Manifold, 1/4" Tube		Not illus.	8		.03
114632	ELBOW, 1/4" Tube, 1/8" pipe thread		425	6		.15
114659	GASKET, Capscrew, 17/64" ID x 3/8" OD		408	1		.04
114670	SCREWS, Gear Housing (Flat Head, 3/8"—16x3/4")		415	2		.04
114939	TEE, Nozzle Drip Line Manifold, 1/4" Tube, 1/8" pipe thread		431	1		.20
114947	WASHER, Flywheel Housing		441	6		.02
114981	COCK, Cylinder Block Water Drain, 1/8"		408	1		.35
115551	LOCKWASHER, Front End Gear Housing		415	4		.02
115779	NUT, Air Cell Pulley Stud		461	1		.20
117049	NUT, Rocker Arm Shaft Spring Clip, 3/8"-24.		419	4	65/per	.04
117051	NUTS, 1/2"—20		410	17	30/per	.04

Buda Part No.	DESCRIPTION	Mfr.	Illus. on Page	Amt. Req.	Weight Lbs.	Price Each
117052	NUTS, Fuel Injection Pump Stud, ⅜"—16		425	3		$ .06
117060	NUTS, Conduit Channel, ¼"—20		432	4	150/per	.05
117061	NUTS, Generator, 5/16"—18		434	2	90/per	.02
117062	NUTS, Intake Manifold Shield and Adaptor		417	2		.02
117064	NUTS, ½"—13		425	3	15/per	.04
117066	NUTS, Anchor Bolt, ⅝"—11		461	6	⅛	.06
118537	NUTS, 15/16"		Not illus.	6		.08
118748	CONNECTOR, Rocker Arm Oil Line (68F1) ¼"—⅛"		Not illus.	1	30/per	.08
118753	ELBOW, ¼" Oil Line Tubing, ⅛" pipe thread	GE	455	2		.10
118805	TEE, ¼" Line with ⅛" pipe thread	GE	455	1		.20
118831	PLUG, ⅛" slotted headless		Not illus.	2	30/per	.05
120214	LOCKWASHER, Water Inlet Manifold Capscrew, 5/16"		420	8	300/per	.02
120229	CAPSCREW, Water Inlet Manifold, CD. Pl.		420	8	35/per	.04
120382	LOCKWASHERS, Air Cell Retainer Flange		412	12	200/per	.02
120487	SLEEVES, Rocker Arm Long Oil Line Ball		420	2		.06
120488	NUT, Rocker Arm Long Oil Line		420	2		.04
121370	ELBOW, 5/16"—⅛" pipe thread		420	2		.10
121711	CONNECTOR, Rocker Arm Long Oil Line		420	1		.04
121932	NUT, Air Cell Retainer Flange Stud, ⅜"—24-CD. Pl.		412	12		.04
122006	NUTS, ⅜"—24		414	16	65/per	.08
123865	NUTS, Vibration Dampener, ½"—13 Slotted		459	6	15/per	.06
127875	BUSHING, Oil Pressure Connection		Not illus.	2		.10
128149	COUPLING, Safety Control Reducing, ½"x ¾" Bushing		432	1		.28
137255	SCREWS, Name Plate, ⅛" x ¼"		Not illus.	6		.01
138796	SETSCREW, Generator Coupling Hub	CE	457	1		.24
140381	ELBOW, Fuel Tank (flared fitting)		460	2		.08
141358	DOWEL, Connecting Rod		Not illus.	6		.04
141360	DOWEL, Main Bearing Flange		409	2		.08
144613	NIPPLE, Safety Control Pipe, ¾" close		432	1		.12
ARC-440300T	ASSEMBLY, Slip Ring	CE	445	2	3¼	28.80
1867667	CLIP, Terminal, Solenoid Safety	PES	432	6		.02
M-2860351-G2	BLOCK, Terminal	GE	453	1		$ 1.20
CL-3887725-G45	RESISTOR, 1200-Ohm. (for No. 608)	GE	453	1		4.00
M-4196148-G1	LAMP, Synchronizing	GE	452	2		.80
K-6173199-G1	SWITCH, Model 165-B1	GE	452	1		19.20
K-6279577	ASSEMBLY, Generator Control Unit	GE	452	1		592.00