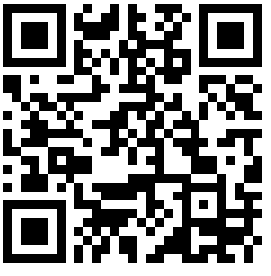


TM 11-946

WAR DEPARTMENT TECHNICAL MANUAL

POWER UNIT
PE-167-A

RESTRICTED. DISSEMINATION OF RESTRICTED MATTER. The information contained in restricted documents and the essential characteristics of restricted materiel may be given to any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work, but will not be communicated to the public or to the press except by authorized military public relations agencies. (See also par. 18*b*, AR 380-5, 28 Sep 1942.)

WAR DEPARTMENT 21 OCTOBER 1944

WAR DEPARTMENT TECHNICAL MANUAL
TM 11-946

POWER UNIT
PE-167-A

WAR DEPARTMENT *21 OCTOBER 1944*

RESTRICTED. *DISSEMINATION OF RESTRICTED MATTER.* The information contained in restricted documents and the essential characteristics of restricted materiel may be given to any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work, but will not be communicated to the public or to the press except by authorized military public relations agencies. (See also par. 18*b*. AR 380-5, 28 Sep 1942).

WAR DEPARTMENT,
WASHINGTON 25, D. C., 21 OCTOBER 1944.

TM 11-946, Power Unit PE-167-A, is published for information and guidance of all concerned.

[A. G. 300.7 (24 Apr 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

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

DISTRIBUTION:

IC 11 (5).

(For explanation of symbols see FM 21-6.)

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

DESTRUCTION NOTICE

WHY —To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW —1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut—Use axes, handaxes, machetes.

3. Burn—Use gasoline, oil, flame throwers, incendiary grenades.

4. Explosives—Use firearms, grenades, TNT.

5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—1. Smash—Engine cylinder and cylinder head, crankcase, carburetor, fuel strainer, air cleaner, fuel tank, control box, generator frame, blower housing and flywheel.

2. Cut—Exhaust pipe, wires and cables, armature and field windings.

3. Burn—Wire and cables, oil and fuel, manuals and other documents, chests and crates.

4. Bury or scatter—All of the above pieces after breaking.

DESTROY EVERYTHING

SAFETY NOTICE

Do not attempt to make or change load connections without placing the load switch in neutral position.

Do not touch brushes or commutator with bare hands while the unit is in operation.

Provide ample ventilation when operating the unit in a confined space.

EXHAUST GASES ARE POISONOUS AND EXCESSIVE INHALATIONS MAY RESULT IN SEVERE SICKNESS OR DEATH.

Do not service with gasoline while the unit is running or if a radio transmitter is operating in close proximity.

Avoid spilling gasoline on a hot engine.

Observe every standard safety regulation.

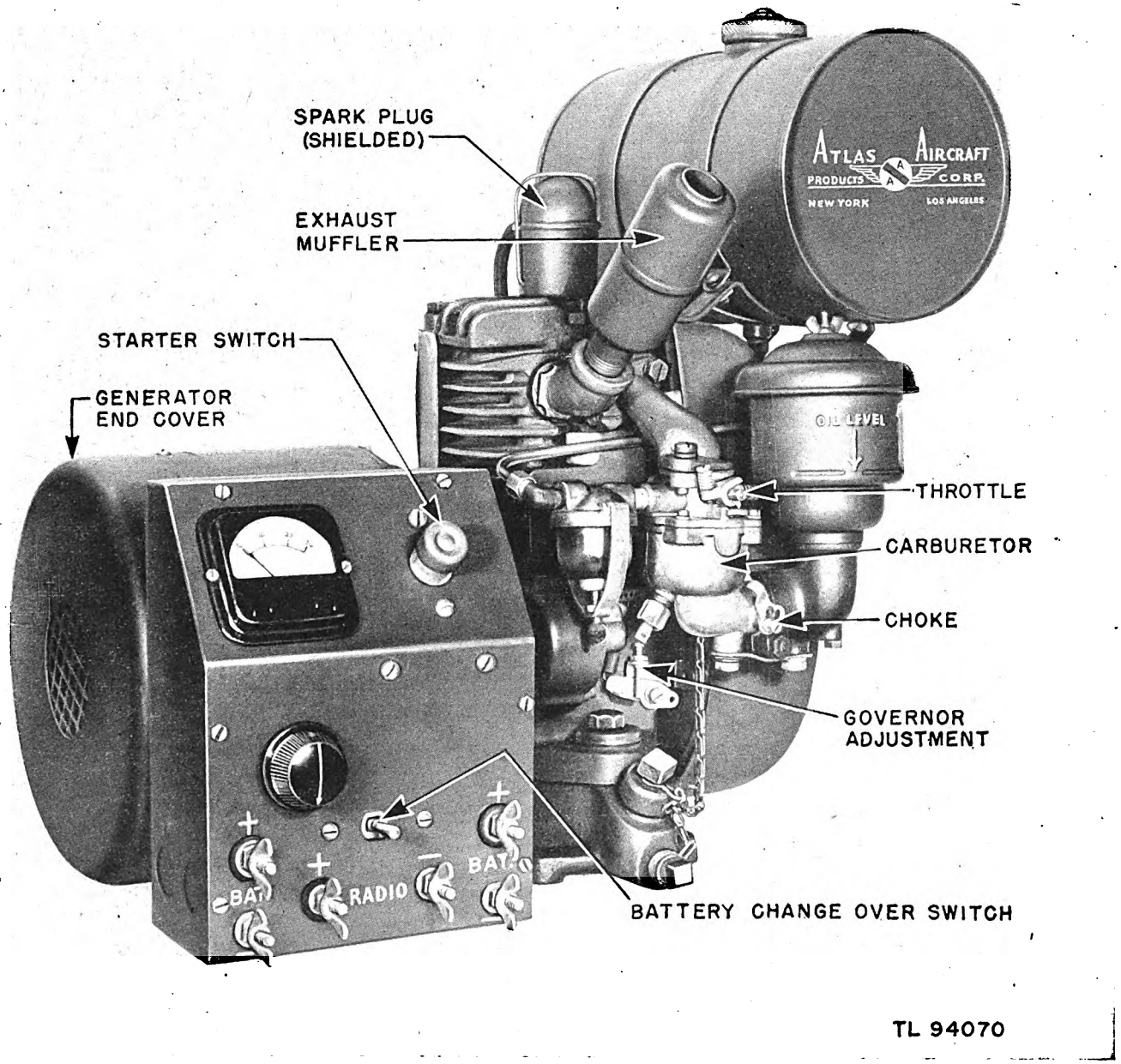


Figure 1. Power Unit PE-167-A, control box side.

SECTION I
DESCRIPTION

1. GENERAL.

Power Unit PE-167-A is a complete, self-contained, gasoline - engine - driven, electrical - generating set for charging 12-volt storage batteries. The unit consists of a single-cylinder, air-cooled, 4-cycle, gasoline engine; a 15-volt, 350-watt, d-c generator and a control box. The entire equipment is so mounted as to form a unit assembly.

2. ENGINE.

a. The engine is a single-cylinder, 4-cycle, L-head, air-cooled unit. (Briggs and Stratton model NP.) It has a 2-inch bore and 2-inch stroke and piston displacement of 6.28 cubic inches. This engine is rated at 1.40 horsepower at its governed speed of 2,350 rpm.

b. Fuel is supplied from a 1-gallon tank, which is an integral part of the unit. The fuel flows from this tank, by gravity, through a conventional fuel strainer and sediment bowl to a float-feed carburetor. The capacity of the fuel tank (1-gallon) is sufficient to operate the unit for a period of approximately 7 hours.

c. Ignition is provided by a high-tension magneto, built within the engine flywheel, and a fully shielded ignition cable and spark plug.

d. The engine is lubricated by a pump and splash system. The oil reservoir, in the base of the engine, has a capacity of 1 pint. Oil is pumped from the oil reservoir into a trough below the connecting rod into which the lower end of the connecting rod dips as it passes bottom dead center. The oil is thrown or splashed to the internal engine parts.

e. The unit may be started either by means of a starting rope and a starting sheave attached to the flywheel or by means of an external battery which, when the starter button is pressed, supplies electrical energy to the generator which then acts as a d-c motor.

3. CONTROL BOX.

The control box is mounted on the carburetor side of the generator and contains all necessary meters, switches, controls, and connections for starting and the operation of the generator. Contained within this control box are the reverse-current relay, field rheostat, and a 0.5-mf filter capacitor. Mounted on the face of the control box are the starter switch, an 0-30 d-c ammeter, field rheostat control knob, a 30-ampere double-pole double-throw switch, and six terminals. These terminals are provided with wing nuts and divided into three sets of two terminals each. The terminals marked BAT at the right and left sides are for attaching two 12-volt batteries while the center terminals marked RADIO are for connection to a radio set or other equipment.

4. GENERATOR.

The generator is of the self excited shunt-field type with a separate starter winding. It is directly connected to the engine and the rotating armature is carried on an extension of the engine crankshaft. This generator, driven at a speed of 2,350 rpm, has an output of 350 watts, 15 volts, direct current. A fan, built within the generator provides a circulation of air for cooling the generator windings. The generator has a normal temperature rise of 50°C (122°F).

5. TOOLS AND SPARE PARTS.

The tools and spare parts are packed in separate cardboard cartons and are placed within the metal-lined cloth barrier inside the packing case which contains the unit. Following is a tabulation of the tools and spare parts:

TOOLS

Item	*Quantity*
Screw driver, 6-in.	1
Adjustable wrench, 6-in.	1
Wrench for oil filler plug	1
Wrench, spark plug	1
Starter rope	1

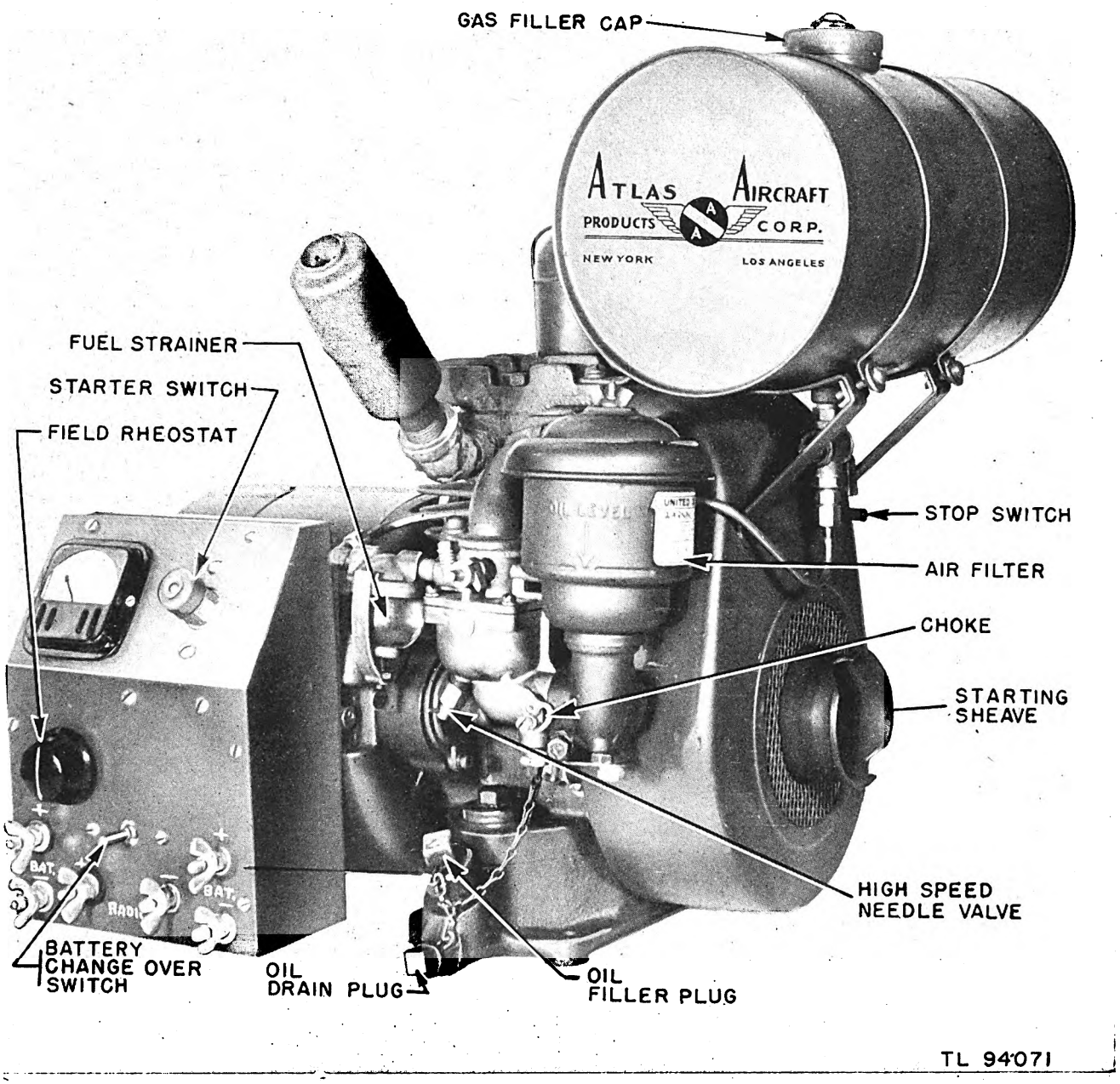


Figure 2. Power Unit PE-167-A, details.

EQUIPMENT SPARES

Item	*Quantity*
Spark plug, J-8	2
Cylinder head gasket	1
Valve spring	1
Retainer	1
Pin, wrist	1
Connecting rod assembly	1
Brushes, generator	4
Contact point assembly	1
Capacitor	1
Set of gaskets	1

6. WEIGHTS AND DIMENSIONS.

Component	*Length (in.)*	*Width (in.)*	*Height (in.)*	*Weight (lbs.)*
Engine	9	12½	17	46¾
Generator	6⅝	7½	7½	29½
Control box	6¼	2½	8	2
Complete assembly	16	12½	17	79¼

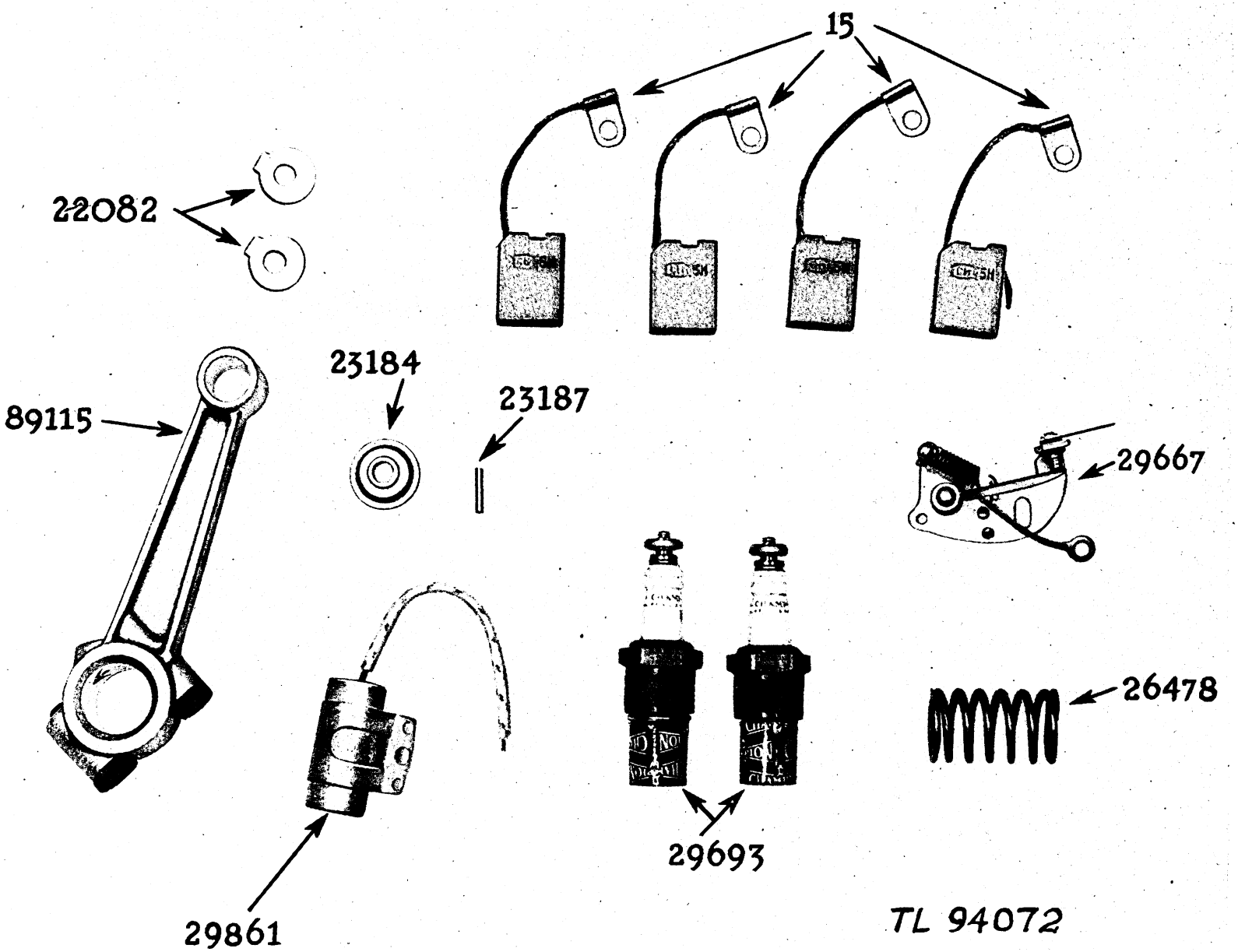


Figure 3. Power Unit PE-167-A, spare parts.

