TM 11-915

WAR DEPARTMENT TECHNICAL MANUAL

POWER UNITS PE-84, PE-84-A, PE-84-C, AND PE-84-D

WAR DEPARTMENT • 15 JUNE 1944

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TM 11-915

This manual supersedes TM 11-915-D, Power Unit PE-84-D, 22 October 1942

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

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The Adjutant General.

DISTRIBUTION:

As prescribed in paragraph 9a, FM 21-6; IBn 44(3): IC 11, 44(5).

IBn 44: T/O and E 44-135, AAA SL Bn.

IC 11: T/O 11-107, Sig Dep Co; 11-127, Sig Rep Co; 11-327, Sig Port Sv Co; T/O and E 11-587, Sig Base Maint Co; 11-592, Hq & Hq Co. Base Dep; 11-597, Sig Base Dep Co.

IC 44: T/O and E 44-136, Hq & Hq Bty, AAA SL Bn; 44-138, AAA SL Bty.

For explanation of symbols, see FM 21-6.

CONTENTS

IV. MAINTENANCE—Continued

V. SUPPLEMENTARY DATA

DESTRUCTION NOTICE

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

WHEN—When ordered by your commander, or when you are in immediate danger of capture.

HOW —1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools, etc.
2. Cut —Use axes, handaxes, machetes, etc.
3. Burn —Use gasoline, kerosene, oil, flame throwers, incendiary grenades, etc.
4. Explosives—Use firearms, grenades, TNT, etc.
5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—1. Smash—Magneto, spark plugs, carburetor, manifold, cylinder heads radiator, battery, alternator housing and slip rings, exciter housing and commutator, circuit breaker, meters, voltage regulator, control switch box, starting motor, charging generator, and gasoline tank.
2. Cut —Hose connections, spark plug wiring, alternator and exciter leads, cooling fan belt, and generator belts.
3. Burn —All parts, wiring, etc., which can be burned.
4. Bury or scatter—Any or all of the above pieces after breaking or burning them.

DESTROY EVERYTHING

SAFETY NOTICE

DO NOT REMOVE GUARDS, SHIELDS, SCREENS, ETC., WHILE THE UNIT IS IN OPERATION. THESE SAFETY DEVICES ARE PROVIDED FOR YOUR PROTECTION AND ARE TO BE REMOVED ONLY TO PERFORM NECESSARY SERVICE OR MAINTENANCE WORK. DO NOT REMOVE THEM UNLESS ABSOLUTELY NECESSARY.

SECTION I

DESCRIPTION

1. General

a. Power Unit PE-84-(*)[1]. Power Unit PE-84-(*) is a portable, self-contained, gasoline-electric power plant, consisting of a four-cylinder engine, directly connected through a full-metallic flexible coupling to an alternator (a-c generator). The entire unit, including radiator, engine, generator, and generator-control panel, is mounted on an electrically welded steel subbase. A 15-gallon gasoline tank is mounted over the flywheel housing. (See figs. 1 and 2.) The engine is equipped with a fuel pump for supplying gasoline to the carburetor from either this tank or from drums of gasoline which may be placed alongside the generator set. The valve which connects the tank to the fuel pump is located beneath the tank and just behind the instrument panel. The valve which connects the fuel pump to an outside supply is located on the outside just below the instrument panel. Obviously, both of these valves should not be open at the same time, except momentarily, when shifting from one source of gasoline supply to the other. A length of flexible tubing is furnished for connection to the fuel drum.

b. Lubrication, Carburetion, and Ignition. The engine is equipped with a gear type lubricating oil pump which furnishes oil under pressure to all engine bearings. A renewable cartridge type oil filter is supplied for maintaining the condition of the oil. Carburetion is accomplished by means of a conventional type carburetor with the air entering through an oil type air cleaner and backfire arrester. The carburetor throttle is equipped with a substan-

[1] The symbol (*) refers to models A, C, and D of Power Unit PE-84.

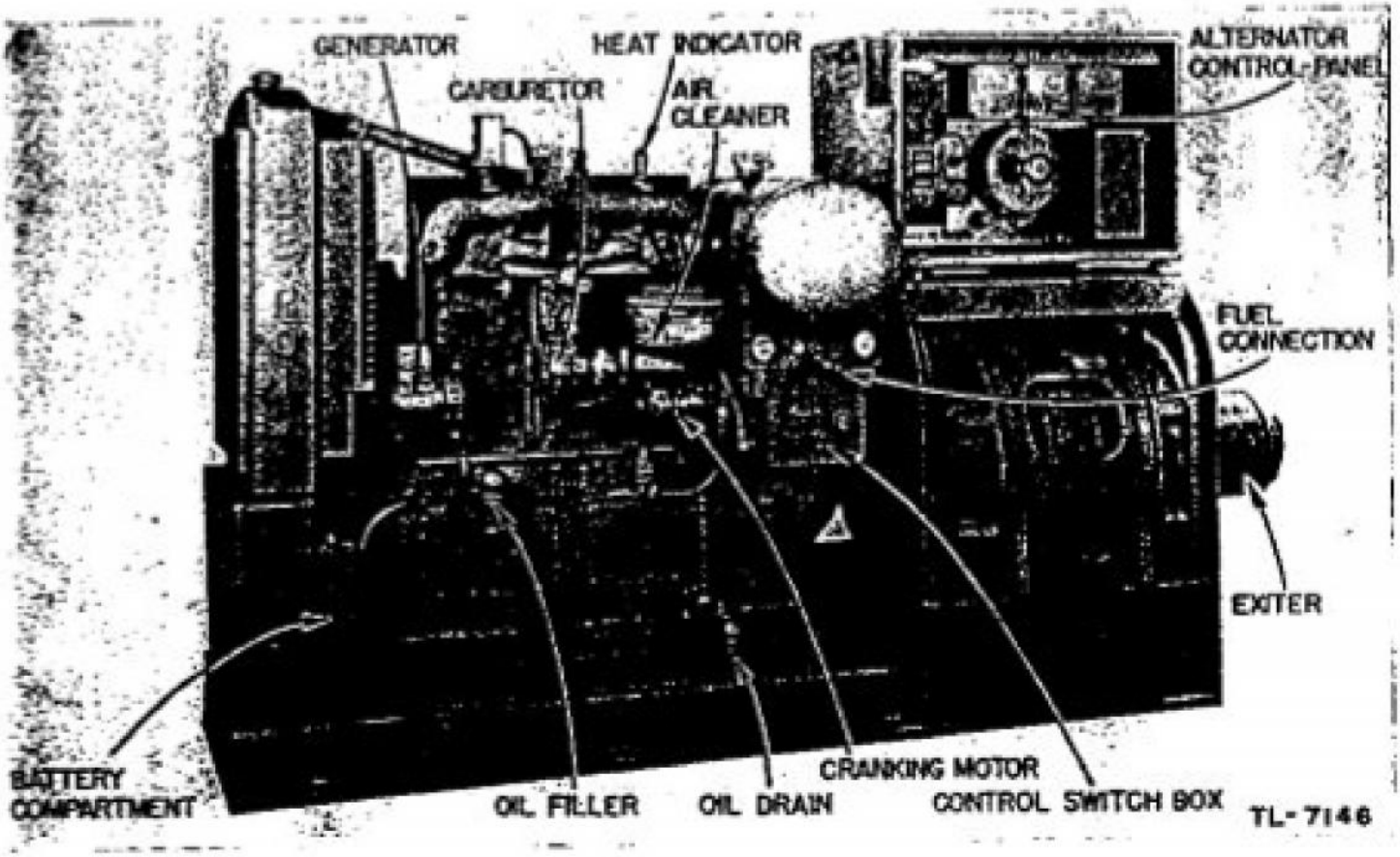


Figure 1. Power Unit PE-84-(*), carburetor side.

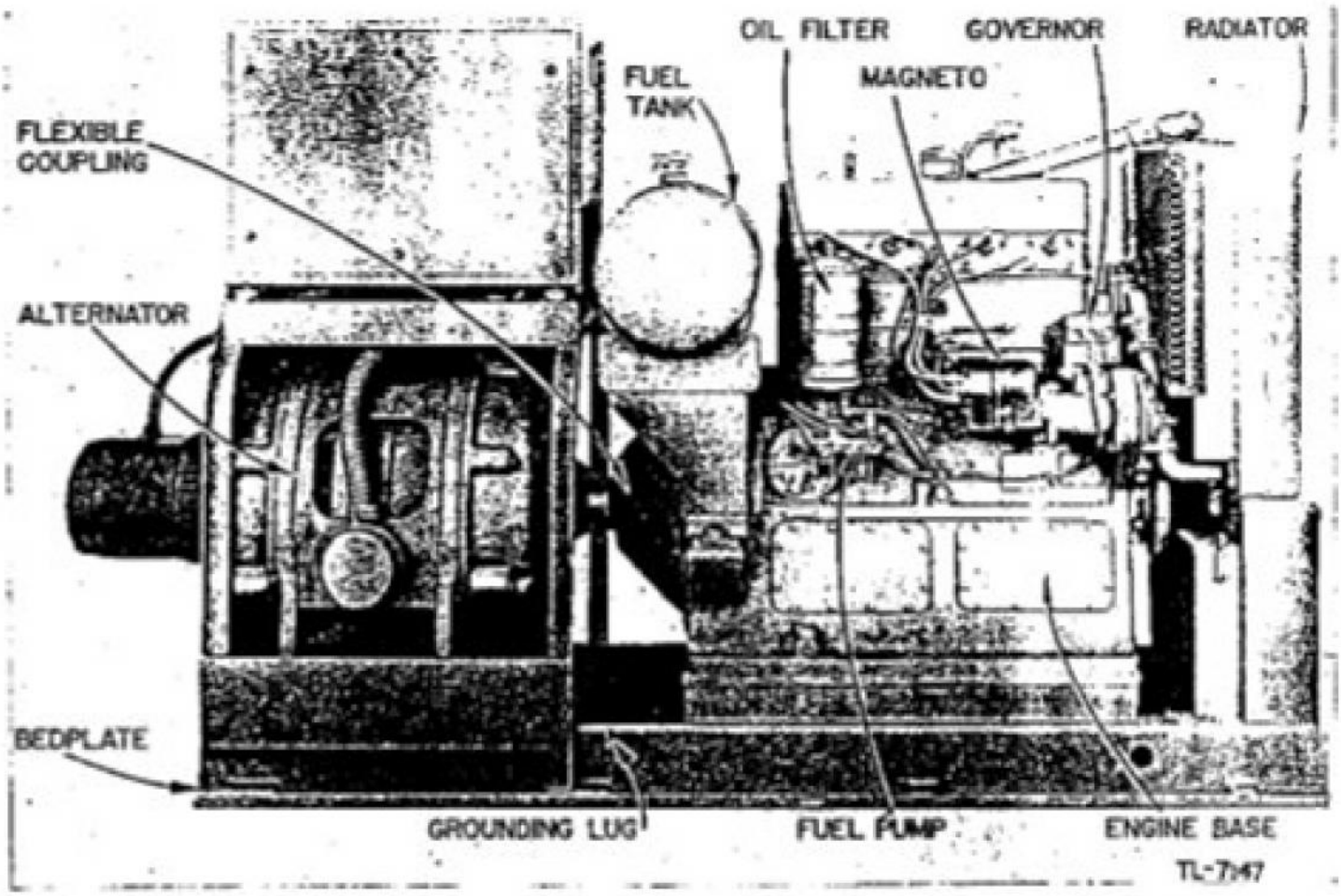


Figure 2. Power Unit PE-84-(*), magneto side.

tial hand lever, and ordinarily, has only two positions: STOP and RUN. In the STOP position, the carburetor lever makes contact with a limit switch which serves as the ground for the magneto. Therefore, in order to stop the engine, it is necessary to throw this carburetor lever into the position marked STOP, whereupon engine operation will cease promptly, thereby avoiding auto ignition and backfiring. Ignition is supplied by a magneto which is completely radio shielded. All spark plugs and ignition wires are completely shielded.

c. Speed Regulation and Starting. Speed regulation is obtained by means of a hydraulic type governor, while starting is accomplished by a heavy-duty 12-volt battery and electric starting motor. The starting motor switch is of the magnetic type. The push button which operates this switch is mounted in the automatic safety control box below the instrument panel. The entire unit is completely radio shielded, even to the extent of shielding the battery-charging circuit and using capacitors on the battery-charging generator.

d. Alternator and Control Panel. The rotating field type alternator is equipped with damper windings and has a directly connected exciter. The control panel, which is inclosed in a steel cabinet with removable front and rear panels, is mounted on special vibrationproof fittings, which are supported by a steel frame that extends directly over the alternator.

