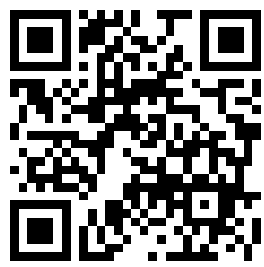

TM 11-960

WAR DEPARTMENT TECHNICAL MANUAL

POWER UNIT
PU-32/C

WAR DEPARTMENT *27 DECEMBER 1944*

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WAR DEPARTMENT,
WASHINGTON, 25, D. C., 27 December 1944.

TM 11-960, Power Unit PU-32/C, is published for the information and guidance of all concerned.

A. G. 300.7 (11 Sept 1944).

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

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

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For Explanation of Symbols see FM 21-6.

DESTRUCTION NOTICE

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

WHEN—When ordered by your commander.

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

2. Cut—Use axes, handaxes, machetes.

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

4. Explosives—Use firearms, grenades, TNT.

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

USE ANYTHING IMMEDIATELY AVAILABLE

FOR DESTRUCTION OF THIS EQUIPMENT

WHAT—1. Smash—Cylinder head, cylinders, spark plugs, magneto, carburetor, generator, meters, and gauges.

2. Cut—All connecting wires and cables.

3. Burn—Instruction books, canvas cover, and shipping case.

4. Bend—Base, housing, control cabinet, etc.

5. Bury or scatter—Any or all of the above pieces after breaking.

DESTROY EVERYTHING

SAFETY NOTICE

1. **DO NOT ATTEMPT ADJUSTMENTS OR CHANGES ON WIRING WHILE POWER UNIT PU-32/C IS IN OPERATION. THIS UNIT GENERATES HIGH VOLTAGE. SEVERE AND POSSIBLY FATAL SHOCKS MAY BE ENCOUNTERED ESPECIALLY WHEN POWER UNIT IS OPERATING ON WET OR DAMP GROUND.**

2. **SUFFICIENT AND PROPER VENTILATION MUST BE PROVIDED IF THE POWER UNIT IS OPERATED IN A CONFINED SPACE. EXHAUST GASES PRODUCED ARE POISONOUS, AND EXCESSIVE INHALATIONS MAY RESULT IN SEVERE SICKNESS OR DEATH.**

3. **DO NOT SERVICE WITH GASOLINE WHILE POWER UNIT IS RUNNING OR IF A RADIO TRANSMITTER IS OPERATING IN CLOSE PROXIMITY TO POWER UNIT.**

4. **OPERATOR SHOULD OBSERVE EVERY STANDARD REGULATION WHILE OPERATING THIS POWER UNIT.**

NOTE

IF THIS UNIT IS USED FOR EMERGENCY SERVICE, IT WILL BE OPERATED NOT LESS THAN ONE HOUR EACH WEEK CARRYING THE FULL CONNECTED LOAD.

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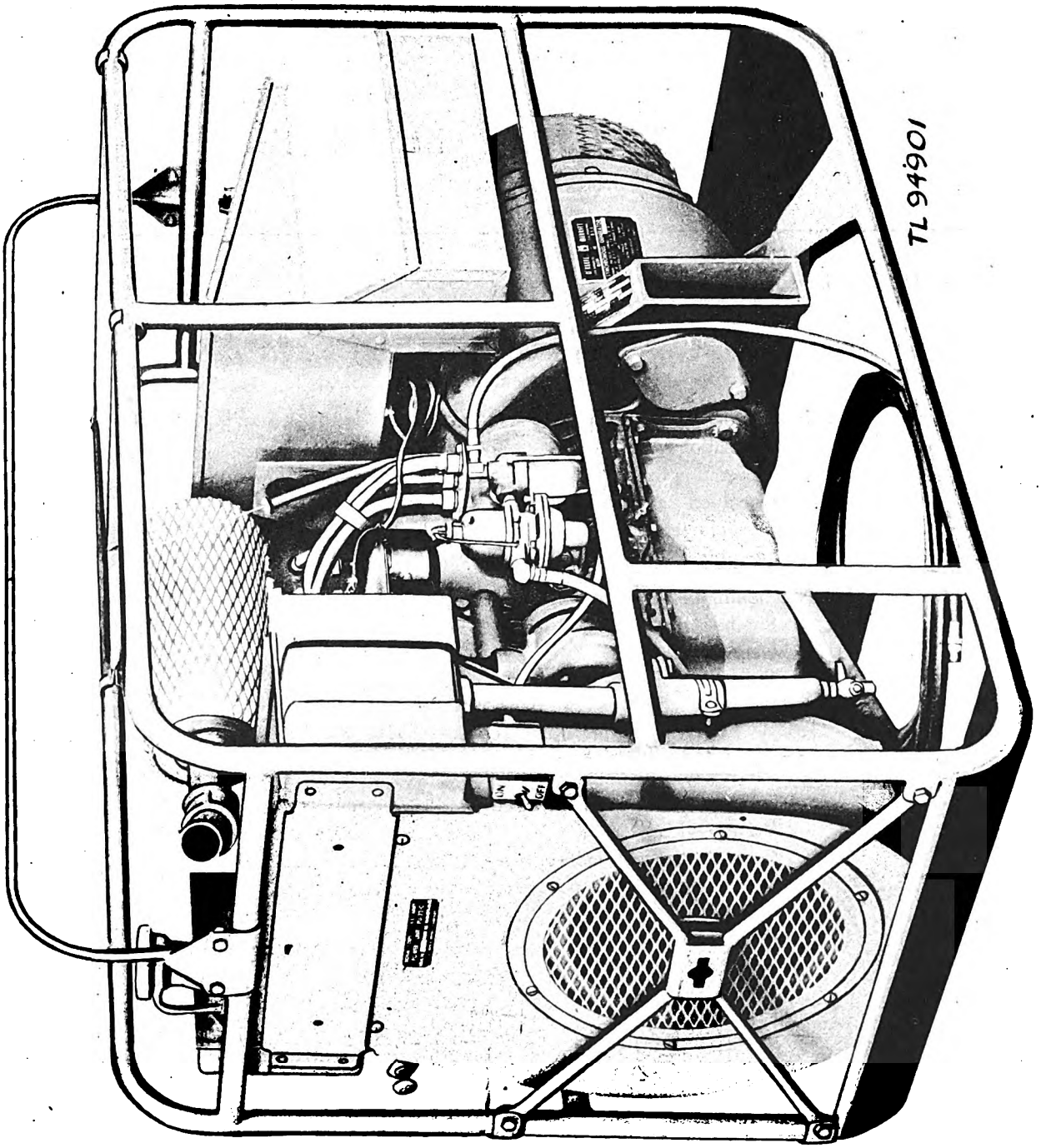


Figure 1. Power Unit PU-32/C.

SECTION I

DESCRIPTION

1. GENERAL.

Power Unit PU-32/C (fig. 1) is a complete electric generating plant. It consists of a gasoline engine and an alternating-current (a-c) generator, with the necessary accessories and controls, all mounted in a tubular metal frame with a skid base. The generator delivers 5 kilowatts at 60 cycles, a-c.

a. Engine. A conventional automotive-type, internal combustion gasoline engine (figs. 2 and 3) is used. It furnishes the power which drives the generator to which it is direct-connected. It also drives certain necessary accessory equipment. At normal operating speed of 1,800 revolutions-per-minute (rpm), the rated horsepower is 13.5, and at full load the fuel consumption is 1-1/4 gallons per hour.

b. Generator. The a-c output of the specially-constructed generator (figs. 4 and 5) is designed for the following circuits: 120 volts single phase, two-wire; 120 volts three-phase, three-or four-wire; or 208 volts three-phase, three-or four-wire. Its flexibility allows it to be used on single-phase lighting and control circuits and single- and three-phase motor circuits at the same time. The rated capacity of this generator is 5.0 kilowatts (6.25 kilovolt-amperes at 0.8 power factor).

c. Control Panel. Engine and generator controls are contained in an aluminum cabinet (figs. 6 and 7) mounted directly above the generator. This cabinet has a hinged cover, upon which all of the instruments are mounted. The instruments are accessible from the rear by removing the screws along the top edge of the cover and lifting the panel upwards.

2. TABLE OF MAJOR COMPONENTS.

Quantity	Article	Width (in.)	Length (in.)	Height (in.)	Weight (lbs.)
1	Power Unit PU-32/C	23¾	44	35	600
1	Engine with accessories	19½	24¾	26	240
1	Generator with adapter ring	14	17	14¼	220
1	Control panel assembly	21	17¾	11¾	35
1	Radiator assembly	19½	10	10	19
2	Tool and spare parts boxes	5	15¾	7¾	5
1	Frame and cover	22	45	35	54

3. DESCRIPTION OF MAJOR COMPONENTS.

Power Unit PU-32/C consists of the following major components:

a. Engine. The engine is a four-cylinder, L-head, water-cooled, automotive type engine which develops 13-1/2 horsepower at a normal operating speed of 1,800 rpm. The speed is controlled by a flyweight, mechanical governor which is gear-driven from the camshaft. The engine furnishes power to drive the main generator to which it is direct-connected. It also drives certain necessary accessory equipment and is designed to operate with regular unleaded gasoline of 60 to 65 octane rating.

(1) COOLING SYSTEM. The water cooling system includes an automotive-type radiator, blower, and water pump. A thermostat in the water outlet elbow at the top of the cylinder head controls the water circulation. The radiator is mounted horizontally on the front part of the unit. The underside of the radiator fits over the opening of the blower housing. A blower, inside this housing, is mounted on an in-line shaft keyed to the front end of the engine crankshaft. Cooling air is drawn from in front of the unit and is discharged upward through the radiator.

(2) IGNITION SYSTEM. An aircraft-type magneto

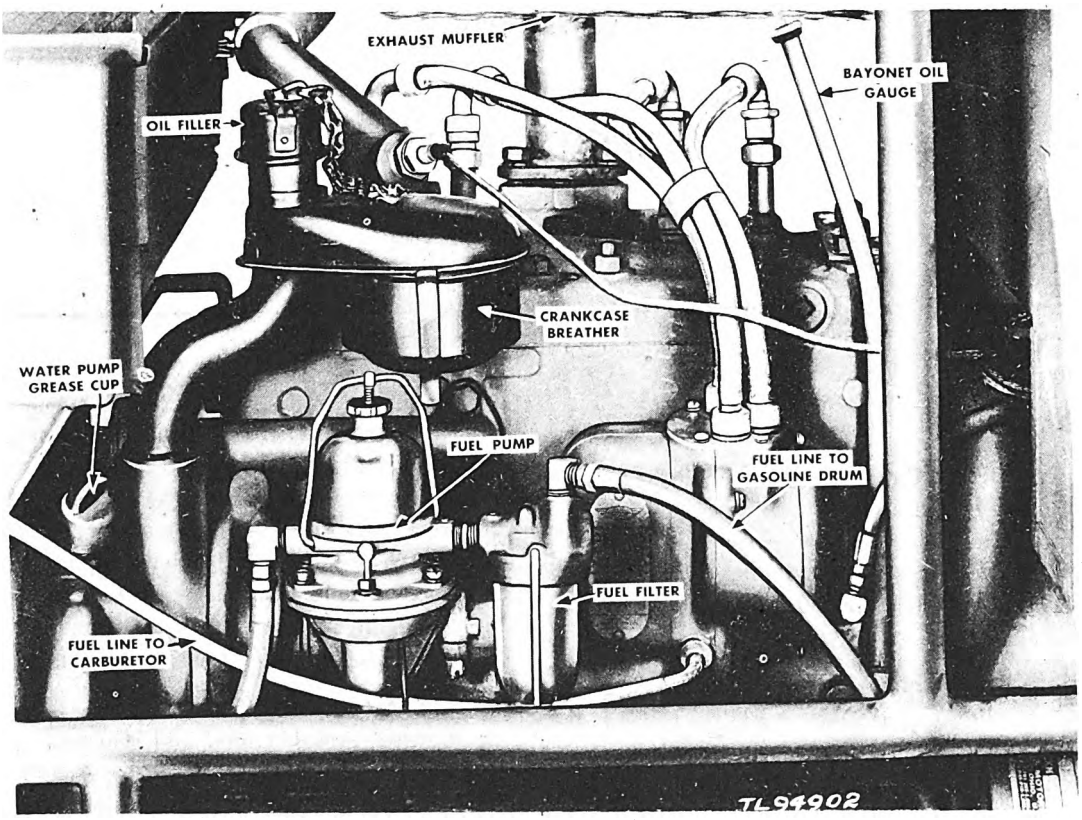


Figure 2. Engine for Power Unit PU-32/C, right side.

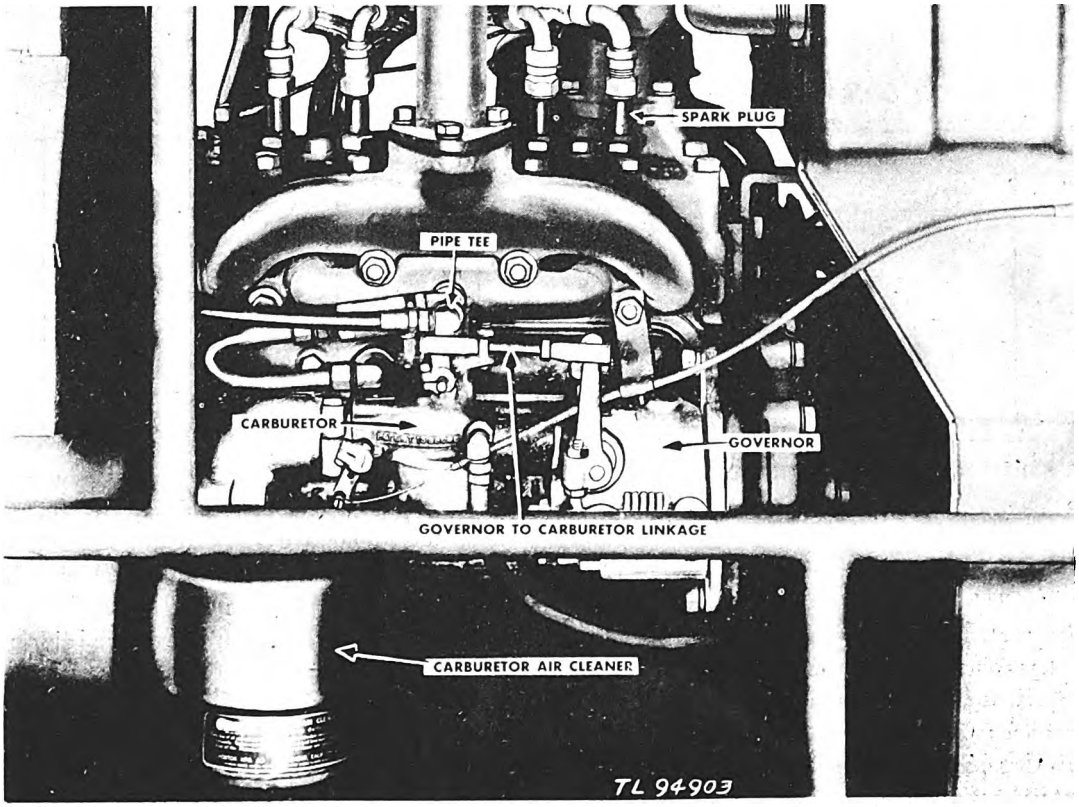


Figure 3. Engine for Power Unit PU-32/C, left side.

with impulse starting (fig. 8) is used for ignition. This magneto is mounted on the right side of the engine (looking at power unit from the front of the radiator) and is connected to the water pump shaft by a floating disk-type coupling. An ignition switch (figs. 1 and 9) is mounted on the right-hand side of the blower housing, in order to be accessible when cranking the engine, and connects with the magneto through a shielded wire.

(3) FUEL SYSTEM. Power Unit PU-32/C is not equipped with a gasoline tank, but a 20-foot rubber fuel line is provided to reach a gasoline container placed anywhere within a 20-foot radius of the power unit. A fuel pump assembly (fig. 2) draws the gasoline through a sediment bowl and valve mounted next to the fuel pump, and then to a standard commercial-type carburetor with a fixed jet. This carburetor is fitted with a combination oil-type air cleaner and silencer.

(4) OILING SYSTEM. A gear-type oil pump supplies pressure for lubrication of the main, connecting rod, and camshaft bearings. Other internal parts are splash lubricated, including the engine governor.

(5) ENGINE GOVERNOR (fig. 3). The governor, mounted on the left side of the engine, is a precision ball-bearing type which is gear-driven from the camshaft. The governor arm is directly connected to the carburetor butterfly by means of a throttle control rod, and has a sensitivity adjustment that enables the engine to hold the generator frequency to within approximately one-half cycle from no load to full load. The governor is adjusted at the factory and normally requires little attention, but it is essential that it function properly. Good regulation cannot be obtained with the engine in bad condition.

(6) EXHAUST SYSTEM. The exhaust manifold is built around the intake manifold in order to warm the fuel mixture as it enters the cylinders. A steel muffler, covered with asbestos, is mounted directly above the manifold and exhausts directly above the radiator, in order to carry the fumes upward with the air stream.

b. Generator. The a-c generator used on Power Unit PU-32/C is a four-pole, revolving field type with a built-in d-c exciter. The exciter armature and the alternator revolving field are both carried on the main generator shaft which is supported by an annular ball bearing at the exciter end and by the engine crankshaft at the generator fan end. An adapter casting serves as a mounting to couple the generator frame to the engine block, and also serves as a housing for the generator fan. The rated output of the generator at 1,800 rpm is 5 kilowatts (6.25 kilovolt-amperes at 0.8 power factor.) The following voltages may be obtained: 120 volts, single-phase, two-wire; 120 volts, three-phase, three- or four-wire; or 208 volts, three-phase, three- or four-wire.

c. Control Panel Assembly. The control panel (fig. 6) is located directly above the generator and carries the following controls and indicators:

(1) A-C VOLTMETER. 0-150 volts scale, indicates output voltage.

(2) FREQUENCY METER. Indicates the output frequency.

(3) RUNNING TIME METER. Indicates the total operating hours.

(4) WATER TEMPERATURE GAUGE. Indicates the temperature at the top of the engine water jacket.

(5) OIL PRESSURE GAUGE. Indicates the operating pressure of the engine lubricating oil.

(6) VACUUM GAUGE. Indicates throttle opening position; from closed throttle at 14 to 16 inches of vacuum to open throttle at 4 to 6 inches.

(7) MANUAL FIELD-VOLTAGE CONTROL RHEOSTAT. Used for adjusting the output voltage when the regulator is switched off.

(8) VOLTAGE REGULATOR RHEOSTAT. Used for controlling the output voltage when using the voltage regulator.

(9) CIRCUIT BREAKER. Serves as a load switch and trips automatically when the power unit is heavily overloaded.

(10) VOLTAGE REGULATOR SWITCH. Connects the voltage regulator into or out of the circuit.

(11) POWER OUTLETS. A duplex 2-wire utility outlet and one 4-wire receptacle are provided on the control panel.

(12) A-C OUTPUT TERMINALS. Four ⅜-inch terminal studs (fig. 4) are located at the rear of the control panel. These studs are insulated with a bakelite barrier and have a bakelite-insulated thumb screw for connection to the main load of the unit.

(13) SUPPRESSION CAPACITORS. Four mica capacitors are used to bypass radio interference. These are connected by short copper strips to the output terminals.

d. Tool and Spare Parts Boxes. Two aluminum tool boxes are mounted on the main generator bracket on each side of the control cabinet, and are integral parts of the cabinet. The tools are securely fastened by a hasp to prevent loss of contents.

(1) The tool box contains the following parts:

1 pair of gas pliers
1 set tappet wrenches
1 set feeler gauges
1 small screwdriver
1 large screwdriver
1 hammer, 1 lb., machinists
1 small box assorted cotter keys
1 set open-end wrenches
2 sheets #00 sandpaper

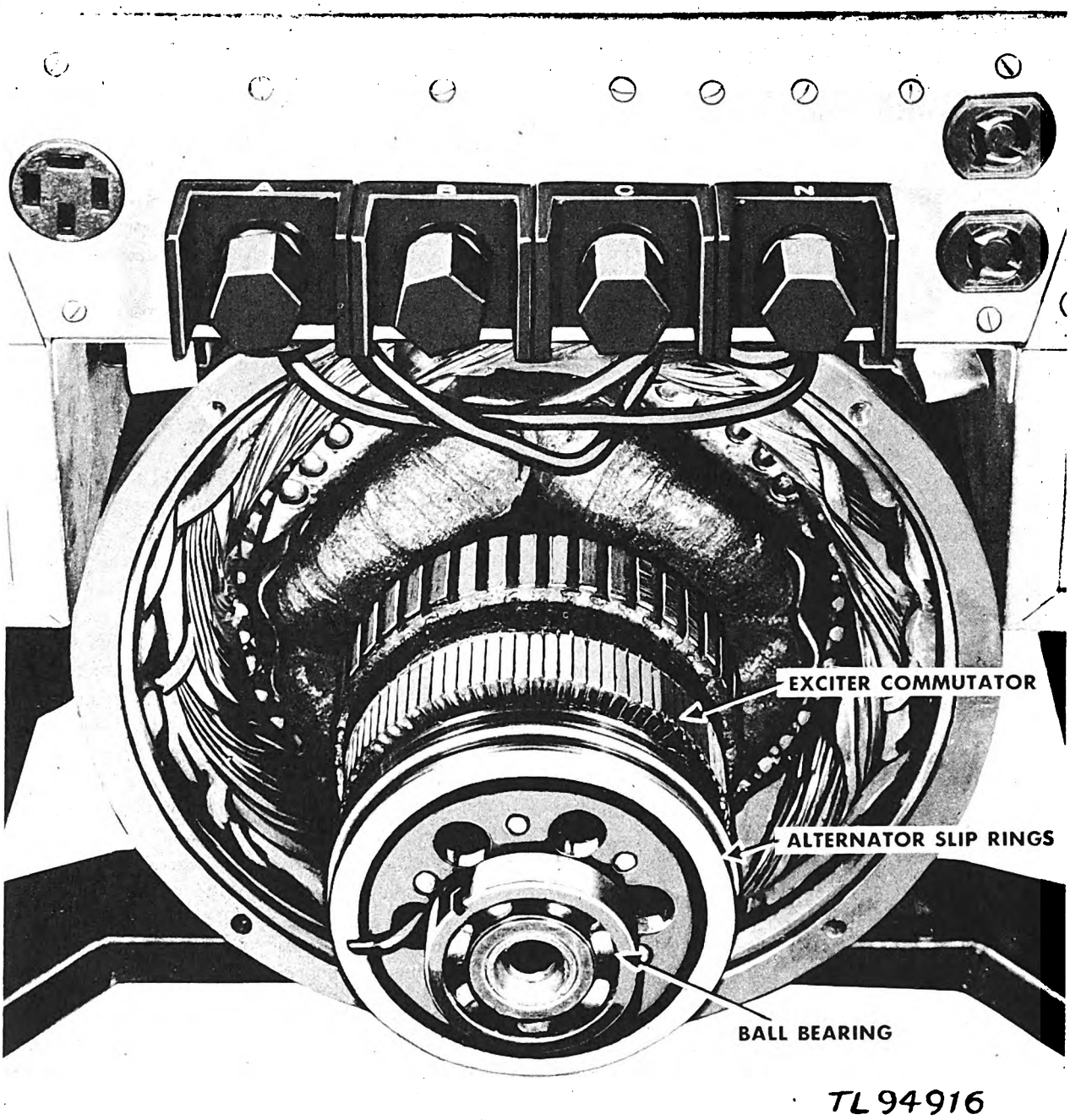


Figure 4. Generator, with end bell removed, showing slip rings and exciter commutator. Note terminal block above control panel.

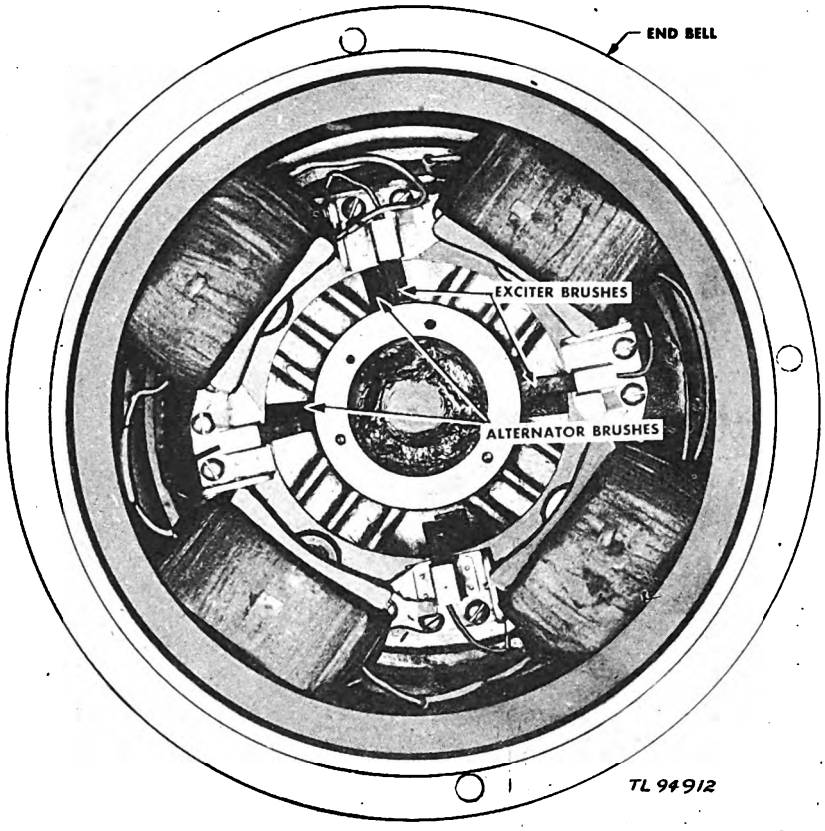


Figure 5. Generator end bell, with exciter field coils mounted inside.

1 small spool, soft, iron wire
1 bottle gasket seal, Pulman or Bowes, or equal, with brush
1 valve lifter
1 valve grinding kit, zip compound
1 ¼-lb. roll friction tape

(2) The spare parts box contains the following:

1 water pump repair kit
1 set expansion plugs (2)
1 fuel pump diaphragm
1 sediment bulb
3 sets spark plugs (12)
1 set gaskets (complete set of 12)
1 set exhaust valves (4)
1 spring and retainer (valve) and locks (4)
1 set magneto points
2 magneto capacitors
1 set radiator hose and clamps (3)
1 set alternator brushes (4)
2 sets exciter brushes (8)
2 sets brush capacitors (4)
2 extra cylinder head gaskets

SECTION II
INSTALLATION AND OPERATION

4. INSTALLATION.

a. Handling the Uncrated Power Unit. The skid base permits towing the power unit short distances over firm ground with truck or tractor. In sand or soft, muddy soil it may be necessary to lay down planks over which to skid the unit. Center the tow rope or chain at one end of the framework near the skid. Use a long hitch and tow slowly. To hoist the power unit, attach a hoisting chain to the yoke at the center of the unit between the engine and the control cabinet. Rollers may be used under the tubular metal frame.

b. Uncrating and Unpacking the Power Unit. The crated power unit is completely sealed and contains a dehydrating substance to prevent moisture condensation within the unit. Therefore, do not uncrate until ready to use.