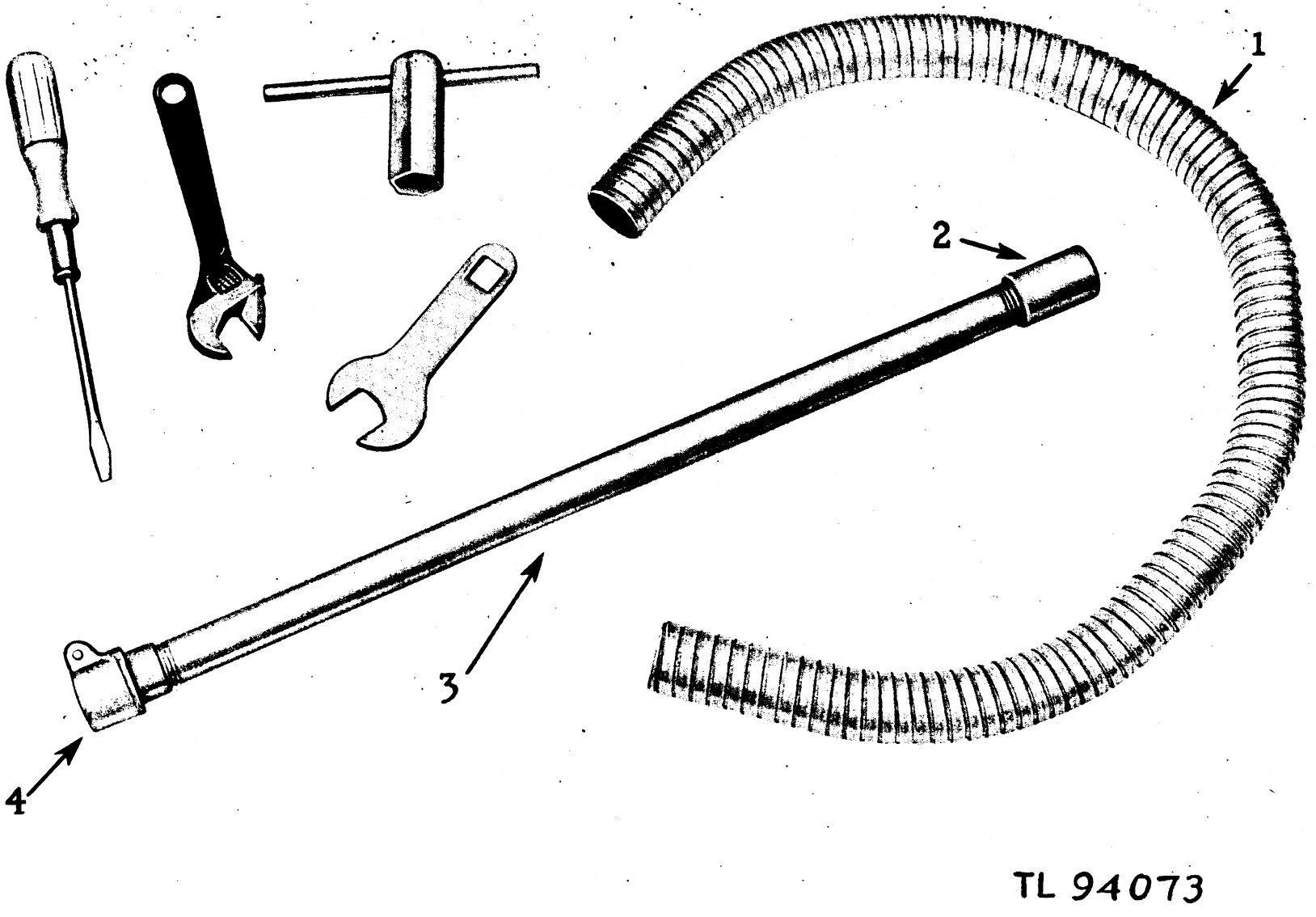


Figure 4. Tools and exhaust fittings.

SECTION II

INSTALLATION AND OPERATION

7. INITIAL PROCEDURE.

a. Remove the unit from its packing case and inspect it for possible damage and missing parts. Check the packing list carefully to make sure that the equipment is complete. Report any damage or shortage immediately.

b. Clean off any cinders, dirt, oil, or other foreign matter that may have accumulated in shipping and check for loose nuts, bolts, and screws.

c. Crank the unit several times by hand to make sure that all parts move freely. If the unit is new, remove the crankcase drain plug (yellow) and drain any rust-proofing oil that may be present. Remove all seals from the carburetor intake, breather, exhaust and other openings.

8. INSTALLATION.

a. Choose a general location that will be consistent with the assignment to be carried out and the length of any attaching cables. The unit may be operated either outdoors or within a building, shelter or vehicle.

b. If the unit is to be operated out-of-doors, construct a base of approximately 2-inch by 4-inch timber of suitable length and fasten the unit to this base with bolts or lag screws. Select a dry, level spot. In selecting a location, give due consideration to shelter from the elements and enemy observation. Avoid low ground or depressions that may be flooded by sudden rains and try to place the unit so that exhaust gases will be carried away from operating personnel.

c. If the unit is to be operated within a building, shelter or vehicle, provide adequate ventilation to carry off any escaping exhaust fumes and supply an ample amount of oxygen. Locate the unit as close as possible to an opening through which the exhaust may be extended to the outside. Avoid unnecessary bends in the exhaust line. Fasten the base of the unit securely to the floor with bolts or lag screws. At least 2-feet of space should be provided on all sides of the unit.

d. A 4-foot length of flexible metal hose with couplings and two 1½-foot lengths of rigid pipe, with couplings are provided to carry the exhaust away from the unit.

9. PREPARATION FOR USE.

a. Inspect the unit thoroughly and check all electrical and fuel connections. See that all connections are clean and tight. Check the oil drain plug (yellow) in the base of the engine and see that it is tight.

b. Remove the oil filler plug (blue) on the base of the engine and fill the oil reservoir with 1¾ pints of Oil, Engine, U. S. Army Spec No. 2-104B according to the War Department Lubrication Order attached to the unit. If there is no lubrication order attached to the unit, the following instructions will apply:

Temperature	*Oil*
Above 32° F	OE-SAE 30
32° to 0° F	OE-SAE 10
Below 0° F	Dilute OE-SAE 10

LOW TEMPERATURE NOTE: For sub-zero operation, dilute OE-SAE 10 with 25 percent gasoline. Mix the oil and gasoline thoroughly, in a clean container just before placing it in the unit.

Do not mix the oil and gasoline until just before starting. When adding oil during sub-zero operation, add only undiluted OE-SAE 10.

If there is no lubrication order attached to the unit, requisition War Department Lubrication Order No. 3224 from the Philadelphia Signal Depot or Utah ASF Depot, Ogden, Utah, by Signal Corps stock No. 6D10115-24 and attach it to the unit when received. A reproduction of this lubrication order is shown in figure 5.

c. Remove the oil reservoir from the oil-bath air cleaner and clean it thoroughly. Fill this reservoir with the same grade of engine oil as that used in the engine. DO NOT USE DILUTED OIL IN THE AIR CLEANER. Under sub-zero operating conditions, fill the air cleaner oil reservoir with Oil, Lubricating, Preservative, Special, U. S. Army Spec No. 2-120. Fill the reservoir up to the bead on the inside of the bowl. Make sure that all connections to the carburetor are dust- and air-tight. See figure 2.

d. Wipe off all moving control parts and lubricate them lightly with a few drops of engine oil

WAR DEPARTMENT LUBRICATION ORDER NO. 3224

WAR DEPARTMENT, WASHINGTON 25, D. C., 3 JULY 1944

POWER UNIT PE-167

Lubricant • Operating Hours

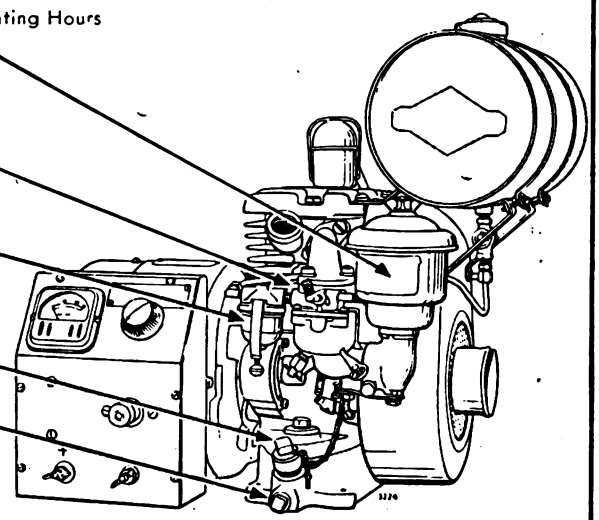
Air Cleaner OE 8
Check level and refill to level mark.
Every 24 hours, remove, drain, clean and refill.
Every 256 hours, remove and wash all parts.

Crankcase Breather OE 256
Remove valve cover plate, retainer spring and oil spray shields, wash all parts.

Fuel Strainer 64
Remove and clean sediment bowl and screen.
Also open fuel tank shut-off valve to drain water and sediment.

Crankcase Fill and Level Plug OE 4
Check level

Crankcase Drain 24
Drain and refill. Cap. approx. 1/2 qt.
Drain only when hot.



COLD WEATHER—Below 0°F. drain crankcase daily. Refill crankcase with 3/8 qt. OE SAE 10 and 1/8 qt. gasoline thoroughly mixed. Check level more often. Maintain at level of fill plug hole by adding undiluted OE SAE 10 only.
HOURS—Reduce hours under severe operating conditions.
CLEAN parts with SOLVENT, dry cleaning or OIL, fuel, Diesel. Allow parts to dry thoroughy before lubricating.
OIL CAN POINTS—Every 64 hours, lubricate Governor and Throttle Control Linkage with OE.
DO NOT LUBRICATE—Magneto, Governor, Power Generator and Exciter.
REFERENCE— **TM 11-946**

Copy of this Lubrication Order will remain with the equipment at all times. Instructions contained therein are mandatory and supersede all conflicting lubrication instructions dated prior to 3 July 1944.

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

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

KEY

LUBRICANTS	LOWEST EXPECTED AIR TEMPERATURE		
OE—OIL, engine	above +32°F.	+32°F. to 0°F.	below 0°F.
Crankcase	OE SAE 30	OE SAE 10	See Cold Weather Note
Except Crankcase	OE SAE 30	OE SAE 10	PS
PS—OIL, lubricating, preservative, special			

No. 3224

Requisition LUBRICATION ORDER from Philadelphia Signal Depot, or Utah ASF Depot, Ogden, Utah, by Signal Corps Stock No. 6D10115-24

TL94075

Figure 5. Power Unit PE-167-A, lubrication order.

(OE). Use special preservative lubricating oil (PS) for this purpose during cold-weather operation.

e. Remove the fuel-tank cap and make sure that the air vent, in the cap, is clear. Fill the fuel tank with 1 gallon of clean gasoline. Make sure that the fuel used is free from water or other foreign matter. Open the fuel shut-off valve below the fuel tank and see that fuel flows into the glass sediment bowl of the fuel strainer. Inspect the fuel that flows into the sediment bowl for traces of dirt and water. If foreign matter is present, shut off the fuel valve; remove and clean the sediment bowl; open the fuel shut-off valve before replacing the bowl and drain all foreign matter from the tank. Close the fuel valve, replace the sediment bowl and refill the fuel tank.

10. OPERATION.

a. Connect a 12-volt battery to each set of two terminals marked BAT at the right and left side of the control box. Be sure that the positive post of the batteries is connected to the + terminal and the minus post to the — terminal. Attach the radio set or other equipment to the two center terminals on the control box. Make sure that

correct polarity has been observed. Tighten the wing nuts securely. See figure 2.

b. Make sure that all instructions have been followed carefully and place the toggle switch, in the center of the control box panel, so that its handle is at right angles to the face of the panel. Turn the rheostat knob clockwise as far as it will go.

c. If the unit is new, check the setting of the carburetor needle valve. This is a tee valve which projects from the bottom of the carburetor bowl. Turn this valve clockwise as far as it will go without forcing. **DO NOT FORCE THE VALVE OR DAMAGE TO THE VALVE AND ITS SEAT WILL RESULT.** Open this valve by turning it counter-clockwise between one, and one and one-half turns. Turn the idle adjusting screw clockwise as far as it will go without forcing and then turn it back between one-half to three-quarter turn. Place the carburetor choke lever in closed position (lever inclining toward the carburetor bowl).

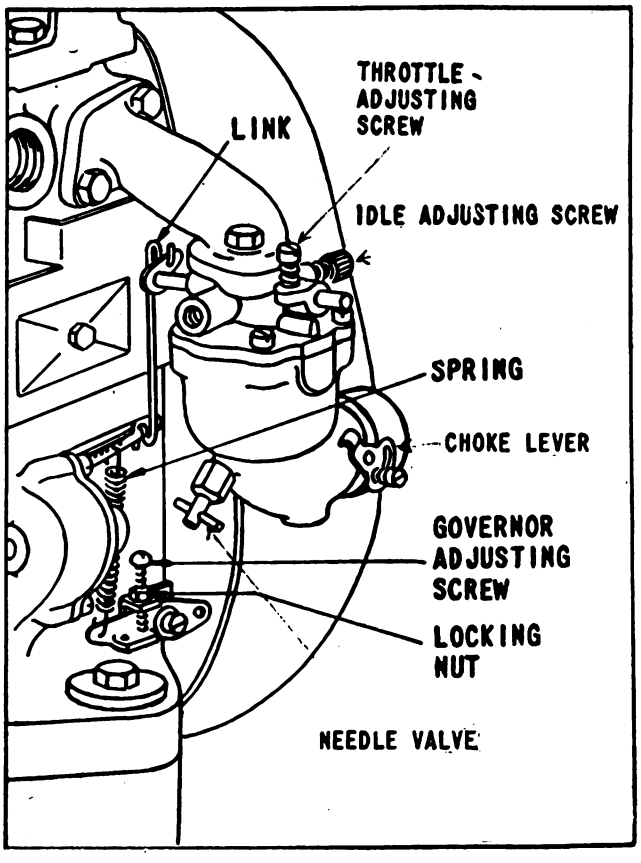


Figure 6. Carburetor and governor adjustments.

d. Press the starter button on the control box and hold it in for between 10 to 15 seconds. The unit should start within this period. If the unit does not start, wait 15 seconds and with the choke partially open make another attempt to start the unit. On a new unit, remove the spark plug and wash it thoroughly in Solvent, Dry Cleaning, Federal Spec P-S-661a before making any further attempt at starting. Allow the spark plug to dry thoroughly and replace it in the cylinder. Be sure to replace the spark plug gasket. If the unit still refuses to start, refer to the trouble and remedy chart (par. 45).

e. As soon as the unit starts, open the choke valve gradually until it is in wide-open position. Allow the unit to warm up for about 10 minutes. If it is necessary to keep the choke valve partially closed when the engine is fully warmed, open the carburetor needle valve slightly. Open this valve to the point where it is possible to operate the engine with the choke fully open.

f. When the unit has reached operating temperature, check to see that the rheostat knob is turned in a fully clockwise position. Apply the load by throwing the toggle switch on the control panel to the left or right. The handle of the toggle switch should point toward the battery that is to operate the equipment. While this battery is operating the equipment, the other battery will be charging. Adjust the rheostat knob until the desired charging rate is indicated on the ammeter. The charging rate ammeter must never indicate more than 23 amperes.

g. If the batteries are discharged or it is necessary to manually start the unit for some other reason, adjust the carburetor and choke as instructed in subparagraphs c and d above for electric starting. Wind the starting rope around the starting sheave in a clockwise direction and give it a quick, steady pull. It may be necessary to repeat this operation several times under cold weather operation before the unit starts.

h. To stop the unit, press the stop button on the upper right-hand side of the blower housing and hold it in until the engine has stopped turning. See figure 2. Should this button fail to function, shut off the fuel supply and allow the unit to run until the fuel in the carburetor is used up. Use the latter method for stopping the unit whenever it is to be shut down for a prolonged period.

11. ROUTINE SERVICE.

a. **General.** Keep the unit clean and free from sand, dust, and water. Keep the cooling air passages free from foreign matter. Keep all electrical and fuel connections tight. Protect the unit from all unnecessary exposure to the weather.

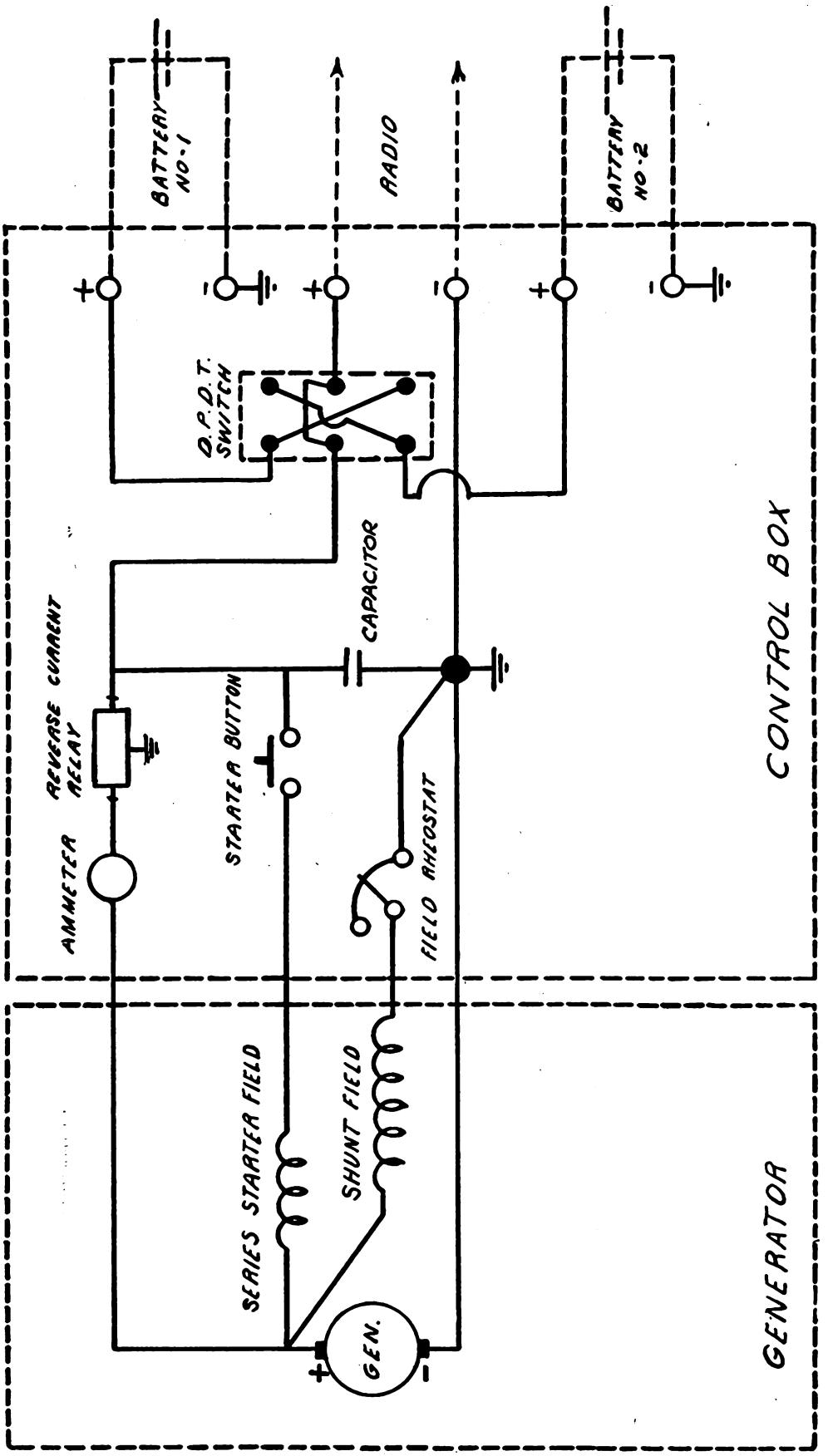


Figure 7. Power Unit PE-167-A, wiring diagram.