2. Major Components

a. Gasoline Engine. The gasoline engine is a 46-horsepower (hp), four-cylinder, water-cooled unit, designed to run at a governed speed of 900 revolutions per minute (rpm). (The engine is manufactured by the LeRoi Company.)

b. Alternator. The alternator (a-c generator) is a single-phase, 2-wire unit. It is rated at 25 kilovolt-amperes (kva), 80-percent power factor, 900 rpm, 120 volts at full load, and is furnished with a directly connected exciter, rated at 1 3/4 kilowatts (kw), 125 volts (v). This exciter supplies direct current to the alternator field windings. (This alternator is manufactured by Westinghouse Electric Manufacturing Company.)

c. Control Panel (fig. 3). The following equipment is mounted on the control panel: a 225-ampere, two-pole circuit breaker, which serves as a circuit breaker and a disconnecting switch; a voltmeter, for indicating the voltage across the single-phase line; an ammeter, for indicating the total current supplied

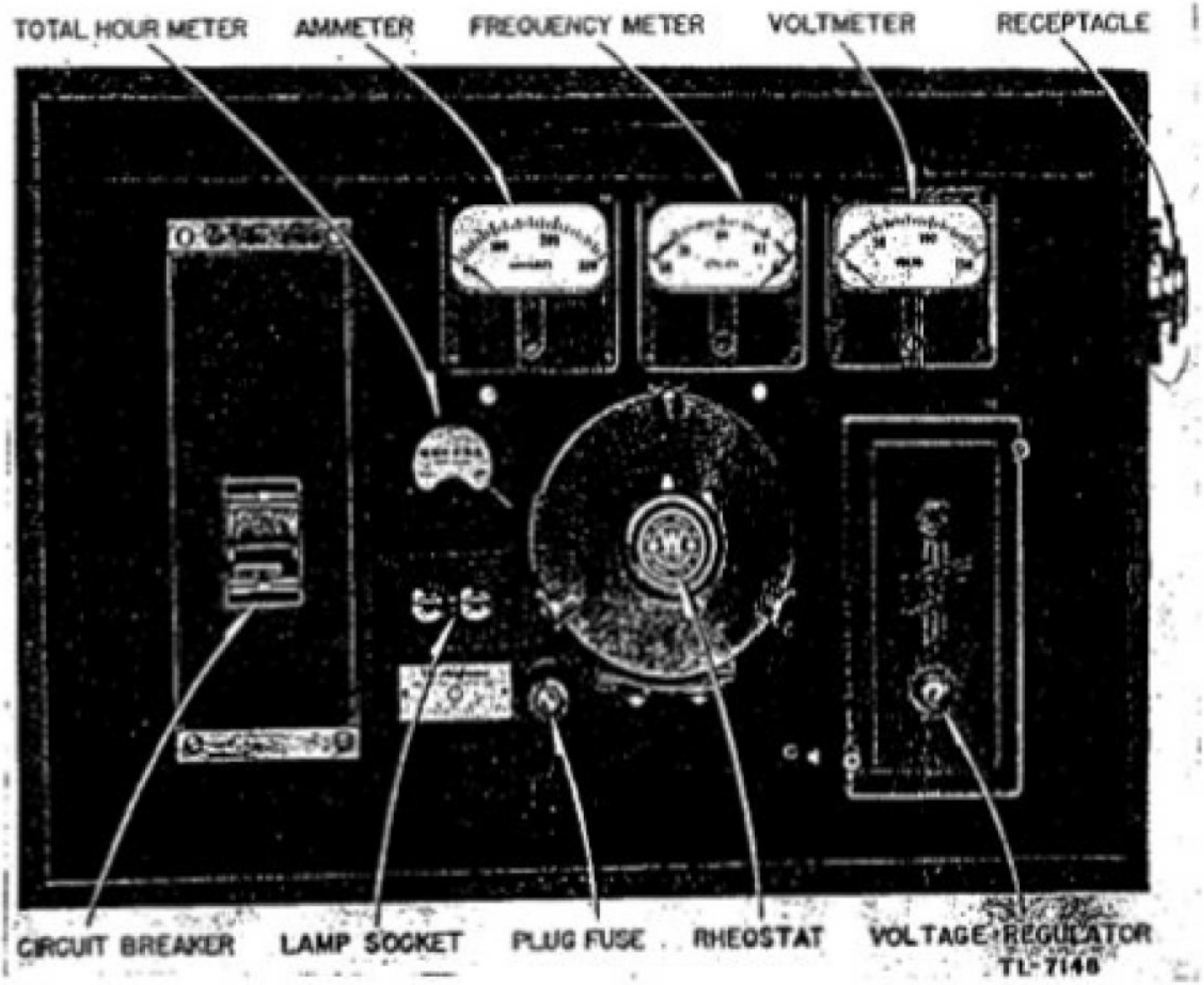


Figure 3. Power Unit PE-84-(*), electrical control panel.

by the alternator; a frequency meter, for indicating the frequency of the alternating current in cycles per second; and a total-hour meter for recording automatically the total hours of operation. A lamp socket, for providing current for a trouble lamp or other low-amperage connection is also included. This socket is fused with a 20-ampere plug fuse. A female receptacle, for emergency connections, is located on the side of the control panel. Six terminal posts for power leads are mounted back of the panel. One side of these single-phase circuits is grounded. The exciter's field rheostat, its adjusting handle, and an automatic regulator for controlling the voltage regulation are mounted on the front of the panel.

d. Control-switch Box. This unit is mounted directly under the gasoline tank on the carburetor side of the engine. The box includes a thermostat switch, an oil-pressure switch, two pilot lights, and the engine starter button.

3. Specifications

The following chart shows the specifications of the various components of Power Unit PE-84-(*):

Approximate capacities (U. S. measure):	
Fuel tank	15 gal. U.S.
Cooling system	9 gal. U.S.
Crankcase (oil pan)	28 qt. U.S.
Engine:	
Model	D-382
Cylinders	4
Bore	4½ in.

Stroke	6 in.
Speed (governed)	900 r.p.m.
Magneto (fixed spark)	American Bosch—MJB4A-314
Spark plug gap	0.025–0.030 in.
Valve clearance (engine hot)	0.015 in.
Carburetor	Zenith updraft 1¼ in.-62A10
Governor	Woodward hydraulic 040348

Power take-off:

Thomas flexible coupling	313-DF

Power alternator (generator):

Model	Westinghouse 25KVA
Type	G-synchronous
Exciter	E-83
Voltage	120 alternating current
Cycles	60
Phase	single

General (fig. 4):

Length, over-all	111 3/4 in.
Width, over-all	35 in.
Height, over-all (to top of cabinet)	64 1/8 in.
Weight	5,000 lb.

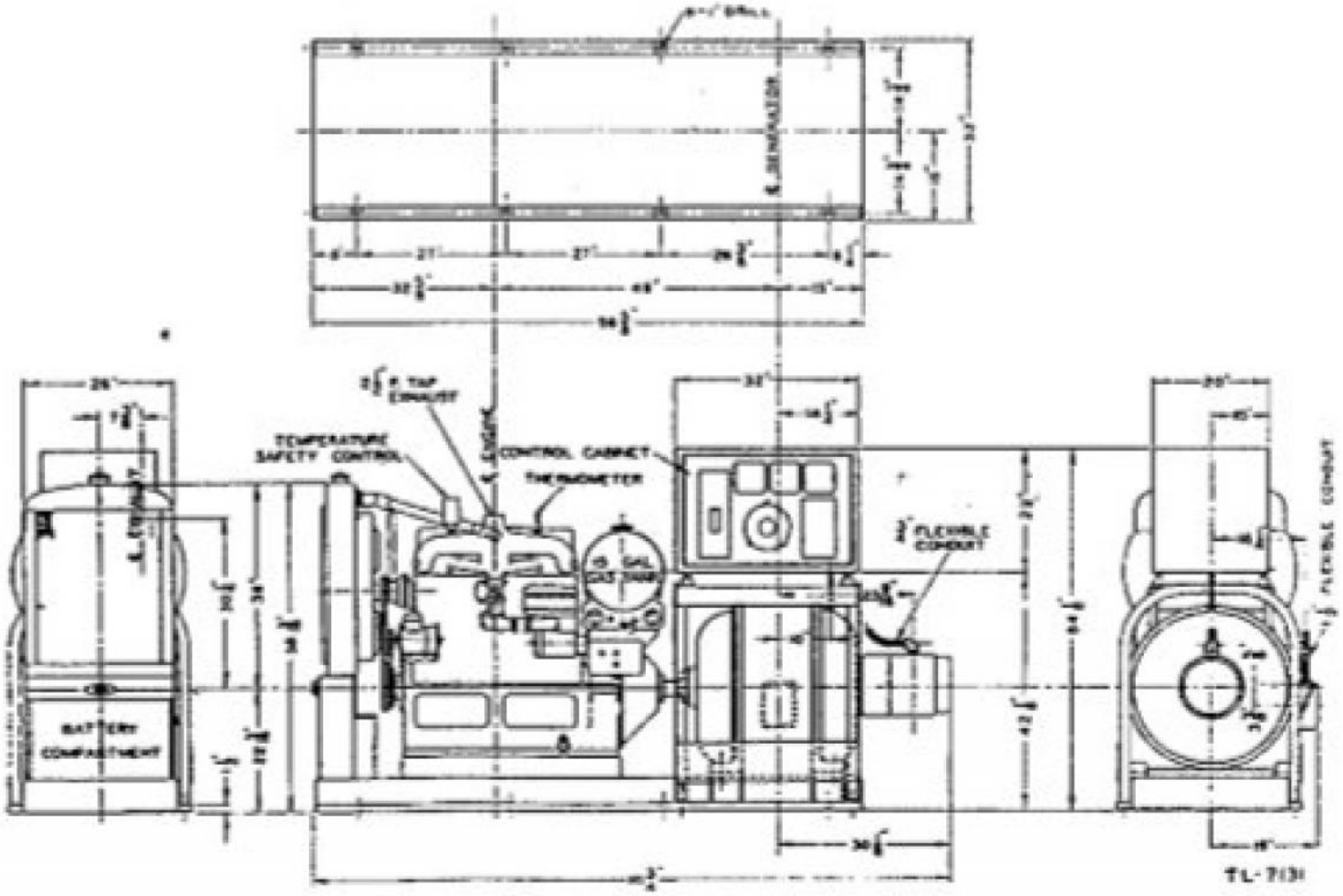


Figure 4. Outline drawing of engine generator set.

SECTION II

INSTALLATION AND OPERATION

4. Preliminary Operations

Before running the power unit for the first time, or after moving it to a new location, perform the following operations:

a. Unpack or uncrate the unit.

b. Inspect the entire unit for any possible damage in transit or shipping.

c. Crank the engine with the hand crank to insure that all parts turn freely.

d. Make all necessary connections: fuel, ground, and power.

e. Install the muffler (fittings packed in spare parts box.)

f. When the completely assembled unit is to be mounted in a truck or on a floor, place sufficient shims under each foundation bolt so that when the bolts are tightened, the bedplate will not be distorted.

5. Starting

When starting any new engine, or an engine that has been standing idle for some time, make the following check-up:

a. See that the cooling system is full of clean water or antifreeze. (The PE-84-(*) cooling system has a capacity of approximately 9 gallons, U.S. measure.)

b. See that the oil is up to the proper level in the crankcase. The approximate capacity of the crankcase is 7 gallons, U.S. measure. The oil filler pipe is on the side of the engine below the battery-charging generator. The dip stick gauge, for indicating the oil level, stands out from the side of the engine just below the starting motor. In checking the oil level, remove the dip stick, wipe it clean, insert it slowly in its place in the side of the engine, and leave it for 2 or 3 minutes before withdrawing it for a reading.

c. Before starting the engine for the first time, remove the spark plugs and pour about 2 tablespoonfuls of a mixture of equal parts of oil and gasoline into each cylinder to insure lubrication of the pistons and cylinders.

d. After connecting the engine to the fuel supply, prime the fuel pump and carburetor by manipulating the priming lever, which is located underneath the gasoline pump. If the glass filter bowl on the gasoline pump shows any amount of water and dirt, it should be removed, cleaned, and replaced. When replacing, be sure that the edges of the bowl fit evenly and tightly against the cork gasket.

e. Examine the battery to see that the electrolyte is approximately 1/2 inch over the top of the plates.

f. Make certain that the circuit breaker on the control panel is in the OFF position.

g. To start the engine, move the carburetor shaft lever to the RUN position; pull out the choke rod on the engine instrument panel; then push the start button on the safety control box until the engine fires. As the engine warms up, push the choke rod in gradually. If the engine has been standing idle for quite a long period, it may be necessary, on the first start, to hold the governor throttle partly open by pushing toward the radiator on the governor control rod on the governor side of the engine. As soon as the engine oil pressure builds up and supplies oil for the operation of the governor, the governor will be able to maintain the correct engine speed. As soon as the engine is started and up to speed, all engine instruments and general operation conditions should be checked, to make sure that each element is performing its required function.

Caution: Never pull the choke out after the engine is warm; this causes an excess of raw fuel to be drawn into the cylinders, resulting in dilution of the crankcase oil or possibly stopping the engine, due to an over-rich mixture.

h. If the engine does not start immediately, push in the choke control and continue cranking until the engine fires. (Do not crank continuously for longer than 30 seconds without allowing the cranking motor to cool.)

i. In extremely cold weather, when starting is sometimes difficult, turn the engine over a few revolutions with the choke control pulled out. If the engine still does not start, it may be necessary to pour a small quantity of gasoline into each cylinder through the spark plug holes. Wait a few moments for the gasoline to evaporate, turn on the switch, and proceed as before.

j. Do not race a cold engine. After the engine is

warmed up sufficiently, trip the circuit breaker to the ON position for electric power.

6. Stopping

The following procedure should be used to stop the engine:

a. Trip the circuit breaker to the OFF position.

b. Move the carburetor shaft lever to the STOP position. This cuts off the fuel supply to the carburetor and grounds the magneto.

c. If the power unit is to be shut down for any length of time, the fuel supply should be shut off and the carburetor bowl should be drained. (When the unit is to be moved to a new location, it is best to allow the fuel to remain in the carburetor.)

7. Cold Weather Operation

When operating the power unit in temperatures less than 32° F., observe the following precautions:

a. Fuel system. Use only high-test, winter-grade gasoline to aid in starting; keep the gasoline supply tightly covered to prevent evaporation. Fill the fuel tank at the end of the day's run, to prevent moisture from collecting in the tank.

b. Lubrication. Be sure to use the correct grade of lubricant in the engine crankcase and air cleaner, as referred to in chart in paragraph 43.

c. Cooling System. When the temperature is less than 32° F., there is danger of the water freezing in the cooling system. To overcome this, either drain the system at the end of each run or use one of the recommended antifreeze solutions shown in the chart below.

d. Draining the System. Open the drain cocks in the lower radiator connection, manifold, and cylinder block (located beneath the carburetor). See that the drains are not plugged and that the water drains out completely.