(1) PROCEDURE. Remove the metal band which fastens the treated paper on the top of the crate. Remove

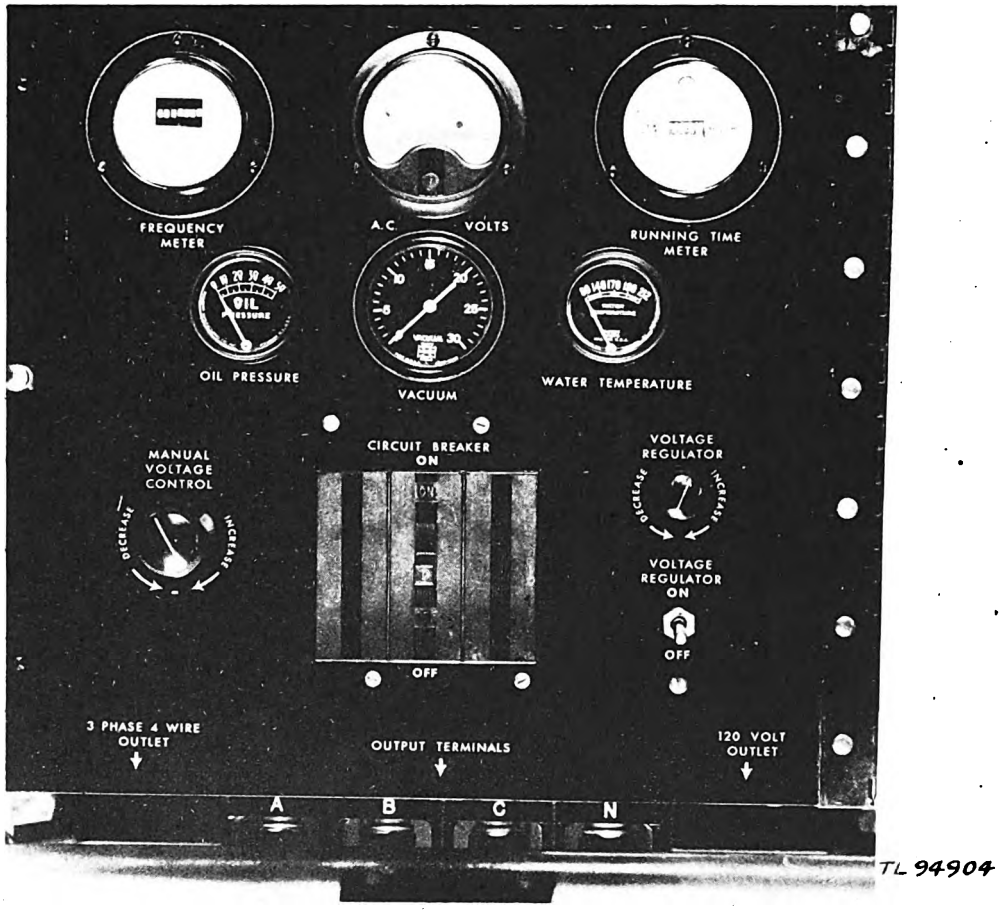


Figure 6. Control panel, Power Unit PU-32/C.

this paper from the top edges. Remove the metal straps from the corners and around the bottom. Remove the top and ends from the crate, then remove the two sides. Cut the cord and remove special shellmar barrier wrapping by opening the seams. Remove the cardboard cover. The power unit may then be lifted from its wooden base by removing the nuts from the bolts protruding through the skid base.

(2) ACCESSORIES. Remove silica jel plugs from cylinder head and replace with spark plugs that are packed with spare parts. Remove seals attached to the engine manifold, air cleaner, crank opening, oil breather intake, and generator housing. Remove the dehydrating bags on top of the engine.

c. Importance of Proper Installation. Although Power Unit PU-32/C is built to rigid specifications and carefully inspected before leaving the factory, it cannot function properly and give the best service unless the operating conditions are reasonably favorable. Many of these conditions depend entirely on the installation. The instructions which follow apply under usual conditions. When they cannot be followed exactly, use them as a guide and make the best installation that circumstances permit.

d. Choice of Location. (1) RELATION TO LOAD. Locate the unit as near the center of the load as practicable. This assures lower line loss with a given size of wire and improves the control of voltage at the remote end of the lines. The size of line wires required depends largely upon the distance from the power unit to the load, the amount and kind of load and the permissible voltage drop between power unit and load. Be sure to use wire that is large enough for the purpose. If you do not know the proper size of wire, refer to the wiring tables in subparagraph **e.** below.

(2) SURROUNDING CONDITIONS. Always provide the most favorable operating conditions that circumstances permit. The canvas covering on Power Unit PU-32/C protects it so that it may be operated out-of-doors, if necessary, but rain, snow, dust and grit, and extremely cold weather are very unfavorable to satisfactory operation and long life. Wherever possible, install the power unit inside a building or mobile vehicle.

e. Wire Size Tables.

(1) UNITY POWER FACTOR LOAD, 120-VOLT SYSTEM.

Load in watts	A-c amperes	Distance in feet									
		100	200	300	400	500	600	700	800	900	1000
500	4.17	10	10	10	10	10	10	10	8	8	8
1000	8.34	10	10	10	8	8	6	6	6	6	4
1500	12.5	10	10	8	6	6	6	4	4	4	2
2000	16.7	10	8	6	6	4	4	4	2	2	2
3000	25.0	10	6	6	4	2	2	2	2	1	0
4000	33.4	8	6	4	2	2	1	1	0	0	
5000	41.7	8	4	2	2	1	0	0			

(2) AT 80% POWER FACTOR LOAD, 208-VOLT SYSTEM.

Load in watts	A-c amperes	Distance in feet									
		100	200	300	400	500	600	700	800	900	1000
1000	5.2	10	10	10	10	10	10	10	10	8	8
1500	7.8	10	10	10	10	10	8	8	8	8	6
2000	10.4	10	10	10	10	8	8	6	6	6	6
3000	15.6	10	10	8	8	6	6	6	4	4	4
4000	20.8	10	10	8	6	6	4	4	4	2	2
5000	26.0	10	8	6	4	4	2	2	2	2	1

NOTE: No. 4-0 wire is the largest size practical for commercial use. Do not use wire smaller than No. 10, supported every 75 feet, for outside leads, because it does not have sufficient strength to withstand bad weather conditions although it may be large enough to carry the electrical load.

f. Indoor Installation.

(1) SPACE REQUIRED. If the power unit is to be permanently installed, provide an indoor location. This is particularly important in cold climates. Provide a floor space 9 by 12 feet, or larger, in size. Install the power unit lengthwise in the space and at least 2-1/2 feet, from the nearest wall or partition, to provide easy access for servicing. Usually the front of the power unit, as viewed from the engine end, should be toward an outside wall so that the exhaust line can be extended outdoors conveniently. Provide ventilation (at least a door and a window on different sides of the room) so that the room temperature may be controlled. If necessary, in order to prevent too great a rise in room temperature, attach a canvas duct to the radiator grille and to a wall opening at least as large, so that the heated air will be conducted outside the room.

(2) FOUNDATION. Attach the power unit to a firm, level base by any practical means. The base must be strong enough to permanently support the weight of the power unit which is approximately 610 pounds. It may be made of concrete or heavy timbers and should extend about 10 inches above the floor level for convenience. Shock-absorbing material may be used between the power unit and the base, if desired.

(3) EXHAUST. Exhaust gases are deadly poisonous. Pipe them to the outside of the building. A 10-foot length of flexible exhaust line is furnished with the power unit. Connect one end of this to the exhaust outlet which is located near the upper left front corner of the power unit. The exhaust pipe must extend outside the building by the most direct route practicable. If additional pipe is necessary, increase the size by one pipe size for each additional 10 feet of length. **Be sure that all connections are mechanically secure and gas tight.** Avoid unnecessary turns. Pitch the pipe downward from its connection at the power unit, if possible. If necessary to pitch the pipe upward, install a condensation trap in the line at the point where the upward pitch starts. This trap may be assembled from suitable pipe fittings. Its purpose is to catch water that condenses in the exhaust line and to prevent the water from running into the muffler of the power unit. The trap must be drained periodically to perform this function. An exhaust line gets hot. If it passes through an inflammable wall, partition or floor, install it in metal collars so as to separate it at least several inches from the inflammable material. Support the pipe securely at necessary points. If necessary, shield the pipe so that no one will get burned by contact with it.

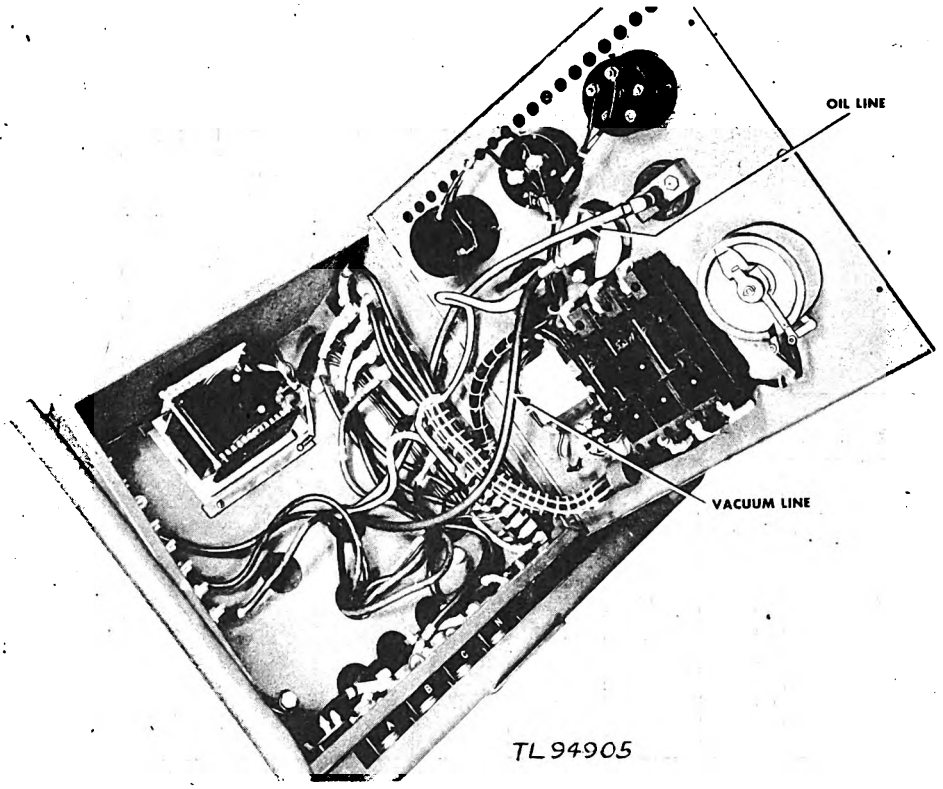


Figure 7. Control panel wiring, Power Unit PU-32/C.

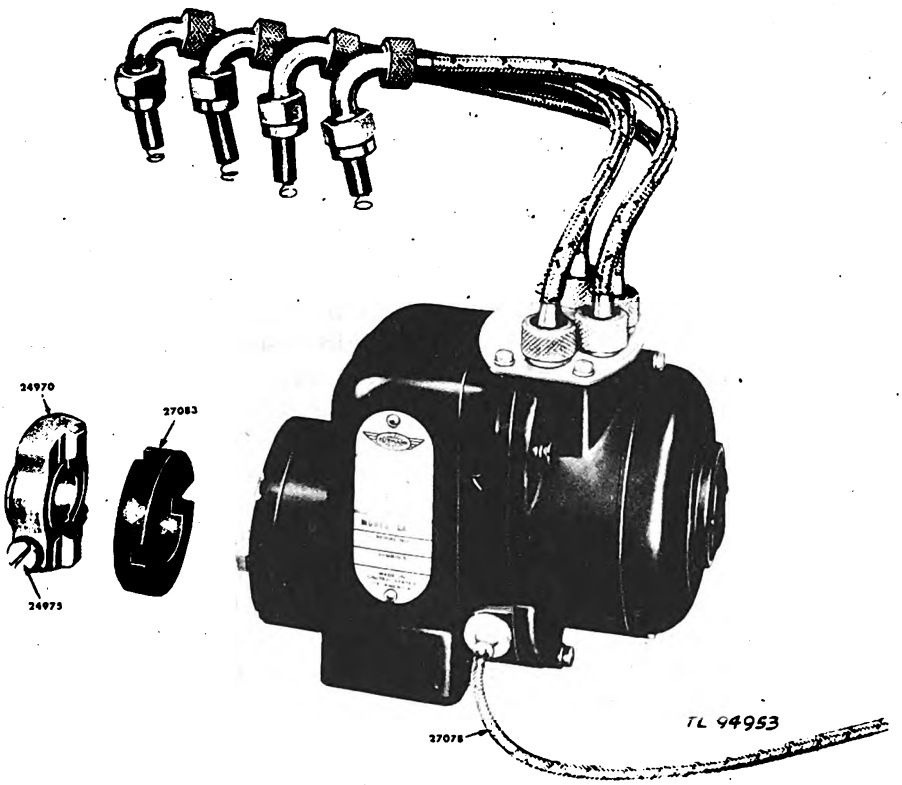


Figure 8. Magneto, Power Unit PU-32/C.

(4) FUEL TANK. Provision is made for connecting the fuel supply to the unit. The fuel supply will usually be in regular gasoline drums. Use the 20-foot lengths of flexible fuel line furnished (fig. 1). Install the fuel tank out-of-doors, if possible, but not farther from the power unit than the 20-foot fuel line will permit. If a longer fuel line is used, the pump may fail to keep the carburetor supplied with fuel. The bottom of the fuel tank should not be more than 6 feet below the fuel pump at the power unit. Be sure that the fuel line has a continuous downward pitch from power unit to tank. The tube must be inside the tank, extending to within an inch or two of the bottom so that the fuel may be drawn from the tank by the pump. Do not install the tank near the exhaust line. The tank must be vented.

(5) ELECTRICAL CONNECTIONS. Make sure that all electric wires entering the room and within the room are properly supported and insulated. Connect the load wires to the a-c output terminals (fig. 4) on the rear of the control panel. The following table shows the correct connections for single- or three-phase operation:

Phase	Volts	Wires	Links	Terminals
1	120	2	Delta	A-B
3	120	3	Delta	A-B-C
3	120/208	4	Wye	A-B-C-N

The size of insulated wire to use within the room for connecting the load to the power unit depends on the load amperes and the type of insulation on the wire. The following sizes are recommended as the smallest safe sizes for use within the room to carry the full load of the power unit; use No. 0 for 120-volt service, if the insulation contains rubber, or No. 2 if the insulation does not contain rubber; use No. 6 for 240-volt service if the insulation contains rubber, or No. 8 if the insulation does not contain rubber. Make sure that all connections are mechanically and electrically secure.

g. Mobile Installation.

(1) MOUNTING. Attach the power unit securely to the floor or other supporting member of the vehicle in which it is installed. It should be so installed that it will set approximately level when in normal operation. Take full advantage of the available space in locating the power unit so as to provide proper ventilation and space for servicing. Use as much of the 10-foot length of flexible exhaust tube as needed and pipe the exhaust gases outside the vehicle. Keep this pipe at least several inches from inflammable material and support it securely so that it will remain permanently in place. **This is important because exhaust gases are deadly poison.**

(2) EXHAUST. Do not run the vehicle into a closed building and operate the power unit without carefully attaching an extension exhaust line that will carry all the exhaust gases outside the building. The size of this extra piping should be increased one pipe size for each 10 feet of length.

(3) VENTILATION. If the vehicle is a closed one, proper ventilation must be provided. This will require at least two openings, an inlet and an outlet, near opposite ends of the power unit. Several smaller openings will serve, if necessary, but there must be a total of at least 3-1/2 square feet of opening for the inlet and a similar amount for the outlet. If necessary, connect a canvas duct to the radiator grille and the outlet opening in such manner that the heated air is forced outside the vehicle and thus prevented from recirculating.

(4) WIRING. Support all permanent wiring within the vehicle so that vibration will not destroy the insulation or break the wires. Wiring is easily run in any direction. Do not let its location interfere with convenient servicing of the power unit. If power is taken off the unit by flexible cable, provide a reel for the cable and store it in such location while in transit that it will not become damaged. Do not store other items on, or against, the power unit, or loosely within the compartment in such manner as to risk damaging the unit in transit.

(5) LEVELING. If the power unit is to be operated for hours at a temporary location, locate the vehicle so that the power unit is reasonably level.

5. PREPARATION FOR USE.

a. Removing Seals. Remove all paper seals on the air cleaner, crankcase breather, and oil filler tube. Remove the protecting paper from the under side of the fan belt. Fill the air cleaner with oil as outlined in paragraph **5b**(6). During the export packing process, the inside of the combustion chamber is sprayed with rust-preventive oil. This oil may foul the spark plugs. Therefore, remove the plugs and clean them in gasoline before attempting to start the engine.

b. Procedure. Comply with the following instructions in the order given:

(1) INSTALLATION. Recheck to make sure that all instructions for installing the plant as given in paragraph 4 have been complied with.

(2) COVERING. Remove the canvas which covers the unit.

(3) CRANKING. Crank the engine over a few times with the hand crank to make sure that the pistons are free and that the generator turns freely. The hand crank is attached on the front skid below the blower housing. Keep it there when not in use.

(4) ELECTRICAL CONNECTIONS. Check all electrical connections to make sure they are tight and clean.

(5) CRANKCASE LUBRICATION. Fill the crankcase

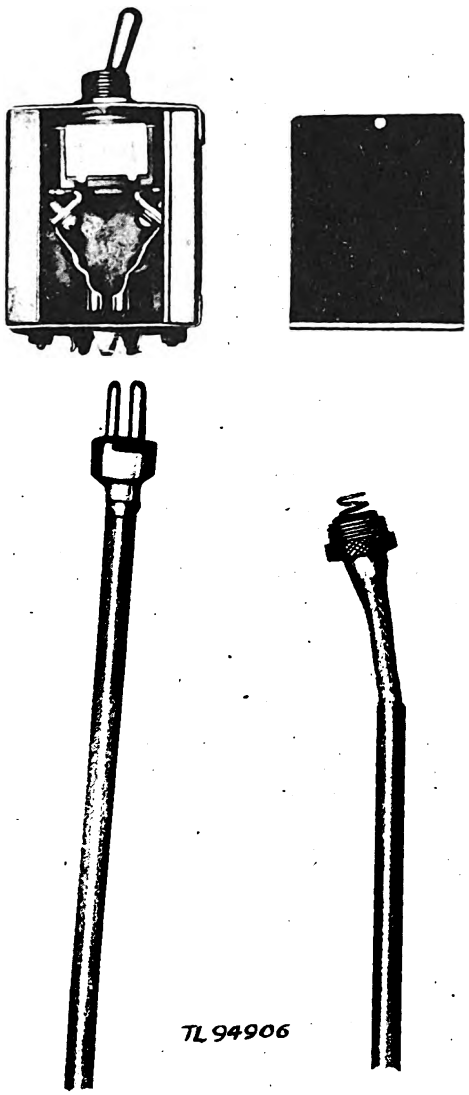


Figure 9. Ignition switch, Power Unit PU-32/C.

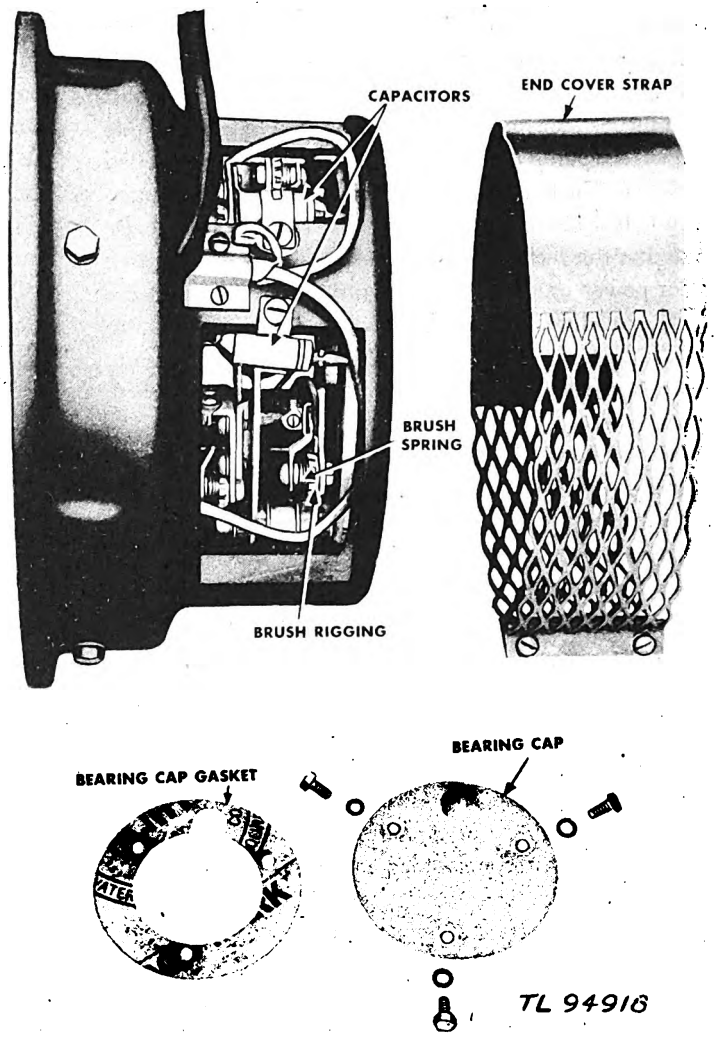


Figure 10. Generator end bell with cover strap removed to show brush rigging.

with oil to the FULL level, as indicated by the bayonet gauge. Use U. S. Army Spec. No. 2-104-B oil of proper SAE number according to the lowest temperature to which the power unit will be exposed, as indicated in the following table:

Temperature	*SAE Number*
Above 32° F	SAE-30
From 0° F to 32° F	SAE-10
Below 0° F	See below

Drain crankcase. Refill crankcase with 2-1/2 quarts OE, SAE-10, check level and mark this level "X" on the gauge. Add 1 quart gasoline to bring level from "X" to FULL mark. During operation, maintain at "X" level mark by adding OE, SAE-10. Immediately before shutdown fill to "X" mark with OE, SAE-10; then add gasoline to FULL mark. Run engine for five minutes. Refer to figures 13 and 14, Lubrication Chart, in connection with crankcase and other lubrication.

(6) AIR CLEANER. Remove the oil cup from the intake-air-cleaner and fill to the proper level, as marked on the cup, with oil of the same grade as used in the crankcase. Replace the cup, making sure that the snaps hold it securely in place.

(7) THROTTLE CONTROL ROD BALL JOINTS. Place a drop of light cylinder oil in each ball joint of the throttle control rod and check to make sure the throttle mechanism moves freely.

(8) MAGNETO. See that the cam-lubricating felt wick is saturated with oil OE, and that the impulse coupling is lubricated with Grease PS.

(9) WATER DRAIN COCK. Close the water drain cock at the lower radiator connection and the water drain cock on the right side of the cylinder block below the magneto.

(10). RADIATOR. Fill the radiator to one inch below the bottom of the radiator neck with clean, alkali-free water. Distilled or rain water may be used. If there is danger of freezing use a standard antifreeze solution in proper proportion. Carefully check all connections for water leaks, correcting any found. The capacity of the cooling system is 9 pints.

(11) CIRCUIT-BREAKER. Make sure that the CIRCUIT BREAKER handle is in the OFF position so that the load is not connected to the alternator.

(12) LOAD WIRES. Check the load wires for proper connections.

(13) A-C TERMINAL JUMPERS. The terminal jumpers at the a-c terminal block on the rear of the control panel are connected properly for an output of 120 volts and will need no attention if that is the desired voltage. If an output of 208 volts is desired, it will be necessary to change the jumper connections. Remove the two round-head screws from the left-hand side of the control panel (looking toward panel from the generator end of the unit) and swing the panel upward on its hinge. Remove the three jumpers from the top of the terminal block on the left-hand side inside the cabinet. These jumpers have the triangular marking delta above them. Reconnect the three jumpers so that they are now across the terminals marked "Y" (fig. 4). Refer also to paragraph 4*f*. (5).

(14) FUEL SUPPLY. Connect the 20-foot flexible fuel line to the sediment bowl on the engine and insert the other end in the gasoline container placed in the vicinity of the power unit. By means of the lever on the side of the fuel pump, pump the carburetor bowl full of fuel. If the engine camshaft sets so that the pump diaphragm is in its lowest position, the lever will not operate the pump. In that case, insert the hand crank and crank the engine one complete revolution. Then the pump can be operated by the lever. Always push the lever down after pumping. If left up, the pump will not be operated by the engine. Examine the entire fuel system for leaks and correct any found.

6. OPERATION.

a. Preliminary. When the instructions in paragraphs 4 and 5 have been complied with, the power unit is ready for use and may be started. If the power unit was prepared for cold weather operation, the initial filling with diluted oil may have been purposely delayed until immediately before starting the power unit. Check the oil level by means of the bayonet gauge. Make sure that the crankcase is filled with proper oil to the FULL mark on the gauge before attempting to start the power unit.

b. Starting the Power Unit. Make sure that the circuit breaker (fig. 6) is in the OFF position. Snap on the ignition switch, pull out the choke button at the front of the housing and crank the engine.

c. Operation After the Engine Starts. Check the oil gauge immediately after starting the engine. The pressure will be high until the engine warms up. Observe the readings of the meters on the control panel as a check on the normal operation of the power unit. Normal readings for engine instruments after the plant reaches normal operating temperatures are as follows: Water temperature—approximately 175° F; oil pressure—approximately 20 pounds; vacuum gauge, no load—approximately 17 pounds.

d. Voltmeter Reading. The voltmeter is connected in the circuit ahead of the circuit breaker and will indicate the line voltage at all times.

e. Frequency Meter Reading. The frequency meter, wired in the circuit with the voltmeter, will indicate the frequency continuously. Normally the frequency will change a fraction of a cycle as the load is varied.

f. Connecting the Load. To connect the load to the unit, throw the main switch to the ON position. This switch is a circuit breaker and will automatically disconnect the generator from the load if any external trouble develops. To reset the circuit breaker, throw the switch to the extreme OFF position and then to the ON position. It will throw out again if the trouble has not been cleared. The trouble, generally a short circuit in the line, should be cleared before further use. The generator can withstand 25 percent overload for as long as two hours.

g. Regulation. (1) MANUAL VOLTAGE CONTROL. To set the voltage to 120 volts, turn the voltage regulator switch to the OFF position and adjust the voltage by means of the manual field control rheostat.
(2) AUTOMATIC VOLTAGE CONTROL. If it is desired to use the voltage regulator, turn the voltage regulator switch to the ON position and adjust the voltage by means of the regulator rheostat.
(3) INITIAL SETTING. As an initial setting, the no-load voltage (circuit breaker open) may be set to approximately 125 volts at 61 cycles, with the voltage regulator on. A final adjustment may then be made after the load has been applied. The normal frequency under load is 60 cycles. The frequency is adjusted by adjusting the engine governor as follows:

(a) To increase engine speed (raise the frequency) turn screw A to the right, or clockwise.

(b) To decrease engine speed (lower the frequency) turn screw A to the left, or counterclockwise.