b. Every 4 Hours. At the start of each run and after every 4 hours of operation, stop the unit and add oil to the crankcase to a level even with the top of the filler hole. At the same time check the fuel supply and add fuel as needed to maintain operation.

c. Every 8 Hours. At the end of every 8 hours of operation, remove the cover from the oil-bath air cleaner and add oil to bring the oil level up to the indicator bead. Check the fuel supply and the crankcase oil level at the same time.

d. Every 24 Hours. At the end of every 24 operating hours, remove the oil drain plug (yellow) from the base of the engine and drain the oil from the crankcase. Do this immediately after stopping the unit while it is still hot. Catch the drained oil in a pan or other suitable receptacle. Remove the spark plug, clean it thoroughly and check and adjust the point gap. The correct gap is 0.025 inch (par. 22).

e. Every 48 Hours. At the end of every 48 operating hours, remove the cylinder head and clean out all lead and carbon deposit from the combustion chamber (par. 23). While the cylinder head is removed, inspect both valves carefully. If the valve face or valve seat are coated with lead, scrape them clean. Remove the valve cover plate from the side of the cylinder and check the valve tappet clearance (par. 24).

f. Every 64 Hours. At the end of every 64 operating hours, shut off the fuel supply and remove and clean the glass sediment bowl and screen of the fuel strainer (par. 25). Before replacing the bowl and screen, open the fuel valve and drain any foreign matter from the fuel tank. Catch all drainings in a pan or other receptacle to reduce fire hazard. Wipe off all moving control parts and linkage and lubricate them with a few drops of engine oil (OE).

g. Every 256 Hours. At the end of every 256 operating hours, remove the oil-bath air cleaner, disassemble it and wash all parts thoroughly in cleaning solvent or diesel fuel oil (par. 21). Permit all parts to drain before reassembling and replacing on the engine. Make sure that all gaskets are replaced and that all connections are dust- and air-tight. Remove the cooling air shrouds and thoroughly clean all cooling fins and air passages. Remove the flywheel and check the magneto breaker points. Clean and adjust them if necessary and replace both points if either one is badly burned or pitted (par. 27). Remove the crankcase breather from the valve spring chamber, disassemble it and clean it thoroughly (par. 28).

12. COLD-WEATHER OPERATION.

When operating in extremely cold temperatures, always drain the engine crankcase when the unit is to remain shut down for a period of several hours. Attach a tag to the unit as a warning to others that the crankcase must be filled before operating the unit. See the lubrication order attached to the unit or refer to figure 5 for the correct lubricants to use under various temperature conditions. Always crank a cold engine by hand before attempting to use electric starting. When possible, heat the unit by covering it with a tarpaulin and placing fire pots under the tarpaulin. **BE EXTREMELY CAUTIOUS OF THE FIRE HAZARD WHEN THIS IS DONE.** If difficulty is experienced with ice forming on the carburetor, place the exhaust outlet so that the hot exhaust gases are directed against the carburetor. **DO NOT GET THE EXHAUST CLOSE ENOUGH TO CAUSE A FIRE HAZARD.**

13. CONTROL BOX ADJUSTMENTS.

a. Rheostat. Before starting the unit, place the rheostat in resistance-out position. Extreme clockwise rotation of the rheostat.

b. Ammeter. With the toggle switch in neutral position, the ammeter will show no reading. Throwing this switch to the right will place the left-hand battery on charge, while throwing it to the left will place the right-hand battery on charge. The ammeter will indicate the rate of charge and should never read over 23 amperes. This switch is so arranged that while one battery is on charge the other battery is connected to the load.

SECTION III

FUNCTIONING OF PARTS

14. ENGINE.

The driving member of Power Unit PE-167-A is a single-cylinder, air-cooled, gasoline engine of conventional 4-cycle design. In this engine, four strokes of the piston are required to accomplish the functions of intake, compression, power and exhaust. The valves are so timed by means of the timing gears and camshaft that the intake valve is open while the piston is moving downward on the intake stroke, both valves are closed while the piston moves up on the compression stroke and down on the power stroke, and the exhaust valve is open while the piston moves upward on the exhaust stroke. The magneto is so timed that a spark is introduced into the engine cylinder, by means of the spark plug, at the exact moment that the piston reaches firing position near the top of its compression stroke. The correct proportions of gasoline and air to form an explosive mixture are provided by the carburetor and drawn into the engine cylinder on the intake stroke of the piston.

15. CARBURETOR.

The fuel used in this unit is Motor Fuel (All Purpose), U. S. Army Spec No. 2-103B. It flows by gravity from the fuel tank, mounted above the blower housing, to a conventional, float-feed carburetor. Detailed information on the functioning of carburetors will be found in TM 10-550.

16. MAGNETO.

The engines used on these units are provided with a high-tension magneto built within the engine flywheel. Detailed explanation of the functioning of magnetos will be found in TM 10-580.

17. SPEED REGULATION.

These power units are fitted with a governor of the flyball or counterweight type. This governor, by automatically maintaining a constant engine speed, maintains constant output voltage. The governor consists of two flyballs fastened to the governor pinion-gear shaft inside of the governor housing. The pinion gear is driven by the cam gear. As the speed of the engine increases, the flyballs are driven away from the governor shaft by centrifugal force and forced against the governor cup facing the pinion gear (fig. 28). The cup is moved outward by the action of the weights and acts upon the crank and lever which are connected through suitable linkage to the carburetor throttle. Any movement of the governor flyballs, caused by a rise or drop in load affecting the engine speed, is immediately transmitted to the carburetor throttle, thereby increasing or decreasing the throttle valve opening and engine speed. The governor setting may be adjusted by means of a governor adjusting screw on the side of the engine crankcase (fig. 5) just above the oil filler plug.

18. BATTERY CUT-OUT (REVERSE-CURRENT RELAY).

a. The function of the battery cut-out is to prevent accidental discharge of the battery if the generator voltage drops below the voltage of the battery being charged.

b. This cut-out consists of a magnet core, a shunt winding, a series winding, an armature and contact, and an armature spring and a stationary contact.

c. The shunt winding of the cut-out is connected across the generator output. The current flowing through the winding produces a magnetic flux in the cut-out core. When the generator output reaches approximately 16 volts, this flux produces a pull on the cut-out armature strong enough to pull the armature toward the core and close the contacts. The series winding is connected in series with the positive side of the battery-charging circuit. It is so wound on the cut-out core that when the current flows through it from the generator to the battery, the magnetic pull produced adds to the pull developed by the shunt winding.

d. If for any reason the generator voltage drops or the battery voltage rises, the charging current decreases. When the charging voltage equals the battery voltage, no current flows. If the charging voltage drops below the battery voltage, current flows from the battery into the generator through

the series winding of the cut-out. This tends to drive the generator as a motor. Since the direction of this current is in reverse direction to the flow of the charging current, the magnetic force developed by the series winding is opposed to the pull developed in the shunt winding. The total pull is therefore weakened and the armature spring pulls the armature away from the stationary contact. This opens the contacts and cuts the flow of current from the battery to the generator.

19. FIELD RHEOSTAT

The field rheostat is a variable resistance in series with the shunt-field circuit. This rheostat by varying the magnetic flux in the shunt-field winding controls the generator voltage output.

SECTION IV

MAINTENANCE

NOTE: Failure or unsatisfactory performance of equipment will be reported on W.D., A.G.O. Form No. 468. If this form is not available, see TM 38-250.

20. CARBURETOR ADJUSTMENT

The carburetor used on this unit is of the adjustable, float-feed type. The throttle is automatically controlled by the governor. Make carburetor adjustments only when the engine is warm and under full load. To adjust the carburetor, close the main-jet needle valve by turning the tee handle, projecting at an angle from the bottom of the carburetor bowl, as far as it will go in a clockwise direction. DO NOT FORCE THIS VALVE AS DAMAGE TO THE VALVE AND SEAT WILL RESULT. Close the idle adjustment valve, located behind the air cleaner, by turning its screw clockwise as far as it will go. Open the main-jet needle valve by turning the tee handle between one, and one and one-half turns from its fully closed position. Set the idle adjusting screw about three-fourths turn open. Start the engine and allow it to reach operating temperature. Apply a load to the unit and readjust the main-jet needle valve by setting it to the point at which the engine operates most smoothly with the choke fully open. If, when starting a cold engine, it is necessary to keep the choke partially closed for several minutes, open the main-jet needle valve slightly until the unit operates smoothly with wide-open choke (fig. 6).

21. AIR CLEANER SERVICE.

a. At the end of every 8 operating hours, remove the wing nut on the top of the oil-bath air cleaner and lift off the air cleaner cover. Check the level of the oil in the oil reservoir and if it is not up to the bead stamped into the cleaner, add oil according to the lubrication order to correct the oil level.

b. At the end of every 24 operating hours, empty the oil from the air cleaner, wipe out the oil reservoir and refill it with fresh oil according to the lubrication order.

c. At the end of every 256 operating hours, loosen the clamp that holds the air cleaner to the carburetor air intake and remove the entire air cleaner assembly from the engine. Disassemble the air cleaner completely and wash all parts thoroughly in cleaning solvent or diesel oil. Allow the parts to drain thoroughly. Reassemble the air cleaner and reinstall it on the engine. Fill the oil reservoir according to the lubrication order and make sure that all gaskets have been replaced and that all connections are dust- and air-tight.

22. SPARK PLUG ADJUSTMENT.

Remove the spark plug at the end of every 24 operating hours and clean it thoroughly. Scrape all carbon and lead deposit from the inside of the spark plug with a small knife or other suitable tool. Be careful not to damage the porcelain insulator. Clean the spark gap points with fine sandpaper and wash the plug in cleaning solvent. Check the spark gap opening with a 0.025-inch feeler gauge. If the gap needs adjustment, bend the outer electrode to correct the gap. DO NOT ATTEMPT TO BEND THE CENTER ELECTRODE. Inspect the spark plug carefully for crack-

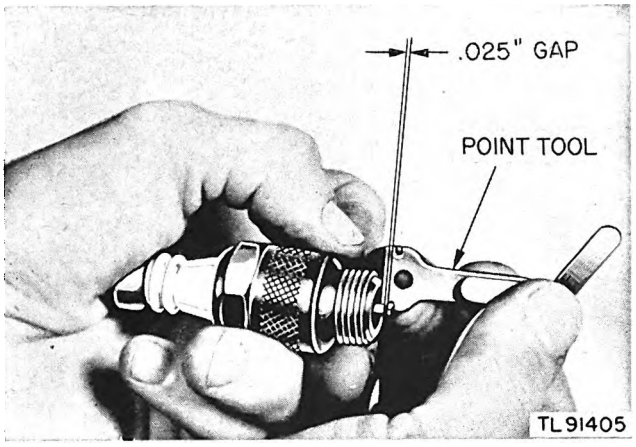


Figure 8. Adjusting spark plug.

ed porcelain or badly burned spark gap points. If the spark plug is in doubtful condition, replace it with a new one. Be sure to replace the spark-plug gasket when replacing the spark plug in the engine (fig. 8).

23. REMOVING CARBON.

Remove the carbon and lead deposits from the combustion chamber at the end of every 48 operating hours. Proceed as follows:

a. Remove the spark-plug shield cap, spark plug, and spark-plug shield.

b. Remove the screws that hold the fuel-tank bracket to the cylinder head.

c. Remove the cylinder-head cap screws and lift off the cylinder head.

d. Clean out the carbon and lead deposits from the inside of the cylinder head and from around the valve seats with a carbon-scraping tool and wire brush.

e. Rotate the crankshaft to bring the piston to the top of the cylinder bore and clean the top of the piston. Blow out any carbon particles with an air hose.

f. Inspect both the intake and exhaust valves carefully and scrape off any carbon or lead deposits that may be present. If the valves appear to be in need of grinding, grind them as instructed in paragraph **24b** below.

g. While the cylinder head is removed, check the valve tappet clearance as instructed in paragraph **24a.**

h. When all operations have been completed, replace the cylinder head and reassemble all removed parts by reversing the operations for removal. In replacing the cylinder-head gasket, make sure that the surfaces of both cylinder and cylinder head are clean and smooth. If the old gasket is in good condition, clean both sides carefully, coat both surfaces with grease, General Purpose No. 2 U. S. Army Spec No. 2-108 and place it on the top of the cylinder. Set the cylinder head in place and insert the cylinder-head screws.

i. Tighten the cylinder-head screws by tightening each screw alternately, a little at a time, in accordance with the sequence shown in figure 9.

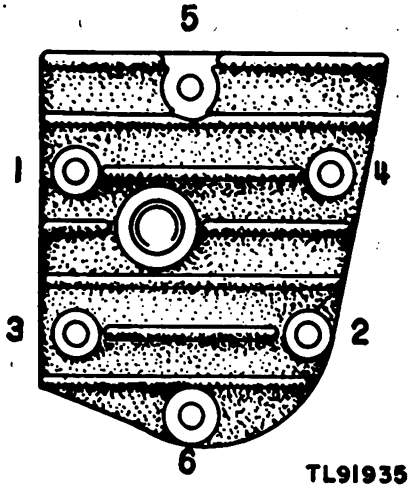


Figure 9. Cylinder head tightening chart.

24. CHECKING AND GRINDING VALVES.

a. Checking Valve Tappets. Check the clearance between the valve tappets and valve stems every 48 operating hours. Proceed as follows:

(1) Shut off the fuel supply and disconnect the fuel pipe from the fuel strainer intake.

(2) Remove the cap screws that hold the carburetor flange to the cylinder and remove the complete carburetor, fuel strainer, and air cleaner assembly.

(3) Remove the cap screw in the center of the valve cover plate and remove the valve cover plate and oil-spray shield.

(4) Rotate the crankshaft until one of the valve tappets is at its lowest point and check the gap between the tappet and valve stem with a feeler gauge. Rotate the crankshaft again until the other valve tappet is at its lowest point and check the tappet clearance for that valve. The correct gap for the intake valve is 0.008 inch (cold). The correct gap for the exhaust valve is 0.015 inch (cold).

(5) If the valve tappet clearance is too great, it will be necessary to grind the valve further down into its seat or to replace it with a new valve. If the clearance is too close, remove the valve and grind its stem until the correct clearance is reached. See subparagraph **b** below, for instructions when grinding valves.

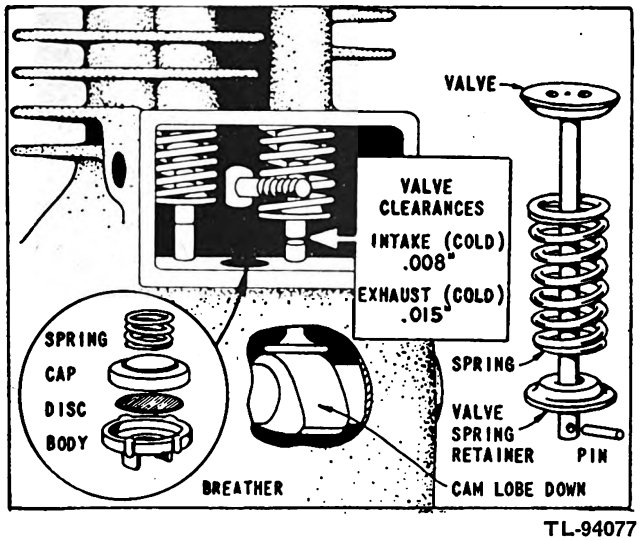


Figure 10. Valve and crankcase breather, details.

b. Grinding Valves. When it is necessary to grind the valves or to correct tappet clearance, remove the cylinder head as directed in paragraph **23** and remove the valve cover plate as instructed in subparagraph a above. With the cylinder head and the valve cover plate removed, proceed as follows:

(1) Rotate the crankshaft until the valve tappet for the valve to be ground is at its lowest point.

(2) Insert a valve-lifting tool between the valve spring retainer and the base of the valve spring chamber and compress the valve spring with the valve-lifting tool. With the valve spring compressed, withdraw the valve-spring retainer pin with a pair of pliers. Be careful not to drop the valve-spring retainer pins or other small parts into the crankcase.

(3) Release the valve-lifting tool, lift the valve out of the cylinder and mark it so as to be sure to return it to its original seat. Pry out the valve spring and valve-spring retainer washer and mark the spring for identification. Repeat the same operations for the other valve.

(4) Clean the valves and valve stems with a wire brush and inspect them carefully. If the valve is badly burned or the stem is excessively worn or bent, replace it with a new valve. If the valves are badly pitted but still usable, reface the valves and valve seats. The correct valve angle is 45°. If the valves are only slightly pitted, grind them with fine valve-grinding compound.

(5) Place a light coil spring, just long enough and heavy enough to lift the weight of the valve, over the valve stem. Coat the face of the valve with a light smooth coating of fine valve grinding compound and place the valve in the seat from which it was removed. The coil spring should now be under the head of the valve and resting on the valve guide. Check that the valve tappet is at its lowest point.

(6) With a valve-grinding tool, bear down lightly on the valve and rotate it back and forth on its seat. Allow the spring to lift the valve every few rotations and turn the valve about a half turn while it is clear of its seat. Bear down again and continue this operation until a smooth, dull, silvery ring appears completely around the face of the valve and valve seat. Check the valve stem while grinding the valve to make sure that the stem is not riding on the valve tappet.