Caution: *In freezing* weather, before filling the radiator with water, cover the entire radiator and then start the engine. Put in water immediately after the engine starts. This prevents water from freezing while the engine is being warmed up.

Freezing point		Antifreeze solutions (24 U. S. quart cooling system)								
		Methyl alcohol			Ethyl alcohol			Ethylene glycol		
C.	F.	Approx. quantity in qt. (U. S.)	Specific gravity	Percent by volume	Approx. quantity in qt. (U. S.)	Specific gravity	Percent by volume	Approx. quantity in qt. (U. S.)	Specific gravity	Percent by volume
−6°	20°	4.5	.9822	12.5	6	.9796	16.5	6	1.022	16.5
−11°	10°	7.5	.9726	20.5	9	.9704	25.5	9	1.034	25.5
−18°	0°	10	.9638	28	12	.9611	33.5	12	1.044	33.5
−23°	−10°	12.5	.9560	34.5	14.5	.9511	40.5	14	1.051	39
−29°	−20°	14	.9493	39	17	.9392	47.5	15.75	1.058	44
−34°	−30°	15.75	.9421	44	19.5	.9244	54.5	17	1.062	47.5
−40°	−40°	17	.9358	47.5	22.5	.9068	63	18.5	1.064	51.5

FUNCTIONING OF PARTS

8. Engine

The engine is a 46-horsepower, 4-cylinder, valve-in-head unit, with a 4 1/2-inch bore, a 6-inch stroke, and a compression ratio of 6 to 1. The cylinders are of the wet-sleeve type and have a total displacement of 382 cubic inches. The following Technical Manuals cover the fundamental operating principles for this type of engine: TM 10-570, TM 10-550, and TM 10-580.

9. Cooling System

a. Positive Centrifugal Pump. The radiator and fan cooling system is of sufficient capacity to maintain a water temperature safely below the boiling point with the engine operating on continuous load in a surrounding temperature of 120° F. The water is circulated through the engine block, cylinder head, and radiator by a positive centrifugal pump.

b. Thermostat. In order to maintain a satisfactorily high engine temperature under widely varying climatic conditions, the unit is equipped with a thermostat and bypass. The thermostat, which is located in the radiator fitting between the radiator top-tank and the radiator inlet water connection, controls the water temperature and prevents water from flowing through the radiator until the engine has reached the operating temperature. With the thermostat closed, the water circulates through the engine only.

10. Lubricating System

a. Force Feed. Full force-feed lubrication is supplied to the crankcase bearings, camshaft bearings, connecting-rod bearings, valve mechanism, timing gears, and governor. Pistons and piston pins are splash lubricated. The oil supply is contained in the oil pan (fig. 5), which has a capacity of 28 quarts. Oil is fed to the moving parts of the engine by a gear type pump. An oil-pressure relief valve is provided to prevent the oil pressure from building up to an excessive degree. Normal oil pressure for the engine

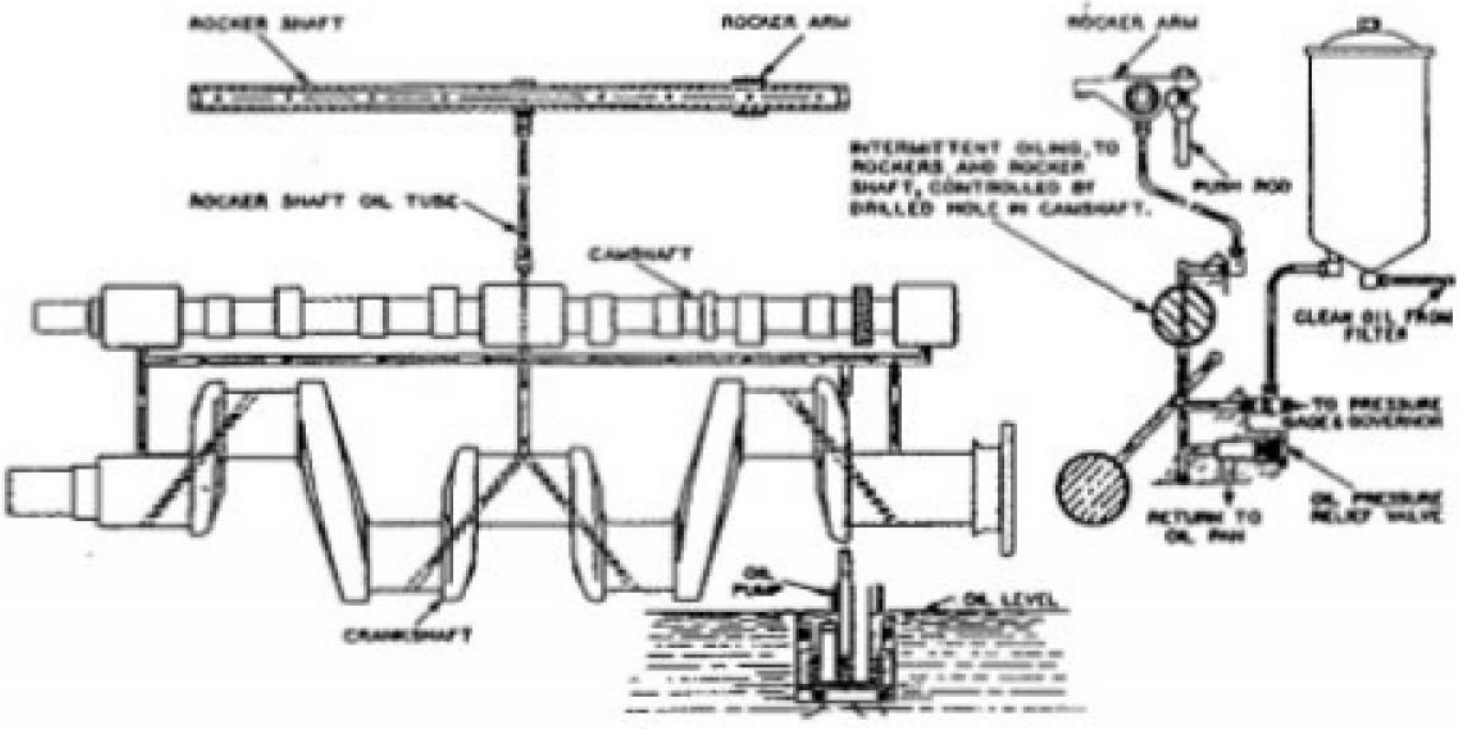


Figure 5. Oil diagram.

Note. Extreme temperatures, load conditions, or the use of improper grades of oil, may cause these pressures to vary.

is 20 to 30 pounds per square inch under average working conditions.

b. Oil Pump. The oil pump is a single-stage, gear-driven type, operating off the camshaft, to which the pump is attached by cam screws. Oil is drawn out of the oil pan through a screen of small mesh, which strains out any large dirt particles, up through the pump body to an opening between the pump body and the crankcase where it enters drilled passages in the crankcase. Both the drive pinion and the idler gear are keyed to their shafts, as is the upper drive gear, which meshes with the camshaft.

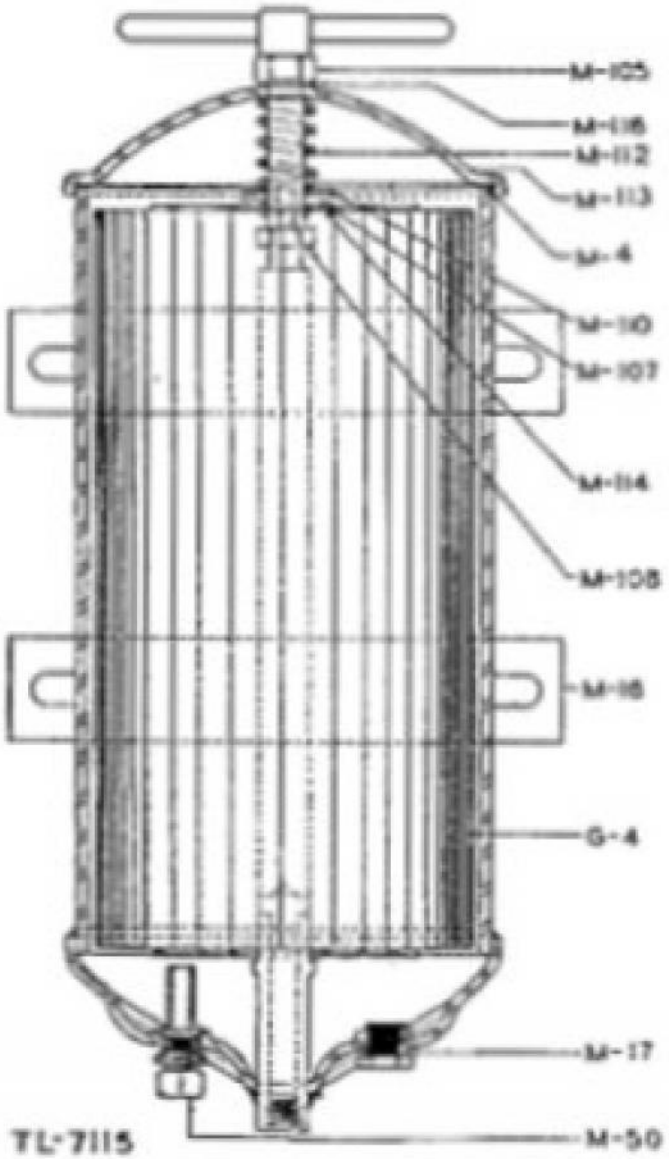


Figure 6. [illegible]

c. Oil Filter. A replaceable, cartridge type, lubricating oil filter, or clarifier, is conveniently located on the left side of the engine. In operation, a quantity of oil is bypassed from the main circulatory system, through the filter element to the crankcase. (See fig. 6.)

11. Carburetor

a. General Purpose. The general purpose of the carburetor is to discharge the desired amount of fuel into the air stream entering the engine, in order to atomize the fuel and make the proper air-fuel mixture. The air-to-fuel ratio is not constant for all speeds and loads; it is varied by the carburetor to give the best operating performance as the conditions change. The carburetor has been calibrated to meter the correct amount of fuel for smooth operation throughout the operating range; its function does not extend beyond the proportionate mixing of fuel and air.

b. Zenith Carburetor Model 450 Series. (1) *Use.* This carburetor is used on Power Units PE-84-A which have the following engine serial numbers: 145430 to 145661, and 146150 to 146355, inclusive.

(2) *Description.* (*a*) The Zenith model 450 series carburetor is a plain tube type with an adjustable main jet, an accelerating pump, and an economizing device.

(*b*) The main jet determines the maximum amount of fuel which may be obtained for high speed operations. The main jet adjustment reduces this amount if it is turned toward its seat. Ordinarily the main jet adjustment has no effect after it is open two turns.

(*c*) To set this adjustment, retard the spark and open the throttle to approximately one-fourth of the way. Turn the adjustment clockwise to shut off the fuel. The engine speed then decreases because of too lean a mixture. Open the adjustment until the engine speed decreases because of too much fuel. The adjustment should be set at a position halfway between these two extremes.

(3) *Operation.* (*a*) The Zenith compound nozzle system of carburetion consists of two jets: the main jet, directly connecting fuel in the bowl with the air stream in the carburetor barrel through the main jet discharge tube; and the compensating jet, projecting into an open well and connected with the air stream through the supplemental jet.

(*b*) The main jet flow varies with suction, delivering more fuel as the engine speed increases. Thus, it tends to produce a rich mixture at top engine speed. The compensating jet is not affected by suction, and hence delivers the same amount of fuel at all speeds. This tends to cause a lean mixture at top engine speed. In combination, the rich and lean jets give an average mixture of correct proportion.

(4) *Idling.* (*a*) The idling system functions only on starting and idling. When the throttle is opened past the idling position, the fuel goes the other way through the discharge tubes and the idling system is automatically out of operation. (See fig. 7.)

(*b*) The system consists of an idling jet and tube to supply the fuel, an idling needle valve to correct the idling mixture, and a channel to carry the mixture into the carburetor barrel at the edge of the throttle.