(c) Lock the adjusting screw with the locknut B and tighten spring slide shoulder screws after the final setting.

h. Engine Adjustment. As soon as the engine starts, the manual choke control should be pushed in until it is about one-fourth out. As the engine warms up, the choke should be gradually returned to its normal or "in" position. If the engine has been shut down a short time before and is still warm, it will not be necessary to use the choke.

i. Faulty Starting. If the engine fails to start in 15 to 20 seconds of cranking, or stops running, the operator should shut off the switches and look for the cause.
(1) FLOODING. If it is suspected that failure to start or run is due to flooding, push in the choke and crank the engine from 10 to 15 seconds with the ignition switch off. Then start the engine.
(2) IGITION FAILURE. Check for ignition faults: For a quick check of the ignition system, remove a spark plug wire and hold it near the engine block while engine is being cranked with the ignition switch on. There should be a strong blue spark when the magneto fires that position. If there is no spark, or if spark is very weak, check all wiring connections at the magneto and ignition switch.
(3) LACK OF FUEL. Check the fuel reaching engine cylinders: Uncouple fuel line at carburetor and operate pump lever on fuel pump to see if gasoline flows freely to the bowl. If it is not flowing freely, uncouple the gasoline sediment bowl from the fuel pump and connect the fuel line directly to the fuel pump. Operate the pump lever again and check to see if the gasoline flows freely through the pump to carburetor. If it does not, then the trouble lies in the pump. If it does, then the trouble is in the bowl. Take off glass sediment bowl and clean it with gasoline. Also clean filter element. This element is made up of a number of very thin disks held together by a screw on the bottom and therefore should be handled carefully. If compressed air or a tire pump is at hand, the filter element should be blown out before replacing the bowl. After these operations, reassemble the unit and test again for flow of gasoline to the carburetor by cranking the engine from 10 to 15 seconds with the choke out and the ignition switch off. Then remove a spark plug. The spark plug should be wet or damp with gasoline if the carburetor line is clear and free.

j. Precautions. (1) The engine unit should be kept clean and adequately supplied with water, lubricating oil, and gasoline at all times. Care should be exercised to see that antifreeze is added to the water supply when operating in cold climates and the proper grade of oil is used for the temperature under which the unit is operating.
(2) Always be certain that the main switch (circuit breaker) is open (OFF) when connecting or disconnecting power cable, and before starting engine.
(3) If the unit is used in a building or enclosure, be sure that a hose or pipe is attached to the engine exhaust and run through an opening to the outside. Exhaust fumes and gases might prove harmful to operating personnel.
(4) Periodic examinations should be made to see that all electrical connections and leads are in good order and that electrical indicators and controls are functioning properly.

7. PARALLEL OPERATION.

Two or more Power Units PU-32/C may be operated in parallel where a greater power output is required than can be obtained from a single unit. Satisfactory parallel operation may be obtained if the governors are readjusted to allow reasonable load division.

a. Governor Adjustment. The units are shipped with governors adjusted for close frequency regulation. For satisfactory parallel operation, the governors must be readjusted to give even closer frequency regulation (greater stability) and also to give each unit the same speed under a given load. The regulation adjustment is made by screwing out the governor sensitivity adjusting screw

to give the spring maximum lever arm effect. This will increase the speed, so the slide adjusting screw must be backed out to reduce the speed to normal. The regulation with this adjustment should be about two or three cycles.

b. Load Connections. With the circuit breakers in the OFF position, connect similar phases together between the two terminal blocks on the control panels. Connect terminal A on one unit to terminal A on the second unit. Likewise, connect B to B, C to C, and N to N. Connect the load to either control panel.

CAUTION: DO NOT CONNECT TERMINALS WITH DISSIMILAR LETTERS TOGETHER BETWEEN THE TWO TERMINAL BLOCKS.

c. Parallel Operation. With the governors properly adjusted and the units running at rated speed, the generators may be connected in parallel to the load simply by closing the respective circuit breakers on the control panels without regard to exact synchronism. Sets operating in parallel should have their governors adjusted for the same regulation. The final speed adjustment, which determines the sharing of the load, should be made under load after the units have been paralleled.

8. STOPPING THE POWER UNIT.

To stop the power unit, turn the ignition switch on the front of the unit to OFF. This grounds the magneto. The unit may also be gradually stopped without touching the power unit by removing the fuel line from the gasoline container.

SECTION III
FUNCTIONING OF PARTS

9. ENGINE THEORY.

a. Four Stroke Cycle. The engine used in Power Unit PU-32/C is a conventional automotive type of internal-combustion gasoline engine. Such engines develop their power by burning a mixture of gasoline and air under compression in the cylinders and applying the resulting expending force on the heads of the pistons. The resulting downward motion of pistons is transmitted through connecting rods to the crankshaft, resulting in rotary motion of the crankshaft. This engine operates on the usual four-stroke-cycle principle, the action of which may be considered as being a repetition of a cycle of four different strokes. The action of each cylinder is the same, but is 180° of crankshaft travel later than that of the preceding cylinder. Firing order is 1-2-4-3.

(1) INTAKE STROKE. The piston travels downward while the intake valve is open and the exhaust valve is closed. The resulting reduction in pressure within the cylinder causes air to be drawn in through the air cleaner, carburetor, intake manifold, and intake valve port. As the air passes through the carburetor the proper proportion of gasoline is mixed with it.

(2) COMPRESSION STROKE. The piston travels upward with both valves closed and compresses the fuel mixture in the combustion chamber at the upper part of the cylinder. As the piston reaches the top of the stroke a spark occurs at the spark plug and burning of the fuel mixture begins.

(3) POWER STROKE. Burning of the fuel mixture continues, developing great heat and pressure. Both valves remain closed and the piston is forced downward, transmitting its power to the crankshaft.

(4) EXHAUST STROKE. The piston travels upward with exhaust valve open, intake valve closed, and forces the exhaust gases from the cylinder. These gases pass out through the exhaust port, exhaust manifold, exhaust pipe, and muffler.

b. Power. The amount of power developed by the engine and hence its speed, under a given load, is determined by the position of the throttle valve in the carburetor which regulates the amount of fuel mixture that enters the cylinders. The throttle valve is automatically controlled by the engine governor.

c. Valves and Camshaft. The valves are operated in proper sequence and timing by tappets which ride on a series of cams on the camshaft. The camshaft is turned by a gear which is driven by a pinion on the crankshaft, and turns at just half the speed of the crankshaft. The valves are closed by spring action. A gear on the camshaft drives the oil pump, water pump, and magneto. The governor is driven by a separate gear which meshes with the timing gear group at the front of the engine.

d. Carburetor. (1) The engine is equipped with an updraft, fixed jet type carburetor (fig. 1). The prime function of the carburetor is to deliver a proper mixture of fuel and air to the engine under all load conditions.

(2) Gasoline enters the carburetor bowl through the float-operated needle valve assembly. The level to which the gasoline rises in the bowl is controlled by the float.

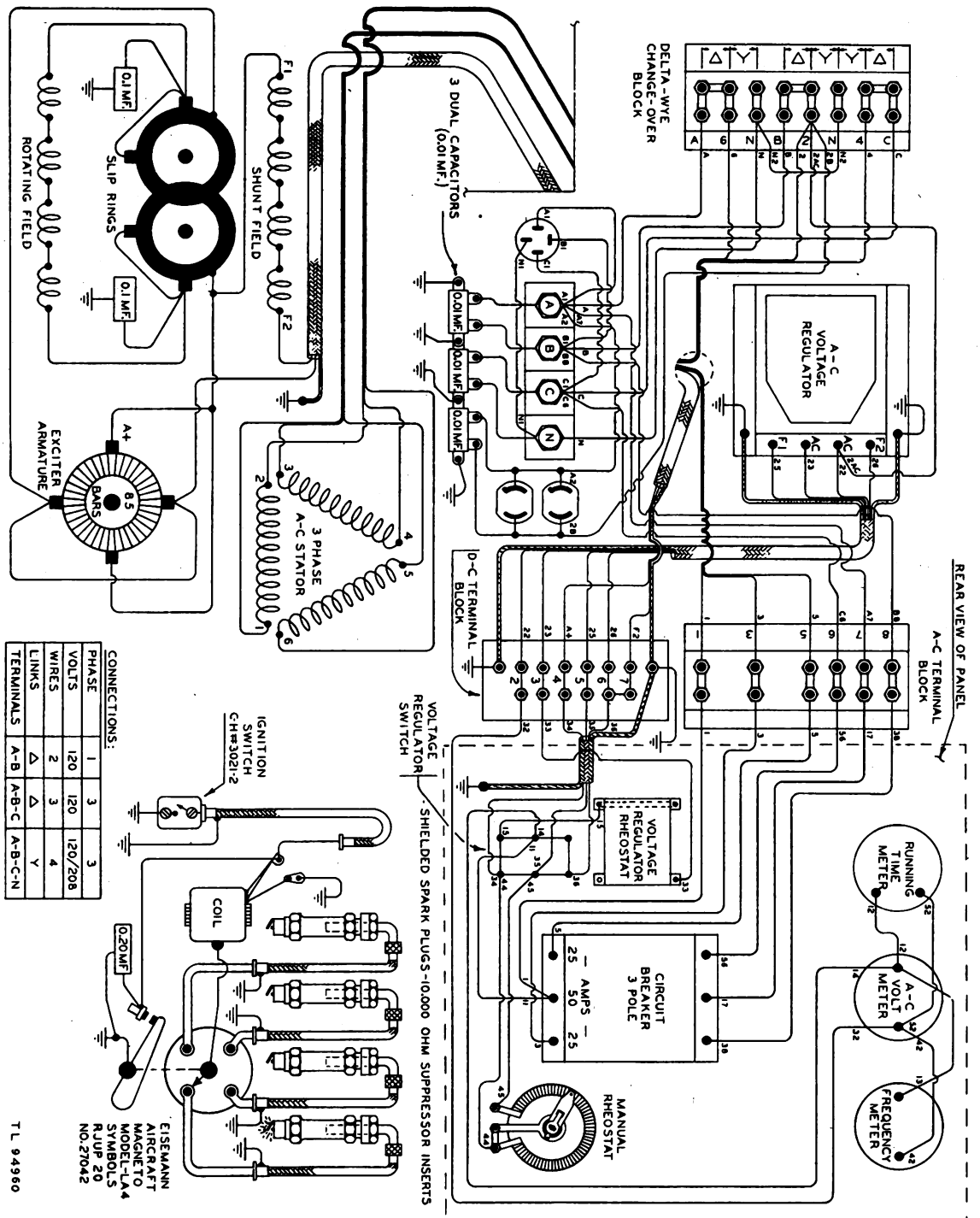


Figure 11. Schematic wiring diagram, Power Unit PU-32/C.

From the bowl the gasoline enters the venturi through the central jet. There is no adjustment on this jet, or on the needle valve, as the gas mixture is predetermined and fixed at the factory. Therefore, satisfactory operation should be obtained as long as the jet is clean and the float valve seats properly.

e. Vacuum Gauge. The vacuum gauge, mounted on the instrument panel (fig. 7), is connected by a flexible rubber hose to the intake manifold of the engine. One of its functions is to indicate to the operator the approximate load that is being applied to the engine. The reading will drop from about 15 or 16 inches under no load to 6 inches under full load. Another function is to indicate the running condition of the engine. A badly fluctuating needle between 10 and 15 inches may indicate a defective cylinder head gasket or valve. An extremely low reading under light load may indicate a leak in the intake manifold or gasket. Throw the electrical load on and off quickly. If the gauge indicator fails to drop to approximately 4 inches as the full load is applied, and fails to recoil to at least 18 inches as the load is removed, it may be an indication of diluted oil, poor piston ring sealing, or abnormal restriction in the carburetor, air cleaner, or exhaust.

NOTE: The above readings apply at sea level. There will be approximately a one-inch drop for each 1,000 feet of altitude.

10. GENERATOR THEORY.

The generator consists of an alternator and exciter enclosed in a single housing. The alternator is designed to produce 60-cycle a-c while the exciter furnishes d-c for the excitation of the alternator field windings. The alternator may be divided into a revolving field and a stationary armature. Exciter armature and the alternator revolving field are both carried on the main generator shaft which is supported by the annular ball bearing at the exciter end and by the engine crankshaft at the generator fan end. An adapter casting serves as a mounting to couple the generator frame to the engine block, and also serves as a housing for the generator fan.

a. Nomenclature. The term "stator" means that part of the electrical machine which remains stationary. The term "rotor" applies to the winding which revolves within the stator. That part of the alternator which produces power for the external load is referred to as the armature and may be either revolving or stationary. In this case it is stationary and is called the stator.

b. Stator. The alternator stator, or armature, consists of three groups of coils, all connected in series. The coil leads are connected directly to the a-c output terminal block on the rear of the control panel. As the magnetized poles of the revolving field pass the conductors in each coil, alternating voltage is induced in the stator winding. No collector rings or brushes are required in this a-c power circuit. Since any flow of electrical current creates a force which tends to oppose the force which generates it, mechanical power equal to the resulting electrical power, plus the losses of generation, are necessary to start and maintain the flow of electrical current. The magnetic lines which induce this power, are carried to the stator by the alternator field poles, which rotate inside the armature. The poles of the alternator are alternately north and south in polarity around the rotor. The current in a given stator coil alternates as it is passed first by a pole of one polarity, then by a pole of opposite polarity. The polarity of the field poles does not change.

c. Rotor. The rotor consists of four pole pieces upon which are mounted coils connected to each other in series. The coil leads are connected to the two slip rings. There is a definite relation between the speed, the number of poles on the rotor, and the generated frequency. Rated engine speed must be maintained on the power unit to produce the specified frequency of 60 cycles.

d. Exciter. (1) To maintain the polarity of the field poles at a strength necessary to give the desired voltage, and counteract the opposing demagnetizing effect when power is taken from the alternator, a d-c excitation is required in the field pole windings. For this purpose, a small d-c generator called the exciter is built into the alternator. The exciter is attached to the outer end of the alternator and supplies the d-c used to excite the revolving field. The output voltage is automatically controlled by a voltage regulator or manually controlled by a rheostat on the control panel. No rheostat is necessary in the alternator field, as all control can be obtained by varying the exciter output.

(2) The exciter field coils are mounted upon four field poles located in the rear end bell. They are connected in series and shunt-connected to the exciter armature. The exciter armature is the smaller of the two groups of windings on the rotor, and generates d-c for both the exciter field and the alternator field. Jumpers on the alternator brush ring connect the slip ring brushes directly to the d-c brushes (fig. 10) on the exciter armature commutator, which is the terminus for the coils wound on the armature core. The exciter brushes are connected together in pairs and so arranged that they come in contact with commutator bars that always have the same polarity as they pass under the same brush. The schematic diagram figure 11, illustrates the generator circuit.

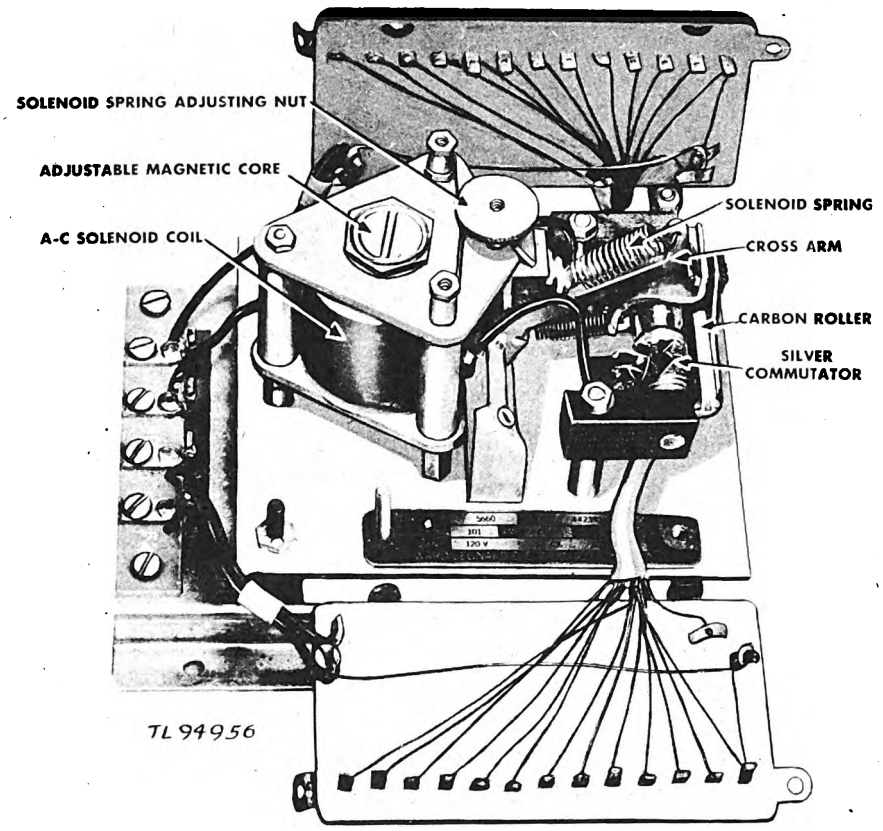


Figure 12. Voltage regulator.

11. VOLTAGE REGULATOR.

a. The voltage regular (fig. 12) is a device for automatically obtaining constant voltage for all normal load conditions. The regulator performs the functions of an automatic field-control rheostat.

b. The regulator consists mainly of an a-c solenoid, a commutator, and two resistor plaques. The solenoid coil is connected to the output of the stator winding and is affected by voltage changes. These changes actuate the solenoid plunger and also the cross arm which moves the carbon contact. This contact is in the form of a roller and moves across the silver commutator, thereby adjusting the resistance of the plaques to a value which maintains the generator voltage.

c. The regulator has two separate electrical circuits; one a-c and the other d-c. The a-c circuit consists of the solenoid coil; two 100-ohm dropping resistors which are located in the resistance plaques; and the 160-ohm voltage regulator rheostat located on the panel. The d-c circuit consists of two 50-ohm tapped resistors and the commutator. The resistors take the place of the field rheostat and are adjusted by the movement of the carbon roller on the silver commutator. The commutator consists of a stack of insulated silver segments, each segment connected to a tap on the regulator resistance. The commutator is ground to a "V" shape. The carbon contact roller rests on the commutator at two points, and short-circuits all the resistance included between these two points. By moving the contact roller transversely across the commutator, the distance between these two points of contact is changed, and thus the effective resistance of the voltage regulating resistor is adjusted. The solenoid is quick-acting and allows the regulator to momentarily overcorrect and then find a new steady-state position. The carbon contact roller is not in constant motion, moving only when the load is changed.

d. To use the regulator, switch the voltage regulator switch on the control panel to the ON position and adjust the voltage to 120 volts by means of the voltage regulator rheostat. When the regulator is ON, the manual field control rheostat is shorted out and the a-c solenoid is connected to the stator circuit. In the OFF position the regulator resistance is shorted out and the a-c solenoid circuit is opened. This circuit arrangement permits adjustments to be made on the regulator when the generator is running, merely by switching the regulator to the OFF position.

e. The regulator is set at the factory to have the proper sensitivity for the generator in the power unit. If greater

sensitivity is desired, adjust the regulator as follows:
(1) Set the voltage at 120 volts and warm up the generator set for at least one hour.
(2) Loosen the lock nut, then screw in the adjustable magnetic core. Turn the core in by half-turn steps as the adjustment is extremely sensitive.
(3) Restore the generator voltage back to 120 volts by increasing the solenoid spring tension. This is done by screwing down the solenoid spring adjusting nut. Care should be taken to adjust the voltage to as near its previous value as possible (without touching the panel rheostat) so that the regulator solenoid coil current will be held constant. The coil current should be within the limits of 350 to 400 milliamperes.
(4) If greater sensitivity is required, repeat the above procedure until the desired result is obtained. A properly adjusted regulator will hold the voltage to at least within 4 volts. If, at full load, the generator voltage is set at 120 volts, the voltage will not rise to more than 124 volts when the load is removed.
(5) Do not increase the sensitivity to a point where instability or hunting is established. The tendency toward instability is usually greatest at no-load. An unstable regulator may be made more stable by reducing the sensitivity. This is done by reversing the procedure used to increase sensitivity.

f. Do not lift the contact roller from the commutator as the contact pressure spring may be overstressed, thereby reducing the contact pressure. This is carefully set at the factory and should be 100 grams. Never touch the contact roller while the regulator is operating, as arcing will occur at the point of contact, causing the commutator surface to become pitted and rough. If, through any accident, the commutator should become roughened, polish the surface with jeweler's rouge or crocus cloth. After polishing, be sure to remove all traces of rouge from the surface of the commutator. After the regulator has been operating for a few hours, a fine black line will appear along the point of contact on the silver commutator. This is a normal condition.

g. Keep regulator free from dust, dirt, and moisture. Do not oil or otherwise lubricate any part of the voltage regulator.

SECTION IV
MAINTENANCE

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report). If Form No. 468 is not available, see TM 38-250. Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form No. 54 (unsatisfactory report).

12. MAINTENANCE FORMS.

a. To insure mechanical efficiency, it is necessary to inspect the power unit systematically at intervals each day it is operated and at other specified intervals, so that defects may be discovered and corrected before they result in serious damage or failure. Certain scheduled maintenance services will be performed at these designated intervals.

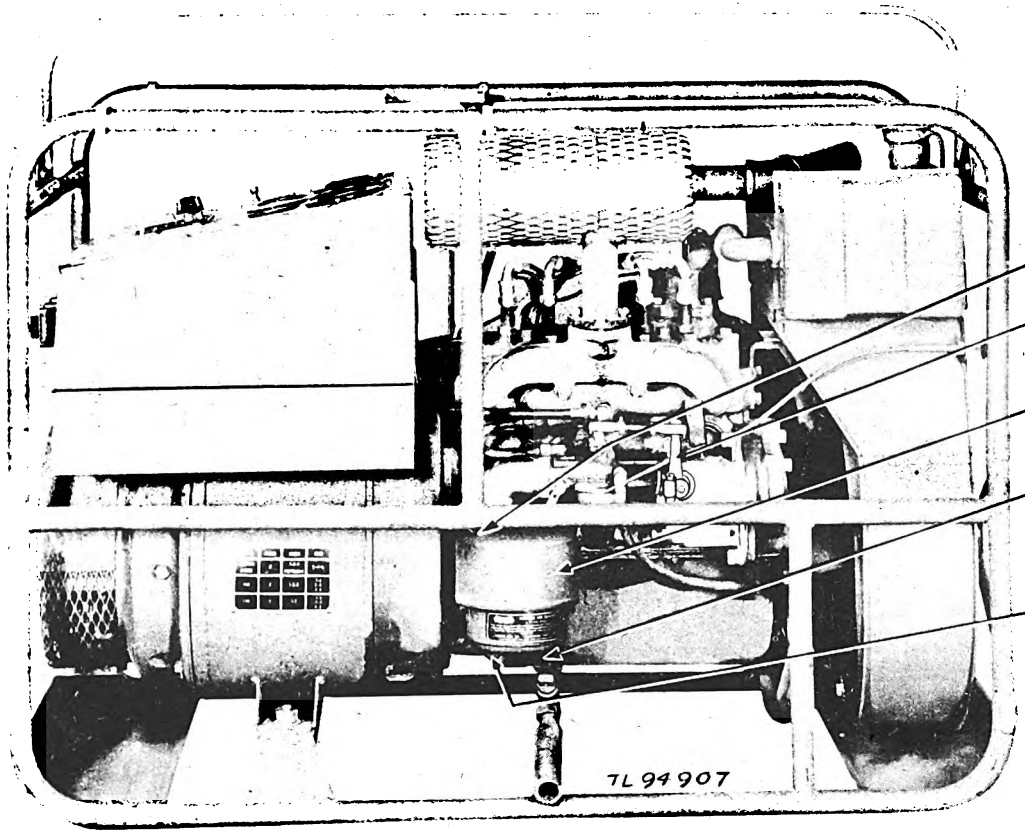
b. The operator of Power Unit PU-32/C should have available War Department Form 48 (Driver's Trip Ticket and Preventive Maintenance Service Record). This form may be adapted to Signal Corps power units by crossing out those items which pertain solely to vehicles and adding any additional items pertaining to the power unit which are not included on the form. Refer to TM 9-2810, Motor Vehicle Inspections and Preventive Maintenance Services.

c. Unit mechanics' preventive maintenance services and technical inspections may be facilitated by the use of W.D., A.G.O. Form No. 461 (Preventive Maintenance Service and Technical Inspection Work Sheet for Wheeled and Half-Track Vehicles). This form may be adapted (by elimination of solely vehicular items) to power units above 2.5 kilowatts rating which are used by the Signal Corps. The columns headed "6000 Mile"" and "1000 Mile" on Form No. 461 are comparable to the semi-annaual and monthly maintenance of power units.

d. W.D., A.G.O. Form No. 6 (Duty Roster) may be adapted for recording lubrication and maintenance service records for power units. This is the only form authorized for this purpose by the Signal Corps. Refer to TM 9-2810.

13. LUBRICATION.

a. Types of Lubricants. The following is a list of the specified lubricants to be used on the Power Unit PU-32/C (figs. 13 and 14):



OPERATING HOURS	LUBRICANT	
8	OE	**CARBURETOR AIR CLEANER.** CHECK OIL LEVEL AND REFILL TO LEVEL MARK
64	OE	**GOVERNOR AND THROTTLE CONTROL LINKAGE.** USE 3 OR 4 DROPS OF OE AT EACH POINT
64	OE	**CARBURETOR AIR CLEANER.** REMOVE OIL CUP, DRAIN, CLEAN, AND REFILL TO LEVEL MARK, USING OE
64	OE	**CRANKCASE.** DRAIN AND REFILL. CAPACITY IS APPROXIMATELY 3-1/2 QUARTS. DRAIN ONLY WHEN HOT AFTER OPERATION. BE SURE PRESSURE GAUGE INDICATES OIL IS CIRCULATING
256	OE OH	**CARBURETOR AIR CLEANER.** REMOVE OIL CUP, BAFFLE, AND LOWER SCREEN. WASH PARTS, USING SOLVENT, DRY CLEANING, OR OIL, FUEL, DIESEL. ALLOW TO DRY AND REFILL USING OE. FROM 0° F TO —40° F, USE OH; BELOW —40° F, REMOVE OIL AND OPERATE DRY

Figure 13. Lubrication chart, Power Unit PU-32/C, right side.

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 (PAR. 5)
EXCEPT CRANKCASE	OE SAE 30	OE SAE 10	PS
WB—GREASE, GENERAL PURPOSE, NO. 2. ALL AIR TEMPERATURES			
PS—OIL, LUBRICATING, PRESERVATIVE, SPECIAL			
WP—GREASE, WATER PUMP, FOR ALL TEMPERATURES			
OH—OIL, HYDRAULIC			

	LUBRICANT	OPERATING HOURS
CRANKCASE LEVEL GAUGE. CHECK OIL LEVEL	OE	8
CRANKCASE BREATHER. CHECK LEVEL AND REFILL TO LEVEL MARK	OE	8
WATER PUMP. TURN CUP 1/4 TURN	WP	8
CRANKCASE BREATHER. REMOVE, DRAIN, CLEAN AND REFILL	OE	64
FUEL STRAINER. REMOVE AND CLEAN SEDIMENT BOWL AND DISC TYPE FILTERS. REMOVE AND CLEAN FUEL PUMP STRAINER SCREEN LOCATED ON RIGHT SIDE OF ENGINE		64
CRANKCASE BREATHER. REMOVE AND WASH ALL PARTS, USING SOLVENT, DRY CLEANING, OR OIL, FUEL, DIESEL. ALLOW TO DRY AND REFILL TO LEVEL MARK, USING OE. FROM 0° F TO —40° F, USE OH; BELOW —40° F, REMOVE OIL AND OPERATE DRY	OH	256
GENERATOR BEARING. REMOVE END COVER PLATE. KNEAD WB GREASE INTO SPACE BETWEEN INNER AND OUTER RACES. REMOVE EXCESS LUBRICANT, THEN REINSTALL COVER PLATE	WB	512
MAGNETO AND MAGNETO IMPULSE COUPLING. SATURATE CAM LUBRICATING FELT WICK WITH OE. REPACK THE BALL BEARINGS WITH WB. CLEAN THE IMPULSE COUPLING BY USING SOLVENT, DRY CLEANING, OR OIL, FUEL, DIESEL ALLOW THE PARTS TO DRY AND LUBRICATE, USING PS	OE WB PS	2048

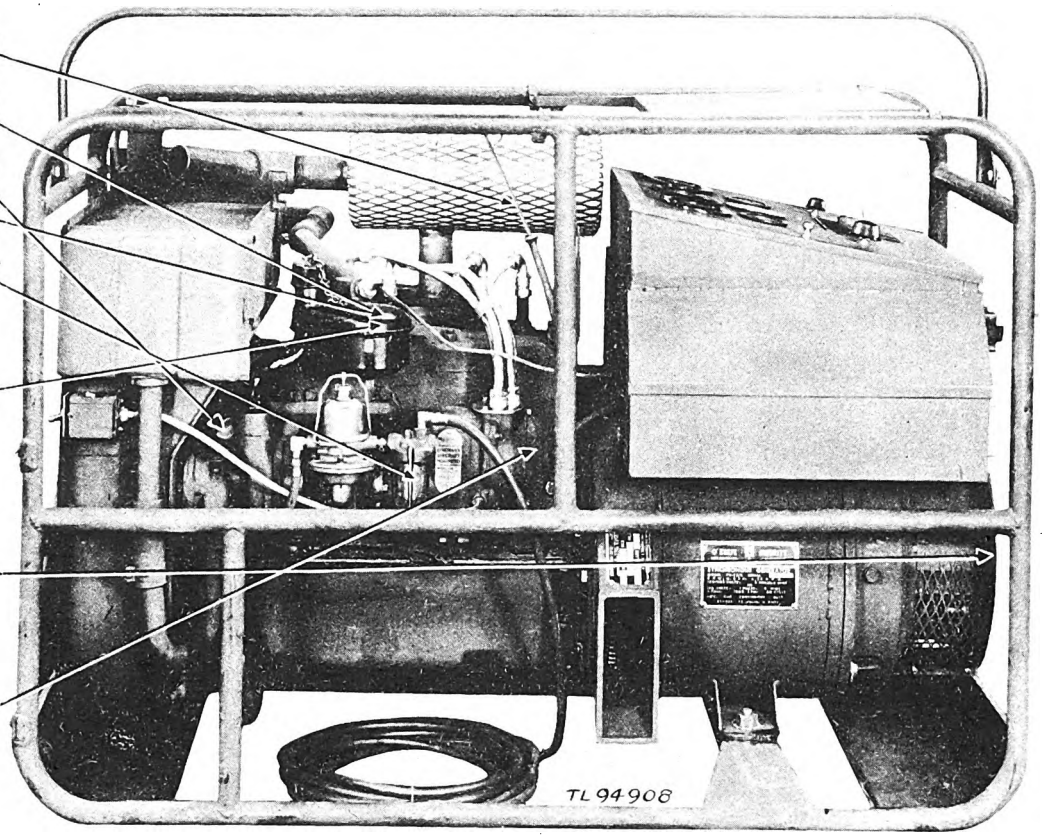


Figure 14. Lubrication chart, Power Unit PU-32/C, left side.