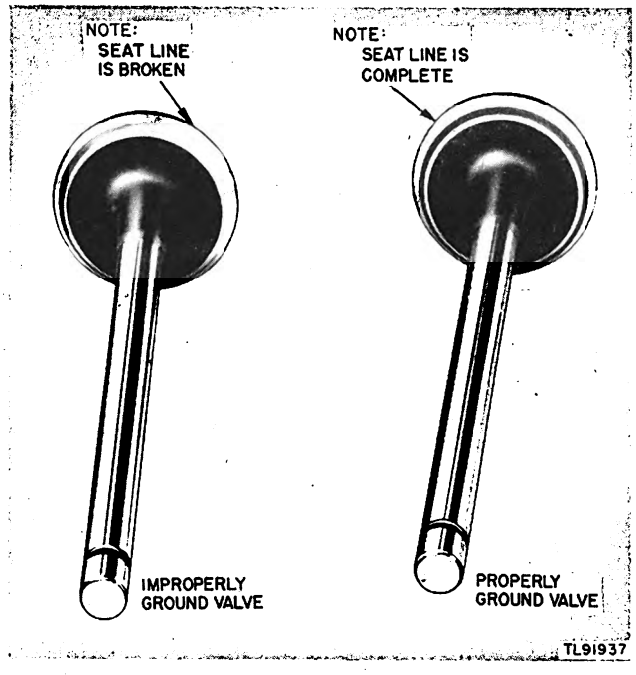


Figure 11. Proper and improper valve grinding.

(7) Repeat the same operation for both valves. When the valve face and valve seat have a satisfactory appearance, remove the valve and wash it in diesel oil or cleaning solvent. Remove all traces of grinding compound from the valve chamber. Wipe the valve and seat dry with a clean cloth. Place a series of pencil marks at close intervals around the face of the valve and place it back on its seat. Rotate the valve about a half turn on its seat and remove it and inspect the pencil marks. If they are evenly smudged all the way around, the valve may be assumed to be satisfactory.

(8) Place the valve back in its seat and while bearing down on the head of the valve, check the clearance between the valve tappet and valve

stem. If the clearance is too close, remove the valve and grind the stem slightly on a grinding wheel. Grind only a little at a time and keep the bottom of the valve stem square with the side. Check the stem-to-tappet clearance each time the stem is ground to avoid grinding the stem too far. Continue this operation until the proper clearance is reached. Repeat this operation for both valves.

(9) When the valve face, seat, and valve stem clearance are satisfactory, reassemble the valves in their original places in the cylinder. Check the valve springs by comparing them with new springs before replacing them and substitute new springs for any that appear unsatisfactory.

(10) Reassemble all parts by reversing the operations for disassembly. Be sure that all gaskets are in good condition and be sure that they are replaced.

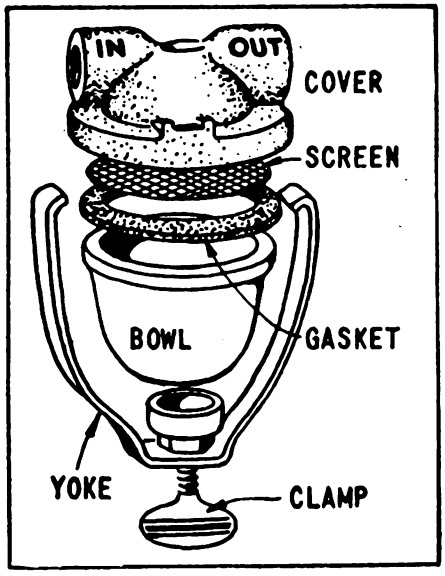


Figure 12. Fuel strainer, details.

25. CLEANING FUEL SYSTEM.

a. At the end of every 64 operating hours, shut off the fuel supply and clean the fuel filter. Loosen the knurled nut below the glass filter bowl, swing the bowl bracket to one side and remove the bowl. Remove the screen from the fuel strainer body and thoroughly wash both the bowl and screen in cleaning solvent. Blow out the screen with a pump or air hose. Open the fuel valve before replacing the screen and sediment bowl and drain any water or other foreign matter from the fuel tank. Catch any drainings in a can or other receptacle. Shut off the fuel supply and reassemble the screen and bowl to the fuel strainer body. Be sure to replace the cork gasket at the top of the sediment bowl and make sure that it is seated properly. Turn the fuel valve on and check for leaks. If there is any leakage at the top of the sediment bowl, replace the cork gasket with a new one.

b. At the end of every 1,024 operating hours, drain the entire fuel system and remove the fuel tank, fuel pipe, and fuel strainer. Flush the fuel tank thoroughly with cleaning solvent. Blow through the passages of the fuel strainer and the fuel pipe with a pump or air hose. Reassemble all parts, fill the fuel tank and check for leaks. Take necessary measures to stop any leaks that may appear.

26. COOLING SYSTEM.

At the end of every 256 operating hours, remove the cooling-air shrouds and thoroughly clean the cooling fins and air passages. Proceed as follows:

a. Shut off the fuel supply and disconnect the fuel pipe from the bottom of the fuel valve.

b. Insert a socket wrench on the nut in the center of the starting pulley. Strike the wrench handle a sharp blow in a clockwise direction which should loosen the nut and remove the nut and pulley.

c. Remove the two screws that hold the fuel-tank bracket and blower housing to the cylinder head and remove the screws from each side of the blower housing. Remove the blower housing and fuel tank as a unit.

d. Remove the screws that hold the cylinder baffle plate to the side of the cylinder and remove the baffle. Clean the cooling fins with a wire brush. Brush the air vanes on the flywheel with the wire brush and blow off all dust and dirt with a pump or air hose.

e. Reassemble the disassembled parts by reversing the order of removal. Check the fuel system for leaks when the reassembly has been completed.

27. SERVICING MAGNETO.

a. Remove the blower housing and fuel tank assembly and starter pulley as instructed in paragraph 26. Place a block of hard wood against the end of the engine crankshaft and strike it a sharp blow with a hammer. Grasp the top of the flywheel and slide it from the crankshaft. Be careful not to lose the key when removing the flywheel from the shaft.

b. With the flywheel removed, rotate the crankshaft until the breaker contacts of the magneto

are open to their widest gap. Inspect the breaker points for burning or pitting. If the points are only slightly burned or pitted, clean them with a fine-grit hone. If the points are badly burned or pitted, replace the entire breaker plate assembly. Check the gap between the breaker points with a 0.020-inch feeler gauge. The points must be open to their widest gap and the gauge must be a snug fit between the points. If the point gap is incorrect, loosen the adjusting-lock screw and move the contact bracket up or down until the correct gap is reached. Lock the adjusting-lock screw securely and make sure that the contact points line up squarely (fig. 13).

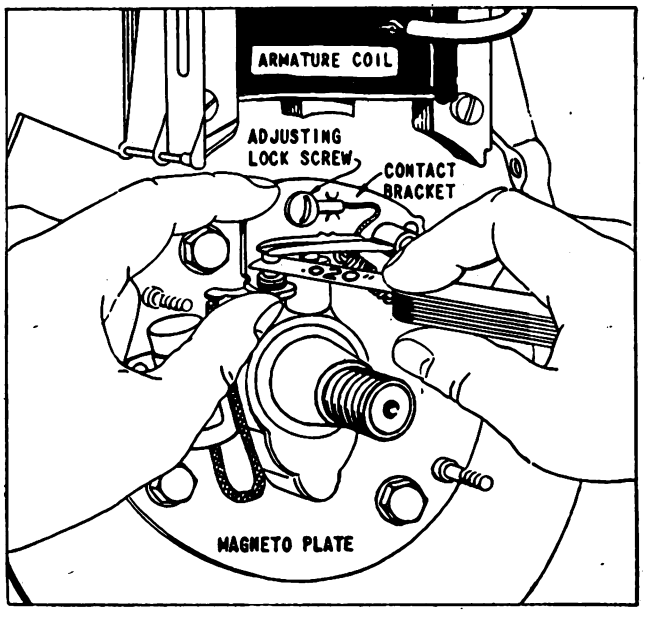


Figure 13. Magneto contact point adjustment.

c. If the magneto contacts are badly burned, it is quite possible that the magneto capacitor may be faulty. Remove and test the capacitor and if faulty, install a new one. A faulty capacitor may also cause hard starting, sputtering and misfiring under load.

d. Reassemble all parts by reversing the operations for disassembly. Be sure to replace the key when replacing the flywheel and tighten the flywheel nut securely. When replacing the magneto plate assembly, be sure to replace the gasket between the magneto plate and crankcase, and make certain that the gasket is in good condition. The magneto is correctly timed when the flywheel is properly assembled to the crankshaft. Do not attempt to change the timing by relocating any parts or by filing the crankshaft.

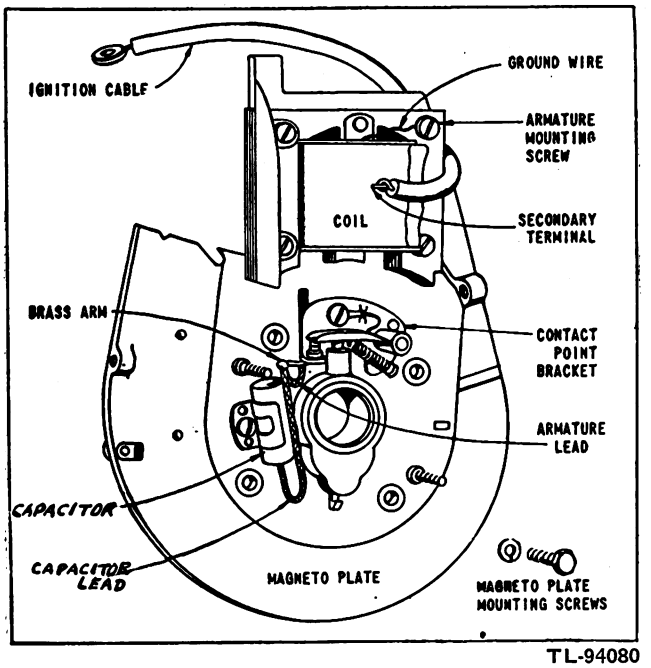


Figure 14. Magneto plate, details.

e. An air gap of between 0.008 and 0.012 inch must be maintained between the armature core of the magneto and the flywheel. This gap should be just sufficient to prevent rubbing and must never exceed 0.012 inch. Adjust the gap by placing a feeler gauge of proper thickness between the flywheel and the ends of the armature core and loosen the four mounting screws that hold the core in position. Slide the magneto armature assembly up or down as required until the correct gap is reached. Tighten the mounting screws securely (fig. 15).

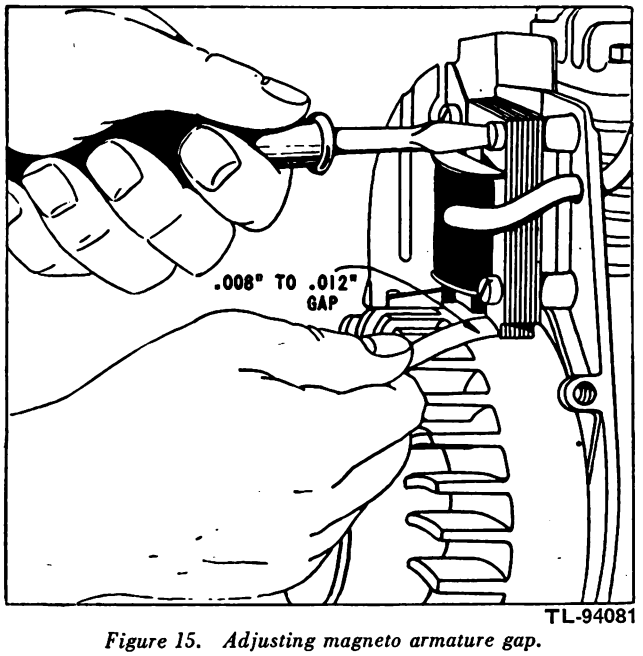


Figure 15. Adjusting magneto armature gap.

28. CRANKCASE BREATHER.

At the end of every 256 hours of operation, remove the valve cover plate on the side of the cylinder as instructed in paragraph **25a.** Remove the crankcase breather by prying it out of the valve-spring chamber and wash it thoroughly in cleaning solvent. The spring on top of the breather holds the breather assembly in place by pressing against the oil-spray shield in back of the valve cover plate. Be sure that this spring is in place before replacing the oil-spray shield and valve cover plate. See figure 10.

29. COMPRESSION.

Check the compression by turning the engine quickly with the starter rope. If the shaft is rotated slowly, sticky valves may not be detected. If noticeable resistance is offered every second revolution, the compression may be assumed to be satisfactory. Possible causes of poor compression are a loose cylinder head, a faulty cylinder-head gasket, loose spark plug, valves sticking or not seating properly, improper lubrication, worn piston rings, or a worn piston or cylinder.

30. ENGINE DISASSEMBLY.

If it is necessary to disassemble the engine for replacement of piston rings, piston or other internal engine parts, proceed as follows:

a. Remove the fuel tank and blower housing as instructed in paragraph **26c.**

b. Remove the carburetor, fuel strainer and air cleaner assembly as instructed in paragraph **24a.**

c. Drain the lubricating oil from the engine as instructed in paragraph **11d.**

d. Remove the generator from the engine as follows:

(1) Remove the generator end-bell.

(2) Disconnect the brush leads from the brushes and remove the brushes.

(3) Remove the control box cover and disconnect the generator leads from the control box.

(4) Remove the control box from the unit.

(5) Remove the long screw that holds the generator cooling fan to the end of the armature and remove the fan.

(6) Remove the screws that hold the brush-holder bracket and remove the bracket.

(7) Pull the armature from the engine crankshaft. The armature fits onto the crankshaft on a taper fit. Strike it from side to side with the hand, if necessary, to loosen it.

(8) Remove the four screws that hold the generator frame to the engine end-bell and remove the generator frame.

(9) The cylinder and crankcase assembly is held to the engine base by two cap screws and two dowels. Remove the screw plug on the engine base, below the carburetor, and remove the cap screw under that plug with a socket wrench. Remove the cap screw from the other side of the engine base and lift the cylinder and crankcase assembly from the base. **LIFT THIS ASSEMBLY CAREFULLY SO AS NOT TO DAMAGE OR BEND THE DOWELS OR POSSIBLY CRACK THE BASE CASTING.**

31. REMOVING THE CONNECTING ROD AND PISTON.

a. Proceed as instructed in paragraph **30** above.

b. Remove the spark-plug shield cap, disconnect the spark plug wire and remove the spark plug and shield.

c. Remove the cylinder head as instructed in paragraph **23.**

d. Mark the lower end of the connecting rod and the connecting-rod bearing cap with a file so as to be sure of replacing the cap in the exact position from which it is removed. Remove the two connecting-rod bearing-cap screws and remove the bearing cap. Replace the screws in the lower end of the connecting rod to prevent their loss.

e. Push the lower end of the connecting rod up so as to force the piston assembly out of the top of the cylinder and withdraw the piston assembly.

32. CHECKING PISTON AND PISTON RINGS.

a. To Check Piston. Carefully remove the piston rings from the piston. With the piston rings removed, replace the piston in the cylinder and check the clearance between the piston and cylinder wall with a feeler gauge. The piston-to-cylinder-wall clearance should be between 0.0045 and 0.0065 inch. If the clearance is excessive, it will be necessary to fit a new piston unless the cylinder is also worn. Check the inside of the cylinder with an inside micrometer (fig. 16). The standard cylinder bore is between 1.999 inches and 2.000 inches. If the cylinder is worn more than 0.003 inch, it should be replaced or rebored and new pistons and piston rings fitted.

b. Fitting Piston Rings. The pistons in these engines have four grooves but only three piston rings are used. The top groove is a heat-insulating groove and rings are fitted to only the three lower grooves. Check the piston rings by pushing them well down into the cylinder bore and measuring the gap between the ends of the ring. The

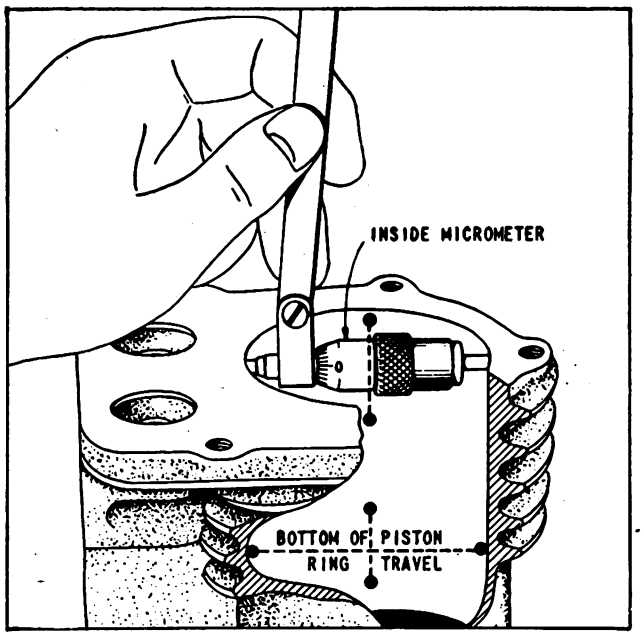


Figure 16. Checking cylinder bore.

correct gap is between 0.007 and 0.017 inch. If a larger gap is indicated, replace with new rings. If, when fitting new piston rings, the gap is too small, carefully file a little from each end of the ring until the correct gap is reached.

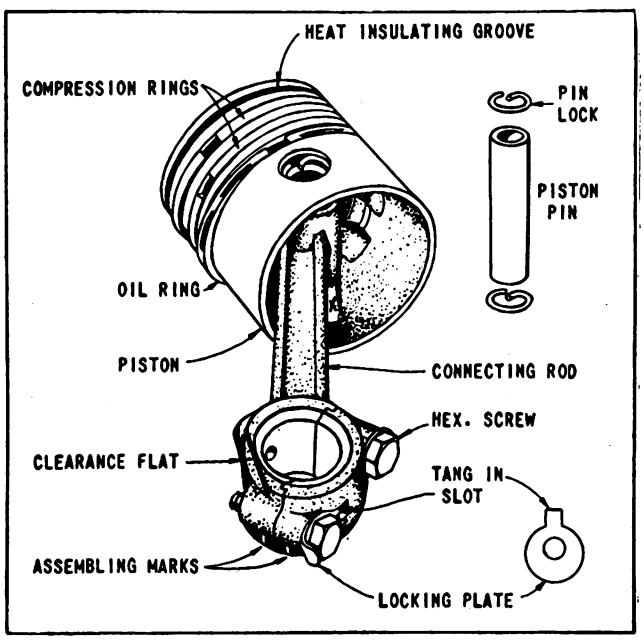


Figure 17. Connecting rod and piston assembly.

c. Installing Piston Rings. Clean all carbon and other foreign matter from the ring grooves. Take three or four narrow strips of shim stock or feeler stock and hold them equally spaced on the length of the piston. Slide the lowest piston ring over the strips until it is in position over its ring groove. Pull the strips from under the ring and seat the ring in its groove. Repeat this operation until all of the piston rings are in place. See that the rings move freely in their grooves. If the rings fit too snugly in their grooves, remove them and lap their sides on a piece of crocus cloth resting on a surface that is perfectly flat and smooth.

d. Piston Pins. While the piston and connecting rod assembly are out of the cylinder, check the fit of the piston pin. The piston pin is a slip fit and is held in position by a lock ring on each side of the piston. This pin should be just tight enough to require reasonable hand pressure to push it into place. If the piston pin appears too loose, try a new pin in its place.