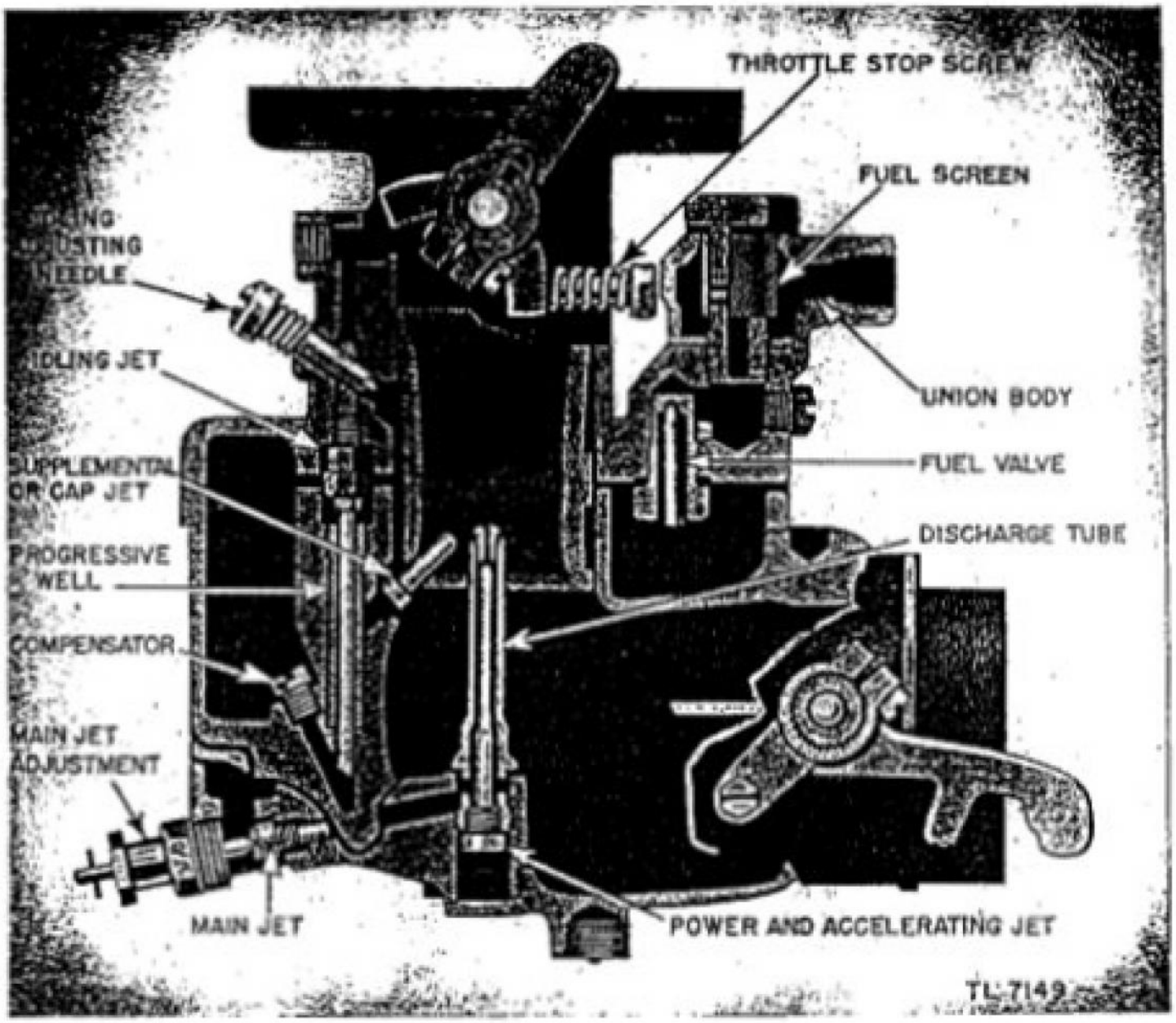


Figure 7. Cutaway view of Zenith carburetor, model 480 series.

The desired idling speed is set by the stop screw on the throttle lever.

(5) *Full power and acceleration.* (*a*) Full power, either for top speed or hard pulling, requires a richer mixture than part throttle operation. Acceleration also requires a richer mixture.

(*b*) This additional richness of mixture is provided by combined accelerating and economizing systems operated by the vacuum above the throttle valve.

(*c*) There is a plunger pump to force fuel into the air stream, a check valve to prevent fuel from being forced back into the fuel bowl, and an economizer valve to control the additional fuel flow. The suction above the throttle holds the pump at the top of the pump well when the throttle is partially closed. As the throttle is opened, the suction decreases, releasing the pump which drops to the bottom of the well, forcing fuel ahead of it.

(*d*) The economizer valve is opened as the pump nears the bottom of the well. This opens a passage for the accelerating charge and, if the throttle is held open, for the additional ration of fuel necessary for full speed or power.

(6) *Economy.* (*a*) As the throttle is closed, the pump is lifted by the increased suction, so the fuel flow is reduced for anything less than full-load operation.

(*b*) This vacuum type accelerating and economizing system may be used to advantage with a governor. In this case, the carburetor throttle valve is usually wide open; the speed is controlled by the governor valve. By bridging the governor with a suction line, the pump is actuated by the suction above the controlling governor valve and economizer action is thus retained.

(7) *Starting.* (*a*) The idling system acts as a priming device. When the engine is at rest, the idling jet is submerged in the fuel that fills the well. The

throttle should be slightly opened, as this results in a very strong suction on the idling jet. The fuel passing at high velocity over the edge of the throttle plate is finely atomized and the high vacuum instantly vaporizes and mixes it with the air. This will insure the first few explosions. With the usual manually controlled strangler, it is sometimes difficult to keep the engine running. To overcome this, a spring-loaded strangler is used.

(*b*) The strangler shaft is off center so that engine suction tends to pull it open. A spring tends to pull the strangler shut, but, except at cranking speeds, the spring is the weaker of the two forces. Accordingly, as the engine is accelerated or retarded, the strangler opens and closes, always being in a position to deliver just the right amount of air. This prevents over-choking and crankcase dilution and insures continued running even in the coldest weather.

(*c*) The strangler control is pulled out as usual for starting. It is left alone or pushed in slightly until the engine warms up, then pushed in to the open position. No jiggling of the control is necessary.

(8) *Governor operation.* The suction passages (figs. 8 and 9) are so arranged that the accelerator and economizer device will operate equally well with or without a governor. When no governor is used, the screw at the top (No. 1) is removed, and the vacuum is then transmitted down the vertical passage

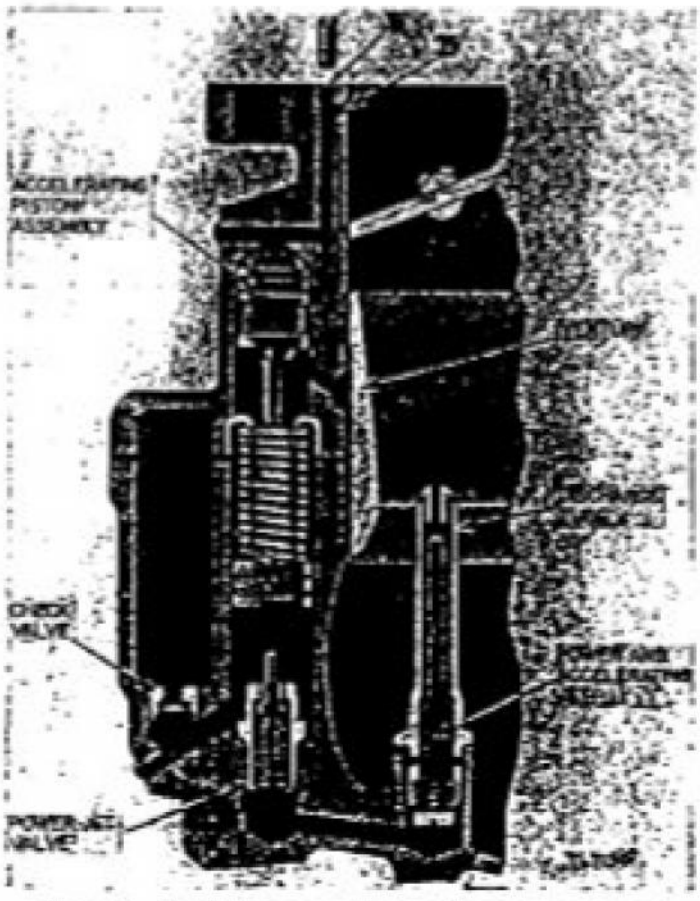


Figure 8. Zenith 430 series carburetor, showing various passages No. 1 and No. 2.

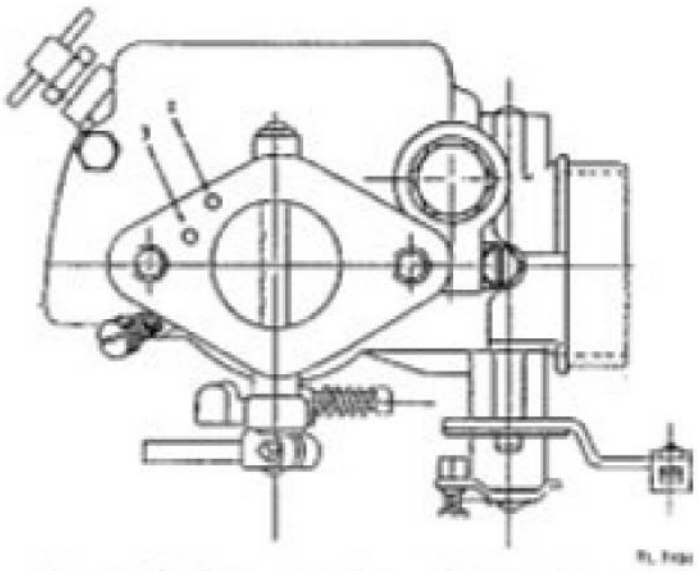


Figure 9. Zenith 430 series carburetor, showing various passages No. 3 employed when governor is used.

from hole No. 2. When a governor is used, the passages are closed off at No. 1 and No. 2 by installing a screw at this point and the vacuum is transmitted down through hole No. 3, connecting with a drilled passage in the governor valve body which takes the suction above the governor valve. A special gasket is used between the carburetor and governor valve body.

(9) *Fuel level.* (*a*) Correct setting of the float which controls the fuel level is of utmost importance. (See fig. 10.)

(*b*) The fuel level is set at the factory for regular motor gasoline and a pump pressure of 2 pounds per square inch.

(*c*) The dimensions given in the table below are measured from the gasket surface or parting line of the float-chamber cover to the bottom of the float at the center, with the float needle valve in the seated position (holding the throttle valve body upside down).

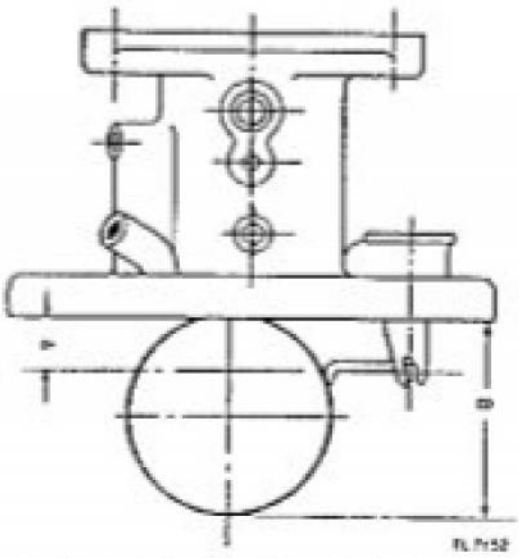


Figure 10. Carburetor fuel level and float setting dimensions (A and B respectively)

Carburetor Size Inches	Model	Fuel level dimensions A Inches	Float setting dimensions B Inches
1 1 4	455	5/8	2 1/8
1 1 2	456	5/8	2 1/8
1 3 4	457	5/8	2 1/8
2	458	5/8	2 25/64

(10) *Air cleaner and air filter restriction.* (*a*) Many air filters used on gasoline engine carburetors accumulate some or all of the dirt they separate from the incoming air. As this dirt builds up there is an action similar to closing the strangler valve; restriction is caused, thus increasing the suction on the carburetor jets. Very little increase in suction will create a mixture so rich that it will not only seriously impair engine operation, but will dilute the oil and cause as much wear as dirt. This is prevented by venting the fuel bowl from the air intake instead of the open air.

(*b*) In the ordinary carburetor, atmospheric pressure always exists in the fuel bowl, regardless of air intake restriction. In this carburetor, whatever pressure exists in the air intake also exists in the fuel bowl. In other words, these pressures are balanced, and if the air intake is restricted, causing a lower pressure therein, the fuel bowl pressure will be equally reduced. In this way no additional fuel will be forced from the jets and the mixture ratios will remain normal.

c. Zenith Carburetor Model 62A10. (1) *Use.* This carburetor (fig. 11) is used on Power Units PE-84-A, which have engine serial numbers 154799 to 154903, inclusive. It is also used on Power Units PE-84-C and D.

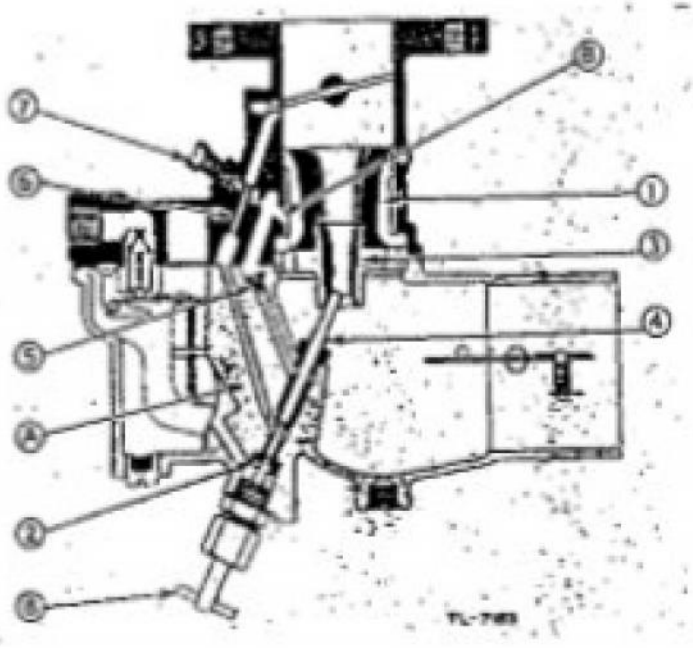


Figure 11. Cross section through Zenith carburetor model 62A10.

(2) *Main jet system.* (*a*) The removable venturi (1) measures the volume of air which passes through the carburetor. The main jet (2), often referred to as the high-speed jet, exerts its principal influence at the higher engine speeds. Fuel from the bowl is metered through the main jet (2) and discharged into the air stream at the point of greatest suction, into the secondary venturi (3), and through the main discharge jet (4).

(*b*) The main jet (2) determines the maximum amount of fuel which may be obtained for high speed operations. The main-jet adjustment (8) reduces this amount if it is turned toward its seat. Ordinarily, the main-jet adjustment has no effect after it is open two turns.