(1) OE-Oil, Engine, U. S. Army Spec No. 2-104-B. See paragraph 5**b** for weights at different temperatures.

(2) PS-Oil, Lubricating, Preservative, Special, U. S. Army Spec No. 2-120, except in crankcase.

(3) OH-Oil, Hydraulic, U. S. Army Spec No. 2-79A from 0° F to —40° F.

(4) WP-Grease, Water Pump, U. S. Army Spec 2-109 for all temperatures.

(5) WB-Grease, General Purpose No. 2, U. S. Army Spec 2-108 for all air temperatures.

b. Lubrication Schedule. Check the following at least as often as indicated:

(1) EVERY 8 OPERATING HOURS.

(a) Crankcase Level Gauge. Check oil level.

(b) Crankcase Breather Air Cleaner. Check level and refill to level mark, using OE.

(c) Water Pump. Turn cup 1/4 turn. Refill cup when necessary, using WP.

(d) Carburetor Air Cleaner. Check oil level and refill to level mark, using OE.

(2) EVERY 64 OPERATING HOURS.

(a) Governor and Throttle Control Linkage. Place 3 or 4 drops of OE at each point.

(b) Air Cleaner. Remove oil cup, drain, clean, and refill to level mark, using OE.

(c) Crankcase Breather. Remove, drain, clean, and refill, using OE.

(d) Fuel Strainer. Remove and clean sediment bowl and disk type filters. Remove and clean fuel pump strainer screen located on right side of engine.

(e) Crankcase. Drain and refill, using OE—capacity approximately 3-1/2 quarts. Drain only when hot after operation. Be sure pressure gauge indicates oil is circulating.

(3) EVERY 256 OPERATING HOURS.

(a) Crankcase Breather. Remove and wash all parts, using Solvent, Dry Cleaning or Oil, Fuel, Diesel. Allow to dry and refill to level mark, using OE. From 0° F to —40° F, use OH; below —40° F, remove oil and operate dry.

(b) Carburetor Air Cleaner. Remove oil cup, baffle and lower screen. Wash parts, using Solvent, Dry Cleaning or Oil, Fuel, Diesel. Allow to dry and refill using OE. From 0° F to —40° F, use OH; below —40° F remove oil and operate dry.

(4) EVERY 512 OPERATING HOURS. Remove generator bearing end cover plate. Knead WB grease into space between inner and outer races. Remove excess lubricant, then re-install cover plate.

(5) EVERY 1024 OPERATING HOURS. Knead WB grease into space between inner and outer races of the fan shaft support bearing. Remove excess lubricant.

(6) EVERY 2048 OPERATING HOURS. Disassemble the magneto and lubricate it as follows:

(a) Saturate cam lubricating felt wick with OE.

(b) Repack the ball bearings with WB.

(c) The impulse coupling should be cleaned by using Solvent, Dry Cleaning, or Oil, Fuel Diesel. Allow parts to dry and lubricate, using PS.

NOTE: Do not lubricate engine governor.

14. SERVICE AND INSPECTION.

a. Daily Service. Check the following at least once a day:

(1) RADIATOR. Check the cooling liquid level. Do not fill the radiator so high to cause unnecessary loss of liquid through the overflow. Never allow the level to fall below the top of the upper hose. Under continuous use, or in hot weather, more frequent attention may be needed.

(2) OIL LEVEL. Check the crankcase oil level. Under continuous service, check more frequently. Never operate the power unit when the oil level is near the EMPTY mark on the bayonet gauge. Fill to the FULL mark on the gauge with the proper oil as specified in paragraph 13**a**.

(3) FUEL SUPPLY. Check supply of fuel as often as necessary to assure a sufficient supply for the power unit at all times.

(4) CONTROL PANEL. Check the various gauges frequently and take any corrective measure indicated. Normal readings are given in paragraph 6.

b. Weekly Service. Check the following weekly, or every 50 operating hours, whichever occurs first:

(1) DAILY CHECK. Check all points mentioned above under Daily Service.

(2) CRANKCASE AND OIL FILTER. Lift out the bayonet oil gauge and examine the oil that adheres to it. If necessary, on the basis of lubricating instructions contained in paragraph 13, change the oil. Drain the oil while the engine is warm. Close the drain valve securely and refill the crankcase to the FULL mark on the gauge with clean, fresh oil of proper kind and gauge.

(3) AIR CLEANER.

(a) If the power unit has been operated under dusty conditions, clean the oil-type air cleaner. If the power unit has been operated only under clean air conditions, the servicing of the air cleaner may be included under Monthly Service.

(b) To clean the air cleaner, remove the cup and clean it thoroughly. Remove the filter element and clean it in Solvent, Dry Cleaning, or Oil, Fuel, Diesel. Allow it to dry. Fill the cup to the level mark with clean oil of the same grade as used in the engine crankcase. Reassemble the cleaner.

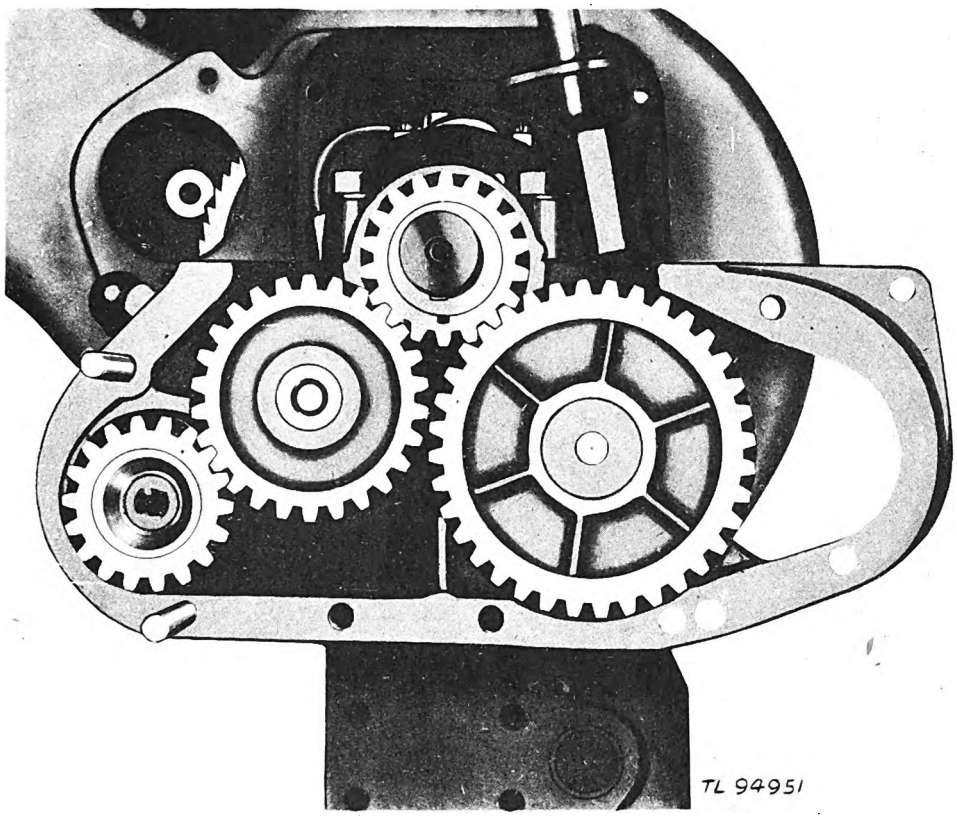


Figure 15. Timing gears and timing hole on manifold side of flywheel cover.

(4) THROTTLE CONTROL ROD BALL JOINTS. Place a drop of oil in each ball joint of the throttle control rod and check to make sure the throttle mechanism moves freely.

c. Monthly Service. Check the following monthly, or every 200 operating hours, whichever occurs first:

(1) WEEKLY CHECK. Check all points mentioned under Weekly Service.

(2) SPARK PLUGS. Remove the spark plugs. Clean them, if needed, and inspect for cracked or badly eroded porcelains. Discard any spark plugs not in good condition and replace with new ones of correct type. Adjust the gaps to 0.025-inch. When installing, make sure the gaskets are in place. Tighten securely.

(3) TIMING THE MAGNETO TO THE ENGINE. Engine timing should be checked to maintain efficiency of the engine and to insure against the damaging effects of an advanced spark setting.

(a) First, crank the engine until the No. 1 piston is on exact top dead center on the compression stroke. The compression stroke is found by turning the engine over with the No. 1 spark plug (plug next to the radiator) removed and holding the thumb over the spark plug hole. When pressure is felt on the thumb, the piston is coming up on the compression stroke. Turn crank slowly and check through the timing hole on the manifold side of the flywheel cover (fig. 15) for the top dead center mark. The correct spark timing point is marked "SPARK" and is 14 degrees, or approximately 1-1/2 inches ahead of the top dead center mark which is indicated by the letters "DC." When the engine is backed up from the DC mark to the SPARK mark, it should be backed up slightly past SPARK position to take up the gear clearance and then brought forward to the SPARK position.

(b) Next, time the magneto to fire on the No. 1 spark plug when the engine is in the above position. The No. 1 spark plug position on the distributor is determined by rotating the magneto in the proper direction until the spark jumps from the No. 1 spark plug lead to the ground. This lead is the one to be connected to the No. 1 spark plug and is stamped "1" on the magneto. The magneto is equipped with an impulse coupling to give it a delayed spark timing at cranking speed, and therefore all timing must be done by first turning in the proper direction until the impulse releases, as indicated by a snapping action, and then turning in the opposite direction not more than one-fourth of a turn, which puts the breaker points in the true running position. With the magneto assembled and connected in this position, the final setting of the

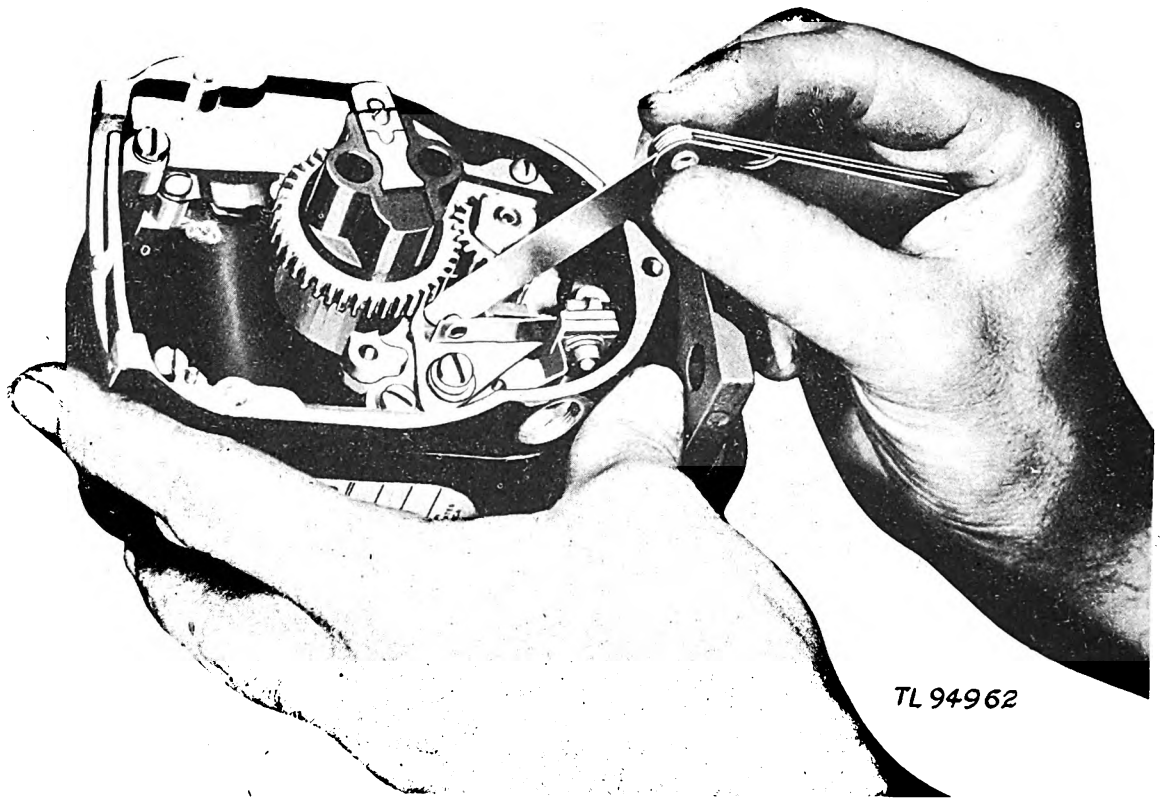


Figure 16. Measuring breaker point gap.

points must be indicated by the use of a timing light, which consists of a 32 candlepower, 6-volt automotive-type bulb connected in series with a storage battery and with the ignition points through the ground wire connection. By rotating the engine forward and then backward a few degrees, the light should indicate that the points are opening at exactly the point of the SPARK line on the flywheel in the center of the flywheel housing inspection opening. The light should dim at the instant the SPARK line centers in the opening. The adjusting screw on the coupling will give a vernier movement to the magnetic shaft. After the correct point has been found, the locknut on this screw should be tightened and locked with a cotter key. Too much emphasis cannot be placed on the importance of timing at this point as any spark in advance of this point is extremely hard on bearings and other internal parts, and any spark occurring later than this point will seriously reduce the power of the engine. The correct breaker point gap is .018 inch (fig. 16).

(c) The firing order is 1-2-4-3, and the leads from the magneto must of course be connected to give this sequence of firing to the plugs. Numbers are stamped adjacent to the spark plug leads on top of the magneto corresponding to the correct plug number.

(4) RE-INSTALLATION. When re-installing the magneto to the engine or when checking the ignition timing, make sure that the alignment of the floating disk between the magneto and the drive shaft is as close as possible. The magneto should be set far back to allow 1/32-inch clearance between the drive disk and the drive disk plate. The magneto drive shaft is spring-loaded and can be moved forward. It should be pulled back as far as possible when checking the disk for clearance. Lubricate as directed in paragraph 13**b** (6).

(5) VALVE TAPPETS. Disconnect the tubes from the valve spring cover, remove the cover screws and the cover. Crank the engine slowly by means of the hand crank and note when the intake valve of No. 1 cylinder begins to open. Then turn the crank one full revolution further. This places the camshaft in the correct position for checking or readjusting both tappets of No. 1 cylinder. Check the clearances with a feeler gauge (fig. 17). The correct clearance is 0.007-inch hot or cold. Adjust the tappets if necessary. Locate the correct positions for each of the remaining cylinders and check and adjust the remaining tappets. In locating the correct position for any cylinder, turn one revolution after the intake valve on that cylinder begins to open. See that the cover gasket

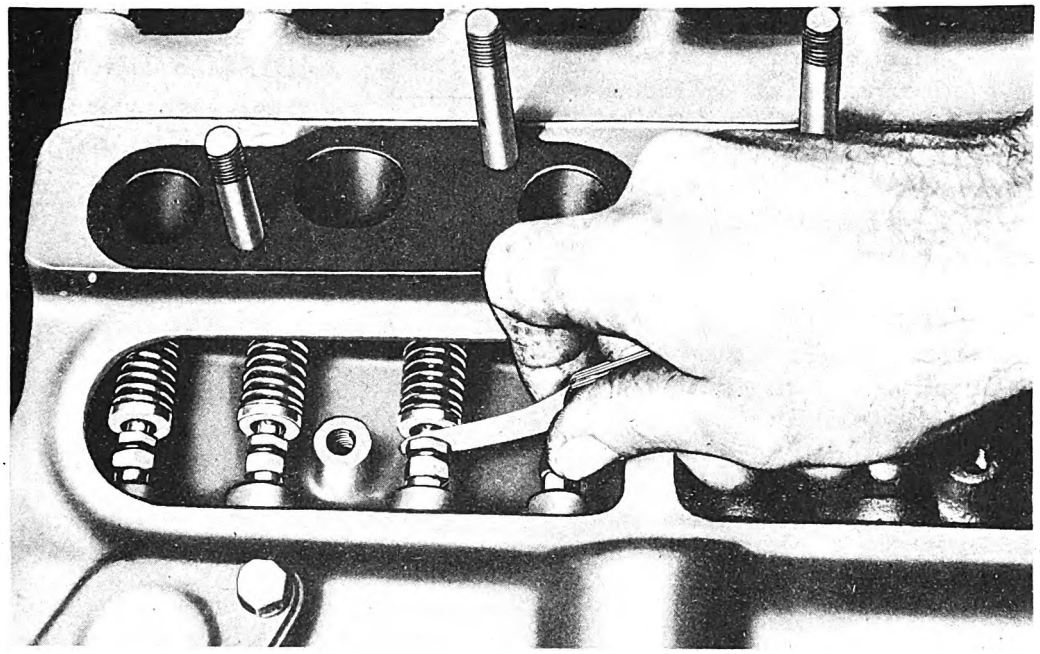


Figure 17. Checking valve tappet clearances.

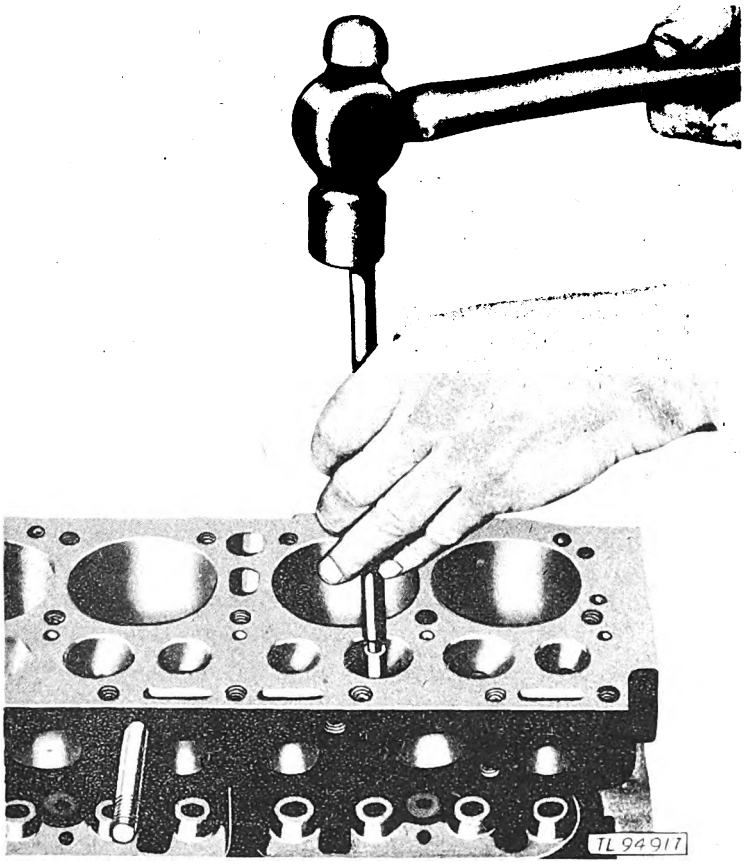


Figure 18. Installing valve guides.

is in good order, replace the cover, tighten the screws and connect the tubes.

(6) EXHAUST SYSTEM. Inspect all exhaust connections, replacing or tightening all parts requiring attention. Include the manifold connections and the flexible exhaust pipe. Permit no leaks that will allow gas to escape inside a building. Clean the exhaust system when required. Continued operation with excessive back pressure will eventually cause trouble even if not bad enough to noticeably affect the engine performance at the time of inspection.

(7) GASOLINE SEDIMENT BOWL. Dirt or water in the gasoline line will be trapped in the glass of the gasoline sediment bowl and will be plainly visible. In freezing weather, this bowl should be examined daily due to the fact that any trapped water might freeze and crack the glass. If the two metallic filter elements are clogged, blow them out with compressed air. These elements are made up of very thin disks held together by a screw and therefore should be handled carefully.

(8) CARBURETOR. With no load on the power unit, but with the engine at normal operating temperature, and with the throttle held so that the engine is operating at about half normal speed, adjust the idle adjustment screw so that the engine will idle smoothly.

(9) CRANKCASE OIL. Be sure to include an oil change in the monthly service. Drain the crankcase oil and refill to the FULL mark on the bayonet gauge with proper oil as indicated on the lubrication chart (figs. 13 and 14) and as instructed in paragraph 13**b**.

(10) GENERATOR. Inspect the commutator and slip rings. Clean them, if needed, by holding a clean piece of canvas against them while the engine is operated slowly by holding the throttle partially closed. For safety, attach the canvas over the square end of a narrow piece of dry wood to serve as a handle. In normal service, the commutator and collector rings acquire a mahogany-colored surface. If this surface is smooth, it requires no attention. Do not attempt to maintain a bright surface with a newly-machined appearance. Check the brushes for good seating contact, free fit in holders and uniformly good spring tension. If brushes are worn to 3/4-inch length, or less, install new brushes. New brushes must be properly fitted. Refer to paragraph 19 for instructions on fitting brushes.

(11) GENERAL. Inspect the power unit thoroughly for leaks, loose electrical connections and other external items which may need attention. Make needed corrections.

15. VALVE SERVICING.

a. When to Grind Valves. (1) Lack of power in an engine may be caused by poor seating of the valves in the

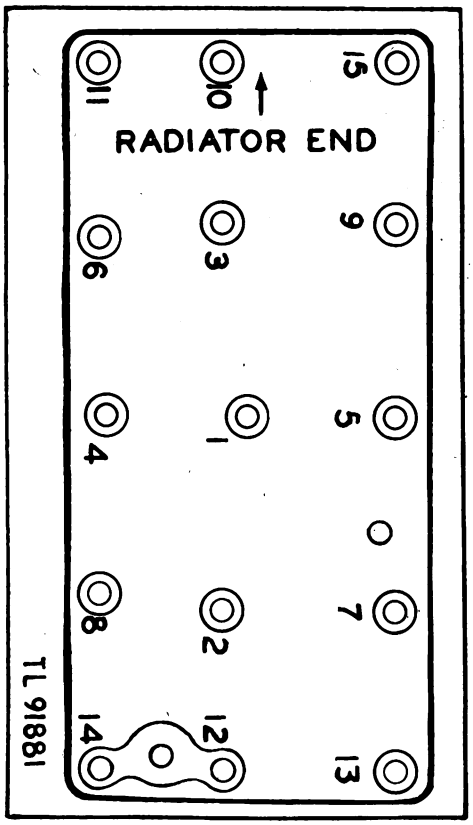


Figure 19. Cylinder head tightening sequence.

valve seats, which allows the gases in the compression chamber to escape into the intake or exhaust manifold.

(2) By the use of a cylinder compression gauge one can readily determine which valves are not properly seating. Compression gauge readings should all be within 10 pounds of each other and not less than 70 pounds.

(3) If no gauge is available, turn the engine by the hand crank and note whether the compression is uniformly good on all cylinders. Compression should rock the crank backward forcibly if allowed to do so when well up on the compression stroke. Compressed gases leaking past an exhaust valve cause a hissing noise at the exhaust outlet. If leaking past an intake valve, a hissing noise may be heard through the carburetor. Disconnect the air cleaner horn at the carburetor and the exhaust line at the power unit and have someone crank the engine while you listen for these sounds, if you have reason to suspect that valves are leaking. Any valve leak present after the tappets are properly adjusted should be corrected by grinding all valves.

b. Grinding Valves. Extreme care should be used whenever valves are ground to maintain factory limits and clearances, as only by maintaining these can one expect to get good engine performance. Proceed as follows:

Figure 20. Checking piston ring to piston clearance.

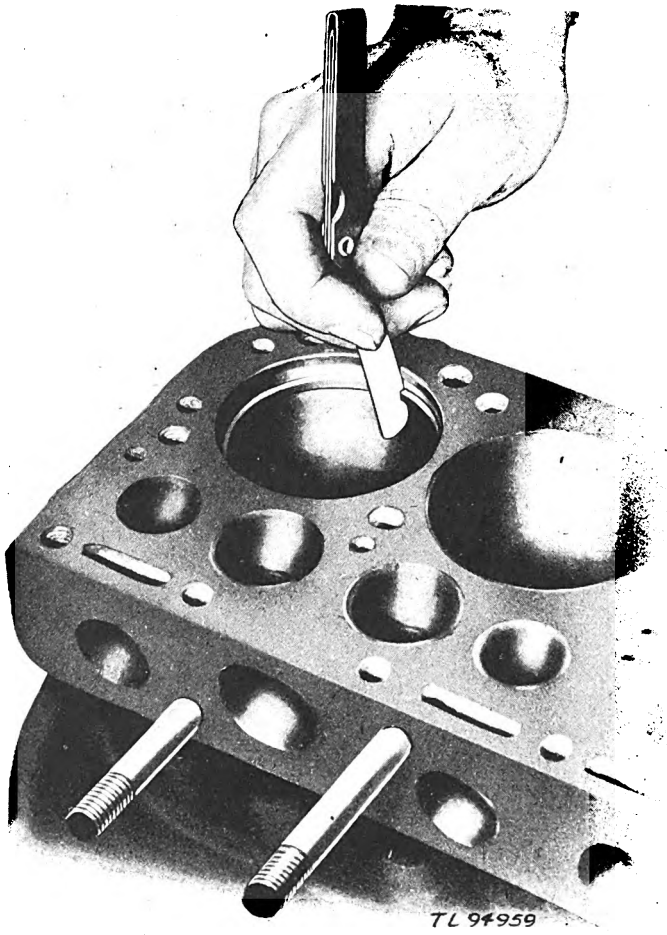


Figure 21. Checking piston ring to cylinder clearance.