33. REPLACING PISTON AND CONNECTING ROD.

a. When all necessary work on the piston assembly has been completed, replace it in the cylinder. Insert the connecting rod and piston assembly from the top of the cylinder bore. Compress the piston rings with a ring compressor or if one is not available, tie each ring with a piece of string. Push the piston assembly down into the cylinder and, if string has been used, cut the string on each ring as it enters the cylinder.

b. Rotate the piston and connecting rod assembly so that the flat shoulder (clearance flat, fig. 17) on one side of the lower end of the connecting rod faces the magneto end of the engine. Lower the connecting rod onto the crankshaft. Place the bearing cap in position and insert the bearing-cap screws. Be sure that the assembling marks are in correct relation to each other and that the nut-lock plates are in place on the cap screws. Have the tang of the lock-plates in the slots on the bearing cap and bend the lip of the lock plates against the hex-heads of the cap screws to hold them from turning. The connecting rod to crankshaft clearance should be approximately 0.003 inch. If the connecting rod bearings are worn, an entire new connecting rod assembly must be installed.

34. SERVICING OIL PUMP.

While the engine base is removed, clean and check the lubricating oil pump. This is a gear type pump which is mounted in the base of the engine and driven off the cam gear. Remove the pump from the base and remove the strainer and spring from the intake tube. Wash the strainer

thoroughly in cleaning solvent. Place the intake tube in a container of cleaning solvent and spin the drive gear in a counter-clockwise direction. Continue this operation until all dirt has been flushed from the pump. Remove the intake tube from the solvent and spin the gear several times. Next, place the intake tube in a container of clean lubricating oil and spin the gear until a good spray of oil is ejected from the outlet nozzle. Reassemble the pump to the base. Make sure that the pump strainer rests on the lugs in the bottom of the base and that the hold-down spring is in place. **DO NOT ATTEMPT TO BLOW THE PUMP OUT WITH AIR.**

35. OIL LEAKS.

If oil leaks from either end of the crankshaft, remove the engine base as instructed in paragraph **30d** (9). Oil return valves are screwed into the crankcase and the magneto back-plate below the main bearings. Screw out these valves and wash them in cleaning solvent. Replace them if they appear unfit for further service.

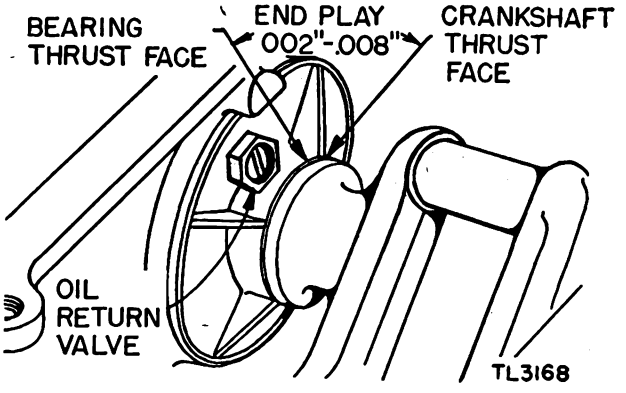


Figure 18. Oil return valve, flywheel end.

36. SERVICING CARBURETOR.

When it is necessary to disassemble the carburetor, proceed as follows:

a. Shut off the fuel valve below the fuel tank and remove the fuel pipe from both the valve and fuel strainer intake.

b. Remove the air cleaner from the carburetor air intake.

c. Disconnect the throttle control rod from the throttle and governor arm.

d. Remove the cap screws that hold the carburetor to the intake flange and remove the carburetor and fuel strainer assembly.

e. Unscrew the fuel strainer from the carburetor.

f. Wash the outside of the carburetor in cleaning solvent or diesel oil.

g. Remove the main-jet needle valve, stuffing-box nut, packing-nut gland, and main-jet nozzle.

h. Remove the screws and lockwashers that hold the upper carburetor body to the lower body and carefully lift the upper body and float assembly from the lower body.

CAUTION: The upper and lower bodies are interlocked by the nozzle. Failure to disassemble in the above order will result in damaged parts.

i. Clean all parts thoroughly. Remove all traces of gum with acetone or alcohol. Blow out all jets and fuel passages.

CAUTION: Do not attempt to force a wire or other hard object through any of the jets.

j. Remove the brass pin that passes through the carburetor float-tang, lift out the valve and check the inlet valve and seat. If the valve or seat are worn, replace both.

k. Check the float level by inverting the upper carburetor body with the float assembly attached and place a flat piece of steel or a steel scale across the carburetor float. The distance between the top of the float and the carburetor flange must be the same on the side opposite the tang as it is on the tang side (fig. 19). Correct any difference by carefully bending the float-hinge tang.

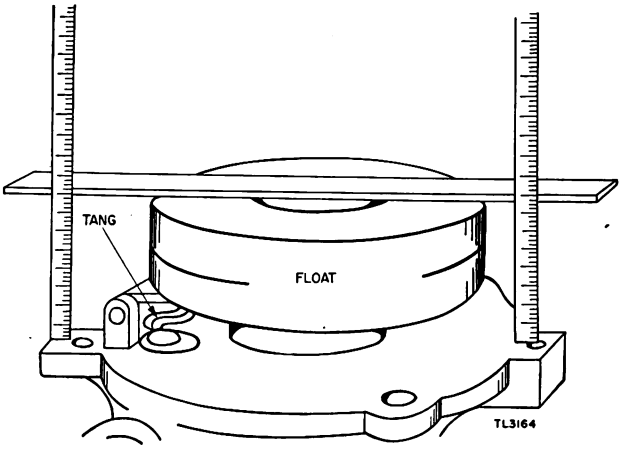


Figure 19. Carburetor float level.

l. Replace any worn or damaged parts and reassemble the carburetor. Be sure to replace all gaskets.

37. CRANKSHAFT BEARINGS.

a. The flywheel end of the crankshaft is supported in a sleeve bearing which is a part of the magneto back-plate (fig. 28). The power take-off end is supported by a ball bearing. If the flywheel end bearing is worn, replace the entire magnet back-plate assembly. If the ball bearing on the power take-off end is worn, proceed as follows:
(1) Drain the crankcase as instructed in paragraph **11d.**
(2) Remove the generator as instructed in paragraph **30d.**
(3) Remove the engine base as instructed in paragraph **30d** (9).
(4) Remove the magneto-point dust cover and then remove the magneto back-plate.
(5) Disconnect the connecting rod from the crankshaft as instructed in paragraph **31d.**
(6) Drive out the camshaft from the power take-off end. Be careful not to lose the expansion plug on the flywheel end (fig. 20). Move the cam gear to one side so as to clear the bearing on the crankshaft while withdrawing the crankshaft through the magneto back-plate opening.

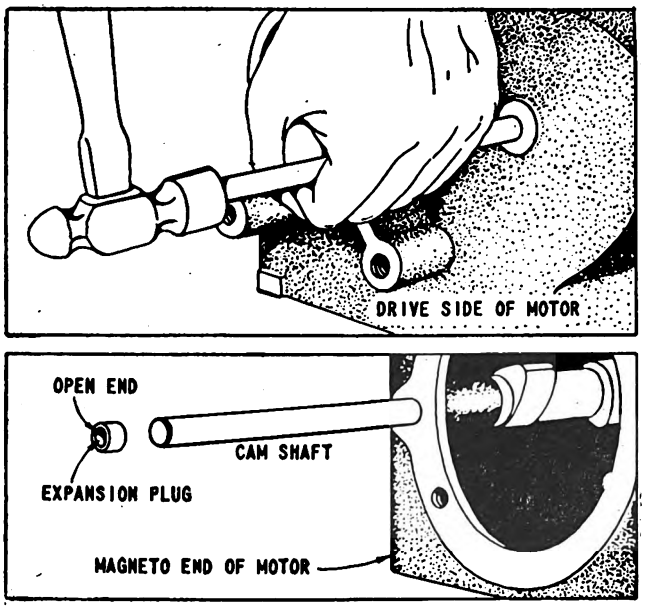


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Figure 20. Removing, and replacing camshaft.

38. REPLACING CRANKSHAFT BALL BEARING.

a. With the crankshaft removed, support the ball bearing in an arbor press as shown in figure 21 and press the shaft out of the bearing.

b. Before replacing the ball bearing on the crankshaft, heat it in hot oil. When heated, the bearing may be slipped onto the crankshaft. Place the bearing on the shaft with the sealed end down and drive it all the way on. Allow the bearing to cool slowly. DO NOT SUBMERGE IN WATER TO COOL. Inspect the oil seals carefully and if worn or damaged, replace them.

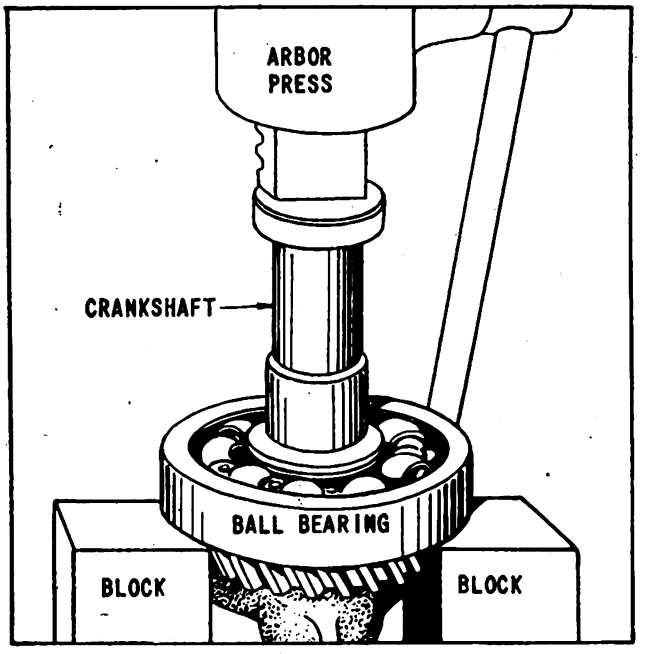

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Figure 21. Removing crankshaft bearing.

39. REPLACING CRANKSHAFT.

Place the cam gear assembly in position with the punch marked side of the cam gear facing the magneto end of the engine. Slide the crankshaft into place with the ball bearing resting in the bearing cap inside of the power take-off end of the crankcase.

40. REPLACING CAMSHAFT.

a. Replace the crankshaft as instructed in paragraph **39** above.

b. Check the camshaft for wear and if satisfactory, replace it in the crankcase. The minimum diameter of the camshaft is 0.037285 inch. If the shaft is worn to a smaller diameter, replace it with a new shaft.

c. Make sure that the ends of the camshaft are free from burrs and insert it in the hole on the magneto side of the crankcase. Line up the cam and cam gear assembly and drive the shaft through until its end is flush with the power take-off face of the crankcase.

d. Replace the expansion plug in the hole through which the camshaft was driven. Before replacing this plug, coat it with Compound, joint and thread, type B. Insert the plug with its open end out.

41. VALVE TIMING.

Timing marks are provided on the crankshaft collar and on the cam gear. Slide the crankshaft toward the magneto end of the crankcase far enough for the crankshaft gear to be out of mesh with the cam gear. Rotate both the crankshaft and the camshaft gear so that the timing marks are directly in line and slide the crankshaft back into place. The two timing marks must line up perfectly for correct timing. Replace the

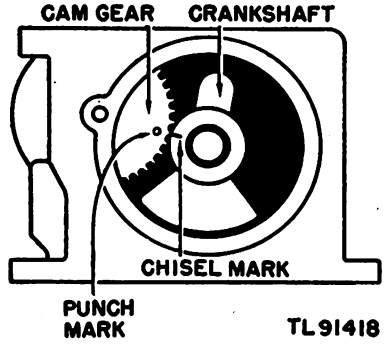

Figure 22. Valve timing diagram.

magneto back-plate and replace the gasket between it and the crankcase with a new gasket. The crankshaft end play should be between 0.002 and 0.008 inch. Use the proper thickness gasket to get the correct end play (fig. 23). Reassemble the magneto as instructed in paragraph **27** and replace the flywheel and blower housing. Reassemble all other parts by reversing the operations used in disassembly.

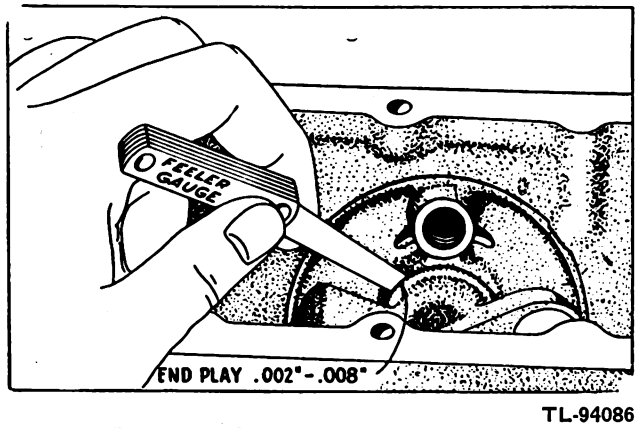

Figure 23. Checking crankshaft end play.

42. GENERATOR SERVICE.

a. General. The generator will require very little attention as it has no bearings. The generator must be kept free from oil, grease, dirt, and moisture, and the cooling fan and air passages must be kept clean.

b. Brushes and Commutator. Remove the generator end-bell every 256 operating hours and inspect the condition of the brushes and commutator. The commutator should have a smooth, dark-brown color. A highly polished surface is not necessary. The commutator must be free from pits and the mica insulating bars, between the commutator segments, must be below the surface of the commutator. Check the brushes to see that they move freely in their holders and that they make good contact with the commutator. Replace any brush that appears badly worn or otherwise unsatisfactory.

c. Cleaning Commutator. Clean the commutator by placing a piece of coarse, clean cloth over the flat, square end of a stick and holding the cloth against the commutator while the unit is running. The cloth must be long enough to enable holding its end against the sides of the stick while performing this operation. If the commutator is very dirty or slightly pitted, substitute a piece of No. 000 sandpaper in place of the cloth. DO NOT USE EMERY PAPER OR EMERY CLOTH FOR THIS PURPOSE. Use the sandpaper very sparingly. If the commutator is badly pitted, out of round, or the mica between the segments is higher than the surface of the commutator, remove the armature and turn the commutator down in a lathe. This work should not be attempted by unauthorized personnel. Disassemble the generator as instructed in paragraph **30d.**

d. Fitting Brushes. To fit new brushes or to reseat old ones, cut a strip of No. 000 sandpaper the width of the commutator. Place the sandpaper with its sanded face toward the brush and curve it part way around the commutator. With the brush resting on the sanded surface of the sandpaper, pull the sandpaper around the commutator in the direction of its rotation. Lift the brush and return the sandpaper to its original position and repeat the operation. Continue this operation until at least a 75 percent brush fit is obtained. Repeat the same operation for each brush.

e. Undercutting Mica. If the condition of the commutator is generally satisfactory but the mica needs undercutting, figure 24 illustrates a satisfactory method to use in this operation.

43. TESTING WINDINGS.

a. Figure 24 illustrates a simple method of testing generator windings for open or short circuits. The necessary equipment consists of a pair of test leads with a lamp socket in series with one lead; a 6- or 12-volt battery and a 3- to

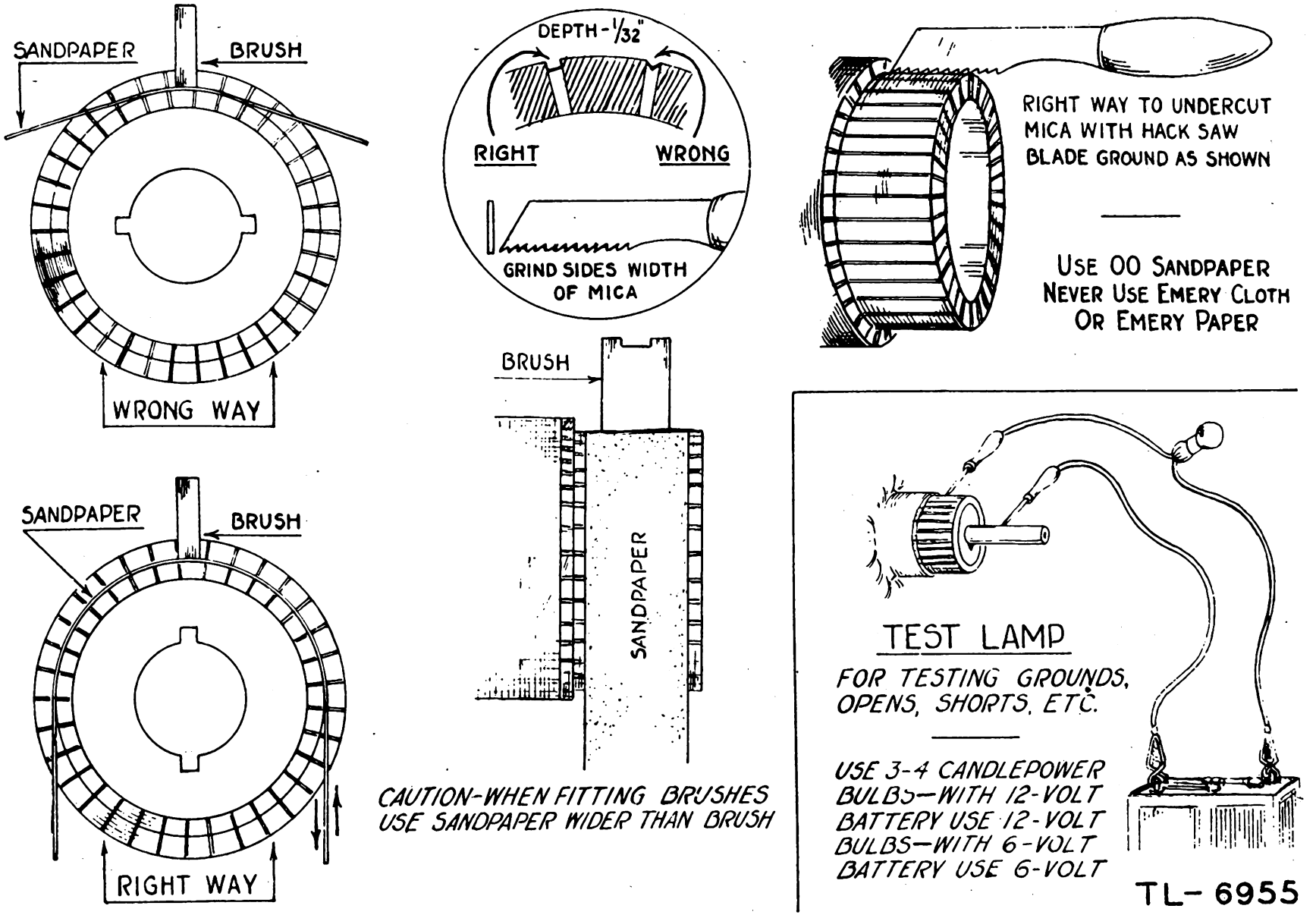

Figure 24. Servicing commutator, and brushes.