(*c*) To set this adjustment, retard the spark and open the throttle to approximately one-fourth of the way. Turn the adjustment clockwise, shutting off the fuel until the engine speed decreases because of too lean a mixture. Open the adjustment until the engine speed decreases because of too much fuel. The adjustment should be set at a position halfway between these two extremes.

(3) *Compensating system.* The compensating system consists of the main-discharge jet (4) and the well vent (5). The flow of fuel from the main jet (2) is controlled by the size of the well vent (5) and the size of the main-discharge jet (4). The mixture delivered through the main-discharge jet may be made richer by either increasing the size of the main-discharge jet or by decreasing the well vent. Conversely, the mixture may be made leaner by either decreasing the size of the main-discharge jet or by increasing the size of the well vent.

(4) *Idling system.* The idling system consists of the idling jet (6) and the idle-adjusting needle (7). The idling jet (6) receives its fuel from the main jet (2) through channel (A). The fuel is metered through the idling jet (6), is mixed with the air which is admitted from behind the venturi (1), then goes through channel (B). The idle-adjusting needle (7) controls the amount of air which is admitted to the idling

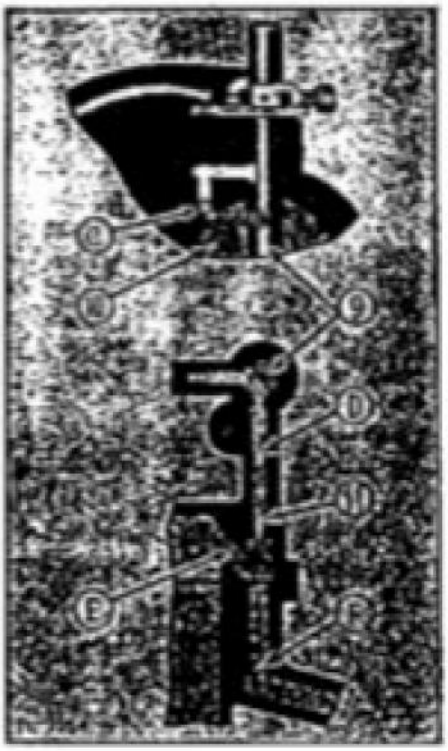


Figure 12. Position of throttle shaft when the throttle is closed.

system. The idling system functions only at idling and low speeds. At such speeds, the throttle plate (10) is almost closed and there is a very strong suction past the edge of the throttle plate. This suction draws the mixture of fuel and air from the idling jet (6) which discharges into the air stream through the priming plug.

(5) *Economizer system.* (*a*) To develop full power, a certain mixture of fuel and air is required. Under part load, a leaner mixture may be used and operating costs reduced. In this carburetor, the mixture is regulated automatically by the position of the throttle shaft.

(*b*) Figure 12 shows the position of the throttle shaft (9) with the throttle closed. At this point, no suction is transmitted to the bowl, because the channel (C) is below the throttle plate (10), thus permitting a full flow of fuel through the idling system.

(*c*) When the throttle is opened sufficiently (approximately one-fourth open) to bring the throttle plate (10) just below the channel (C), a strong suction acts through channels (D) and (E), thus holding back the fuel in the bowl and causing a lean mixture through the part-throttle operation. The suction is controlled by the economizer jet (11). The bowl ventilation from the intake of the carburetor is restricted at (F), thus preventing bowl ventilation from overcoming the suction from channels (C) and (D). For full throttle operation, this suction is cut off, due to the position of the slot in the throttle shaft, and permits the full flow of fuel necessary.

12. Fuel Pump

a. Rotation of the eccentric on the engine camshaft actuates the rocker arm (fig. 13), which in turn pulls the link, diaphragm, and pull-rod assembly downward against the diaphragm spring, thereby creating a vacuum in the pump chamber.

b. On the suction stroke of the pump, fuel from the tank enters through the inlet, passes into the sediment bowl, then through the screen, and on through the inlet valve into the pump chamber.

c. On the return stroke, the pressure of the diaphragm spring pushes the diaphragm upward, forcing fuel from the pump chamber through the outlet valve and out through the outlet to the carburetor.

d. When the carburetor bowl is filled, the float in the carburetor shuts off the needle valve, thus creating a pressure in the pump chamber. This pressure holds the diaphragm downward against the spring pressure, where it remains inoperative in the downward position until the carburetor requires further fuel; then the needle valve opens. The rocker-arm spring is merely for the purpose of keeping the rocker arm in constant contact with the camshaft.

13. Air Cleaner

An oil bath air cleaner, model 37U-OBF (fig. 14), is attached to the side of the cylinder block and connected by means of a cast-iron brace. Air passes through the intake opening down into the bowl of the cleaner, through a bath of oil, then through the filter element where the oil is removed and turned back into the oil bowl, allowing clean air to pass on into the engine. The oil drained back from the screen washes the dirt away.

Figure 13. Fuel pump.

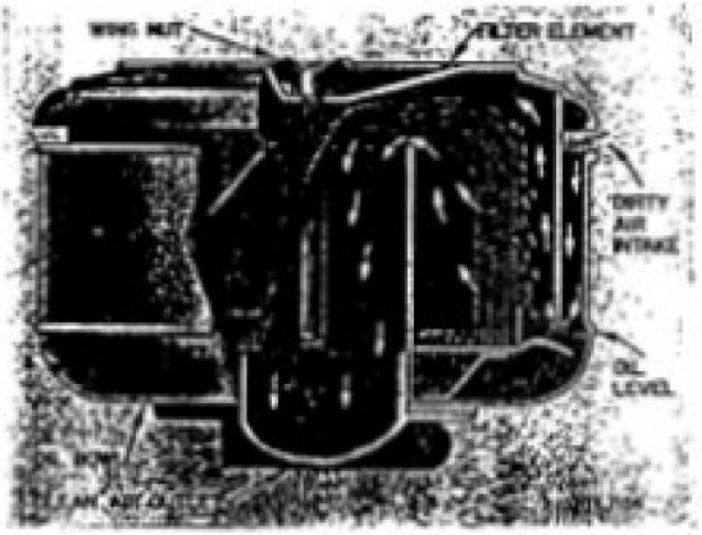


Figure 14. Cross section through air cleaner No. 3711-OBF.

14. Manifolds

Both intake and exhaust manifolds are combined in one casting. The manifold is equipped with a water jacket and is a water-cooled type. (Make certain all connections and hold-down studs have been checked at all times to prevent water leakage.)

15. Governor

a. General. The SG governor (fig. 15) is a hydraulic type; it uses engine lubricating oil, under pressure, as an energy medium. The governor acts, through oil pressure, to increase the fuel supply. It has a useful work capacity of about 6 inch-pounds over the full terminal shaft range of 30°. A spring, which acts to cut off the fuel supply, is incorporated in the fuel control linkage. This spring should oppose the action of the governor with a total resistance of 12 inch-pounds work for full terminal shaft travel.

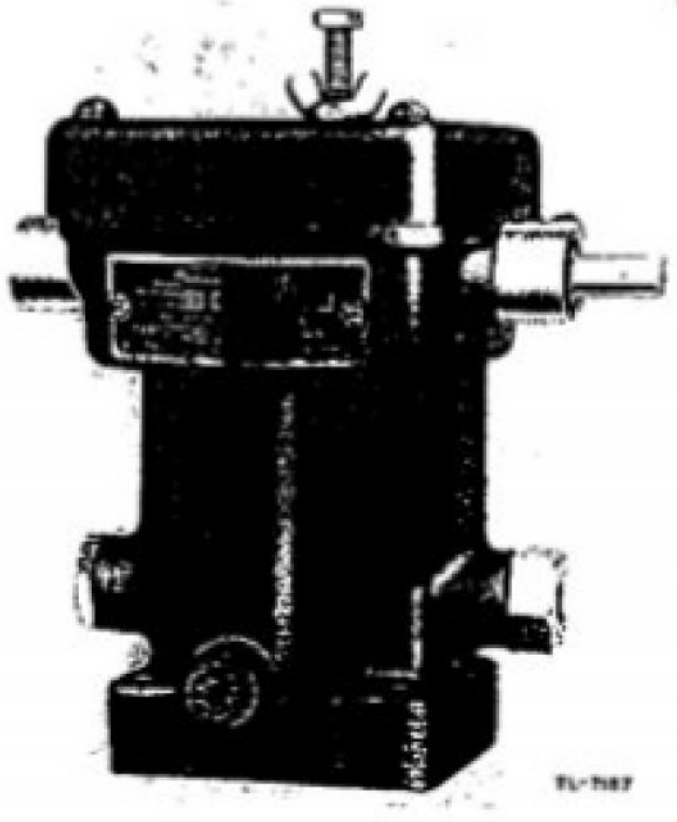


Figure 15. Hydraulically operated engine governor.

b. Speed Droop Adjustment. (1) By *speed droop* is meant the characteristic of decreasing speed with increasing load. Speed droop is introduced into the governing system so that operation may be stable (without hunting). The required magnitude of this speed droop varies with engine applications and may easily be adjusted to suit conditions.

(2) The speed droop is adjusted internally. The cover must be removed to make this adjustment. A range of from approximately one-half of 1 percent to 7 percent may be covered.

(3) If the governor allows the engine to hunt, shut down the engine and remove the cover. Loosen the droop-adjustment screw, which holds the droop-adjusting bracket, and move the droop-adjusting bracket about 1/8 inch away from the center of the governor. This increases the speed droop setting. Tighten the droop-adjustment screw and replace the cover. Start the engine and observe if it is still hunting. If it is, repeat the procedure outlined above until hunting stops.

(4) As the droop-adjusting bracket is moved away from the center of the governor, the droop rivet moves away from the axis of the terminal shaft, and the movement of the power piston, through the floating lever, causes a greater change of loading on the speeder spring, or increased droop.

(5) When the droop-adjusting bracket is pushed as far as it will go toward the center of the governor, the droop rivet is near the axis of the terminal lever. Consequently, as the power piston moves, there will be but a slight up-and-down movement of the floating lever. This, in turn, results in a minimum change of loading on the speeder spring, or a minimum of speed droop.

(6) In general, the engine can be run with the least speed droop that will give the desired stabilization (without hunting) over the operating range. In special cases, as when two units are to be paralleled, greater speed droop may be required in order to match units and secure the proper division of load.

c. Application. (1) The governor has been mounted vertically on the engine with a gasket between its base and the adapter pad. A six-splined 9/16-inch coupling has been provided for driving the governor. The coupling should fit the governor drive shaft freely, but not so freely that excessive backlash exists.

(2) Particular care has been used in manufacturing the governor drive parts, to insure that these parts will run smoothly and not transmit speed irregularities, such as may be caused by shaft run-out, uneven gear teeth, etc. The ballhead in the governor is very sensitive and will pick up these impulses, causing the governor performance to be erratic.

d. Installation and Adjustment. (1) When the governor is installed, particular care should be exercised to see that it is mounted squarely and that the splined drive shaft of the ballhead is in exact alignment with the coupling sleeve on the drive from the engine. (See fig. 16.) The hold-down bolts (or nuts if studs are used) should be securely tightened and pulled down evenly. The oil line between the engine lubricating oil pressure system and the governor should be installed. The proper linkage connections to the speed-adjusting shaft should also be made.

(2) When making up the linkage connections between the terminal shaft and fuel system, care should be taken to insure that the fuel system will be shut off when the terminal shaft of the governor is in the FUEL OFF position.

(3) After making the above-mentioned checks and adjustments, the engine may be started. After the governor begins to receive engine lubricating oil, it will start to open the fuel supply, and continue to do so until the engine fires. After the engine is running, the governor will maintain the engine speed at the rate at which the governor speed adjustment is set.

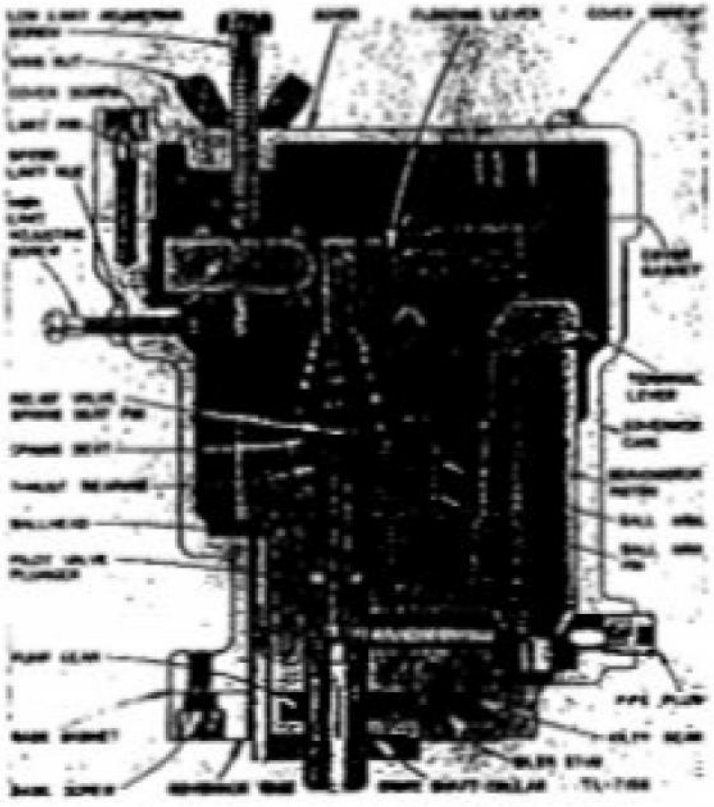


Figure 17. Gateway view (side) of governor.