(1) Drain radiator by opening drain cock at the bottom of the radiator.
(2) Remove fuel line from fuel pump to carburetor.
(3) Remove carburetor air cleaner horn and tube.
(4) Remove choke rod mounting bracket under manifold. Disconnect throttle control rod at governor end and the manual choke wire at carburetor end.
(5) Remove nuts holding carburetor to manifold and remove carburetor.
(6) Remove the crankcase air vent tube.
(7) Remove the bolts which hold the governor bracket and remove the governor assembly.
(8) Remove nuts and bolt holding exhaust pipe to manifold.
(9) Remove manifold stud nuts and manifold.
(10) Disconnect wires from the ignition resistor, remove holding bolt and ignition resistor.
(11) Remove the upper radiator hose. Remove all spark plugs. Remove the cylinder head cap screws, stud nuts and the temperature gauge bulb, then lift head from engine block. Removal is made easy by using lifting hooks screwed in No. 1 and 4 spark plug holes. **Do not drive screw driver or any other sharp instrument in between the cylinder head and the block to break the head loose from the gasket.**
(12) Remove the valve spring cover screws and the cover. Care should be taken not to lose the copper gasket on each screw as well as the screen gasket. Wad a piece of cloth or cotton waste over the three holes in the valve chambers to prevent the valve keys dropping into crankcase upon removal.
(13) With valve spring compressor inserted between valve tappet and spring retainer, raise springs on those valves which are in closed position and remove valve locks. Turn crankshaft with crank until those valves which are open become closed and repeat the operation.
(14) Remove valves and place them in a valve carrying board, so that they can be identified as to cylinders from which they were removed. Remove valve springs. The valve springs should be tested for pressure which should show 100 pounds when valves are open (spring compressed—length 1⅛ inches) or 45 pounds pressure when closed. The free length of the valve spring is 1½ inches. Any springs which are distorted or do not fall within these specifications should be replaced with new springs.
(15) Clean carbon from cylinder head, top of pistons, valve seats and cylinder block. Clean valve guides with guide brush. Clean valves on a wire wheel brush, making sure that all carbon is removed from the top and bottom of the heads. Remove any gum which may have accumulated on the stems.
(16) The clearance between the intake valve stem and the valve guide is 0.0015 to 0.00325 inch, the exhaust valve stem clearance to guide is 0.002 to 0.00375 inch. Excessive clearance between the valve stem and the valve guide will cause improper seating and burned valves. If there is too much clearance between the inlet valve stem and the valve guide, on the suction stroke there will be a tendency to draw oil vapors up the guide into the combustion chamber causing excessive oil consumption, fouled spark plugs and poor low speed performance. Check the wear of each valve guide by inserting a new valve in it and feeling the clearance by moving the valve stem back and forth. If the clearance is excessive, install a new valve guide as instructed in subparagraph **c** below.
(17) Check the clearance of each valve in its guide and discard any having excessive clearance. Reface the usable ones to a 45° angle. Replace discarded valves with new ones. If seats in the block show excessive pitting, reface the seats.
(18) Then, by hand, touch up the valves to the seats with fine valve grinding compound.

c. Removing and Replacing Valve Guides.
(1) When removing the valve guides use a valve guide puller to prevent damage to cylinder block. If a regular puller is not available, a suitable tool can be made from a 2-inch pipe, 6 inches long; a ⅜-inch bolt, 10 to 12 inches long with a long threaded end; a small hexagon nut which will pass through the hole in the cylinder block; and a 2-inch washer with a ⅜-inch hole in it.
(2) The valve guides are installed with a replacer, or a driver, as shown in figure 18. Taking a piece of half-inch round stock 6 inches long and turning down one end to ¼ inch diameter, 1¼ inches long, will make a suitable driver.
(3) The exhaust valve guide is installed in the cylinder block so that there will be a distance of 13/16 inches from the top of the guide to the top of the block. The intake valve guide is set at 13/16 inch from the top of the valve guide to the top of the block.
(4) The valve tappet clearance in the guide should be 0.0005 to 0.002 inch. It is advisable to check the clearance of the valve tappet by moving it back and forth in the guide. If the clearance seems to be excessive, it might be necessary to install a new valve tappet. This operation is covered in this section under paragraph 16.

d. Reassembling.
(1) When assembling valve springs and retainers in engine make sure that the closed coils are up against the cylinder block (fig. 17). Then install the valves, each in its proper seat. Using a valve spring compressor, raise the valve springs on those valves which are in closed position, and insert the valve spring locks with a valve key inserting tool. If no key-inserting tool is available, hold keys in place by sticking them to valve stem with

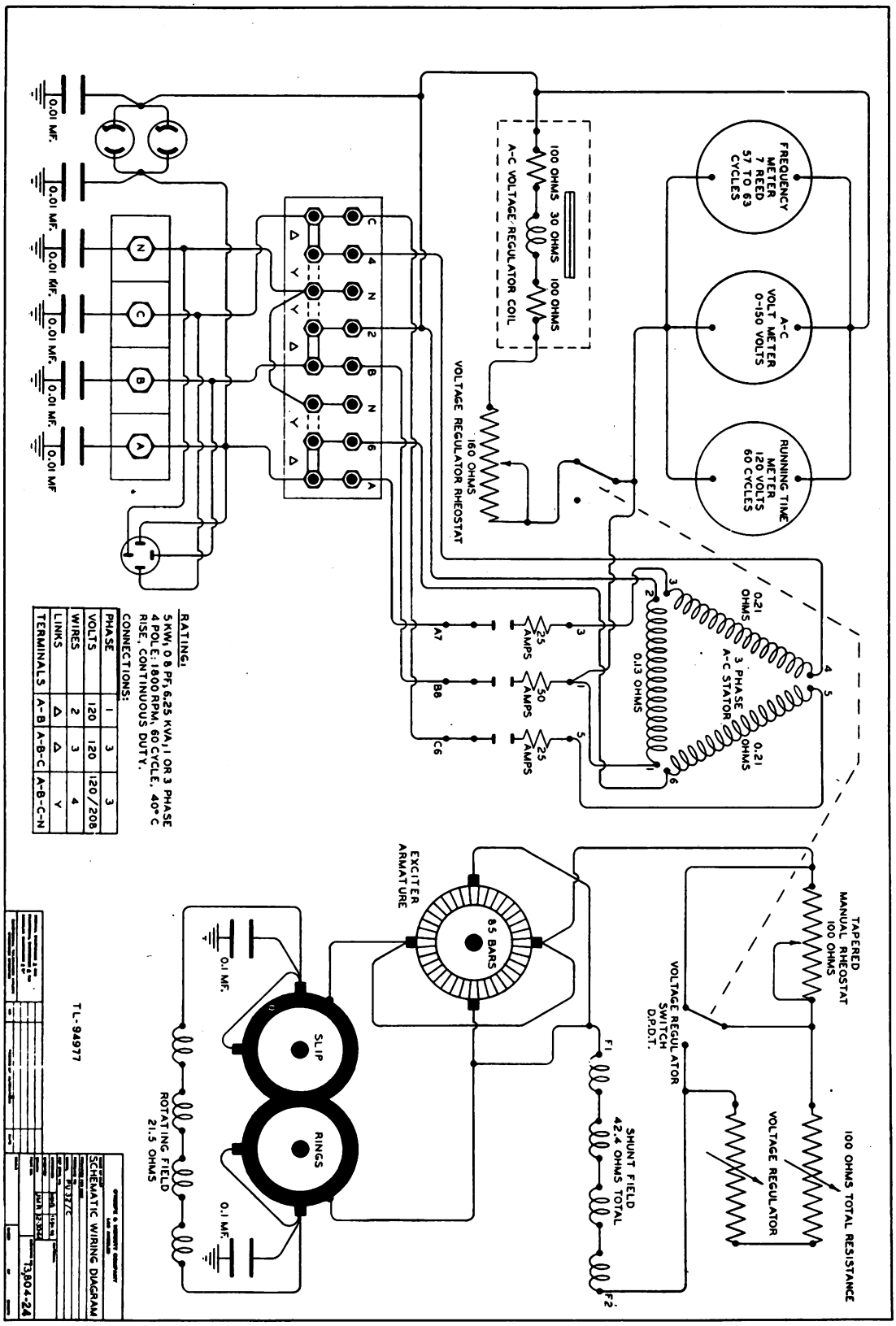


Figure 22. Wiring diagram, Power Unit PU-32/C.

grease. Crank engine until other valves are closed and install the remaining keys.

(2) Adjust the valve tappet to valve stem clearance to 0.007 inch. Remove cloth or waste from valve chamber.

(3) Clean top of block and pistons of all foreign matter and install cylinder head gasket. Clean carbon from cylinder head and wipe off all foreign matter, then install over studs on cylinder block. Install clyinder head cap screws and nuts bringing them down finger tight, then with a wrench tighten cylinder head screws and nuts in sequence as shown in figure 19. Take care to obtain an even pressure at all points.

(4) Clean and adjust spark plugs, setting the electrode gaps at 0.025 inch. Install spark plugs in cylinder head to prevent any foreign matter from entering the combustion chamber during the remaining operations. Be sure to install spark plug gaskets.

(5) Install manifold with new gaskets. Install manifold clamp washers with convex surface toward manifold. Install manifold nuts, drawing them up tight. Install exhaust pipe to manifold with new gasket.

(6) Re-install the governor assembly.

(7) Overhaul and recondition carburetor as per instructions given in paragraph 18. Install carburetor to manifold and attach controls. Install air cleaner horn and tube.

(8) Recondition magneto if required, and set ignition timing in accordance with instructions given in paragraph 14 **c.**

(9) Install upper radiator hose, and all line connections. Close radiator drain cock and fill the radiator with water or antifreeze solution as required. Start the engine and allow to run without load for 5 or 10 minutes. Then stop it and recheck the tappet clearances, removing obstructing parts if necessary.

(10) If necessary, install new valve spring cover gasket (shellac it to the cover). Clean crankcase ventilator tube and screen and reinstall with gaskets, if required. Complete the assembly.

(11) Start the engine. After it reaches normal operating temperature, make any speed adjustment needed to provide correct frequency as shown by the frequency meter.

16. CAMSHAFT AND VALVE TAPPETS.

a. Description.

(1) The alloy steel camshaft rotates on four bearings which are lubricated under oil pressure through drilled passages in the crankcase.

(2) The valve tappets are lubricated through oil troughs cast in crankcase and drilled passages to valve tappet guides. The oil troughs are filled from oil spray holes at connecting rod bearing ends. A groove cut in center of valve tappet shank carries the oil up and down in the guides.

b. Removal of Camshaft or Valve Tappets. To remove the camshaft or valve tappets, proceed as follows:

(1) Raise the power unit about 18 inches from the floor and support it securely in such a manner that the oil pan may be removed later.

(2) Drain the water from the radiator. Remove radiator and blower assembly. Remove exhaust assembly.

(3) Remove cylinder head, manifolds, valves and valve springs, following the instructions in paragraph 15.

(4) Remove oil pump and fuel pump assemblies.

(5) Drain the oil from the engine. Remove the oil pan.

(6) Remove timing gear cover, camshaft sprocket screws, and gears.

(7) Tie all valve tappets up with a string wrapped around heads of adjusting screws and attach to manifold studs.

(8) Remove camshaft and valve tappets.

(9) Carefully inspect camshaft for scores, roughness of cams, and bearings. Examine the valve tappet faces where they contact the cams and replace the tappets if they are found to be scored, rough or cracked. Check clearance of tappets to guides, renewing those tappets which have worn excessively. Tappets are available 0.004 inch oversize.

c. Valve Tappet Guides.

(1) When inspection shows worn guides are to be removed, they may be driven up through the top of the cylinder block with a metal rod and ball peen hammer.

(2) New guides should be driven in place with a special tool consisting of a solid steel rod machined to slip through the valve guide openings, and with one end turned down to fit the inside of the new guide. The shoulder should rest snugly against the guide.

d. Replacing Camshaft or Valve Tappets. To install the camshaft and valve tappets, proceed as follows:

(1) Install valve tappets and tie up in place with string. Install camshaft.

(2) To set the valve timing, observe markings on gears.

(3) Complete assembly by reversing the operations used for removal of the camshaft.

(4) Adjust tappet clearances as given in paragraph 15 **c.**

e. Valve Timing. The punch marks on the timing gears should coincide with each other, and also with the timing mark on the flywheel as seen in the center of the timing hole in the adapter (fig. 15).

f. Crankshaft.

(1) BEARINGS. The steel-backed babbitt-lined bear-

ings are made to size and are interchangeable without line reaming. The running tolerance of the bearings is established at 0.001 to 0.0025 inch. No adjustment is provided on the main bearing. Should the bearings require attention they should be replaced to maintain proper control of oil. If new crankshaft bearings are installed, care should be taken to see that the drilled passages line up with drilled passages in the crankcase, and that the bearings set snugly over the dowel pins. Undersize main bearings are available in 0.010 inch. The bearing inserts are correct size and do not require reaming.

(2) REMOVAL. Whenever it is necessary to remove the crankshaft or install new crankshaft bearings, the engine has to be removed from the housing.

(3) REAR BEARING SEAL. Should it be necessary to install a new seal in the crankcase, it will require the removal of the engine from the housing and the removal of the crankshaft. The same procedure should be followed when installing a crankcase seal as when installing a seal in the bearing cap.

g. Connecting Rod and Piston Assembly.

(1) CONNECTING ROD. The connecting rods are drop-forged. The babbitt bearings are of the replaceable type, steel-backed, babbitt-lined, precision-cut to size and no fitting is required. Clearance on crankshaft is 0.0005 to 0.0025 inch. Total side clearance is 0.005 to 0.009 inch. Undersize rod bearings are available in 0.010 inch size.

(2) PISTON. The clearance of the piston in the cylinder bore is 0.003 inch. Check clearance with 0.003 inch feeler gauge ¾ inch wide; feeler gauge should have from 5 to 10 pounds pull when being removed. The gauge should extend the entire length of the piston on the thrust side which is the opposite side from the T-slot in the skirt. If it is ever found necessary to install an over-size piston, the cylinder bore must be honed with a regular cylinder-honing tool. Do not try to lap in a new piston by using compound, because it will ruin the tin plating on the piston and cause a scoring or wiping condition of both the piston and cylinder walls.

(3) PISTON RINGS.

(a) Width of compression rings is 3/32 inch. Width of oil control ring is 3/16 inch. The upper compression ring is installed with the inside beveled edge up. The face of the lower compression ring is tapered 0.005 inch. Check the clearance of rings to piston and cylinder as shown in figures 20 and 21.

(b) When fitting the rings to the cylinder bores, the end gap is 0.008 to 0.013 inch. When fitting piston rings to grooves, give them the following clearances: Compression rings 0.0005 to 0.001 inch; oil rings, 0.001 to 0.0015 inch. Oversize rings are available in the following sizes: 0.010 inch. Use standard rings up to 0.010 inch oversize cylinder bores.

(4) ASSEMBLING CONNECTING ROD TO PISTON.

(a) Clamp connecting rod in vise using vise-jaw protector shields of a soft metal or two pieces of hardwood on each side of connecting rod 3 inches from piston pin end.

(b) Start piston pin in piston with groove facing down. Assemble piston to connecting rod with the slot in the piston opposite the oil spray hole in the bearing end of the connecting rod. Install the piston pin clamp screw.

(c) Center piston on pin and place assembly on connecting rod aligning fixture. Tilt piston to left with piston resting against surface plate. With feeler gauge measure clearance between piston skirt and surface plate. Tilt piston to right and check clearance. If clearance is within 0.003 inch on both left and right positions, connecting rod is in alignment. A difference greater than 0.002 inch indicates connecting rod is twisted.

(5) CYLINDER BORES.

(a) Checking. The best method for determining the condition of the cylinder bores preparatory to reconditioning is the use of a dial gauge. The dial gauge will instantly and automatically indicate the slightest variation of the cylinder bores. To use the dial gauge, simply insert it in the cylinder bores and move it up and down its full length. It is then turned spirally, or completely rotated at different points, taking readings at each point. In this manner all variations in the cylinder bores from top to bottom may be determined.

(b) Refinishing.

1. When cylinders are more than 0.005 inch out of true it is best to rebore the cylinders.
2. After the cylinder has been rebored within 0.002 inch of the size desired, it should be finished or polished with a cylinder hone. Do not use a piston as a hone. In operating, the hone is placed in the cylinder bore and run up and down the full length of the cylinder wall. This procedure should be followed until the piston can be pushed through the bores with a 0.003 inch feeler gauge ¾ inch wide on the thrust side and show a pull on the feeler gauge of 5 to 10 pounds.

17. OIL CIRCULATING SYSTEM.

a. The oil pump is a planetary gear type. It consists of two spur gears enclosed in a one piece housing. It is provided with a relief valve to control maximum oil pressure. In operation, the oil is drawn from the crank-

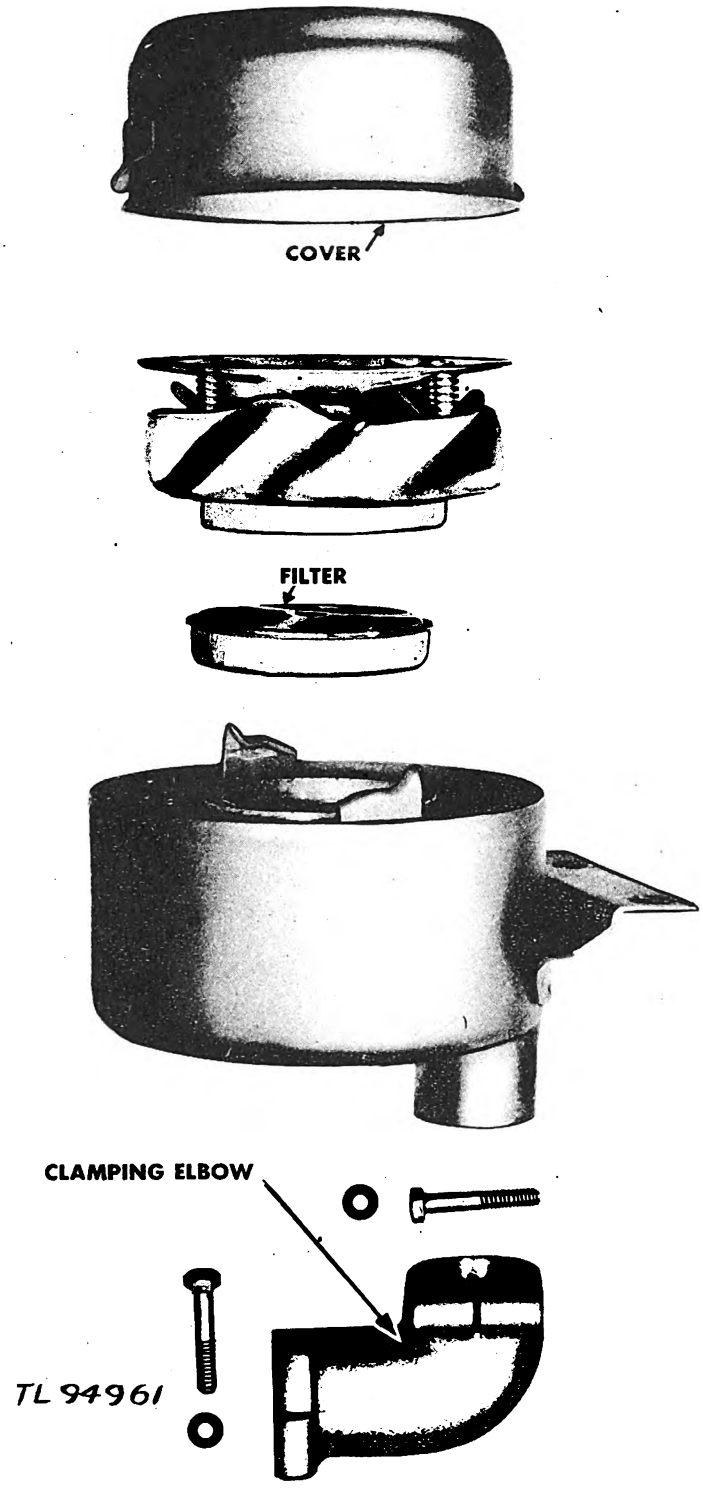


Figure 23. Air Cleaner.

case through the floating oil intake. The oil then passes through a drilled passage in the crankcase to the oil pump from which it passes through drilled passages in the crankcase to the crankshaft and camshaft bearings. The oil pump is driven from a spiral gear on the camshaft.

b. Whenever the oil pump is removed and then replaced on the power unit, the timing must be checked to see that the magneto fires at the correct point according to the position of the timing gears. See figure 15.

18. CARBURETOR.

a. The carburetor mixes the fuel and air in proper proportion for burning in the engine.

b. If the engine is not performing correctly, do not hastily conclude that the carburetor is at fault. First carefully check the ignition system, valve action, timing, compression, fuel system other than carburetor, fuel oil, operating temperature and the load. Only when these items are in normally good condition may the carburetor be properly adjusted. Do not attempt to compensate for a faulty condition elsewhere by changing the carburetor adjustment. Correct the fault where it exists.

c. The carburetor requires little attention other than cleaning and this can be kept at a minimum by using clean fuel and keeping the screens and sediment bowls clean throughout the fuel system. A drain plug and screen at the bottom of the carburetor bowl should be cleaned periodically.

d. Remove the carburetor from the engine and dismantle it for a thorough cleaning. Remove the screw plugs, jets, and the idle adjusting screw. Be careful not to lose any of the fiber washers. Clean jets and passages with compressed air, if available.

e. Do not remove the main nozzle unless necessary to replace it. It can be cleaned without removing. If a new one is installed, make sure that only one gasket is used with it and that the diagonally cut, inner end stands in a vertical position when tight (fig. 25). If necessary, a soft copper wire may be used to clean the jets and the bleed. Never use an iron or steel wire. A slight enlargement or distortion of these holes may make it necessary to replace the part. Replace any parts that are damaged or badly worn.

f. Remove the float and inspect the needle valve. If worn, or known to be leaking, install a complete new needle and seat assembly. Shake the float. If it contains gasoline, it leaks. Install a new one.

g. Check the float level. Hold the cover and float assembly in an upside-down position and allow the float to set the position determined by its own weight. The vertical distance from the gasket surface of the cover to the float should be ⅜ inch wide. If measured with the gasket in place, make allowance for gasket thickness. Take the measurement at the top surface of the float, near the end opposite the float arm. A simple way to take this measurement is to use a sheet metal gauge 2 or 3 inches long and 11/32 inch wide with parallel edges. When set on edge across the inverted cover, with gasket in place, the float should barely touch the gauge by its own weight. Any change in level adjustment should be made by bending that portion of the float arm which rests against the needle valve. Bend very slightly. Do not roughen or destroy its curvature. Do not stretch the needle valve spring.

h. Do not disturb the position of the metering rod, unless necessary to replace it. In that case, set the new rod at same position. If this rod is set too high, the full load fuel mixture will be too rich and vice versa.

i. In reassembling the carburetor, make sure that all fiber washers and gaskets are in place and that all jets and plugs are tight.

j. The pump on this carburetor is not required in constant speed service and should be made inoperative by removing the connecting link between the pump arm and the pump plunger rod.

k. Since a dirty air cleaner may place too great a restriction on the flow of air to the carburetor, always clean it when servicing the carburetor. Also, make sure that the choke opens properly.

l. After reassembling the carburetor to the engine, start the engine. With the power unit operating at no load, turn the idle adjustment screw in (clockwise) until the engine begins to run unevenly due to lean fuel mixture. Then slowly turn this screw in the opposite direction until the engine runs smoothly and the power unit develops maximum voltage. Do not open far enough for the voltage to begin to drop. Recheck this adjustment after the engine has been running half an hour. Proper adjustment is between ½ and 1-½ turns open (counterclockwise) from a completely closed position.

19. GENERATOR.

a. Routine Servicing.

(1) BRUSH INSPECTION. Remove the cover from the exciter every 200 operating hours and inspect the commutator, collector rings, and brushes. Make sure that brushes move freely in holders and have uniformly good

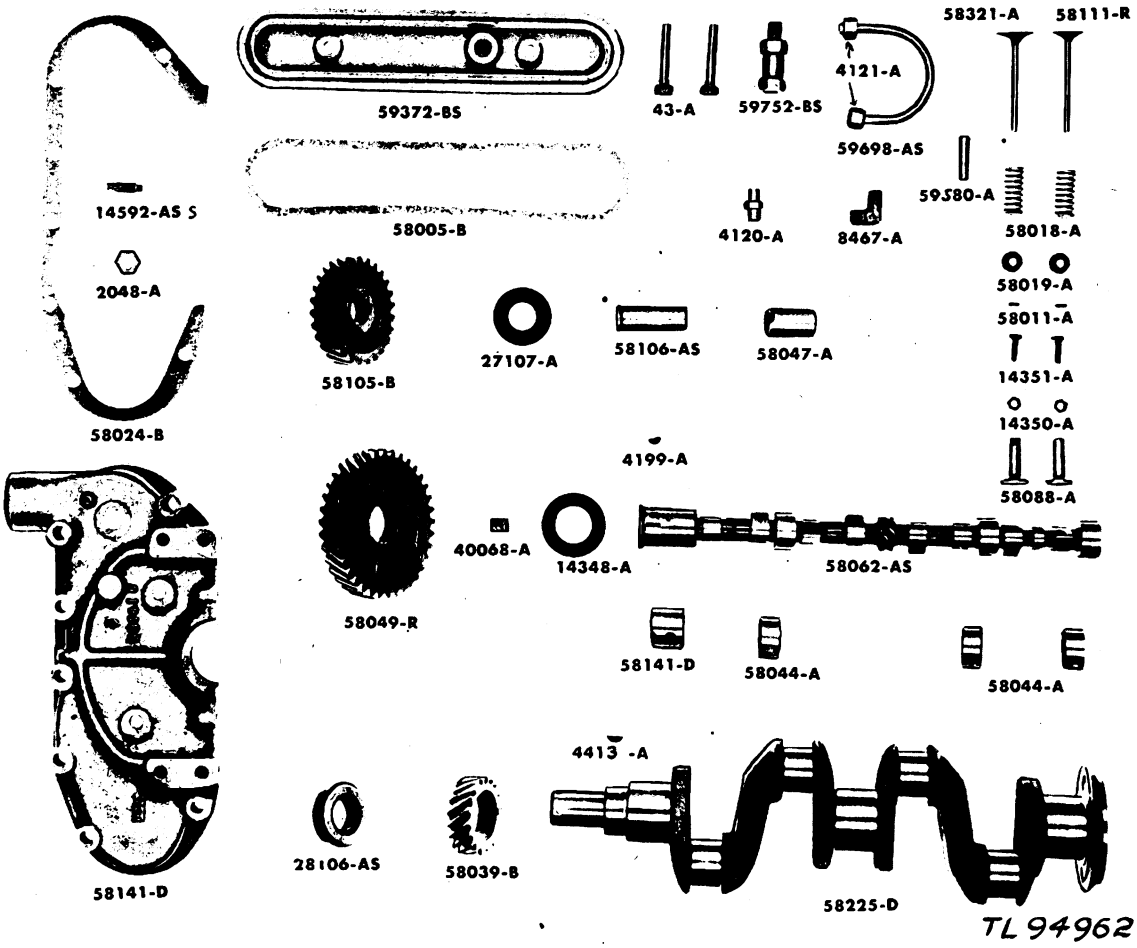


Figure 24. Crankshaft, camshaft, and timing gear group.

spring tension. Correct spring tension is 14.5 to 19.5 ounces for the slip ring brushes; 30 to 40 ounces for the exciter brushes when the end of the spring is even with the top of the brush holder. Replace any brushes worn to less than ¾ inch length.