4- candle power lamp of the correct voltage for the battery used.

b. With the above equipment, windings may be tested by touching the test prods to the ends of the windings. If the lamp fails to light, the winding is open. Test the armature with the same equipment for grounds. Lift the brushes clear of the commutator and place one test lead on the commutator and the other lead on the armature shaft. If the lamp lights, the armature is grounded and must be replaced. Test the field coils by disconnecting the brush-rig leads and touching one of the test leads to the generator frame and the other test lead to the field lead. If the lamp lights, the field is shorted or grounded. To test for an open field circuit, touch one test lead to one end of the field circuit and the other test lead to the other end of the field circuit. If the lamp does not light, the circuit is open. In either case, return the unit to a repair depot.

c. If an ohmmeter is used to check the generator windings, the following readings should be obtained on the ohmmeter:

(1) Resistance of shunt field winding, 6 ohms.
(2) Resistance between commutator bars 90° apart, 0.32 ohms.

44. DISASSEMBLY OF GENERATOR.

When it is necessary to disassemble the generator, proceed as follows:

a. Remove the screws that hold the end-cover and remove the end-cover.

b. Remove the long bolt in the center of the fan and remove the fan.

c. Disconnect all leads between the control box and the other parts of the unit.

d. Remove the leads from the brushes and remove the brushes.

e. Remove the screws that hold the brush-holder bracket and remove the bracket.

f. Pull the armature from the engine crankshaft.

g. Remove the screws that hold the control box and remove the control box.

h. Remove the four screws that hold the yoke to the engine generator bracket.

i. Remove two screws that hold each pole shoe to the yoke.

j. Withdraw the pole shoes.

k. Remove the field windings. Take care, when removing the field windings, not to pull the leads out of the coils when pulling them through the hole in the yoke.

NOTE: Attach tags to all leads as they are removed so as to be certain that they are reconnected properly when reassembling.

l. Reassemble by reversing the operations for disassembly. Be sure to replace all lockwashers and make all connections tight.

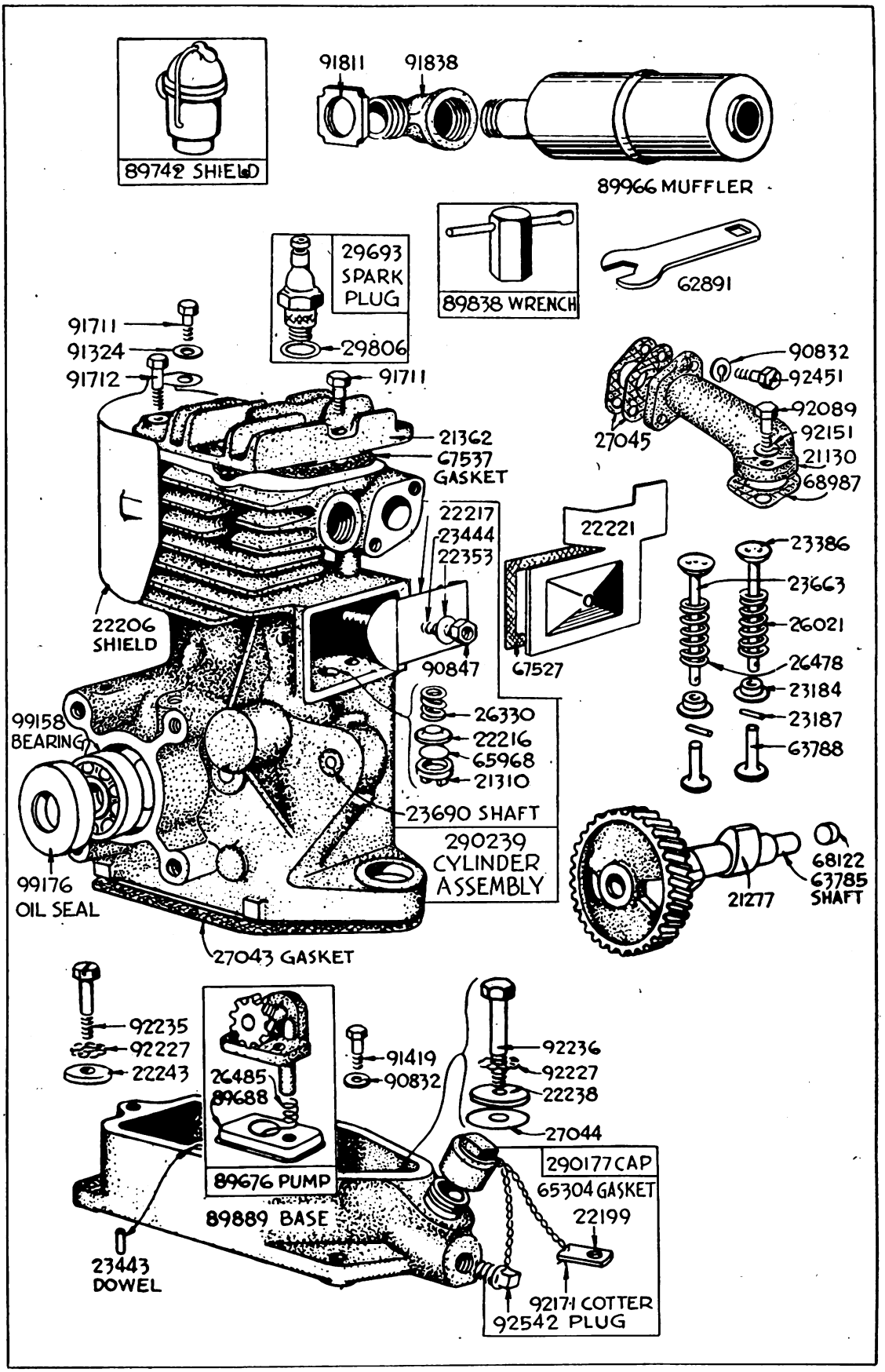

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Figure 25. Main engine parts.

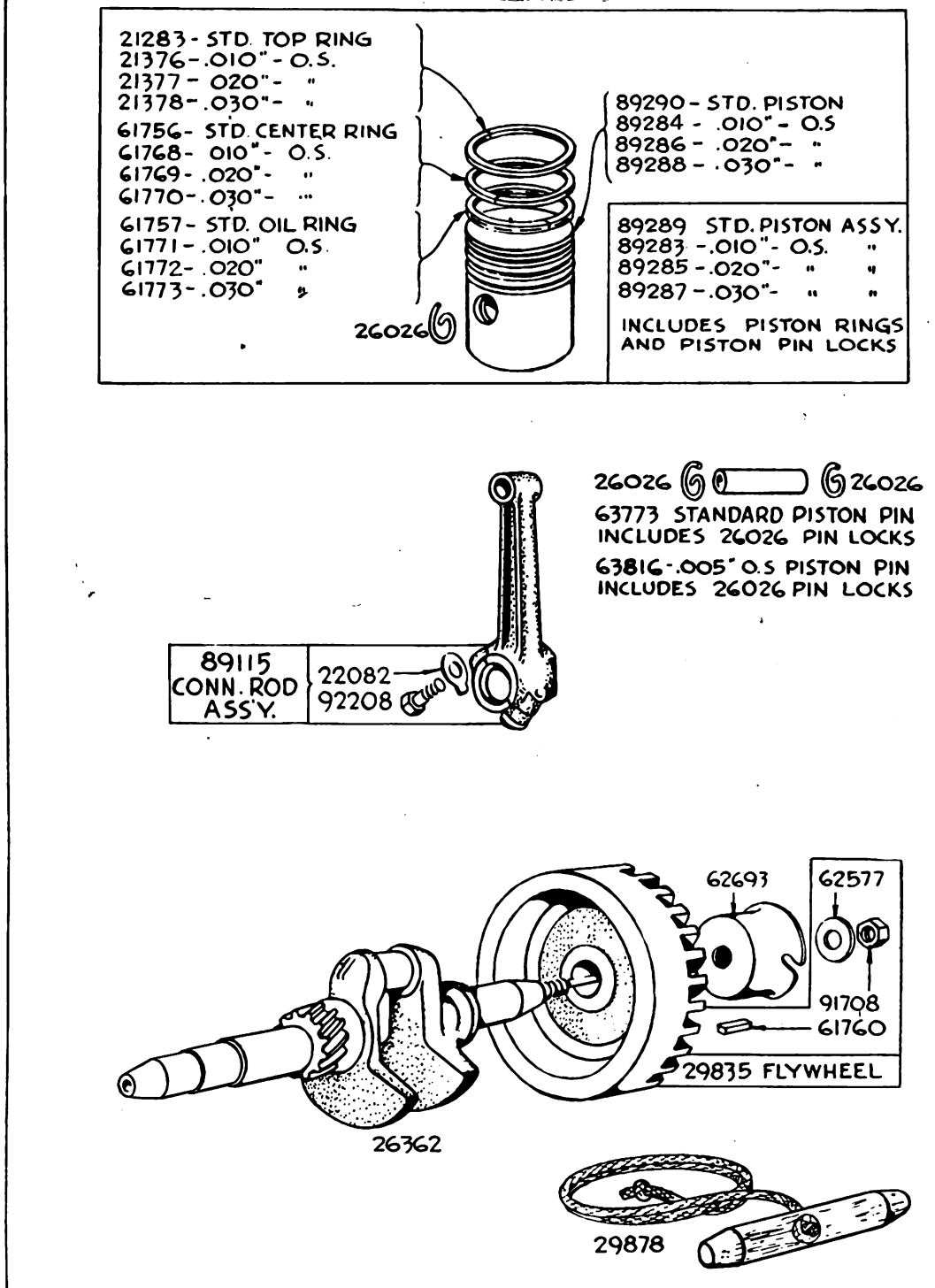

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Figure 26. Piston, connecting rod, and flywheel parts.

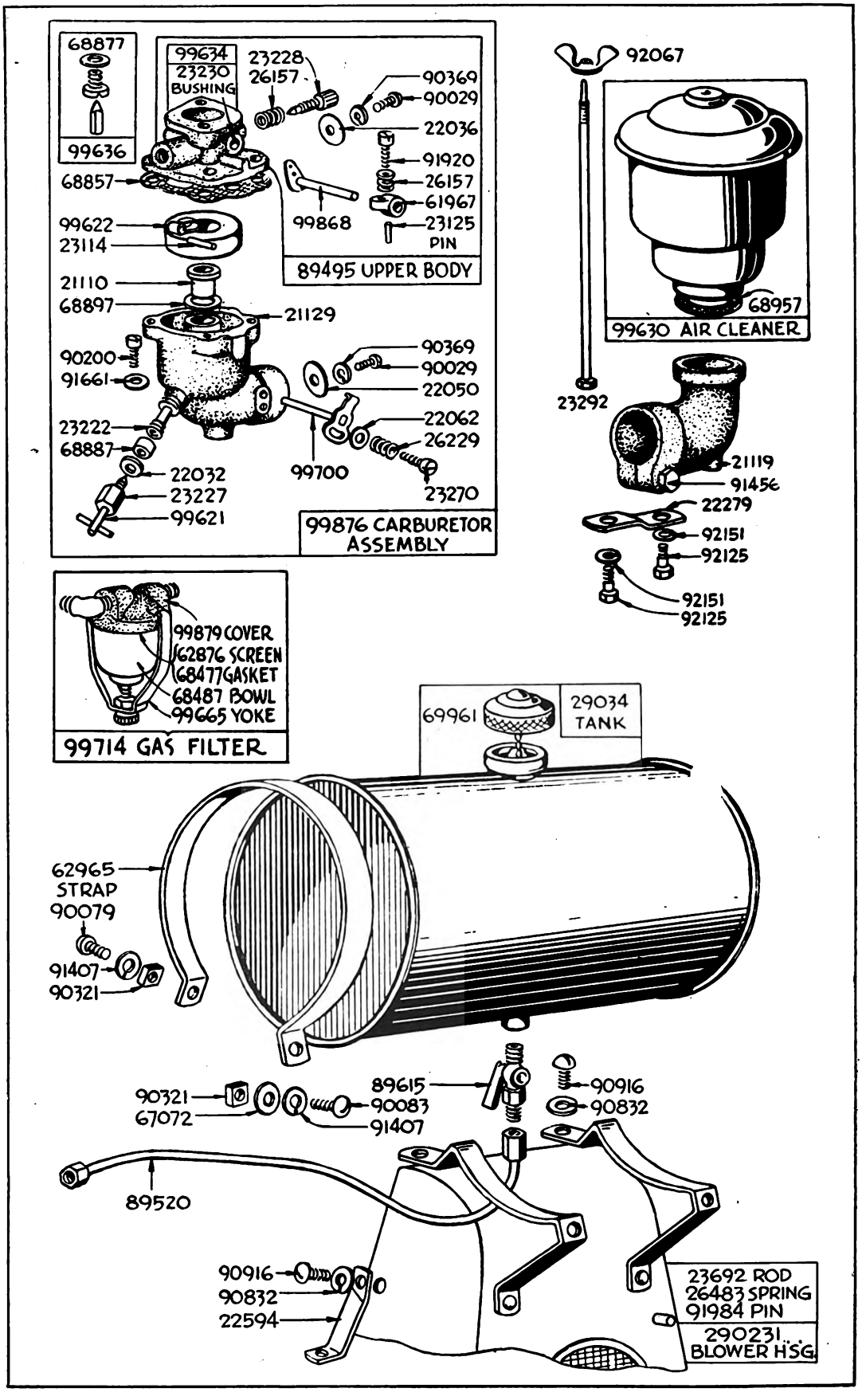

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Figure 27. Fuel supply parts.

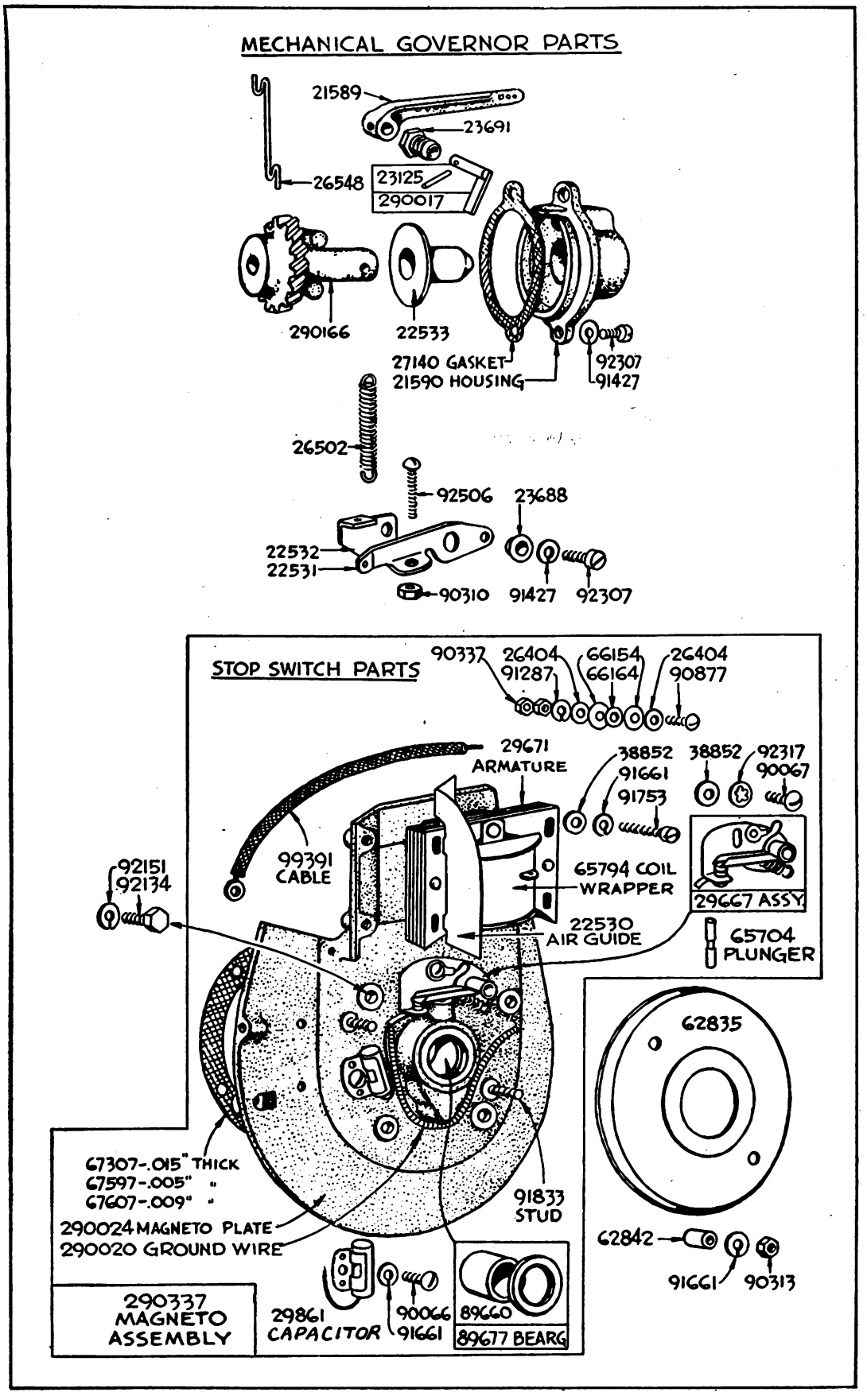

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Figure 28, Governor, and magneto parts.