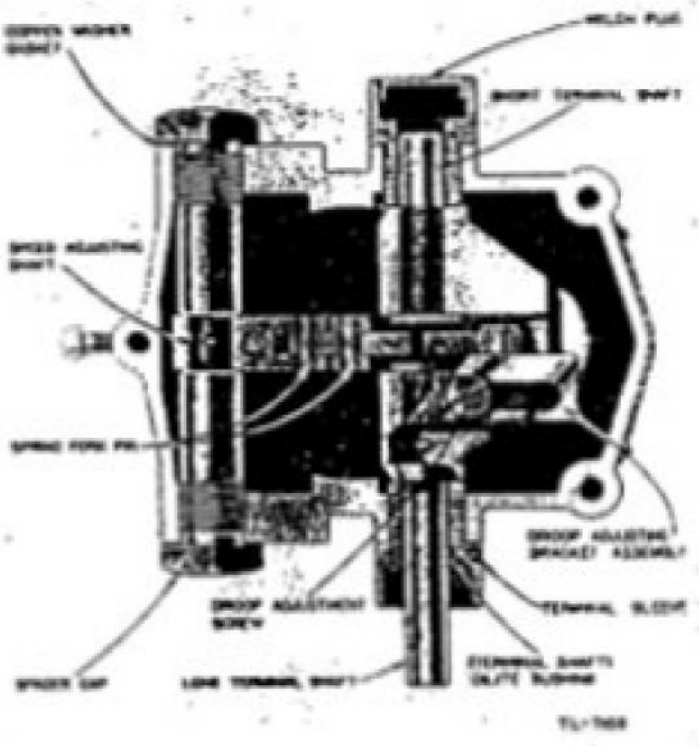


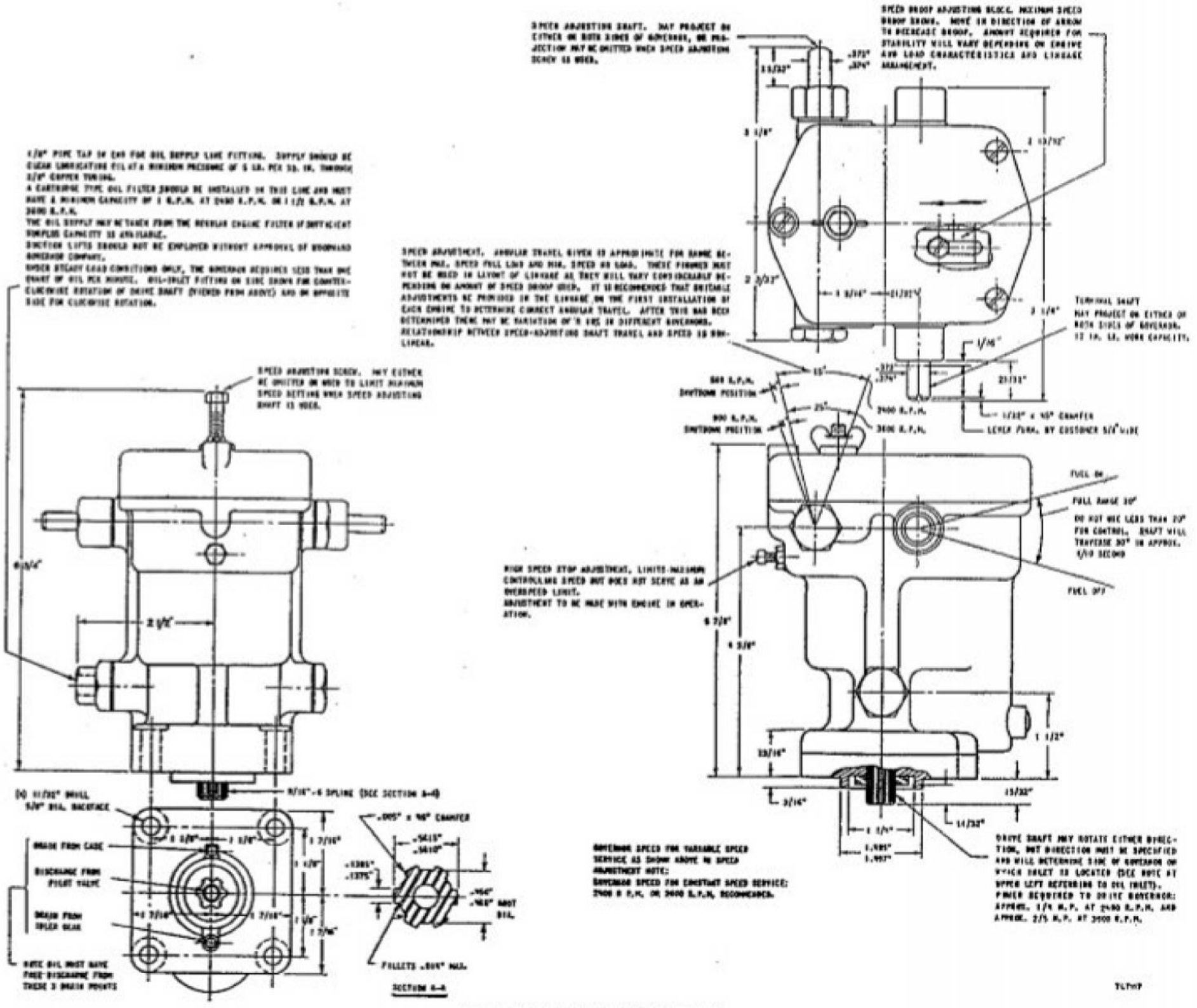
Figure 18. Gateway view (top) of governor.

e. Description of Operation. (1) The hydraulic feature is brought about by oil from the engine lubricating system, being admitted under pressure, to a gear pump in the governor base. (See figs. 17 and 18.) The gear pump raises the oil pressure to a value determined by the relief-valve spring opposing the relief-valve plunger. When the governor is operating, the oil under pressure is maintained in the annular space between the reduced diameter on the pilot-valve plunger and in the bore in the ballhead.

(2) For any given speed adjustment setting, the speeder spring has a definite compression. This must be opposed by the centrifugal force of the flyballs. When these two forces are equal, the land on the pilot-valve plunger exactly covers the lower holes, or ports, in the ballhead. Under a steady load condition, speed will remain constant, and the pilot valve will pass only that amount of oil required to replace leakage, and maintain the required power piston position.

(3) When an extra amount of load is applied to the engine, the speed will drop below that corresponding to the speed-adjustment setting on the speeder spring, the flyballs will be forced inward, and will lower the pilot-valve plunger. This will admit oil pressure underneath the power piston, which will rise. The movement of the power piston is transmitted to the terminal shaft by the terminal lever. Rotation of the terminal shaft causes the fuel setting on the engine to be increased.

(4) As the power piston moves upward, the droop


SPEED ADJUSTING SHAFT. MAY PROJECT ON EITHER OR BOTH SIDES OF GOVERNOR, OR PROJECTION MAY BE OMITTED WHEN SPEED ADJUSTING SCREW IS USED.
SPEED DROOP ADJUSTING BLOCK. MAXIMUM SPEED DROOP DESIRED. MOVE IN DIRECTION OF ARROW TO DECREASE DROOP. AMOUNT REQUIRED FOR STABILITY WILL VARY DEPENDING ON ENGINE AND LOAD CHARACTERISTICS AND LINKAGE ARRANGEMENT.
1/8" PIPE TAP IN END FOR OIL SUPPLY LINE FITTING. SUPPLY SHOULD BE CLEAN LUBRICATING OIL AT A MINIMUM PRESSURE OF 5 LB. PER SQ. IN. THROUGH 1/4" COPPER TUBING.
A CARTRIDGE TYPE OIL FILTER SHOULD BE INSTALLED IN THIS LINE AND MUST HAVE A MINIMUM CAPACITY OF 1 G.P.M. AT 2400 R.P.M. OR 1 1/2 G.P.M. AT 3600 R.P.M.
THE OIL SUPPLY MAY BE TAKEN FROM THE REGULAR ENGINE FILTER IF SUFFICIENT PUMPING CAPACITY IS AVAILABLE.
DIRECTION LISTS SHOULD NOT BE EMPLOYED WITHOUT APPROVAL OF WOODWARD GOVERNOR COMPANY.
UNDER STEADY LOAD CONDITIONS ONLY, THE GOVERNOR REQUIRES LESS THAN ONE QUART OF OIL PER MINUTE. OIL-INLET FITTING ON SIDE SHOWN FOR COUNTER-CLOCKWISE ROTATION OF DRIVE SHAFT (VIEWED FROM ABOVE) AND ON OPPOSITE SIDE FOR CLOCKWISE ROTATION.
SPEED ADJUSTMENT. ANGULAR TRAVEL GIVEN IS APPROXIMATE FOR RANGE BETWEEN MAX. SPEED FULL LOAD AND MIN. SPEED NO LOAD. THESE FIGURES MAY NOT BE USED IN LIEU OF LINKAGE AS THEY WILL VARY CONSIDERABLE DEPENDING ON AMOUNT OF SPEED DROOP USED. IT IS RECOMMENDED THAT SUITABLE ADJUSTMENTS BE PROVIDED IN THE LINKAGE ON THE FIRST INSTALLATION OF EACH ENGINE TO DETERMINE CORRECT ANGULAR TRAVEL. AFTER THIS HAS BEEN DETERMINED THERE MAY BE VARIATION OF 5 DEG IN DIFFERENT GOVERNORS.
RELATIONSHIP BETWEEN SPEED-ADJUSTING SHAFT TRAVEL AND SPEED IS NON-LINEAR.
SPEED ADJUSTING SCREW. MAY EITHER BE OMITTED OR USED TO LIMIT MAXIMUM SPEED SETTING WHEN SPEED ADJUSTING SHAFT IS USED.
TERMINAL SHAFT MAY PROJECT ON EITHER OR BOTH SIDES OF GOVERNOR. 12 IN. LB. WORK CAPACITY.
600 R.P.M. SYNCHRONOUS POSITION
900 R.P.M. SYNCHRONOUS POSITION
2400 R.P.M.
3600 R.P.M.
1/32" x 45° CHAMFER
LEVER FURN. BY CUSTOMER 5/8" WIDE
FULL RANGE 30°
DO NOT USE LESS THAN 20° FOR CONTROL. SHAFT WILL TRAVERSE 30° IN APPROX. 1/10 SECOND
FUEL ON
FUEL OFF
HIGH SPEED STOP ADJUSTMENT. LIMITS MAXIMUM CONTROLLING SPEED BUT DOES NOT SERVE AS AN OVERSPEED LIMIT.
ADJUSTMENT TO BE MADE WITH ENGINE IN OPERATION.
GOVERNOR SPEED FOR VARIABLE SPEED SERVICE AS SHOWN ABOVE NO SPEED ADJUSTMENT NOTE:
GOVERNOR SPEED FOR CONSTANT SPEED SERVICE: 2400 R.P.M. OR 3600 R.P.M. RECOMMENDED.
DRIVE SHAFT MAY ROTATE EITHER DIRECTION, BUT DIRECTION MUST BE SPECIFIED AND WILL DETERMINE SIDE OF GOVERNOR ON WHICH INLET IS LOCATED (SEE NOTE AT UPPER LEFT REFERRING TO OIL INLET).
POWER REQUIRED TO DRIVE GOVERNOR: APPROX. 1/4 H.P. AT 2400 R.P.M. AND APPROX. 2/5 H.P. AT 3600 R.P.M.
(4) 11/32" DRILL 5/8" DEEP, BACKFACE
MAIN FROM CASE
DISCHARGE FROM PILOT VALVE
DRAIN FROM IDLER GEAR
MAIN OIL MUST HAVE FREE DISCHARGE FROM THESE 3 DRAIN POINTS
M/16"-6 SPLINE (SEE SECTION A-A)
.005" x 90° CHAMFER
FILLETS .004" MAX.
SECTION A-A

rivet on the droop-adjusting bracket moves upward and raises the floating lever, which pivots about the spring-fork pin in the speed-adjusting lever.

(5) When the load was applied, the engine speed dropped slightly; and, as a consequence, the centrifugal force of the flyballs decreased. As the floating lever rises, the compression load on the speeder spring is reduced and enables the flyballs to assume again their normal vertical position. The land on the pilot valve plunger again exactly covers the ports in the ballhead, and the power piston stops moving at a position corresponding to an increased fuel setting on the engine. The engine now carries the increased load at a slightly reduced speed because of the slight decrease in the speeder spring compression.

(6) If the load is decreased, the engine speed rises, and the flyballs move outward, lifting the pilot valve plunger. This opens the area under the power piston to the longitudinal drain hole in the ballhead, and allows the spring, which is opposing the governor and acting to decrease fuel, to force the power piston downward and decreases the fuel setting on the engine. As this happens, the floating lever is depressed and increases the compression load on the speeder spring. The centrifugal force of the flyballs increased as the engine speed increased, and the increased compression on the speeder spring forced the flyballs to return to their normal vertical position. The pilot valve ports are then closed, and the power piston movement ceases under the influence of the return spring.

(7) If the governor is to be used for constant speed service, speed adjustment may be made by setting the low-limit adjustment screw. A wing nut is provided to lock the speed-adjusting screw in position.

(8) The engine speed is again steady at a reduced load, having increased slightly due to the increased compression load on the speeder spring.

f. Speed Level Adjustment. Rotation of the speed-adjusting shaft causes the speed-adjusting lever to raise or lower the floating lever. Since the terminal lever is stationary when the load is steady, the floating lever pivots on the droop rivet and increases or decreases the compression on the speeder spring. Increasing this compression causes the speed to rise; decreasing it causes the speed to drop. Rotating the speed-adjusting shaft sufficiently far in the decrease speed direction causes the floating lever to pick up the speeder spring and lift the pilot-valve plunger. This permits the area under the power piston to drain and enables the fuel-return spring to shut off the fuel completely, thus shutting down the engine.

g. Lubrication. The governor is lubricated by oil introduced into the governor housing past the power piston and pilot valve plunger. The rotation of the governor flyballs breaks the oil into a fine mist. The oil collects in the bottom of the governor case and is discharged through a drain hole in the base.