(2) SANDING BRUSHES. Sand new brushes to a good seating contact. This may be done by drawing a strip of No. 00 sandpaper around the commutator, sanded side out, while the brush rests on the sanded surface of the paper with normal spring tension. Make sure that the sandpaper contacts a large area of the commutator both directions from the brush. Draw the sandpaper in the normal direction of armature rotation. Raise the brush for the return stroke. Repeat until a proper seating surface is obtained. Slip ring brushes are sanded in the same manner.

(3) COMMUTATOR. The commutator acquires a mahogany-colored surface after being in service a short time. If smooth, this surface requires no attention. Slight roughness may be improved by holding a piece of No. 00 sandpaper against the surface while the engine operates slowly. Brushes should be lifted in holders while performing this operation. A badly worn, burned, or pitted commutator will require refinishing in a lathe. After refinishing the commutator, or whenever the copper has worn down flush with the mica insulation which is between the bars, the mica must be undercut 1/32 inch.

(4) NEUTRAL POSITION OF EXCITER BRUSHES. The edge of the exciter brush ring has a small indentation that coincides with the edge of the upper left supporting boss when the ring is in proper neutral position. This spot is marked with white paint on both the ring and the support boss. This setting of the brush ring in neutral position should be maintained.

(5) SLIP RINGS. The slip rings require the same attention as the commutator except that there is no mica to be undercut.

(6) CLEANLINESS. After servicing the commutator, slip rings, and brushes, blow the sand, copper, and carbon dust from the generator.

(7) GENERATOR BALL BEARING. Every 3 months, or 512 operating hours, whichever occurs first, remove the bearing cover from the generator end bell. Clean the old grease from the bearing recess and repack with grease, WB. Replace the cover, using a new gasket, if needed. Be sure the retaining clips which hold the outer race of the ball bearing from turning in the end bell are in place.

b. Major Servicing.

(1) REPLACEMENT. Replacement of exciter field coils, rotor or stator, will require removing major parts of the generator. The control cabinet must be removed before major servicing of the generator may be done.

(2) REMOVING EXCITER FRAME. After the control cabinet has been removed, the exciter may be removed. Proceed as follows:

(a) Remove the cover band from the exciter. Lift all brushes high in their holders and set the ends of the springs against them to hold them high.

(b) Remove the end bearing cover from the exciter end bell. Remove the screw and lock which hold the outer race of the ball bearing from turning.

c. Supporting the Rotor. After the end bell or the complete generator frame is removed, the rotor has no rear support and care must be used to avoid placing any weight on this exposed end. At whatever stage the disassembly is stopped, place wood blocking under the bearing end of the rotor shaft to carry the weight of the rotor (fig. 4). To leave it unsupported for a considerable time may result in distorting the shaft. Do not put blocking under the commutator or slip rings. Place blocks either under exciter armature, alternator field pole, or bearing.

d. Removing Generator. After the control cabinet has been removed, the generator frame may be removed. This may be done without removing the exciter from the generator frame, if desired, by sliding the generator frame assembly to the rear until it clears the rotor assembly. Be careful that the frame assembly does not ride on the rotor assembly as it is being removed.

(1) If the rotor assembly is not to be removed, support the bearing end of the rotor on blocks just sufficiently high to carry its weight without distorting the shaft.

(2) If the rotor is to be removed, attach a rope around the shaft near each end of the assembly and support its weight with a hoist. Then remove the cap screws which attach the drive flange to the flywheel. Remove the rotor assembly from the flywheel, taking care not to damage the pilot which fits in a recess in the engine flywheel.

(3) If the adapter ring is to be removed, place blocking under the rear end of the engine, ahead of the adapter ring to support the weight of the engine. Then remove the blocks from under the adapter ring. Remove the bolts which attach the adapter ring to the engine. Slide the adapter ring back until free of the engine.

e. Reassembly of Generator to Power Unit.

(1) Reassembly is accomplished by a reversal of the operation used in disassembly. Use care. Make sure that all contact surfaces between parts are clean before fitting together. Tighten all nuts, screws, and connections securely. Use lockwashers in all places where they were used originally, preferably new lockwashers.

(2) After tightening the cap screws which attach the rotor drive flange to the flywheel, check the alignment of the rotor. The run-out should not exceed a total of

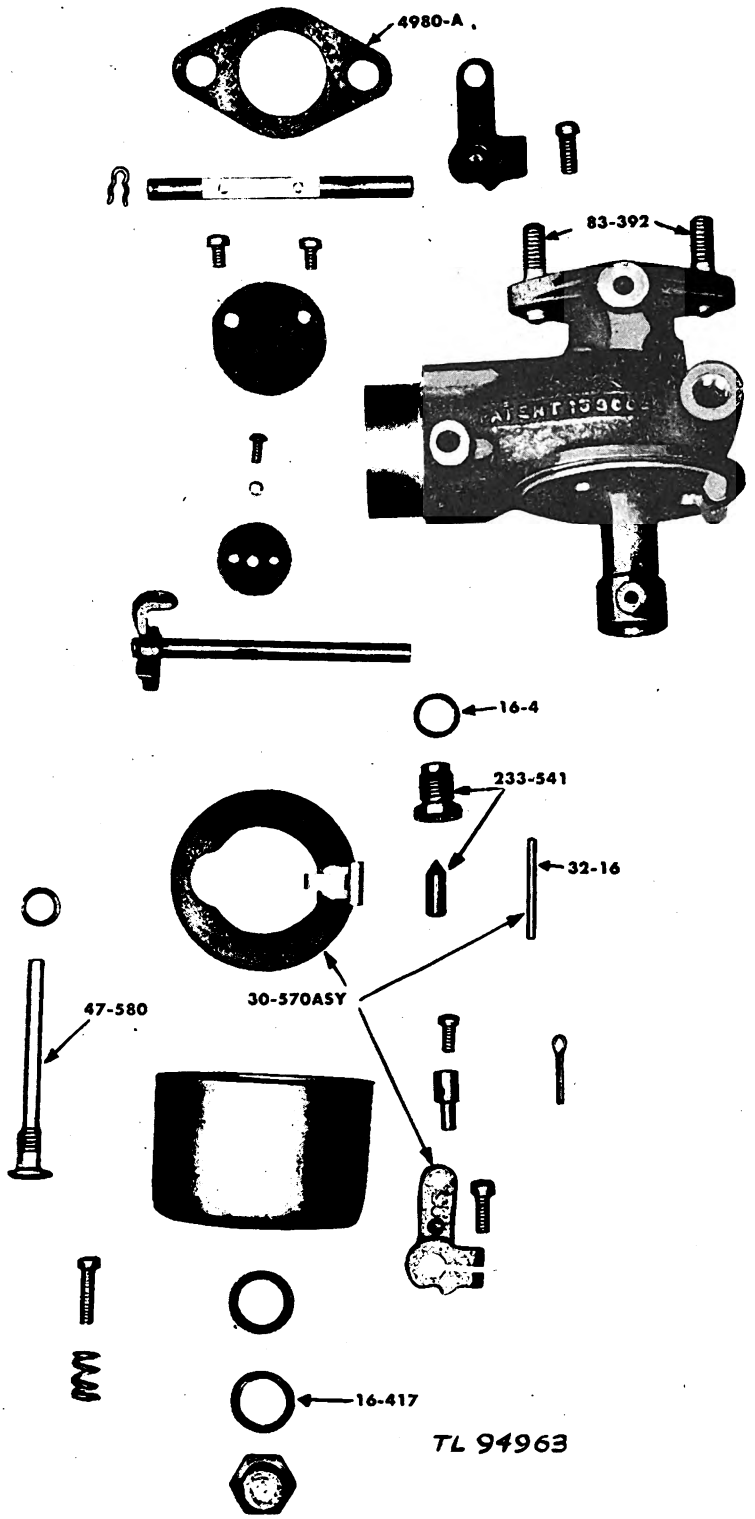


Figure 25. Carburetor parts.

0.010 inch. To correct excessive run-out, turn by means of the hand crank until the high side is up. Grasp the end of the rotor in both hands and push downward, but not too forcibly. Then test again. Repeat until the total run-out as shown by dial gauge is within 0.010 inch. Loosening and re-tightening the cap screws may help to correct excessive run-out.

(3) Be sure to install the rear bearing lock, fitting it into the slot in the bearing race. Pack the bearing housing ⅓ full of grease, WB, before installing cover. Tighten the front engine mounting bolts and the hose clamps. Before starting the engine, check your reassembly carefully to make sure no operation has been omitted.

f. Testing Windings. Most of the testing may be used without disassembling the generator. In each instance where an exciter armature winding or an alternator field winding tests open-circuited, short-circuited or grounded, the practical repair is to install a new rotor assembly. If a stator winding tests open-circuited, short-circuited, or grounded, the practical repair is to install a new stator winding assembly unless the trouble is in the leads outside the winding proper. The rotor windings and the stator windings can be successfully repaired only by a competent rewinding shop. The tests usually require the use of a 6-volt battery, a 3 or 4 candlepower, 6-volt lamp and socket, two test prods and the necessary connecting wire. Certain tests require a d-c voltmeter. Before starting the tests, remove the cover from the exciter, lift all brushes high in their holders and set the ends of the springs against them to hold them high. Then disconnect the four stator winding cables and the exciter leads. See wiring diagram in figure 22. Tag the cables so as to avoid error in replacing them. In using test prods, make sure that good electrical connection is made at points of contact.

g. Suppression Equipment.

(1) GENERAL. To reduce radio interference, the power unit is equipped with capacitors, suppressors, bonding straps, and internal-external tooth (IET) lockwashers. A complete tuneup would include at least a visual inspection of this equipment to make sure none of it is missing and that all connections are clean and tight. In case of excessive radio interference, a more thorough check-up must be made. The suppression equipment is intended to care for interefernce that otherwise would result from the normal operation of the power unit when in normally good condition. An abnormal condition of the power unit, or of the load, may result in more interference than the suppression equipment can control. Therefore, do not assume that the suppression equipment is at fault until the power unit has been checked thoroughly for such condition.

(2) LOOSE CONNECTIONS. Check the entire power unit for loose electrical connections, loose bonding strap connections, loose bolts, nuts, and screws of any kind or location. Keep all these tight at all times. At bonding strap connections and certain other points, special lockwashers with internal and external teeth are used, not only for locking the screws, bolts or nuts securely, but also because the teeth make good electrical contact with adjacent surfaces. Make sure washers are used at proper places.

(3) CAPACITORS. The location and capacitance of suppression capacitors are clearly shown on the wiring diagram (fig. 22). Make sure all are in place and that connections are tight. They may be removed and tested individually, as may be done with a radio capacitor. Replace with new ones any that test open, shorted, or of incorrect capacitance.

(4) BONDING STRAPS. Make sure that all bonding straps are in place and in good order and that connections are electrically good and mechanically secure.

(5) COMMUTATORS, SLIP RINGS, AND BRUSHES. Make sure that there is no abnormal arcing at the exciter brushes. Commutators and slip-rings must be smooth and clean. Mica must be properly undercut on the commutator of the exciter. All brushes must seat properly, with proper spring tensions and in proper positions.

(6) FAULTY CONTACTS. If switch or a-c circuit-breaker contacts are suspected of making poor contact, test one at a time by connecting a jumper across its terminal when it is in a normally closed position. If a switch or the a-c circuit-breaker tests defective, install a new one. A similar jumper test may be made across the terminals of suspected contacts of the voltage regulator. Study the wiring diagram and make sure the jumper is used across the correct terminals and only while the contacts being tested are normally closed.

(7) INTERFERENCE FROM OUTSIDE SOURCES. Defective lamps, transformers or appliances, or poor connections anywhere on the load circuit may result in radio interference which must be corrected at its source. Any commutator type motor may cause radio interference by brush sparking. This condition may be caused by; poor condition of commutator, wrong brush setting, brushes not properly seated or too light spring tension, excessive current caused by overloading motor, or low line voltage.

20. TROUBLE CHART.

a. Engine.

Symptom	Possible cause	Check	Remedy
Engine is cranked but will not start	Faulty ignition	Spark plugs	Clean, adjust, or replace plugs
		Breaker contacts	Resurface or replace contacts and adjust gap
	Lack of fuel or faulty carburetion	Clogged fuel line	Clean
	Fuel screens	Fuel screens	Clean
	Cylinders flooded	Cylinders	Crank few times with spark plugs removed
	Poor fuel	Fuel	Drain, refill with good fuel
	Dirty carburetor	Carburetor	Clean
	Poor compression, usually because of leaking valves	Crank with ignition off, noting whether compression uniformly good on all cylinders	Tighten or replace head gasket. Tighten spark plugs. Adjust tappets. If still not corrected, return unit to depot for repairing.
Engine misses at light load	Carburetor clogged	Carburetor	Clean if needed
	Spark plug gaps too narrow	Spark plugs	Set at .025"
	Intake air leak	Intake manifold	Tighten or replace gaskets
	Faulty ignition	Magneto breaker	Adjust or replace
		Magneto capacitor	Replace
	Uneven compression	Crank with ignition off noting whether compression uniformly good on all cylinders	Tighten head gasket and spark plugs. If still not corrected return to depot for repairing.
Engine misses at heavy load	Spark plugs defective	Spark plugs	Replace
	Faulty ignition	Magneto breaker	Adjust or replace
		Magneto capacitor	Replace
	Clogged carburetor	Carburetor	Clean
	Clogged fuel screens	All fuel screens	Clean
	Tappets adjusted too close	Tappets	Adjust
	Defective high-tension cables	Tigh-tension cables	Replace
Engine misses at all speeds	Fouled spark plug	Spark plugs	Clean and adjust
	Defective or wrong spark plug	Spark plugs	Replace
	Sticking valves	Valves	Return unit to depot for repairing
	Broken valve pin spring	Valve springs	Replace
	Defective ignition wires	Ignition wiring	Replace
	Pitted or improperly adjusted breaker contacts	Breaker contacts	Adjust or replace
	Tappets need adjusting	Tappets	Adjust
Low oil pressure	Oil too light	Inspect oil	Drain, refill with proper oil
	Oil badly diluted	Inspect oil	Drain, refill with proper oil
	Oil too low	Oil level	Add oil
	Oil relief valve not seating	Oil relief valve	Remove and clean
	Badly worn engine bearings	Smoky exhaust, excessive oil consumption which cannot otherwise be accounted for	Return unit to depot for repairing
	Loose connections in oil line	Connections	Tighten or replace
	Badly worn oil pump	No simple check	Return unit to depot for checking
	Defective oil gauge	Oil gauge	Replace

TROUBLE CHART (contd)

b. Generator.

Symptom	Possible cause	Check	Remedy
Engine runs but a-c voltage does not build up	Poor commutation	Exciter brushes	See that brushes seat well on commutator, are free in holders, are not worn shorter than ¾" and have good spring tension; if commutator is scarred or excessively dirty, use a commutator stone or crocus cloth, or both, to refinish.
Excessive sparking	Rough commutator surface Flat spot in commutator	Brushes and commutator	Same as above If commutator is rough or badly grooved, return unit to depot for repair
	Poor seating of brushes on slip rings	Slip rings	Give slip rings same attention as commutator.
	Open circuit, or ground in generator	No simple test	Return unit to depot for repairs.
Voltage unsteady but engine not missing	Poor commutation or poor brush contact at slip rings	Exciter commutator and brushes	See that brushes seat well on commutator, are free in holders, are not worn shorter than ¾" and have good spring tension. If commutator is rough or badly grooved, return unit to depot for repairs.
	Loose connections, especially in exciter circuits	Check for loose connections	Tighten connections
	Fluctuating load	Check load. Some fluctuating loads, such as a motor driving a single action reciprocating pump, are normal conditions	Correct any abnormal load condition causing trouble
Generator overheating	Overloaded	Ammeter	Reduce load
Voltage drops under heavy load	Engine lacks power	See symptom of engine missing under heavy load	See remedies for engine missing under heavy load
		Crank with ignition off, noting whether compression uniformly good on all cylinders	Tighten or replace head gasket. Tighten spark plugs. If still not corrected, return unit to depot for repairing.
		Carburetor	Clean carburetor
		Carburetor air cleaner	Clean air cleaner
		Choke	See that it opens wide
		Carbon in cylinders	Remove carbon
		Restricted exhaust line	Clean or increase the size

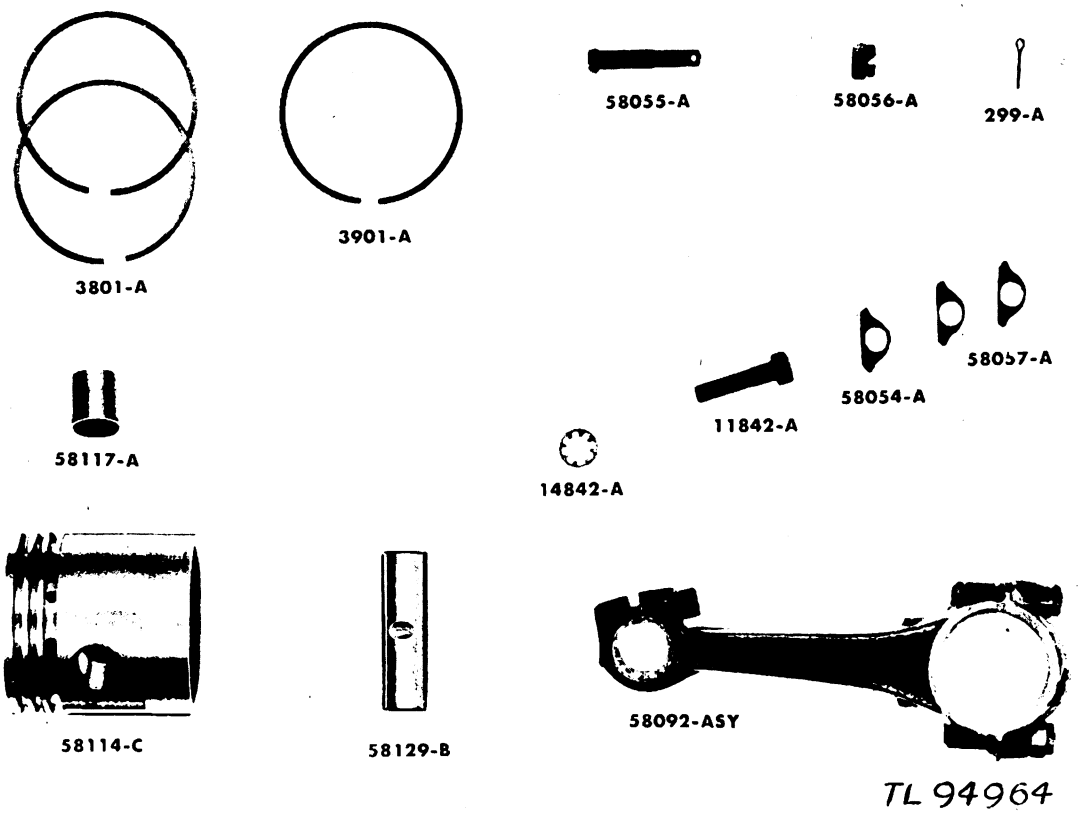


Figure 26. Piston, piston rings, and connecting rod group.

SECTION V

SUPPLEMENTARY DATA

21. MAINTENANCE PARTS LIST FOR POWER UNIT PU-32/C.

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Orgn stock	3d ech	4th ech	5th ech	Depot stock
Fig. 1	3H4531-32	**POWER UNIT, gasoline:** Power Unit PU-32/C; 5kw, 3 ph, 3 wire; 120 or 240 v; 1800 rpm.	1						
Fig. 2	3H1915-9	**ENGINE, gasoline:** 13.5 hp; Hercules Motors model ZXB.	1	0				*	
	Order through AGO channels	**TECHNICAL MANUAL** 11-960.	2						
		ACCESSORY DRIVE GROUP							
	3H4531-35/42	**DRIVE ASSEMBLY:** accessory; includes stud nut, attaching screw lockwasher, key, accessory drive key, attaching stud, accessory drive gear key, oil seal, thrust washer drive bushing, attaching gasket, accessory drive shaft, accessory drive housing, accessory drive gear, water pump shaft sleeve, water pump shaft thrust spring, and drive eccentric; Hercules Motors #59807BS.	1	0			*	*	
	3H4552/113	**GASKET, accessory drive:** mounting; Hercules Motors part 58077-A.	1	2			*	*	
	3H1915-9/S21	**SEAL, oil:** accessory drive; Hercules Motors #4626-A.	1	0			*	*	
		AIR CLEANER GROUP							
Fig. 23	3H1902-3/C10	**CLEANER, air:** oil bath type; w/aluminum elbow; Vortox #S-55-H.	1	0				*	
Fig. 23	3H4531-35/7	**ELBOW, clamping:** air cleaner; Vortox #8238.	1	0			*	*	
		CAMSHAFT GROUP							
Fig. 24	3H4552/27	**BEARING, camshaft:** front; Hercules Motors part #58041-A.	1	0				*	
Fig. 24	3H4552/28	**BEARING, camshaft:** rear and interior; Hercules Motors part #58044-A.	3	0				*	
Fig. 24	3H1915-9/7	**CAMSHAFT ASSEMBLY:** includes thrust plunger and camshaft; Hercules Motors #58062AS.	1	0				*	
Fig. 24	3H4552/29	**GEAR: camshaft:** 36 teeth; Hercules Motors part #58049-A.	1	0				*	

* Indicates stock available.

21. MAINTENANCE PARTS LIST FOR POWER UNIT PU-32/C (contd).

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Orgn stock	3d ech	4th ech	5th ech	Depot stock
Fig. 24	3H4552/30	**KEY, gear:** camshaft; #3 Woodruff; Hercules Motors part #4199-B.	1	0				*	
Fig. 24	3H4552/32	**PLUNGER, thrust:** camshaft; Hercules Motors part #40068-A.	1	0				*	
Fig. 24	3H4552/31	**WASHER, thrust:** camshaft; Hercules Motors part #14348-A.	1	0				*	
		CARBURETOR GROUP							
Fig. 25	3H717-1	**CARBURETOR:** Marvel Schebler model #TCX-39; part #10-2387.	1	0		*	*	*	
Fig. 25	3H717-1/3	**FLOAT AND LEVER ASSEMBLY:** Marvel Schebler #30-570.	1	0			*	*	
Fig. 25	3H717-1/4	**FLOAT VALVE AND SEAT:** matched; Marvel Schebler #233-541.	1	0			*	*	
	3H717-1/2	**GASKET ASSORTMENT:** 6 gaskets for carburetor TCX-39; Marvel Schebler #16-582.	1	0			*	*	
Fig. 25	3H4576A/X2	**GASKET, carburetor:** flange and water inlet; Hercules Motors #4980-A.	2	4	*	*	*	*	
Fig. 25	3H717-1/G5	**GASKET:** float bowl; Marvel Schebler #16-417.	1	2	*	*	*	*	
Fig. 25	3H716/G1	**GASKET:** float valve seat; Marvel Schebler #16-4.	1	0	*	*	*	*	
Fig. 25	3H717-1/N20	**NOZZLE:** carburetor main; Marvel Schebler #47-580.	1	0			*	*	
Fig. 25	3H717-1/7	**SHAFT, float lever:** Marvel Schebler #32-16.	1	0			*	*	
Fig. 25	3H717-1/S10	**STUD, flange screw:** Marvel Schebler #83-392.	1	0			*	*	
		CONNECTING ROD AND CRANKSHAFT GROUP							
Fig. 26	3H4552/39	**BOLT:** connecting rod cap; Hercules Motors part #58055-A.	8	0				*	
Fig. 24	3H1915-9/C80	**CRANKSHAFT:** Hercules #58225-D; p/o Hercules Motors model ZXB engine.	1	0				*	
Fig. 24	3H4552/50	**GEAR:** crankshaft; 18 teeth; Hercules Motors part #58039-B.	1	0				*	
Fig. 24	6L995-61	**KEY:** Woodruff #61; Hercules Motors #4413-A.	1	0				*	
Fig. 26	3H4552/40	**NUT:** connecting rod cap bolt; Hercules Motors part #58056-A.	8	0				*	
Fig. 26	3H1915-9/5	**ROD ASSEMBLY, connecting:** Hercules Motors #58092-ASY.	4	0			*	*	
Fig. 26	3H1915-9/S35	**SCREW:** lock; piston pin; special; Hercules Motors #11842-A.	4	0				*	
Fig. 26	3H4552/42	**SHIM:** connecting rod cap; 0.003" thick; Hercules Motors part #58054-A.	24	0				*	
Fig. 26	3H4552/43	**SHIM:** connecting rod cap; 0.002" thick; Hercules Motors part #58067-A.	24	0				*	
		CONTROL BOARD GROUP							
Fig. 7	3H900-50-18	**BREAKER, circuit:** 3 pole; Wemco # (De Ion); Pioneer Electric Co. #1705.	1	0				*	
	3DA10-302	**CAPACITOR, fixed:** 0.01 mf; O and M #13332 (panel board radio suppression).	6	2			*	*	

Fig. 27	3H4577A/R6	**CONNECTOR, female contact:** duplex twist-tite; Hubbell #9200.	1	0			*	*
Fig. 27	6Z7783-4	**CONNECTOR, female contact:** 4 pole; Hubbell #7250.	1	0			*	*
Fig. 6	3H2200	**GAUGE, pressure:** oil; 0-50; Rochester Mfg. Co. model OPC; Pioneer Electric #1112.	1	0			*	*
Figs. 6 and 27	6Z8645-2	**GAUGE, temperature:** complete w/63" capillary tube and connectors; calibrated 90°-212° F; Rochester Mfg. Co. model VTCC; Pioneer Electric Co. #1113.	1	0			*	*
Fig. 6	3H2145	**GAUGE, vacuum:** 0-30; US Gauge; Pioneer Electric Co. #1789.	1	0			*	*
Fig. 7	3H4531-32/10	**HARNESS, wiring:** complete wiring for panel board; cut to right length with sta-kon press terminals; O and M #13333.	1	0				*
Fig. 7	3H1915-9/23	**LINE, oil:** flex; O and M #12190 (control panel to engine).	1	0			*	*
Fig. 7	3H2689-1	**LINE, vacuum:** O and M #12191 (vacuum gauge to panel board).	1	0			*	*
Fig. 6	3F2789-2	**METER, frequency:** 57-63 cycles; 7 reeds; Aero #7007; Pioneer Electric Co. #1526.	1	0			*	*
Fig. 6	3F3363-2.1	**METER, running time :**125 v; 60 cycles; Aero #1001; Pioneer Electric Co. #1527.	1	0			*	*
Fig. 6	3F8150-107	**METER, voltmeter:** 0-150 v a-c; Wemco #1159010; Pioneer Electric Co. #1553.	1	0			*	*
Fig. 6	3H4109-5	**PANEL, complete:** w/meters, wires; O and M #13300.	1	0			*	*
Fig. 12	3H4962-120	**REGULATOR, voltage:** automatic; complete w/rheostat; 160 ohms; WL #5660; O and M #13350.	1	0				*
Fig. 7	3Z4900.19	**RESISTOR, variable (rheostat):** 100 ohms; 3 taper; WL #1108; Pioneer Electric Co. #1535 (manual field control).	1	0				*
Fig. 9	3Z9858-26	**SWITCH, toggle:** ignition; SPST; Pioneer Electric Co. #2506.	1	0			*	*
Fig. 6	3Z9849.152	**SWITCH, toggle:** voltage regulator; C-H #8824-K5; Pioneer Electric Co. #1547.	1	0			*	*
Fig. 4	2Z9404.162	**TERMINAL, outlet:** a-c; complete for installation; O and M #13345.	4	0			*	*
		CRANKCASE VENTILATION GROUP						
	3H4576A/K11	**FERRULES, ventilation tube:** crankcase; Hercules Motors #4122A.	2	0			*	*
	3H4576A/K9	**FITTING, pipe:** elbow; ventilation; crankcase; Hercules Motors #8467A (in valve cover).	1	0			*	*
	6Z3663-4	**FITTING, pipe:** elbow; ventilation; crankcase; Hercules Motors #13207A (in manifold).	1	0			*	*
	3H4531-35/41	**FITTING, pipe:** union; for crankcase vent tube; metering; includes: crankcase vent tube union metering plug and crankcase vent tube union in vent valve; Hercules Motors #13438AS.	1	0			*	*
	3H4576A/K10	**NUTS, ventilation tube:** crankcase; Hercules Motors #4121A.	2	0			*	*

* Indicates stock available.