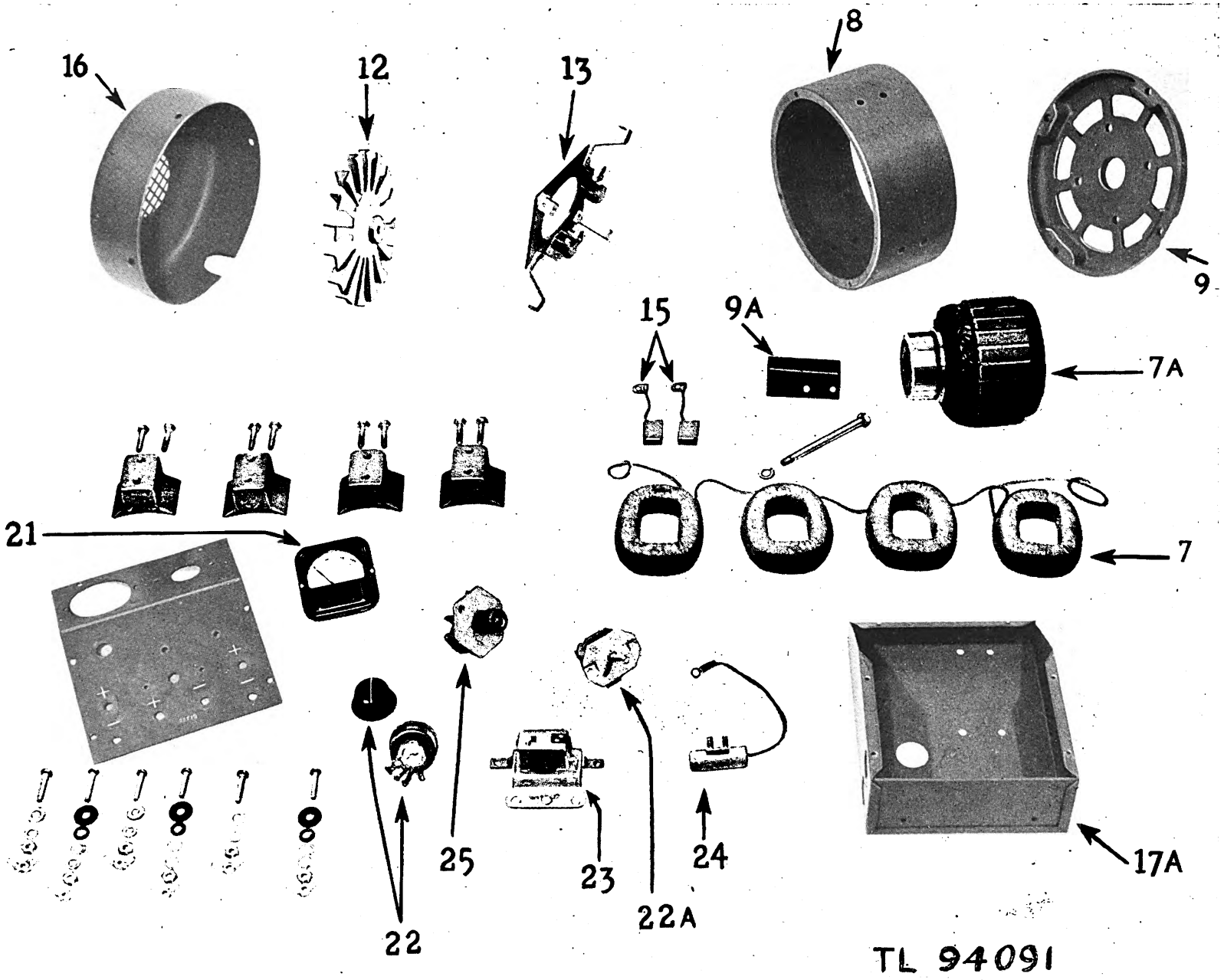

Figure 29. Generator, disassembled.

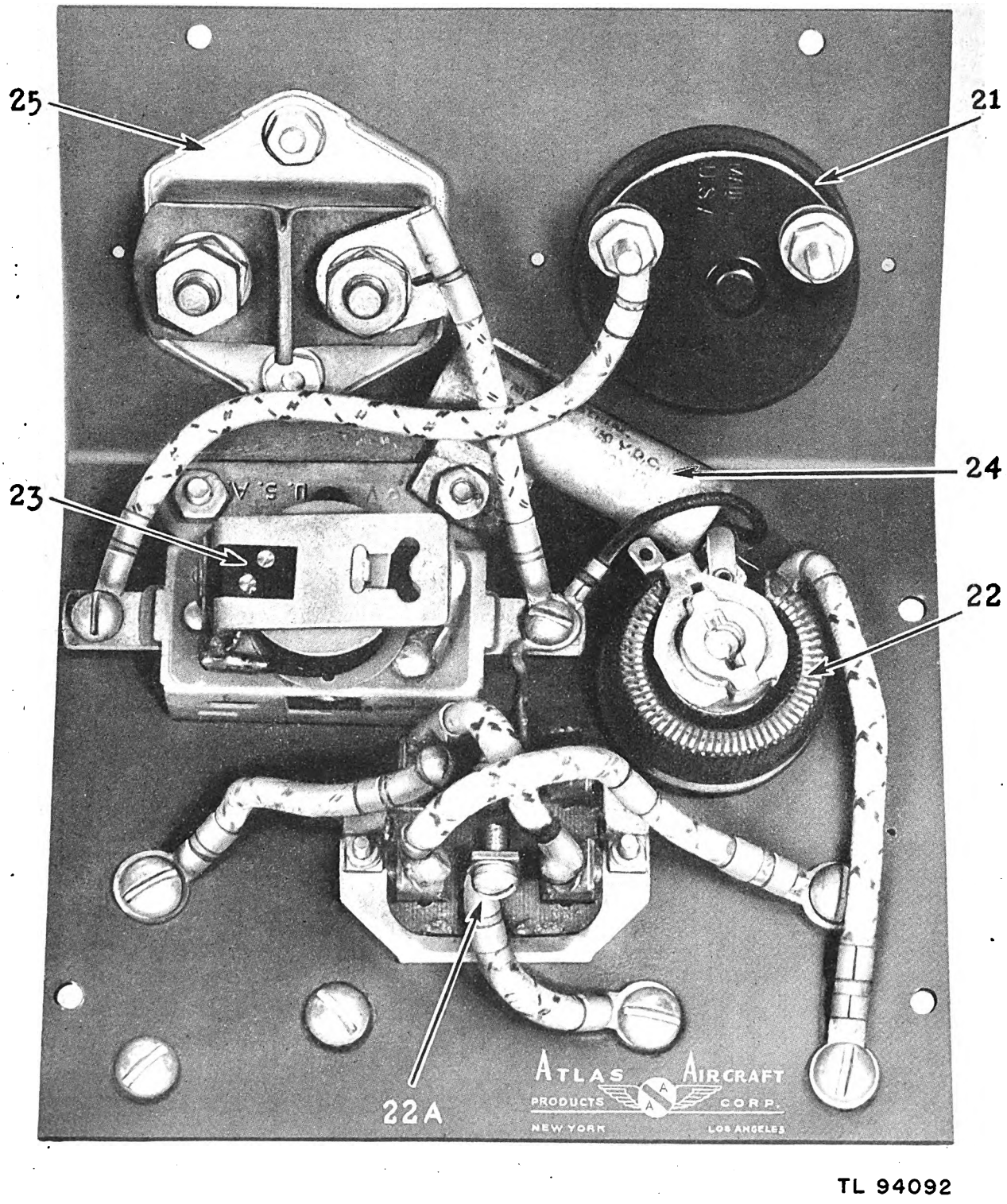

Figure 30. Control panel box cover, rear view.

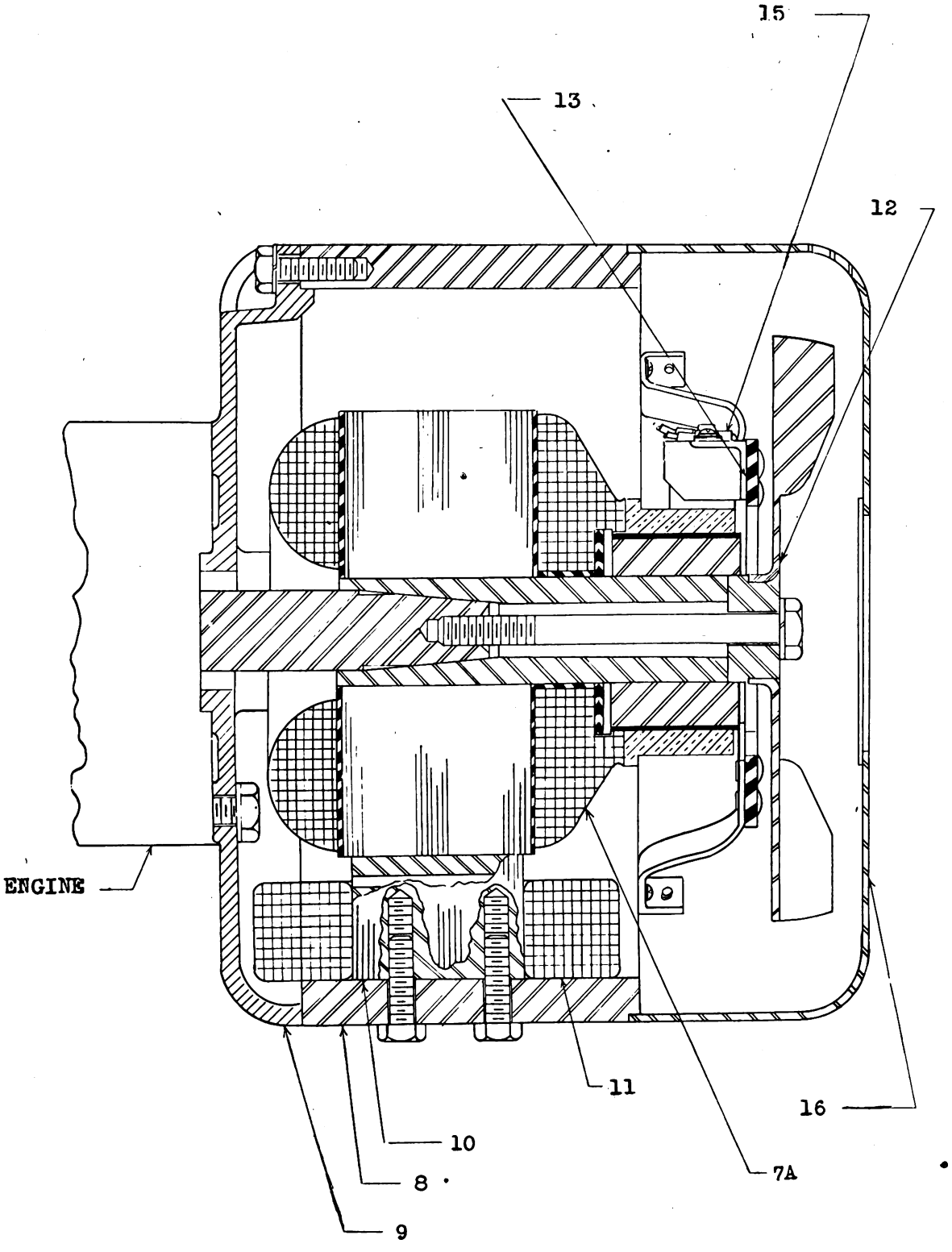

Figure 31. Generator, cross section.

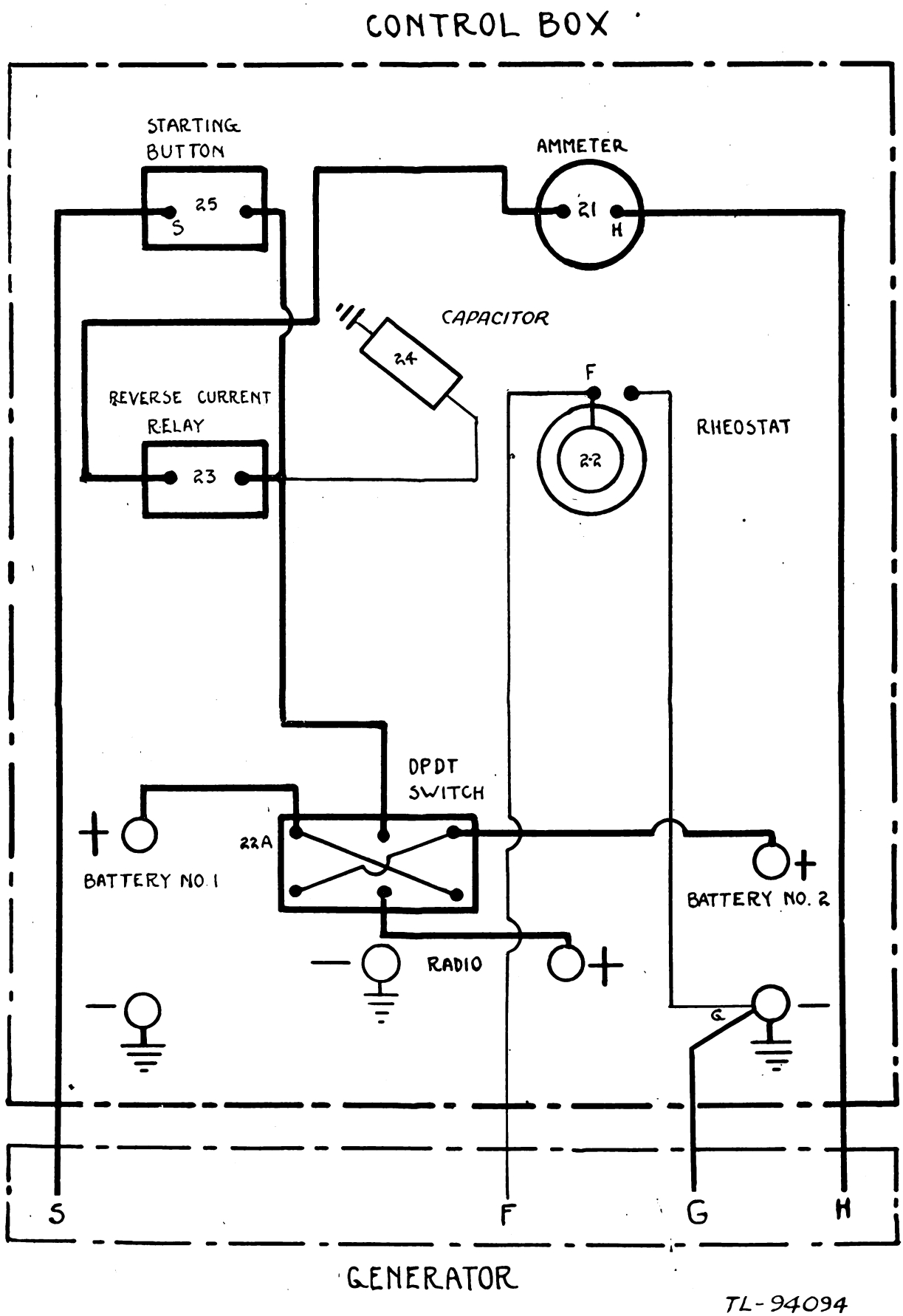

Figure 32. Power Unit PE-167-A, circuit label.

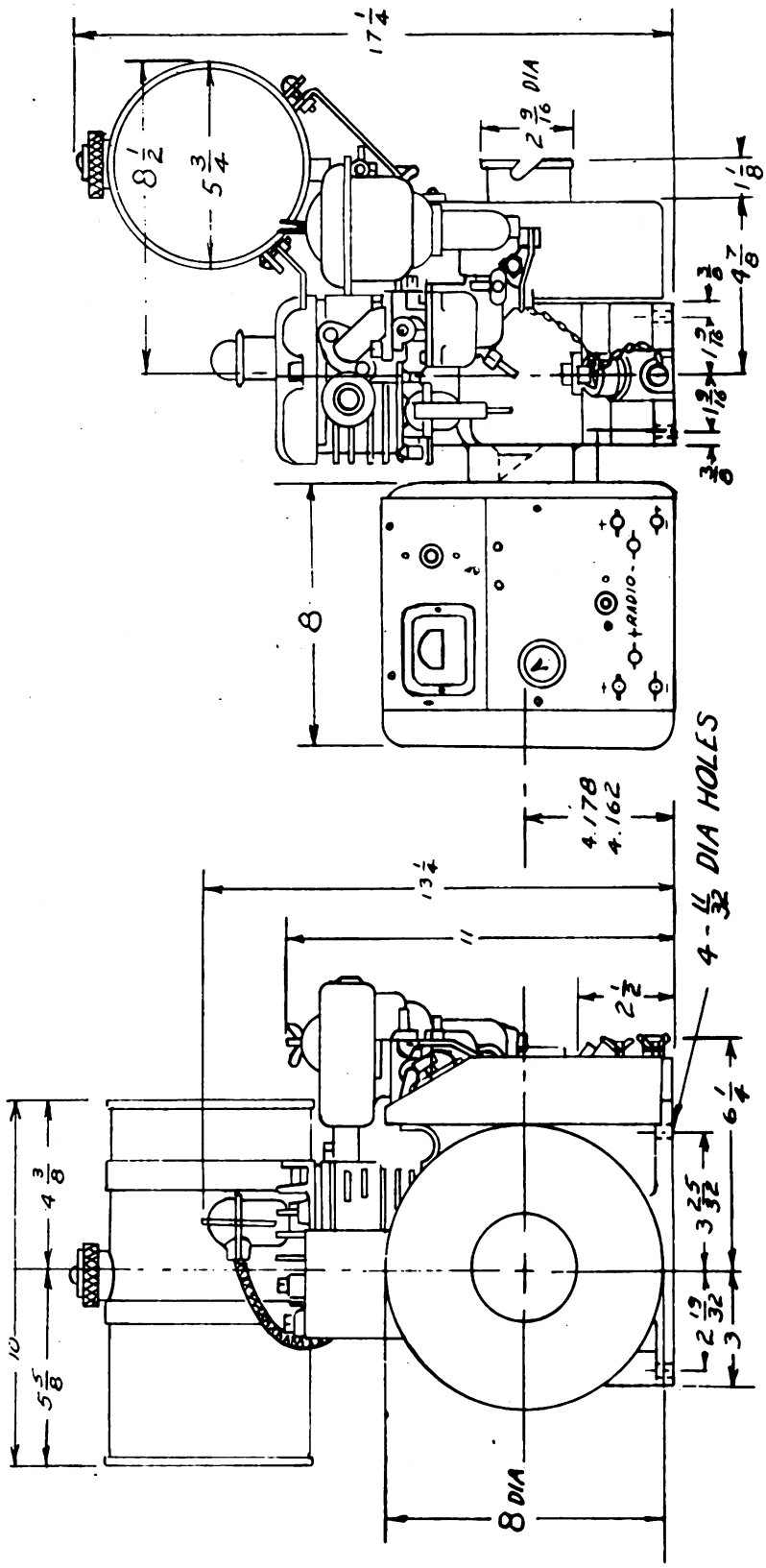

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Figure 33. Power Unit PE-167-A, dimensions.