16. Ignition

a. Magneto. (1) The magneto has a fixed spark and a 35° setting, and is designed for clockwise rotation. It uses the induction principle of current generation. The coil windings are stationary and the magnets rotate between laminated pole shoes. The capacitor and interrupter are also stationary. The brush and rotating track combinations are confined solely to the high-tension distributor. Screened ventilators on either side of the housing and the fan action of the magnet rotor insure constant change of air throughout the interior of the magneto.

(2) A single casting incloses the magneto. The open end of the casting is covered by the distributor plate and a radio shield cover. The observation cover on the radio shield cover, the observation window in the distributor plate, and the arrow on the distributor rotor facilitate timing of the magneto to the engine.

b. Spark Plugs. The spark plugs best suited for this engine are the AC No. 83 Special, and they should ordinarily be used. As an alternative, use Champion No. C7. Do not substitute one brand for the other; use only a full set of either brand.

17. Cranking Motor

The cranking motor is equipped with a Bendix drive and operated from the 12-volt storage battery. The motor is started by means of a magnetic switch, controlled by a push button mounted in the control switch-box assembly.

Caution: Never operate the cranking motor more than 30 seconds at any one time without pausing to permit the cranking motor to cool off. Long cranking periods will cause the cranking motor to overheat and fail.

18. Charging Generator

a. General. The charging generator is rated at 12 volts. It is driven by means of a V-belt and a pulley, which is mounted just behind the fan-belt pulley on the crankshaft extension.

b. Control Unit. A control unit is mounted on top of the generator frame. This unit consists of a cut-out relay, which opens and closes the circuit between the generator and the battery, and a voltage control, which permits full generator output of 6 to 8 amperes (generator at operating temperature) until the battery becomes charged. Then the voltage control operates and reduces the generator output to a small trickle charge of approximately 2 amperes,

sufficient to maintain the battery in a charged condition without overcharging it.

19. Control-Switch Box

There are two control switches in this box: the thermostat and the oil-pressure switch.

a. THERMOSTAT. The thermostat is used to shut down the engine if the water temperature rises above 190° F. The thermostat has a two-circuit single-throw switch, which connects both of the terminals to the grounded side of the battery, whenever the temperature of the water in the engine exceeds 195° F. One of these terminals is connected to the magneto so that the magneto is shorted when the thermostat switch closes. The other terminal is connected to one side of the pilot light, which indicates that shut-down was caused by high water temperature. The other side of this pilot light is connected to the live side of the battery so that when the thermostat switch closes, this pilot light will be lighted. After this thermostat switch has once closed, it will not reopen itself, no matter how cool the water in the engine. The reset button on the top of the thermostat cabinet must be pressed before the thermostat switch will open. The reset button turns out the pilot light and removes the short from the magneto so that the engine can be restarted. When it is necessary to start the engine immediately, after it shuts down because of high water temperature, the radiator should be filled and the reset button held down while the start button is pushed. The reset button should be held down until the cooler water has been circulated to reach the thermostat bulb; the button may then be released and the engine will continue to run.

b. OIL-PRESSURE SWITCH. (1) The oil-pressure switch is used to shut down the engine if the oil pressure drops below 5 pounds per square inch. The oil-pressure switch is closed whenever the oil pressure is less than 5 pounds per square inch, and open when the oil pressure is above 9 pounds per square inch. Whenever the engine stops, the oil pressure will drop to zero, so that the oil-pressure switch cannot be used to light the indicating pilot light (as was done with the thermostat), because then oil failure would be indicated each time the engine stopped, even when purposely stopped. Consequently, it is necessary to add a relay which will close whenever the oil pressure drops too low while the engine is running, but will not close when the drop in oil pressure is caused by the engine slowing down. This selective action is accomplished by connecting the relay coil across the generator which charges the storage battery. Whenever the engine is running near normal speed, the generator will be charging the battery and its voltage will be enough to close the relay, whenever the oil-pressure switch closes because of low oil pressure. However, when the engine slows down (as when it is stopped manually), the generator voltage drops until the automatic cutout opens, disconnecting the generator from the battery and then the generator voltage continues to drop as the speed decreases. The oil pressure drops slowly so that when the oil-pressure switch finally closes, the generator voltage is not sufficient to close the relay and therefore oil failure will not be indicated.

(2) In case of generator failure, the engine can still be run, but the low oil pressure safety feature will not be working. If it is important to retain the low oil-pressure safety feature whenever the engine is run, even though the generator has failed, it will be necessary to connect terminal No. 1 of the pressure switch directly to the battery. With this connection, oil failure will be indicated every time the engine stops, but, at least, the engine will be stopped whenever the oil pressure fails. The start button can be touched to turn out the oil failure pilot light when the engine is stopped.

(3) The sequence of operation is as follows: If the water temperature pilot is lighted, the thermostat reset button should be pressed, and, if necessary, held down while starting. Pressing the start button will drop out the relay and turn out the oil-pressure pilot light, if it is lit. The start button must be held in until the oil pressure builds up. It will do no harm to hold the start button in after the engine has started, because the Bendix drive automatically disconnects the starter when the engine starts. If the oil-pressure pilot lights when the start button is released, the oil level should be checked. However, the light could be caused by the oil being so cold that the pump cannot build up pressure, or possibly because the oil in the pipe leading to the oil-pressure switch may be solidified by the cold and will not transmit the pressure. In this case, the oil in the crankcase and in the oil line should be warmed.

(4) After the engine is running, if the oil pressure drops until the oil-pressure switch closes, the relay coil is connected across the generator and the relay closes. When the relay is closed, the coil is connected directly across the battery and remains closed until the start button, which opens the coil circuit, is touched. Then the relay drops out and cannot be closed again until oil pressure fails while the engine is running. Closing of the relay also makes a connection from the magneto to the ground, shorting the magneto and stopping the engine.

NOTE. Some units are equipped with oil-pressure safety control only. In such cases, disregard the instructions above pertaining to thermostatic control.

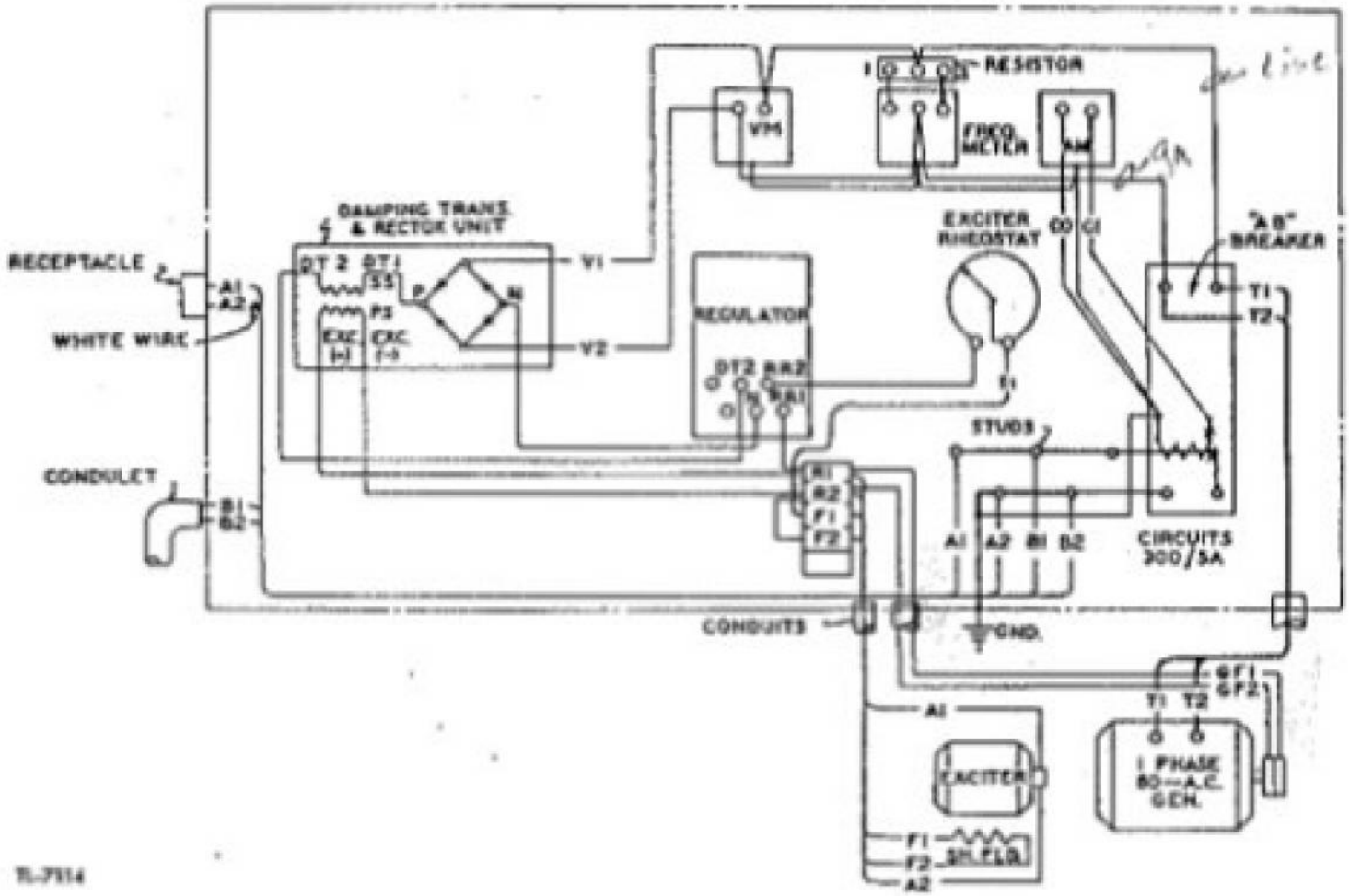


Figure 19. Wiring diagram of alternator (generator) connections. Rear view of panel is shown.

20. Alternator

a. The alternator is a single phase, two-wire, 60-cycle unit which is rated at 25 kva at 80 percent power factor, at 900 rpm, and at 120 volts at full load, with a direct-connected exciter of suitable size to supply current to the alternator field. The alternator will carry rated full load continuously with a temperature rise not exceeding 40° C. above ambient temperature. The alternator is provided with two ball bearings designed so that new grease being added to the bearings flushes out the old grease and forces it into an overflow reservoir. The bearings are suitable for coupled or V-belt drive.

b. The alternator frame is made of a good grade of cast iron and is of the open type. It is of rigid and rugged construction to withstand the vibration and jar of being transported on a trailer. The armature is made of high-grade laminated steel, held rigidly in place in the frame by end plates and keys, and is slotted to receive the stator coils. The windings are held in the slots by moisture-proof wedges. The coils are formed and insulated before winding into the slots. The wound stator is impregnated with an acid-, oil-, and moisture-resisting varnish so that the entire winding is protected from abrasive dust, oil, weak acid, and moisture.

c. The field coils are wound directly on the poles. Each coil layer, as it is wound, is well saturated with a bakelite varnish, and the final coil is treated with a moisture-resistant varnish.

d. Amortisseur (damper) windings are provided. These are connected between poles and are especially designed for use on a single-phase alternator. Single-phase operation produces heavy currents in the damper windings, which may cause overheating in a machine not designed for such operation. If there is no damper winding, the field current required for a given load is increased to such an extent that the output is seriously limited. The damper winding in this generator is designed for satisfactory single-phase operation.

e. The collectors (slip rings) are made of bronze and are machined free of cuts, flats, or any unevenness. The corrosion-resisting brush holders are so constructed that they prevent binding and permit easy removal of the brushes. They are mounted so that the lower edges have a clearance of from 1/8 inch to 5/16 inch from the collector rings, and are centered to prevent the brushes from overriding the edges of

the collector rings under normal operating conditions (when the generator is coupled to the engine.) The alternator brushes are a combination of carbon and graphite.

f. The minimum air gap for the alternator is not less than 70 percent of the nominal gap.

g. When the feet of the alternator are resting on a level surface, the shaft is in a level plane within 0.007 inch to each foot of shaft length. The rotor is dynamically balanced so that the vibration, measured by a vibrometer when the alternator is standing on a solid bedplate, is less than 0.003 inch.

h. All leads from the generator are brought to the control panel, and are inclosed in flexible armored conduits. (See fig. 19.)

i. The alternator and exciter are tested to withstand the high potential tests prescribed in the latest revision of the A.I.E.E. Standards, namely, alternator field windings, 1,500 volts, other windings twice their rated voltage plus 1,000 volts.

j. The exciter is capable of delivering its rated current continuously. Its commutator segments are of best quality hard-drawn copper and are insulated from the shaft and from each other. The insulation between the bars is undercut. Commutator surfaces run true and are free from flaws, tool marks, or other imperfections.

k. The exciter brush holders are mounted so that the lower edge has a clearance of 1/16 inch to 3/16 inch from the commutator surface. The brushes are made of high grade carbon.

l. All coils, leads, terminals, and other connections are secured so that they cannot become damaged, displaced, or loosened by vibration.

m. Openings in the end brackets of the alternator at the collector ring end give access to, and a direct view of the collector rings and brushes while the alternator is in operation.

21. Alternator Controls

a. Voltmeter, Ammeter, and Frequency Meter. (1) The three meters, mounted in a row at the top of the alternator-control panel, include a type HA ammeter, a type HA voltmeter, and a type HY frequency meter. (They are all manufactured by Westinghouse.)

(2) The same size case is used for all three types. The case is square and is arranged for projection mounting. The instruments are held to the panel by two mounting studs placed on the vertical center line.

(3) An unusually high ratio between mounting space and scale length is attained in the type H instruments. The actual scale length is 5 inches and the dimensions of the case are 5 1/2 inches by 5 1/2 inches.