21. MAINTENANCE PARTS LIST FOR POWER UNIT PU-32/C (contd).

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Run-ning spares	Orgn stock	3d ech	4th ech	5th ech	Depot stock
	3H4531-35/36	**TUBE, ventilation:** crankcase; Hercules Motors #59687A.	1	0			*	*	
	3H4531-35/39	**VALVE, ventilation:** crankcase; Hercules Motors #59752BS.	1	0			*	*	
		CYLINDER BLOCK AND CRANKCASE							
Fig. 28	3H4552/8	**BEARING, main:** cap; rear cylinder; Hercules Motors part #58094-B.	1	0			*	*	
Fig. 28	3H4552/7	**BEARING, main:** cap; front and center cylinder; Hercules Motors part #58093-B.	2	0			*	*	
Fig. 28	3H4552/5	**BEARING, main:** upper; front and center cylinder; Hercules Motors part #58040-B.	2	0			*	*	
Fig. 28	3H4552/6	**BEARING, cylinder:** rear main; upper; Hercules Motors part #58042-B.	1	0			*	*	
	3H4552/101	**GASKET, bell housing:** Hercules Motors #58065B.	1	0			*	*	
Fig. 28	3H1915-9/G22	**GASKET, cylinder head:** Hercules Motors #58214-B.	1	2	*	*	*	*	
	3H1915-9/1	**GASKET, fuel pump hole cover:** Hercules Motors #11327A.	1	0				*	
	3H4576A/H2	**GASKET, water outlet pipe:** Hercules Motors #4110-A.	2	4	*	*	*	*	
Fig. 28	3H1915-9/H25	**HEAD, cylinder:** Hercules #59202-D.	1	0				*	
Fig. 28	3H4581A/N11	**NUT, cylinder head stud:** 3/8"-24; Hercules Motors #752-A.	4	0	*	*	*	*	
Fig. 28	3H1915-9/P61	**PLUG, cylinder:** cup type 7/8"; Hercules Motors #3782-A.	1	1	*	*	*	*	
Fig. 28	3H4576/C10	**PLUG, cylinder:** cup type; 1" OD; Hercules Motors #3278-A.	2	2	*	*	*	*	
Fig. 28	3H1915-9/P60	**PLUG, cylinder:** cup type; 1¼" OD; Hercules Motors #3277-A.	2	2	*	*	*	*	
Fig. 28	3H4552/128	**SCREW, cylinder head:** Hercules Motors part #14347-A.	14	0				*	
Fig. 28	3H4552/9	**SCREW, cap:** main bearing; front and int; Mercules Motors part #40070-A.	6	0				*	
Fig. 28	3H4552/10	**SHIM, main bearing:** 0.002" thick; Hercules Motors part #58050-A.	12	0				*	
Fig. 28	3H4552/11	**SHIM, main bearing:** 0.003" thick; Hercules Motors #58051-A.	12	0				*	
	3H1915-9/S60	**STUD, cylinder head:** special; ¾" of 3/8-24 thread x 2½" long; ½" of 3/8-16 thread x 2½" long; Hercules Motors #13246-A.	4	0				*	
		FUEL FILTER GROUP							
Fig. 29	3H1915-9/B35	**BOWL, sediment:** fuel filter; Zenith #F-8-X-12.	1	1		*	*	*	
Fig. 29	3H1915-9/F20	**CLEANER, fuel (filter):** complete; Zenith Carburetor #F-381-X-1.	1	0		*	*	*	
Fig. 29	3H1915-9/G25	**GASKET, cork:** fuel strainer bowl; Zenith #F1X2.	1	2		*	*	*	

		FUEL PUMP GROUP							
Fig. 30	3H4531-32/9	**GASKET, cork:** pump bowl; Vic Mfg. and Gasket Co. #34545.	1	1	*	*	*	*
	3H1915-9/1	**GASKET, vellumoid:** fuel pump mounting; Hercules #11327-A.	1	1	*	*	*	*
	3H4531-35/MP	**KIT, repair:** fuel pump; AC #1538360.	1	0			*	*
Fig. 30	3H4601-23	**PUMP, fuel:** AC #1538312 (left-hand drive).	1	0			*	*
Fig. 2	3H4531-32/3	**LINE, fuel:** flexible; 27" long; O and M #12188 (pump to carburetor).	1	0		*	*	*
Fig. 2.	3H4531-32/4	**LINE, fuel:** flexible; 20' long; O and M #12189 (strainer to tank).	1	0		*	*	*
		GEAR COVER GROUP						
Fig. 24	3H4552/131	**GASKET, gear cover:** Hercules part #58024-B.	1	0			*	*
Fig. 24	3H4563C/G4	**SEAL ASSEMBLY:** gear cover; includes gear cover seal and gear cover seal sleeve; Hercules Motors #28106AS.	1	0			*	*
	3H1915-9/S20	**SEAL, oil:** gear cover; Hercules Motors #11226-A (water pump shaft).	1	0		*	*	*
Fig. 24	3H4579A/B2	**THRUST ASSEMBLY:** gear cover; includes thrust screw and fiber plug; Hercules Motors #14592AS.	2	2	*	*	*	*
		GENERATOR GROUP						
Figs. 4, 5, and 10	3H115-1	**ALTERNATOR:** 6.25 kva; 120/208 v a-c, 60 cycles, 3 phase, 4 wire; or 120 v a-c, single phase, 2 wire; 1800 rpm; w/exciter; 75 v d-c; 4 amps; O and M #13800.	1	0				*
Fig. 4	3H4512.5/B25	**BEARING, ball:** generator; Hoover #7306; O and M #1736.	1	0				*
Fig. 5	3H525-31	**BRUSH, electrical contact:** carbon exciter; O and M #6161.	4	4	*	*	*	*
Fig. 5	3H525-32	**BRUSH, electrical contact:** carbon; alternator; O and M #6162.	4	4	*	*	*	*
Fig. 10	3DB1.01	**CAPACITOR, fixed:** 0.1 mf; Concarbon #GB-01.	2	1	*	*	*	*
Fig. 5	3H115-1/4	**COILS, exciter:** complete w/leads and terminals; O and M #6067.	1	0			*	*
Fig. 10	3H115-1/3	**GASKET, vellumoid:** bearing cap; O and M #13108.	1	0			*	*
Fig. 10	3H115-1/1	**SPRING, brush:** left-hand; O and M #6154.	2	0		*	*	*
Fig. 10	3H115-1/2	**SPRING, brush:** right-hand; O and M #6153.	6	0		*	*	*
		GOVERNOR GROUP						
	3H1915-9/G23	**GASKET, governor:** Hercules Motors #27170-A.	1	2		*	*	*
Fig. 3	3H2477-5	**GOVERNOR:** Wirshing #G1200.	1	0			*	*
Fig. 3	3H2477-5/1	**LINKAGE:** governor to carburetor; Wirshing #G-1200-A.	1	0		*	*	*
		IDLER GROUP						
Fig. 24	3H4552/68	**BEARING, idler shaft:** babbitt lined; Hercules Motors #58047-A.	1	0				*

* Indicates stock available.

21. MAINTENANCE PARTS LIST FOR POWER UNIT PU-32/C (contd).

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Orgn stock	3d ech	4th ech	5th ech	Depot stock
Fig. 24	3H4552/67	**GEAR, idler shaft:** 26 teeth; Hercules Motors part #58105-B.	1	0				*	
Fig. 24	3H4552/66	**SHAFT, idler:** w/plunger assembly; includes thrust plunger and idler shaft; Hercules Motors #58106-AS.	1	0				*	
Fig. 24	3H4552/70	**WASHER:** idler shaft thrust; Hercules Motors part #27107-A.	1	0				*	
		MAGNETO GROUP							
Fig. 31	3H2699-8/B4	**BEARING, ball:** magneto; Eisemann #3507; Norma Hoffman #XA105-P.	2	0			*	*	
Fig. 31	3H525-23	**BRUSH, carbon:** w/spring; high tension pick-up; Eisemann #21062.	1	0		*	*	*	
Fig. 31	3E7245-1	**CABLE ASSEMBLY:** magneto; shielded; w/terminals; and coupling; 19" long Eisemann #27067.	2	0		*	*	*	
Fig. 31	3E7245	**CABLE ASSEMBLY:** magneto; shielded; w/terminals and coupling; 15" long; Eisemann #27068.	2	0		*	*	*	
Fig. 8	3E7245-2	**CABLE ASSEMBLY:** magneto; shielded; w/terminals and coupling; 15" long; Eisemann #27078.	1	0		*	*	*	
Fig. 31	3DA220-1	**CAPACITOR, fixed:** Eisemann #24924 (for points).	1	1		*	*	*	
Fig. 31	3C1079A	**COIL, magneto:** complete w/leads and cone; Eisemann #26825.	1	0			*	*	
Fig. 31	3H2699-44/5	**CONTACT SET:** magneto; spring type; tungsten points; Eisemann #27051.	1	1		*	*	*	
Fig. 8	3H2699-44/2	**COUPLING, magneto:** adjustable; steel; Eisemann #24970.	1	0		*	*	*	
Fig. 8	3H2699-44/1	**DISK, floating:** magneto; canvass bakelite; composition; Eisemann #27083.	1	0		*	*	*	
Fig. 31	6Z3777	**EYELET, brass:** magneto wire holder; Eisemann #26488.	4	0			*	*	
Fig. 31	3H2699-44	**MAGNETO, ignition:** Eisemann model LA-4, #27042.	1	0		*	*	*	
	6L3005-18GC	**NUT, castellated:** Eisemann #24976 (for magneto coupling).	1	0		*	*	*	
Fig. 31	3H2699-44/4	**PLATE, distributor:** magneto; w/carbon brush; spring; screws suppressor; Eisemann #27091.	1	0		*	*	*	
Fig. 31	3H2699-44/3	**ROTO, distributor:** magneto; complete w/gear; Eisemann #24295.	1	0			*	*	
Fig. 31	3H2699-44/9	**SCREEN, ventilation:** magneto peep hole; Eisemann #26788.	1	0		*	*	*	
Fig. 31	3H2699-44/8	**SCREEN, ventilator:** magneto bottom; Eisemann #26992.	1	0		*	*	*	
Fig. 8	6L7918-5-8.81SG	**SCREW, clamping:** Eisemann #24975 (for magneto coupling).	1	0		*	*	*	
Fig. 31	3H2699-44/7	**SEAL, dust:** complete w/felt; Eisemann #23811.	1	0			*	*	

	3H2699-44/6	**SEAL, oil:** Eisemann #24120 (for drive shaft).	1	0			*	*
Fig. 31	3H5255-1	**SPRING, contact:** wire to spark plug; Eisemann #26489.	4	0			*	*
Fig. 31	3G1837-32.20	**TUBE, insulation:** magneto wire at spark plug; Eisemann #26459.	4	0			*	*
	6L71038	**WASHER, flat:** steel; Eisemann #24977 (for magneto coupling).	2	0		*	*	*
		MANIFOLD GROUP						
Fig. 28	3H4552/95	**GASKET:** exhaust and intake manifold; Hercules Motors part #58028-A.	2	1	*	*	*	*
Fig. 28	3H1915-9/M20	**MANIFOLD, exhaust and intake:** Hercules Motors #58357-D.	1	0				*
	6L3506-24-9.10	**NUT:** manifold; Seeze-pruf; 3/8-24; Hercules Motors #13124.	4	0			*	*
Fig. 28	3H4552/96	**STUD:** manifold; 3 1/8" long; 3/8-24 x 3/4" thread and 3/8-16 x 1/2" thread; Hercules Motors #4580-A.	2	0			*	*
Fig. 28	3H4552/97	**STUD:** manifold; 2 1/2" long, 3/8-16 x 1/2" thread, and 3/8-24 x 3/4" thread; Hercules Motors #14387-A.	2	0			*	*
		MISCELLANEOUS GROUP						
	3H4531-32/5	**CHOKE ASSEMBLY:** hand; 23" long; O and M #1286.	1	0		*	*	*
Fig. 33	3H4531-32/8	**COVER:** canvas duck; waterproof; O and M #13802.	1	0		*	*	*
Fig. 33	3H1915-9/C81	**CRANK, hand:** Hercules Motors #59381BS.	1	0		*	*	*
Fig. 3	6Z8635-19	**FITTING, pipe:** tee; 1/4" x 1/8" x 1/8"; O and M #12184 (for vacuum gauge).	1	0			*	*
	6Z7245-2	**FITTING, pipe:** 1/8" close nipple; O and M #12185 (adapter form "Tee" to manifold).	1	0			*	*
	3H1915-9/G26	**GASKET SET:** for Hercules Motors engine model ZXB consists of: 1 fuel pump hole cover, 1 cylinder head, 1 water outlet, 1 gear cover, 2 oil pan, 2 oil pressure adjusting screw, 2 oil filter cover, 2 exhaust and intake manifold, 1 bell housing, 1 accessory drive housing, 2 carburetor main nozzle and bowl lock plug, 2 carburetor main nozzle, 2 water pump discharge pipe, 2 carburetor float valve seat, 2 carburetor float bowl, 1 governor, 2 fuel filter bowl, 1 water pump cover, 2 valve cover, 1 bearing bracket cap, and 2 fuel pump mounting gaskets.	1	0			*	*
	3H4531-32/6	**HOSE, oil:** 6" long; neoprene; O and M #12187 (for oil drain).	1	0		*	*	*
Fig. 27	2Z8404-24	**MOUNT, vibration:** control panel cabinet; complete w/2 bolts; O and M #14014.	4	0			*	*
Fig. 2	3H3981	**MUFFLER, exhaust:** w/insulation assembly; O and M #12162.	1	0		*	*	*
Fig. 3	3H4413-10	**PLUG, spark:** 14 mm special; Champion part #C-10-S.	4	12	*	*	*	*
		OIL PAN GROUP						
Fig. 2	3H4531-32/1	**FILLER, oil:** w/breather and filter; Donaldson #3X-985-45; O and M #12155.	1	0		*	*	*
Fig. 32	3H1915-9/G20	**GASKET:** oil pan; Hercules Motors #59189-B.	2	0			*	*

* Indicates stock available.

21. MAINTENANCE PARTS LIST FOR POWER UNIT PU-32/C (contd).

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Orgn stock	3d ech	4th ech	5th ech	Depot stock
Fig. 2	3H1915-9/G75	**GAUGE, oil:** bayonet; Hercules Motors #59179-AS.	1	0		*	*	*	
		OIL PUMP GROUP							
Fig. 32	3H4552/73	**FITTING, pipe:** union; Hercules Motors #246-A (for discharge pipe).	1	0			*	*	
Fig. 32	3H4552/80	**GEAR:** oil pump drive; Hercules Motors part #27126-A.	1	0				*	
Fig. 32	3H4552/84	**GEAR:** oil pump; Hercules Motors part #27122-A.	2	0				*	
Fig. 32	6L995-2	**KEY:** gear; oil pump; water pump distributor driving; Hercules Motors #1179-A.	3	0				*	
Fig. 32	3H4552/74	**OIL PUMP:** Hercules Motors part #58120-CS.	1	0			*	*	
Fig. 32	3H4552/82	**PIN:** oil pump drive gear; Hercules Motors part #5813.	1	0				*	
Fig. 32	3H4552/71	**PIPE ASSEMBLY:** oil pump discharge; includes 2 nuts; Hercules Motors #58136-AS.	1	0			*	*	
Fig. 32	3H1915-9/8	**RING:** felt; oil pump; Hercules Motors #14087A.	1	0			*	*	
Fig. 32	3H4552/78	**RING:** snap; oil pump; Hercules Motors part #4411-A.	2	0			*	*	
Fig. 32	3H4552/76	**SCREW:** 18 thread; 5/16" x 11/16"; Hercules #303-A.	2	0			*	*	
Fig. 32	3H4552/79	**SHAFT:** drive; oil pump; Hercules Motors part #58124-A.	1	0				*	
Fig. 32	3H4552/85	**SHAFT:** idler; oil pump; Hercules Motors part #27125-A.	1	0				*	
		OIL PRESSURE REGULATOR GROUP							
Fig. 32	3H4552/24	**GASKET:** screw; oil pressure regulator nut; Hercules Motors part #14438-A.	2	2	*	*	*	*	
Fig. 32	3H4552/21	**PISTON:** oil pressure regulating; Hercules Motors #22129-A.	1	0		*	*	*	
Fig. 32	3H4552/23	**SCREW:** adjusting; oil pressure; Hercules Motors #14436-A.	1	0		*	*	*	
Fig. 32	3H4552/22	**SPRING:** regulating; oil pressure; Hercules Motors #1347A.	1	0		*	*	*	
		PISTON GROUP							
	3H1915-9/3	**PISTON:** cast iron #59119AS-010; 0.010" oversize; fitted w/bushings and pins; Hercules Motors; p/o Hercules model ZXB engine.	4	0			*	*	
Fig. 26	3H1915-9/R31	**RING, piston:** compression; 2⅜" x ⅛" standard; Hercules Motors #3801-A.	8	0			*	*	
Fig. 26	3H1915-9/R33	**RING, piston:** compression; 2⅜" x ⅛"; 0.010" oversize; Hercules Motors #3801-A.010.	8	0			*	*	
Fig. 26	3H1915-9/R30	**RING, piston:** oil; 2⅜" x 3/16" standard; Hercules Motors #3901-A.	4	0			*	*	
Fig. 26	3H1915-9/R34	**RING, piston:** oil; 2⅜" x 3/16"; 0.010" oversize; Hercules Motors #3901-A.-010.	4	0			*	*	

		RADIATOR ASSEMBLY GROUP						
Fig. 34	3H305-17	**BEARING, ball:** blower fan; Norma Hoffman #3604.	1	0			*	*
Fig. 34	3H684	**CAP, radiator:** Hobart #5J131C.	1	0		*	*	*
Fig. 34	6Z1928-16	**CLAMP, hose:** radiator; Carson Machine #35-42.	4	2	*	*	*	*
Fig. 34	3H4531-32/7	**COUPLING ASSEMBLY:** blower; Hobart Brothers #5J307.	1	0			*	*
Fig. 34	3H399-3	**FAN, blower:** blower wheel assembly; Hobart Brothers #5J134A.	1	0				*
Fig. 34	3H1915-9/12	**HOSE, rubber:** radiator; Carson Machine #35-41.	2	2	*	*	*	*
Fig. 34	3H1915-9/P26	**PIN, blower coupling to engine:** steel; ¼" diam. x 2¼" long; Hobart Brothers #55183.	1	0			*	*
Fig. 34	3H1915-9/R10	**RADIATOR ASSEMBLY:** McCord #DA148900.	1	0				*
Fig. 27	3H1915-9/T25	**THERMOSTAT:** opens at 155 deg; Sylphon #138.	1	0		*	*	*
		VALVE AND TAPPET GROUP						
Fig. 24	3H4552/64	**GASKET:** valve cover; Hercules Motors part #58005-B.	1	4	*	*	*	*
Fig. 24	3H1915-9/G80	**GUIDE, valve:** Hercules Motors #59580-A.	8	0			*	*
	3H1915-9/6	**INSERT, exhaust valve:** stellite; Hercules Motors #59215-A.	4	0				*
Fig. 24	3H4552/58	**PIN:** valve spring; seat; Hercules Motors part #58011-A.	8	0	*	*	*	*
Fig. 24	384552/65	**SCREW:** 5/16 x 1¼"; 18 thread; Hercules Motors part #43-A (valve cover).	2	0	*	*	*	*
Fig. 24	3H4552/57	**SEAT, valve spring:** Hercules Motors part #58019-A.	8	0	*	*	*	*
Fig. 24	3H4552/56	**SPRING, valve:** Hercules Motors part #58018-A.	8	0	*	*	*	*
Fig. 24	3H4576A/V2	**TAPPET, valve:** standard, Hercules Motors #58088-A.	8	0				*
	3H1915-9/4	**VALVE, exhaust:** stellite; Hercules Motors #58109A.	4	0	*	*	*	*
Fig. 24	3H4576A/V1	**VALVE, intake:** Hercules #58321-A.	4	0	*	*	*	*
		WATER PUMP GROUP						
	3H1915-9/18	**BUTTON:** thrust; pump shaft; Hercules Motors #58369-A.	1	0			*	*
Fig. 35	3H1915-9/C45	**CLAMP, hose:** 1⅛" ID; Hercules Motors #14443A.	2	2	*	*	*	*
	3H4580A/H28	**CUP, grease:** water pump; Hercules #749-A.	1	0		*	*	*
Fig. 35	3H1915-9/G21	**GASKET:** cover; water pump; Hercules Motors #58368-A.	1	0			*	*
Fig. 35	3H4576A/X2	**GASKET:** water pump; discharge pipe; Hercules Motors #4980-A.	1	0		*	*	*
Fig. 35	3H1915-9/11	**HOSE:** water; from water pump to block; 1½" long x 1" ID; Hercules Motors #14458A.	1	1	*	*	*	*
Fig. 35	3H1915-9/13	**IMPELLER, water pump:** Hercules Motors #58363-A.	1	0			*	*

* Indicates stock available.

21. MAINTENANCE PARTS LIST FOR POWER UNIT PU-32/C (contd).

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Orgn stock	3d ech	4th ech	5th ech	Depot stock
Fig. 35	3H1915-9/P27	**PIN, impeller:** water pump; Hercules Motors #3260A.	1	0			*	*	
Fig. 35	3H1915-9/P85	**PUMP, water:** Hercules Motors #58375-CS.	1	0		*	*	*	
Fig. 35	3H4580A/L8	**RING, snap:** water pump shaft; Hercules Motors #4387-A.	1	0			*	*	
	3H1915-9/20	**SEAL ASSEMBLY:** water pump; includes rotary seal carbon washer, spring holder, ring, spring, friction ring, and friction ring band; Hercules Motors #59265-AS.	1	0			*	*	

* Indicates stock available.

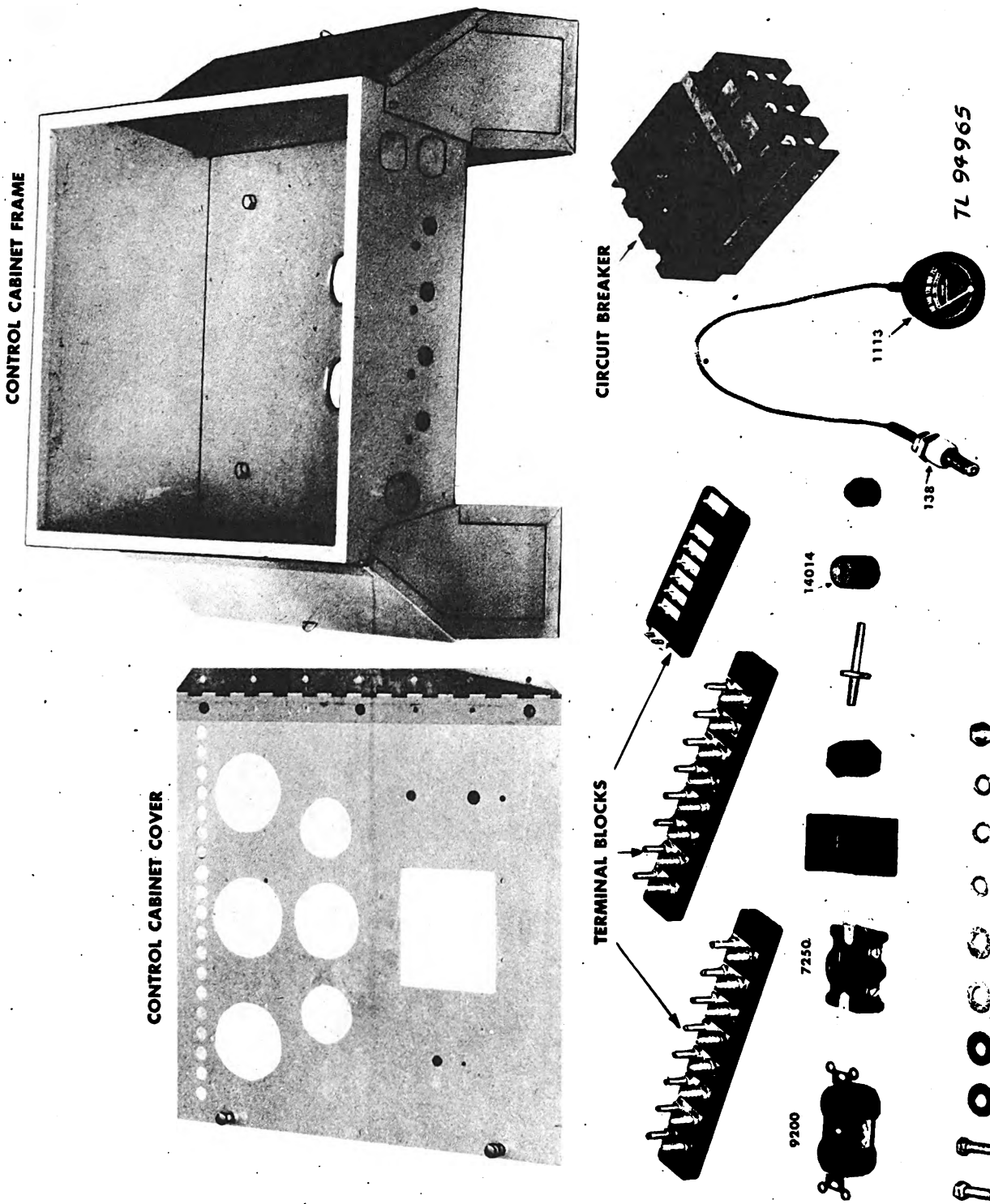


Figure 27. Control panel group.