45. ENGINE TROUBLE AND REMEDY CHART.

a. Engine Will Not Start.

POSSIBLE CAUSE	CHECK	REMEDY
(1) Fuel tank empty.	Check fuel supply.	Fill fuel tank.
(2) Fuel line clogged.	Check fuel strainer, screen, and fuel line.	Clean strainer, screen, and blow out fuel line.
(3) Poor grade of fuel or water or dirt in fuel.	Check fuel strainer sediment bowl.	Drain tank and put in fresh fuel.
(4) Loose or defective wiring.	Check wire connections.	Tighten loose connections. Replace defective wiring.
(5) Spark plug shorted.	Check spark plug for excessive carbon or cracked porcelain.	Clean or replace spark plugs.
(6) Incorrect spark plug gap.	Check spark plug gap with feeler gauge.	Correct spark plug gap to 0.025 inch.
(7) Improper fuel mixture.	Check needle valve adjustment and carburetor float level.	Readjust needle valve and correct float level.
(8) Throttle rod loose.	Check rod between carburetor and governor.	Tighten and adjust rod.
(9) Throttle valve stuck.	Inspect throttle valve.	Remove valve and remove obstruction.
(10) Valve seats fouled.	Check compression.	Remove cylinder head and reseat valves.
(11) Valves sticking.	Check valve springs and valve stems.	Clean stems or replace springs as needed.

b. Engine Overheated.

(1) Exhaust valve clearance too great.	Check clearance.	Adjust to proper clearance.
(2) Oil level too low.	Check oil level.	Add oil.
(3) Fuel mixture too rich.	Check needle valve setting. Check float level.	Readjust needle valve. Adjust float level.
(4) Choke partially closed.	Inspect choke.	Adjust correctly.
(5) Piston rings sticking.	Remove piston and inspect rings.	Clean carbon from ring grooves. To be done by higher echelon only.
(6) Poor ventilation.	Check ventilation in room or shelter.	Provide better ventilation.
(7) Improper timing.	Check piston and valve action in relation to each other.	Refer to higher echelon.
(8) Exhaust clogged.	Check operation without muffler.	Replace muffler.

45. ENGINE TROUBLE AND REMEDY CHART (Contd).

POSSIBLE CAUSE	CHECK	REMEDY
(9) Air cleaner fouled.	Inspect air cleaner.	Clean air cleaner.
(10) Air intake fouled.	Inspect air intake.	Clean air intake.
(11) Cooling fins dirty.	Inspect cooling fins.	Clean cooling fins.
(12) Overload on unit.	Check load.	Reduce load.
c. Engine Knocks.		
(1) Low octane fuel.	Check grade of fuel.	Drain fuel tank and refill with correct fuel.
(2) Carbon in cylinder.	Remove cylinder head and inspect.	Remove carbon.
(3) Broken valve spring.	Inspect valve springs.	Replace broken spring.
(4) Loose main bearings.	Check for oil leaks. Rock flywheel and feel for play.	Refer to higher echelon.
(5) Loose connecting rod bearing.	Short spark plug while running to see if knock disappears.	Refer to higher echelon.
(6) Incorrect fuel adjustment.	Check needle valve adjustment. Check float level.	Adjust needle valve or float level as needed.
(7) Lack of oil.	Inspect oil supply.	Add oil.
(8) Loose flywheel.	Rock flywheel by hand and feel for play.	Remove flywheel and inspect key and keyway. Replace key if needed. Tighten flywheel nut.
(9) Engine overheated.	See par. **45c.**	See par. **43c.**
(10) Loose piston pin.	Short spark plug while running to see if knock disappears.	Refer to higher echelon.
d. Faulty Carburetion.		
(1) Improper adjustment.	Check adjustment.	Readjust carburetor.
(2) Sediment in fuel tank.	Inspect sediment bowl on fuel strainer.	Flush fuel system and put in fresh fuel.
(3) Fuel strainer clogged.	Remove sediment bowl and inspect screen.	Clean screen.
(4) Fuel valve partially closed.	Inspect fuel valve.	Open valve.
(5) Fuel tank vent clogged.	Inspect vent.	Clean vent hole in fuel tank cap.
(6) Water in fuel.	Inspect fuel in sediment bowl.	Drain fuel tank and refill with clean fuel.

45. ENGINE TROUBLE AND REMEDY CHART (Contd).

POSSIBLE CAUSE	CHECK	REMEDY
e. Explosions in Carburetor.		
(1) Lean fuel mixture.	Open needle valve slightly and note effect.	Readjust needle valve.
(2) Air leaks in intake.	Inspect for leaks.	Replace gaskets or tighten loose fastenings.
(3) Intake valve sticking.	Check intake valve action.	Clean valve stem.
(4) Weak or broken intake valve spring.	Inspect valve spring.	Replace valve spring.
(5) Intake valve tappet adjusted too close.	Check clearance.	Readjust valve tappet.
(6) Intake valve warped or broken.	Remove cylinder head and inspect valve.	Replace valve.
(7) Intake valve fouled.	Remove cylinder head and inspect valve.	Clean and grind valve.
f. Excessive Smoke from Exhaust.		
(1) Fuel mixture too rich.	Check needle valve setting. Check float level.	Adjust needle valve. Adjust float level.
(2) Worn piston and/or piston rings.	Check compression.	Report to higher echelon.
(3) Loose bearings.	See par. **45d.**(4).	See par. **45d.**(4).
(4) Oil too light or diluted.	Open crankcase drain and check oil.	Drain crankcase and refill with correct oil.
g. Poor Compression.		
(1) Spark plug loose or gasket missing.	Inspect spark plug.	Tighten, and/or replace gasket.
(2) Loose cylinder head or faulty cylinder head gasket.	Inspect cylinder head bolts and gasket.	Tighten, and/or replace gasket.
(3) Valves sticking.	Check valve action.	Clean valves.
(4) Weak valve springs or valve springs broken.	Inspect valve springs.	Replace valve springs.
(5) Valves fouled.	Remove cylinder head and inspect valves.	Grind valves.
(6) Valve tappet clearance too close.	Check tappet clearance.	Adjust tappets.
(7) Piston rings worn or sticking.	Check compression. Eliminate other causes of poor compression.	Refer to higher echelon.
(8) Worn piston or cylinder.	See (7) above.	See (7) above.

46. GENERATOR TROUBLE AND REMEDY CHART.

POSSIBLE CAUSE	CHECK	REMEDY
a. Sparking at Brushes.		
(1) Brushes not properly seated.	Inspect brushes.	Reseat or replace brushes.
(2) Commutator dirty.	Inspect commutator.	Clean commutator.
(3) Commutator mica high.	Inspect commutator.	Refer to higher echelon.
(4) Armature defective.	See par. **43.**	Refer to higher echelon.
(5) Grounded, open or shorted field.	See par. **43.**	Refer to higher echelon.
b. Voltage Too Low.		
(1) Engine speed low.	Check engine speed with tachometer.	Adjust governor.
(2) Brushes not set properly.	Inspect brush setting.	Reseat brushes.
c. Voltage Too High.		
(1) Engine speed high.	Check engine speed with tachometer.	Adjust governor.
d. Armature Hot.		
(1) Armature shorted.	See par. **43.**	See par. **43.**
(2) Armature hitting pole pieces.	Check armature alignment.	Report to higher echelon.
(3) Cooling passages obstructed.	Inspect cooling passages.	Clean passages.
(4) Poor ventilation in room or shelter.	Check ventilation.	Provide better ventilation.
e. No Generator Output.		
(1) Armature shorted.	See par. **43.**	See par. **43.**
(2) Grounded or shorted field coil.	See par. **43.**	See par. **43.**
(3) Brushes not making contact with commutator.	Inspect brushes.	Clean or replace brushes.
(4) Shorted capacitor.	Test output with capacitor removed.	Replace capacitor.

SECTION V

SUPPLEMENTARY DATA

47. MAINTENANCE PARTS LIST FOR POWER UNIT PE-167-A.

Ref. symbol	Signal Corps stock No.	NAME OF PART AND DESCRIPTION	Quan. per unit	Mfrs. part and code No.	†Station stock	†Region stock
	3H4600-167	POWER UNIT PE-167: 12 volts, 28 amps; 2-wire, d-c.	1			
		ENGINE: Briggs & Stratton model NP type 205757; 4-cycle, 1-cylinder, L-head, 2″-bore, 2″-stroke, 1.1 hp; 2,350 rpm.	1			
		GENERATOR: Atlas Aircraft Products Corp., type 3DP2; 12 volts, 28 amps; 2-wire, d-c.; direct drive.	1			
		ENGINE PARTS				
		Air Cleaner Group				
Fig. 27	3H4577A/C19	AIR CLEANER ASSEMBLY.	1	99630		*
		Camshaft Group				
Fig. 25	3H4577A/C7	CAMSHAFT.	1	63785		
Fig. 25	3H4577A/G27	GEAR, cam.	1	21277		*
Fig. 25	3H1901-AP/P15	PLUG, camshaft	1	68122		*
		Carburetor Group				
Fig. 27	3H753	CARBURETOR ASSEMBLY.	1	99876		*

Fig. 27	3H1901-AP/F1	FLOAT, carburetor.	1	99622	*	*
Fig. 27	3H1901-A/G4	GASKET, carburetor body.	1	68857	*	*
Fig. 27	3H1901-A/V1	VALVE AND SEAT, inlet.	1	99636	*	*
Fig. 25	3H1901-A/G3	GASKET, carburetor: attaching.	1	68987	*	*
		Connecting Rod and Piston Group				
Fig. 26	3H1901-NP/R20	CONNECTING ROD ASSEMBLY.	1	89115	*	*
Fig. 26	3H4577A/P7	PIN, piston: includes 2 each No. 26026 locks.	1	63773		*
Fig. 26	3H1901-NP/P10	PISTON ASSEMBLY: standard; includes rings.	1	89289	*	*
Fig. 26	3H4577A/R21	RING, piston: compression; top; standard.	1	21283	*	*
Fig. 26	3H4577A/R17	RING, piston: compression; center; standard.	1	61756	*	*
Fig. 26	3H4577A/R15	RING, oil: standard.	1	61757	*	*
		Crankshaft Group				
Fig. 26	3H1901-NP/C10	CRANKSHAFT.	1	26362		
Fig. 26	3H4577A/N23	NUT, crankshaft.	1	91708		*
		Cylinder Block and Crankcase Group				
Fig. 25	3H4577A/B3	BEARING, ball: crankshaft, ND 204 P.	1	99158	*	*
Fig. 28	3H4577A/V49	BUSHING, governor crank.	1	23691		*
Fig. 25	3H1901-NP/B31	CYLINDER BLOCK ASSEMBLY.	1	290239		
Fig. 25	3H1901-NP/G1	GASKET, base.	1	27043	*	*

*Indicates stock available. †Parts not stocked in station or region stock are carried in depot stock.

47. MAINTENANCE PARTS LIST FOR POWER UNIT PE-167-A (Contd).

Ref. symbol	Signal Corps stock No.	NAME OF PART AND DESCRIPTION	Quan. per unit	Mfrs. part and code No.	†Station stock	†Region stock
Fig. 25	3H4577A/G1	GASKET, cover plate.	1	67527	*	*
Fig. 25	3H4575C/S19	SEAL, oil.	1	99176	*	*
Fig. 25	3H4577A/S26	SHIELD, cylinder.	1	22206		*
Fig. 25	3H4577A/S52	SPRING, breather retainer.	1	26330		*
		Cylinder Head Group				
Fig. 25	3H4577A/G11	GASKET, cylinder-head.	1	67537	*	*
Fig. 25	3H4577A/H5	HEAD, cylinder.	1	21362		*
		Engine Control Group				
Fig. 29-21	3F1030-41	AMMETER: 0-30, d-c., Sterling Mfg. Co No. 892AO.	1	892AD		*
Fig. 29-24	3DA500-24G	CAPACITOR: 0.5 mfd, Industrial Condenser Co No. 7521.	1	7521		*
Fig. 29-23	2Z7599-63	RELAY, reverse-current: 12 volts; Electra Mfg. Co No. 150-12V.	1	150-12V		*
Fig. 29-22	3Z7006-3	RHEOSTAT: 250-watt, 6-ohm; Ohmite Mfg. Co No. H0143.	1	H0143		*
Fig. 29-25	3Z9824-66	SWITCH, starter: Electric Auto-Lite Co No. SWED-6318.	1	SWED-6318		*
Fig. 29-22A	3Z9849-14	SWITCH: DPDT; 30-amp. @ 24 volt; Cutler Hammer No. 8700.	1	8700		*
		Flywheel Group				
Fig. 26	3H577A/F15	FLYWHEEL.	1	29835		*

Fuel Filter Group

Fig. 27	3H4577A/F7	FUEL FILTER ASSEMBLY.	1	99714		*
Fig. 27	3H1901-AP/B8	BOWL, fuel filter.	1	68487	*	*
Fig. 27	3H1901-AP/G9	GASKET, fuel filter.	1	68477	*	*
Fig. 27	3H1901-AP/S2	SCREEN, fuel filter.	1	62876		*

Fuel Tank Group

Fig. 27	3H1909C/C3	CAP, fuel-tank.	1	69961		*
Fig. 27	3H1901-NP/C30	TANK, fuel.	1	29034		*
Fig. 27	3H1901-NP/L30	TUBE, fuel.	1	89520		*
Fig. 27	3H1901-NP/C25	VALVE, fuel shut-off.	1	89615		*

Governor Group

Fig. 28	3H4577A/B49	BUSHING, governor crank.	1	23691		*
Fig. 28	3H4577A/C44	CUP, governor.	1	22533		*
Fig. 28	3H4577A/G53	GASKET, governor.	1	27140	*	*
Fig. 28	3H4577A/G28	GEAR, governor.	1	290166		*
Fig. 28	3H4577A/L23	LEVER, governor.	1	21589		*
Fig. 28	3H4577A/L24	LEVER, governor control.	1	22531		*
Fig. 28	3H4577A/S58	SPRING, governor.	1	26502	*	*

*Indicates stock available. †Parts not stocked in station or region stock are carried in depot stock.

47. MAINTENANCE PARTS LIST FOR POWER UNIT PE-167-A (Contd).

Ref. symbol	Signal Corps stock No.	NAME OF PART AND DESCRIPTION	Quan. per unit	Mfrs. part and code No.	†Station stock	†Region stock
		Magneto Group				
Fig. 28	3H4577A/C1	CABLE, ignition.	1	99391	*	*
Fig. 28	3H2699-39	MAGNETO ASSEMBLY: Briggs & Stratton No. 290042.	1	290337	*	*
Fig. 28	3H1901-NP/B30	BUSHING, magneto plate.	1	89667		*
Fig. 28	3H4577A/C15	CAPACITOR, magneto.	1	29861	*	*
Fig. 28	3H4577A/P30	CONTACT POINT ASSEMBLY.	1	29667	*	*
Fig. 28	3H4577A/G3	GASKET, magneto: 0.015″ thick.	1	67307	*	*
Fig. 28	3H4577A/G35	GASKET, magneto: 0.005″ thick.	1	67597	*	*
Fig. 28	3H4577A/G4	GASKET, magneto: 0.009″ thick.	1	67607	*	*
Fig. 28	3H4577A/P37	PLUNGER, contact point.	1	65704		*
		Muffler Group				
Fig. 25	3H1901-NP/H15	MUFFLER.	1	89966		*
		Oil Pan Group				
Fig. 25	3H1901-NP/B1	BASE, oil.	1	89889		*
Fig. 25	3H1901-NP/C8	CAP, oil filler: includes gasket, cotter pin and plug.	1	290177		*
		Oil Pump Group				
Fig. 25	3H1901-NP/P20	OIL PUMP ASSEMBLY.	1	89676		*
Fig. 25	3H1901-NP/S40	SCREEN, oil pump.	1	89688		*
Fig. 25	3H1901-NP/S30	SPRING, oil pump.	1	26485		*

Spark Plug Group

Fig. 25	3H4577A/G21	GASKET, spark plug.	1	29806	*	*
Fig. 25	3H4577A/P34	PLUG, spark; with gasket.	1	29693	*	*
Fig. 25	3H4577A/S25	SHIELD, spark plug.	1	89742		*

Starting Crank Group

Fig. 26	3H4577A/R37	ROPE, starter.	1	29878	*	*

Valve Group

Fig. 26	3H4577A/T1	FOLLOWER, cam.	2	63788		*
Fig. 26	3H4577A/P10	PIN, valve retainer.	2	23187	*	*
Fig. 26	3H4577A/R13	RETAINER, valve spring.	2	23184	*	*
Fig. 26	3H4477A/S53	SPRING, exhaust valve.	1	26748	*	*
Fig. 26	3H4577A/S57	SPRING, intake valve.	1	26021	*	*
Fig. 26	3H6682-1	VALVE, exhaust.	1	23663	*	*
Fig. 26	3H6682	VALVE, intake.	1	23386	*	*

(GENERATOR PARTS (D C)

Fig. 29-7A	3H4600-167/W10	ARMATURE ASSEMBLY.	1	ARM801		*
Fig. 29-15	3H4600-167/B5	BRUSH: d-c; carbon; grade CM; size ¾" x ⅜" x 1⅛".	2	BRU-105-2	*	*
Fig. 29-13	3H4600-167/H5	BRUSH HOLDER ASSEMBLY: includes spring.	2	28-1024A		*

ACCESSORIES AND SUPPLIES

	3H4600-167/B1	BOOK, instruction.	2			

*Indicates stock available. †Parts not stocked in station or region stock are carried in depot stock.

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FIELD NOTES