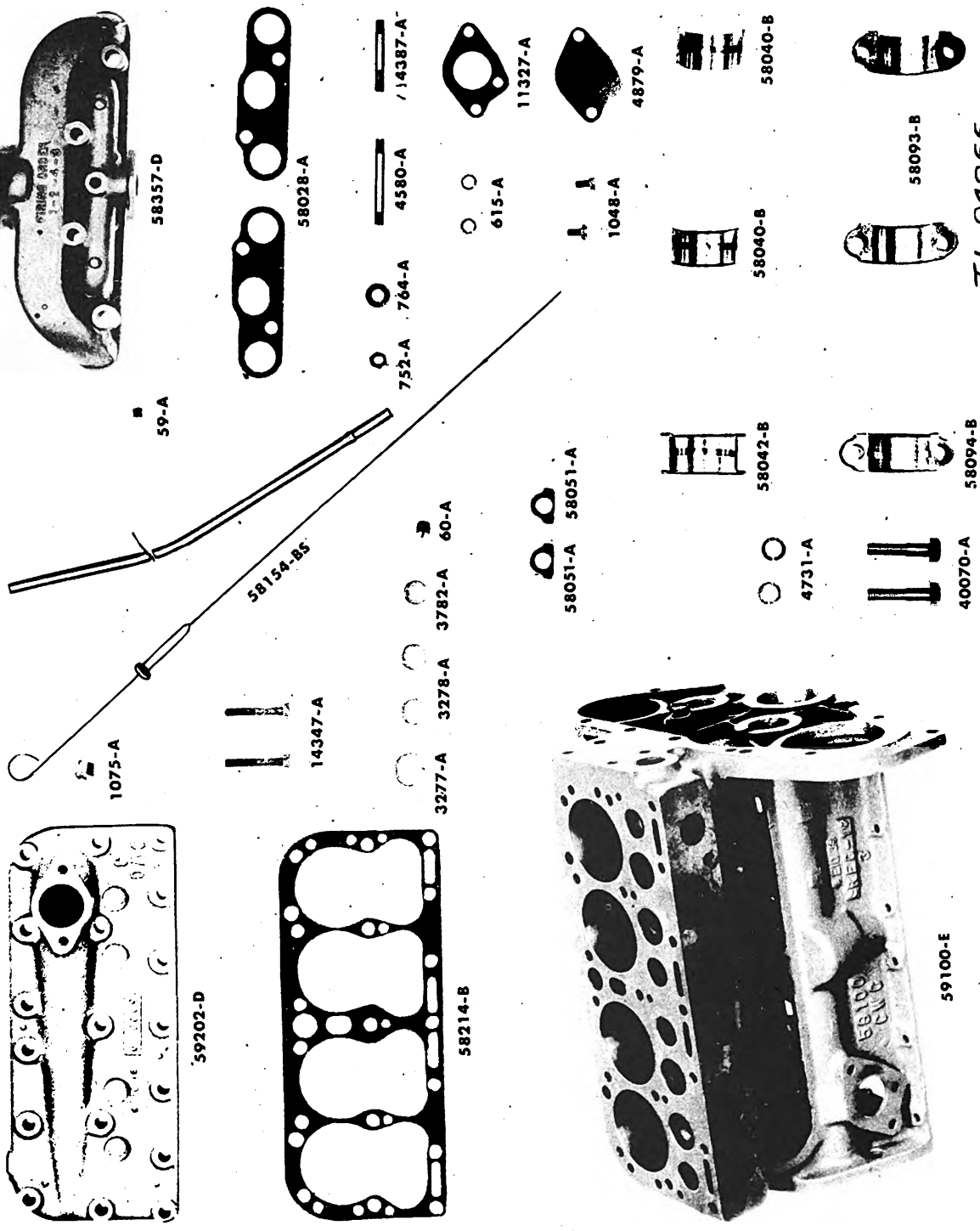


Figure 28. Cylinder block, cylinder head, and manifold group.

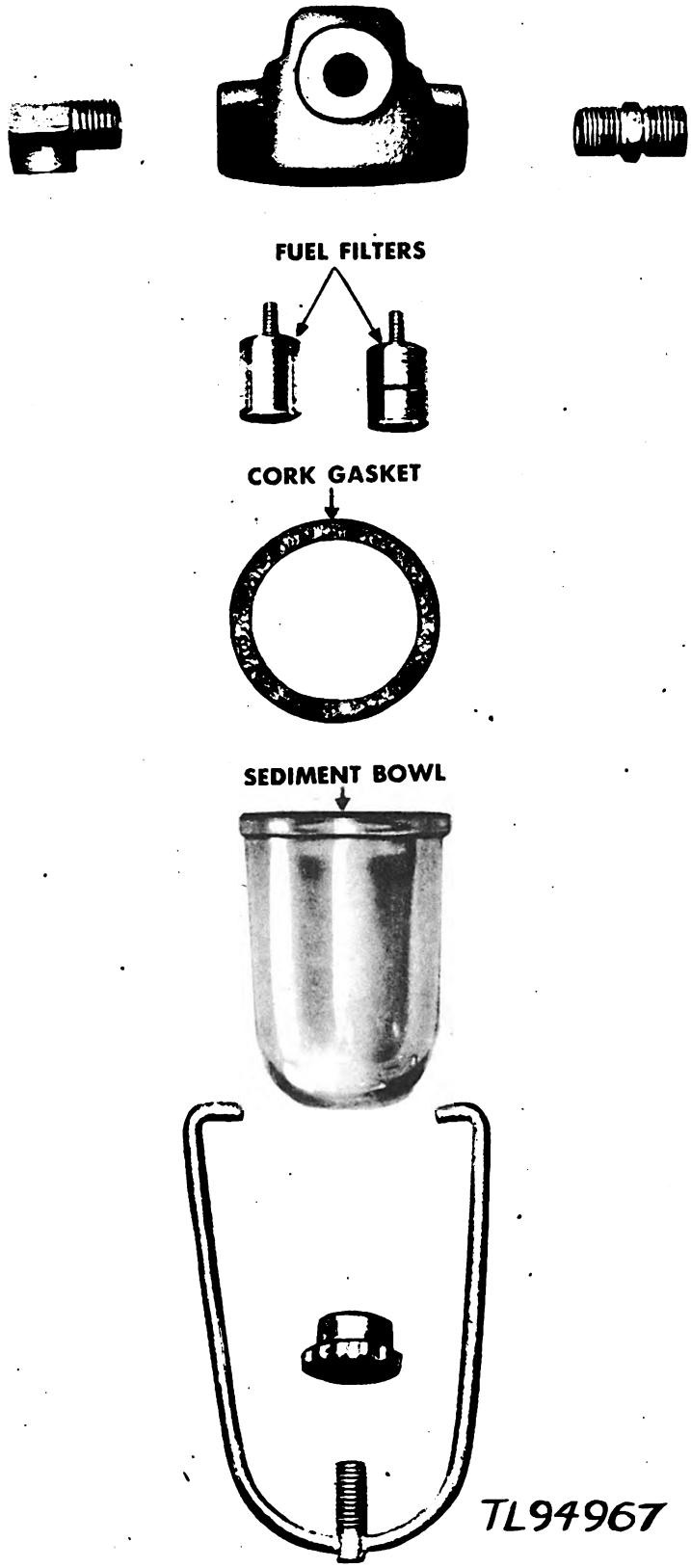


Figure 29. Fuel filter.

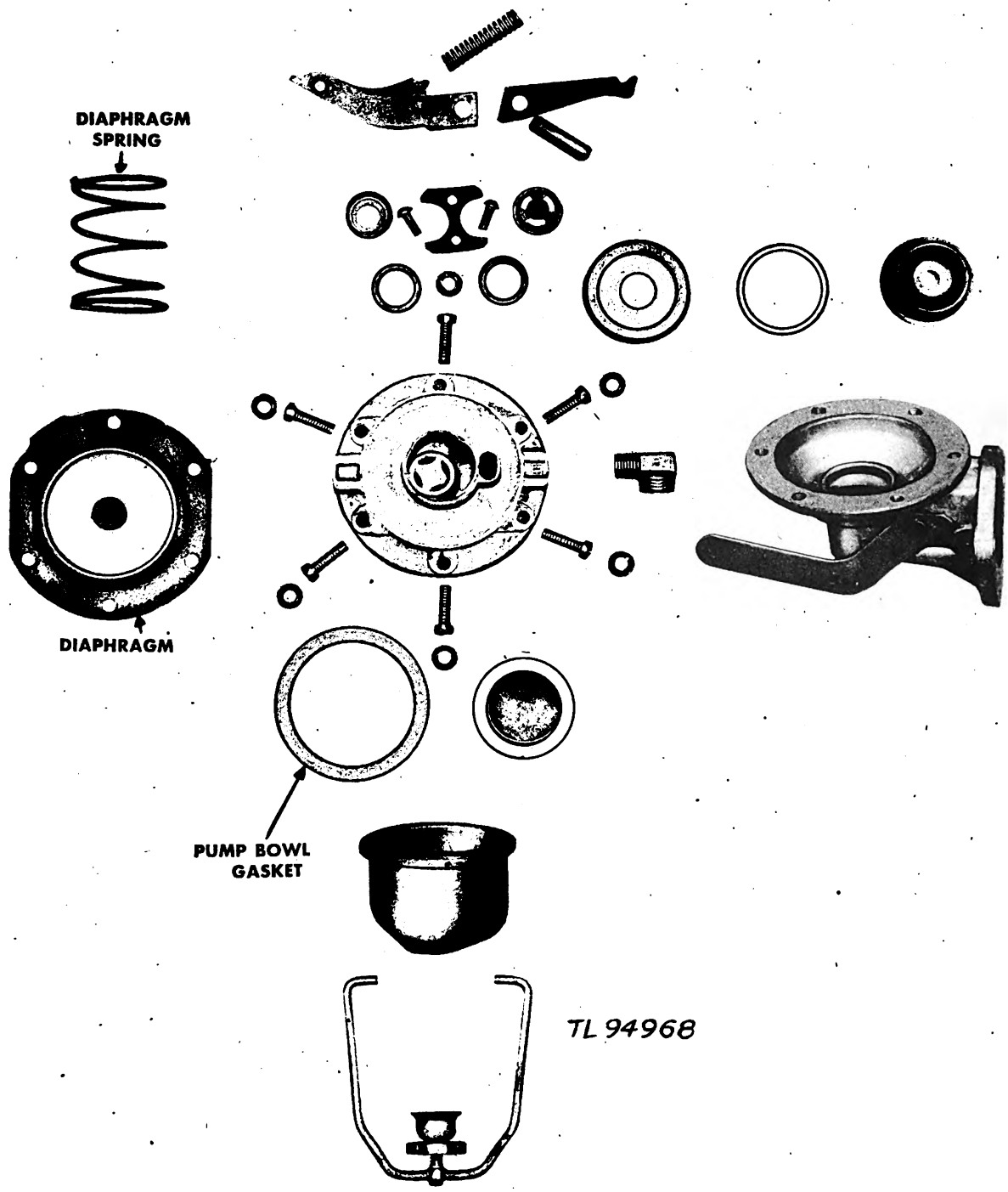


Figure 30. Fuel pump.

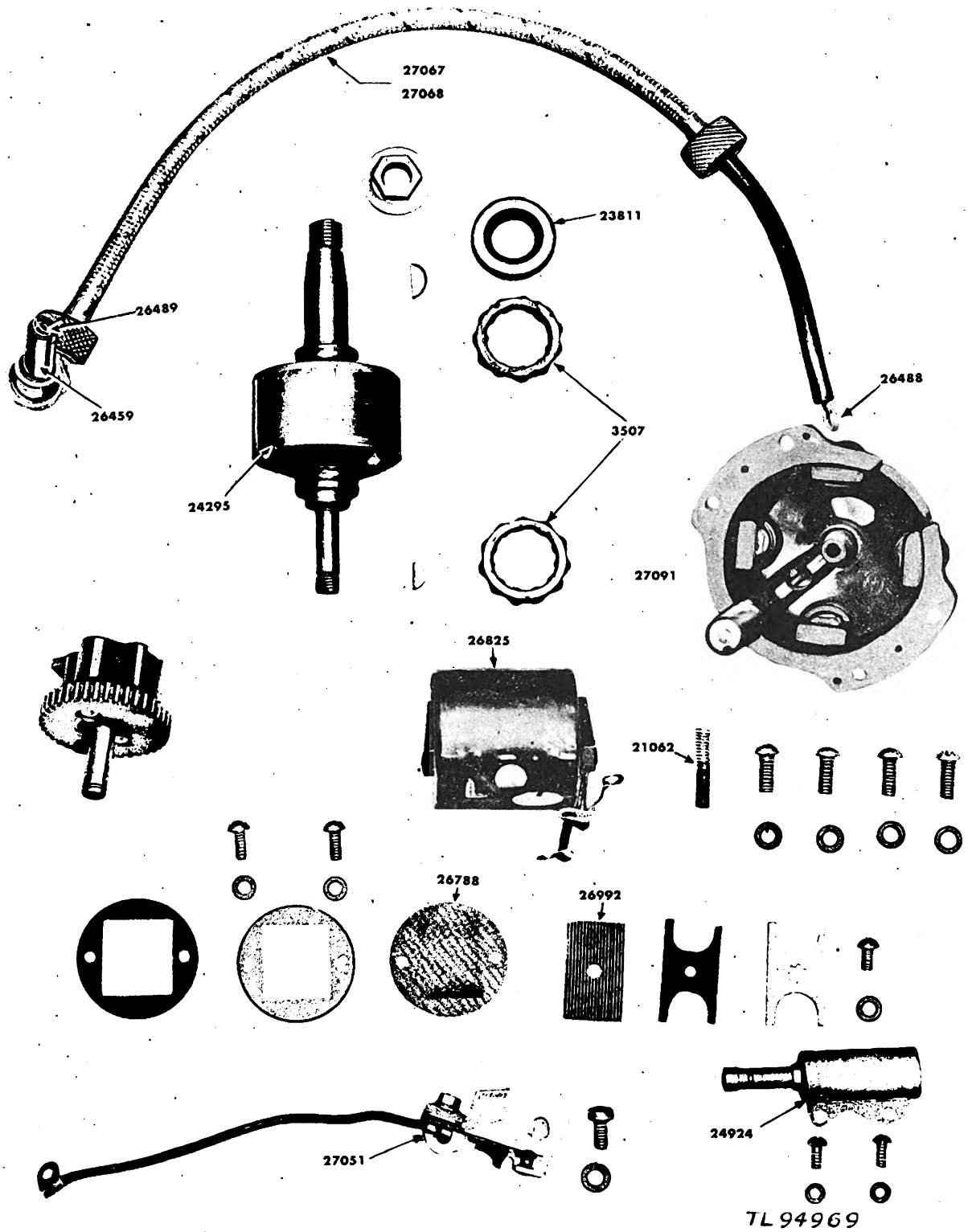


Figure 31. Magneto parts.

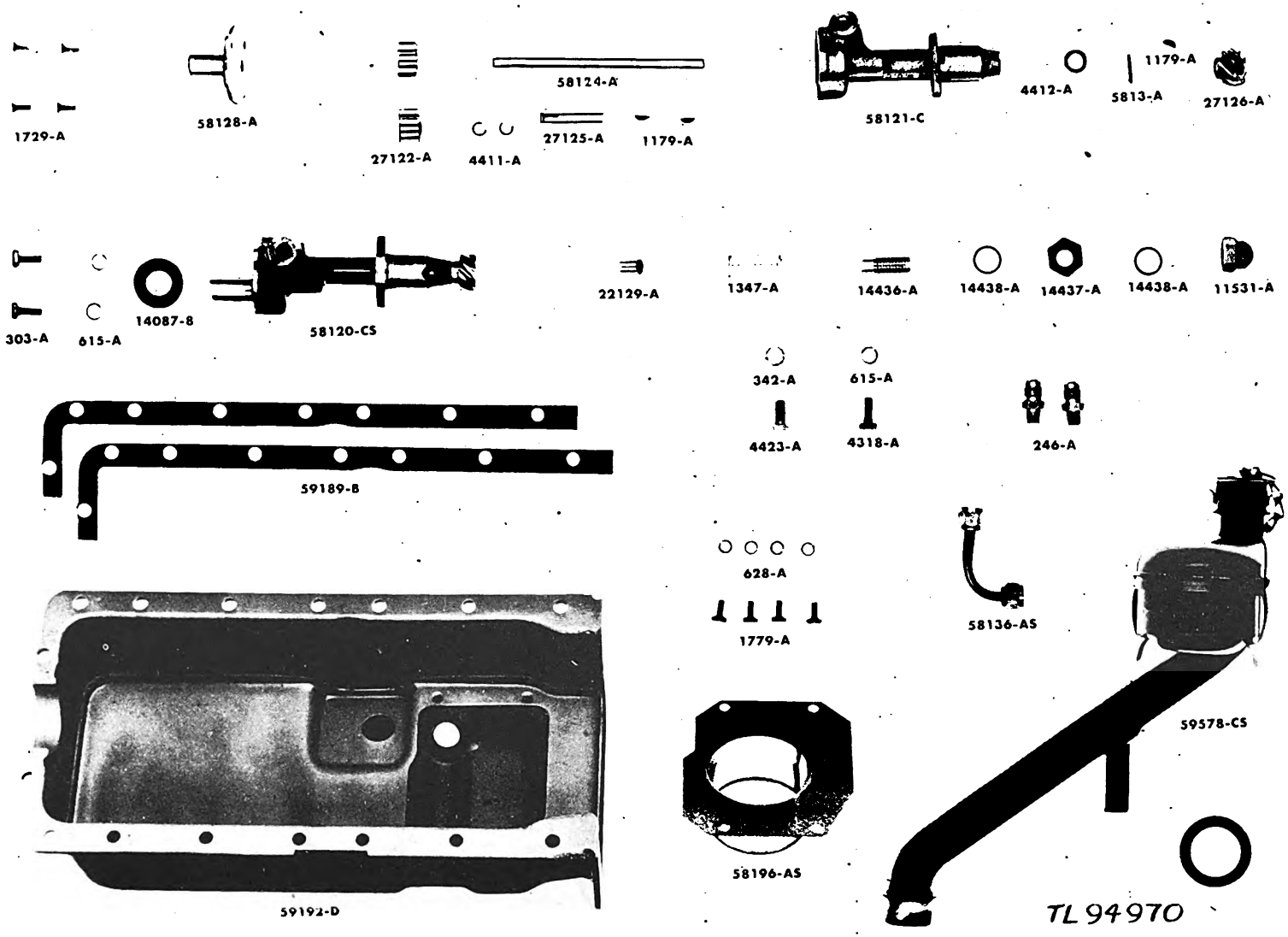


Figure 32. Oil pan, oil pump, and oil filler tube group.

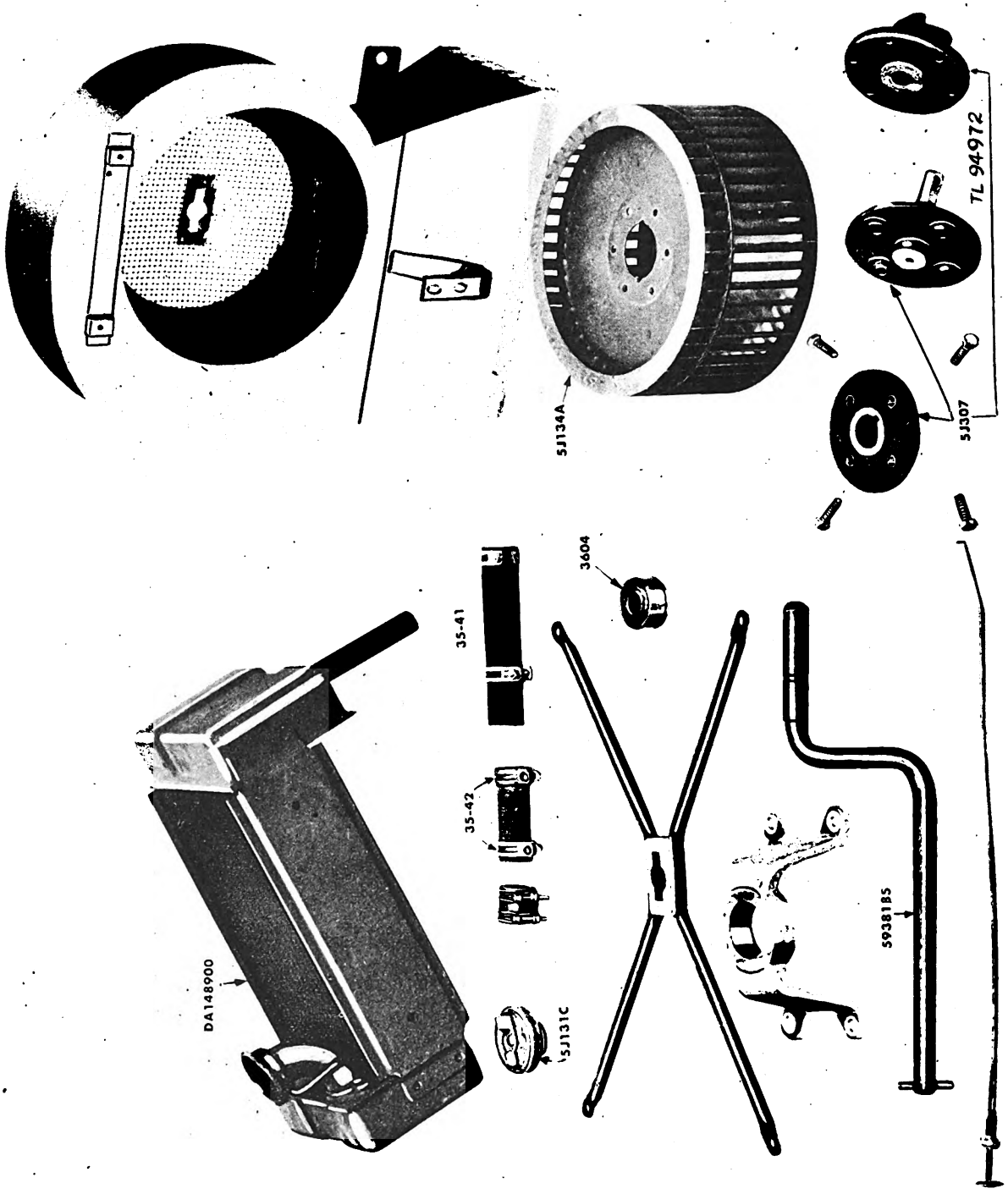


Figure 34. Cooling system group.

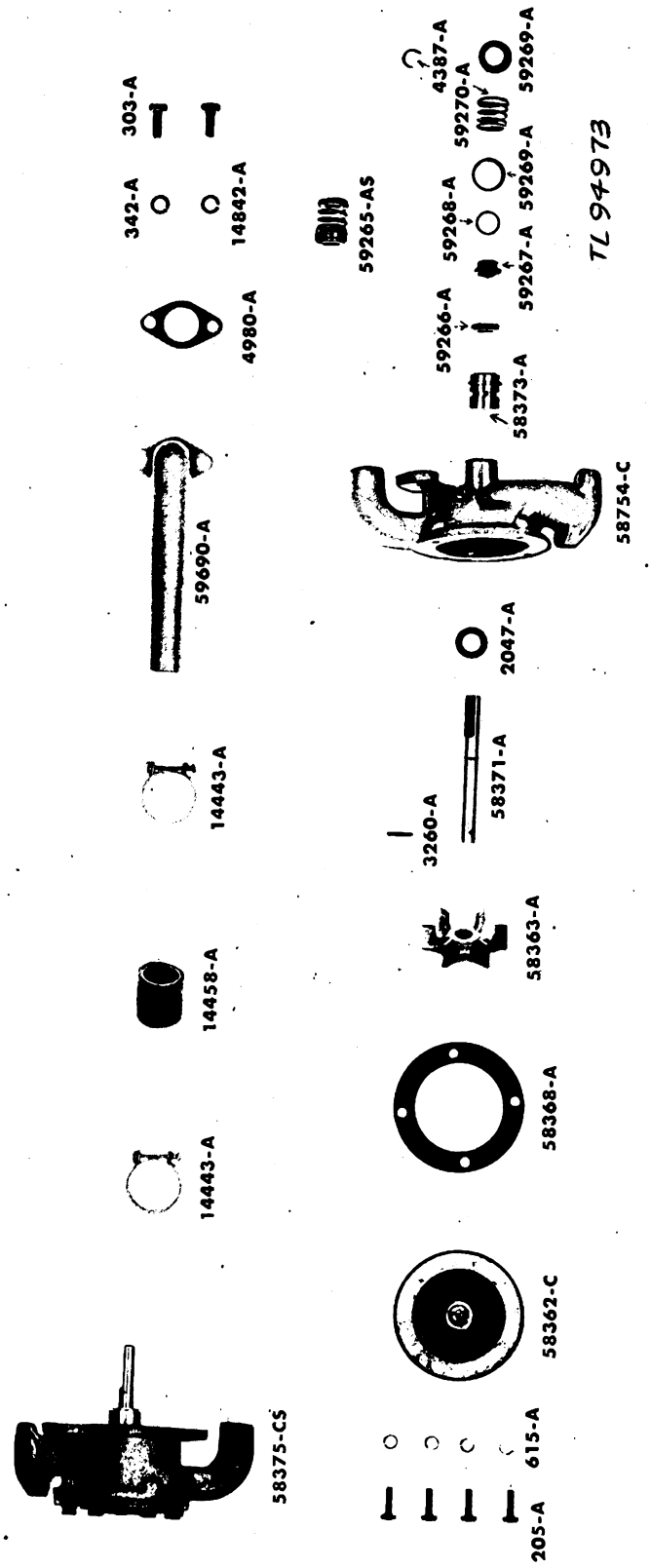


Figure 35. Water pump group.

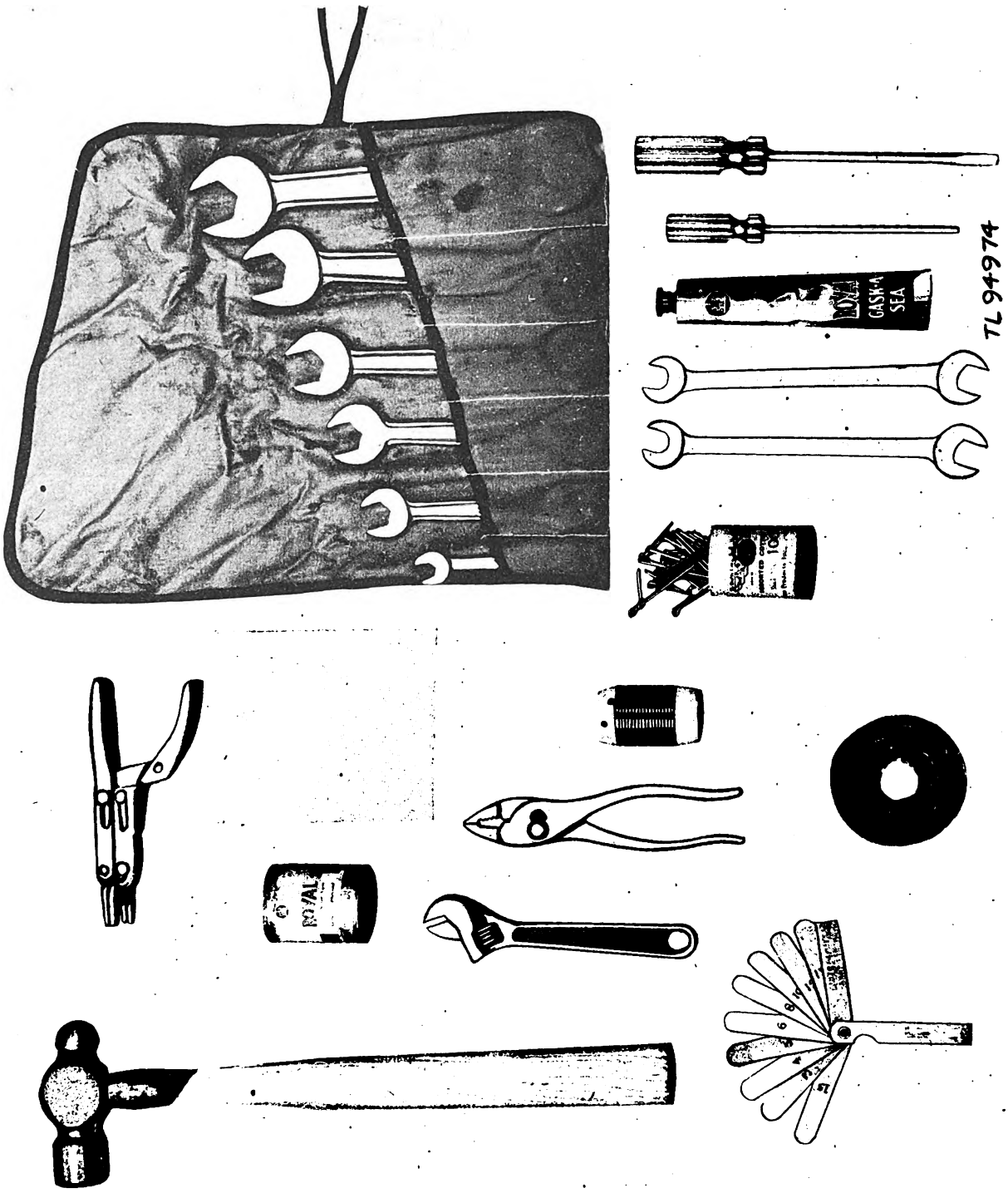


Figure 36. Tools.