(4) All current-carrying terminals are moulded with threaded inserts for 10–32 terminals up to 20 amperes and for all voltmeters.

(5) The voltmeter is self-contained, has no external resistor, and is connected directly to the alternator leads. The ammeter is connected to the secondary terminal of the current transformer. The frequency meter is provided with an external reactor.

(6) The following types of movements are used in these instruments: ammeter (repulsion vane); voltmeter (repulsion vane); and frequency meter (electrodynamic.)

(7) The power consumption is as follows:

Type of meter	Rating	60 cycles			
		Volt-amperes	Watts	Reactive volt-amperes	Percent power factor
Ammeter, type HA	5-amp	0.59	0.42	0.415	71
Voltmeter, type HA	150-v	3.51	3.51	0.023	99+
Frequency meter	115-v	3.5	3.5	0.13	99+

k. Total-hour Meter. (1) *General.* This meter is a time-integrating device that indicates total hours of operation of the alternator.

(2) *Operation.* (*a*) The total-hour meter consists essentially of a synchronous motor, gear train, and six indicating numbered wheels. The meter is connected in parallel with the alternator whose total hours of operation are to be measured. When the unit is started, the self-starting synchronous driving motor starts and runs continuously as long as the unit runs.

(*b*) The synchronous motor drives the gear train, which in turn drives the six number wheels. The meter will indicate accurately as long as the frequency of the supply circuit is well regulated.

(3) *Construction.* (*a*) The motor is a high-torque synchronous type, having 12 poles and operating at 600 rpm on 60 cycles. An oil storage reservoir is provided for the motor bearings, thus reducing the

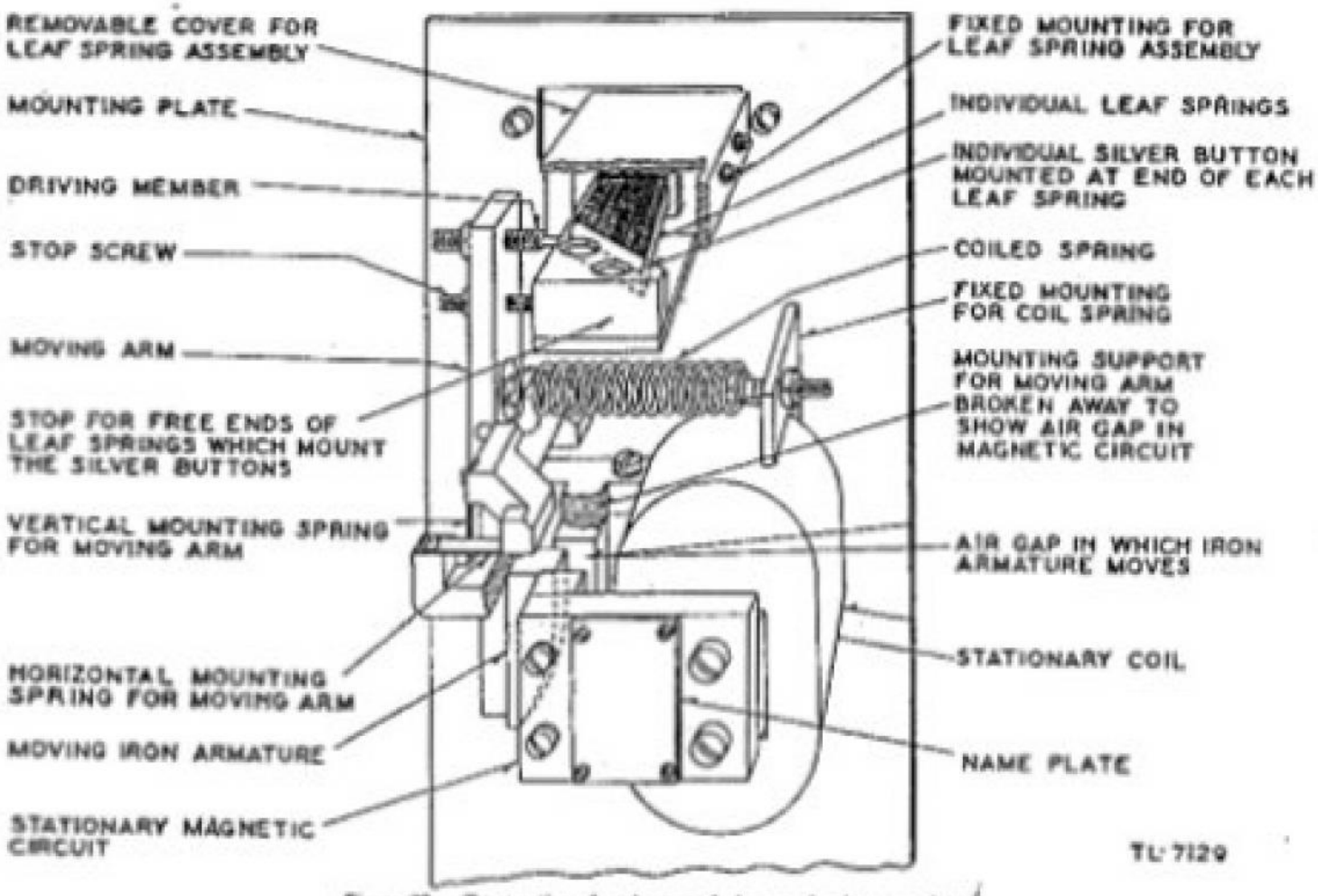


Figure 20. Construction of main control element of voltage regulator.

need for frequent service. When the oil supply is exhausted, it is only necessary to clean the motor bearings and replenish the oil supply.

(*b*) The precision gears are machine-cut and then gold-plated for protection from corrosive action. The bearings are of the highest grade to insure frictionless operation over long periods of service.

(*c*) A zero reset has been provided for use when required. The resetting is accomplished by removing the case and disengaging the number wheel shaft, which allows the number wheels to be set to any desired reading.

c. Voltage Regulator. (1) *General.* The alternator voltage regulator is an SRA–1 unit of the direct, quick-acting, rheostatic type. It is designed for the automatic voltage control of small and medium-size a-c and d-c machines. It is rugged in construction, simple in design, and requires little or no maintenance. There are no vibrating contacts and the regulating action is that of a semi-static device which operates only when a correction in voltage is necessary. This assures reliable operation and long life without the necessity for adjustment or replacement of original parts.

(2) *Sensitivity.* (*a*) Sensitivity represents the band or zone of voltage, expressed in terms of percentage of the normal value of regulated voltage, within which the regulator will normally hold the voltage under steady load conditions. This does not mean that the regulated voltage will not vary outside of the sensitivity zone. It does mean, however, that when the regulated voltage varies more than the per-

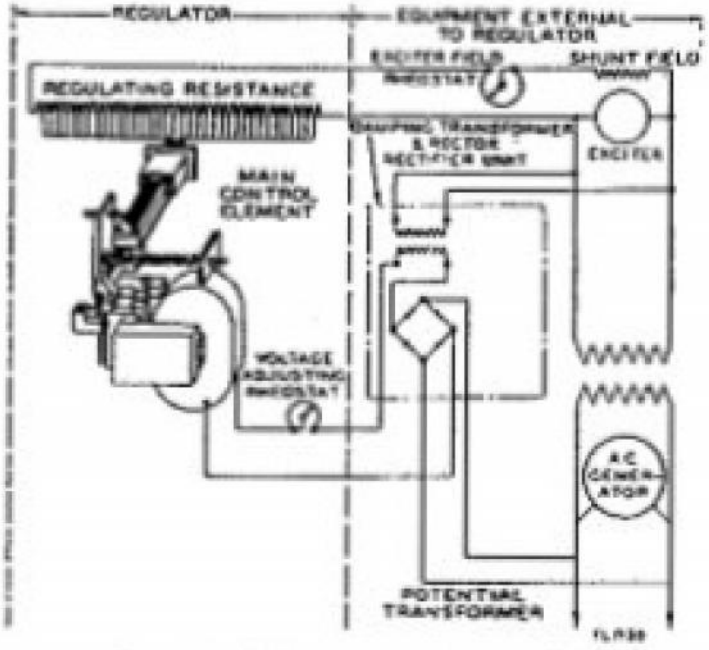


Figure 21. Wiring diagram of voltage regulator.

centage sensitivity from the regulator setting, due to sudden changes in load or other conditions, the regulator will immediately apply corrective action to restore the voltage to the sensitivity zone. The rated sensitivity of this type of regulator is 2 1/2 percent.

(*b*) Regulator sensitivity must not be confused with overall regulation, which involves not only regulator sensitivity but also the time constants of the machines, and the character and magnitude of load changes. A regulator cannot get more from a machine than it is inherently capable of delivering and cannot change a machine's characteristics. The magnitude and rate of load change determines how far the voltage will vary outside of the regulator sensitivity zone and the time constants of the machines chiefly determines the time required to restore the voltage to the sensitivity zone of the regulator. For these reasons, only sensitivity can be specified as far as the regulator is concerned, and not overall regulation which involves factors over which a regulator has no control.

(*c*) The design of the regulator has been so coordinated that any change of regulated voltage is very small, with respect to temperature of the regulator parts, over the range of ambient temperatures usually encountered in normal operating practice. The standard design of the regulator will maintain its rated sensitivity, when operated in ambient temperatures between +15° and +40° C. (+59° and +104° F.). This means that the regulator will hold practically the same voltage, whether it is cold or warm.

(3) *Operation.* (*a*) The regulator is of the direct and quick-acting rheostatic type; correction of voltage is obtained by the regulator element directly varying the regulating resistance in the machine field circuit. The direct acting principle of operation employed keeps the regulating resistance automatically adjusted to the proper amount required to maintain the correct value of regulated voltage. The regulating resistance is entirely stationary, thus eliminating the complication involved where linkage and lever systems mechanically move the resistance assembly in order to vary its resistance, as is necessary with some types of regulators.

(*b*) The few moving parts used are supported by leaf-type springs which provide a fixed and permanent axis that permits free action without the friction of pivots and bearings. (See fig. 20.) This construction, combined with lightweight moving parts whose maximum travel is only a fraction of an inch, practically eliminates the time lag due to the inertia and friction of these parts; this results in a sensitive device which functions quickly.

(*c*) Regulators of this type control the voltage of an a-c generator by varying the resistance in the shunt field circuit of the exciter. In each case, the regulating resistance in the field circuit is varied directly and automatically by the action of the regulator.

(*d*) The control element of the regulator is operated by direct current. A full-wave (copper oxide) rectifier is interposed between the element and the a-c machine, to supply direct current to the regulator element. Since the rectified d-c voltage is proportional to the a-c voltage, the d-c operated element of the regulator responds to changes in the a-c machine voltage.

(4) *Detailed description of operation.* (*a*) The voltage of the machine to be regulated is connected across the regulator coil circuit. (See fig. 21.) An iron magnetic circuit, in the shape of a square C, passes through and mounts the regulator coil. The movable arm of the element is mounted so that the iron armature attached to its lower end can move in the air gap of the magnetic circuit against the pull of a spring. Thus, any change in the value of the voltage being regulated correspondingly changes the magnetizing effect of the coil on the iron magnetic circuit. This in turn causes a change in the flux in the air gap and changes the attractive force on the iron armature of the moving arm, causing it to change its position.

(*b*) The movement of the upper end of the movable arm directly controls the closing or opening (in succession) of a series of silver buttons, depending on the direction of the motion of the arm. Each of the silver buttons is mounted at the free end of an individual leaf spring of conducting material. (See fig. 20.) The other end of the leaf spring is fixed and the assembly holding the fixed ends is arranged so that each one is individually insulated from the others. Each silver button is connected electrically by means of a wire from the fixed end of its leaf spring to a tap on the stationary regulating resistance.

(*c*) The regulating resistance is connected directly in the field circuit (exciter shunt field in a-c applications). At one end of the travel of the moving arm, all of the silver buttons are apart from each other, placing maximum resistance in the field circuit. At the other end of its travel, all of the silver buttons are closed, thus shorting out the resistance in the field circuit through a silver path which reduces the resistance to a negligible value. Thus, as the moving arm operates through its travel, depending on the direction of its motion, it successively opens or closes the silver buttons to increase or decrease the resistance in the field circuit. Since the moving arm has a short travel, all resistance can be inserted or cut out quickly, or it can be varied gradually, depending on the change in excitation required.

(*d*) An important operating feature of design is the

smooth control of excitation made possible by the use of silver buttons. Although the operation of these buttons in sequence appears to cut small steps of resistance in or out in a definite, step-by-step manner, such is not actually the case. When the moving arm operates the silver buttons in sequence, there is a progressive change in pressure between the faces of the buttons, due to the action of the moving arm in deflecting the leaf springs that mount the buttons. Since the effective resistance between silver surfaces is dependent upon the pressure, this effect, combined with the small value of resistance per step, acts to produce an infinite number of steps from practically zero to the maximum. In this manner, the design inherently provides for smooth variation of the stationary regulating resistance.

(*e*) The regulating action of the regulator is that of a semistatic device which operates only when a correction in voltage is necessary. For a given value of regulated voltage and load on the machine being regulated, there is a corresponding value of regulating resistance required in the field circuit, and a corresponding position of the moving arm and silver buttons which will give this value of resistance. Under such conditions, the magnetic pull on the moving arm is balanced against spring pull. When there is a change in load on the machine being regulated, a corresponding change is caused in the voltage. To restore the voltage to its correct regulated value, the moving arm and the silver buttons take a new position corresponding to the changed value of the load.

(*f*) Should additional load be placed on a machine the voltage of which is being regulated, the voltage will drop and an increase in field current is required to bring the voltage back to normal. The drop in voltage decreases the magnetizing effect of the regulator coil and reduces the flux in the air gap of its magnetic circuit. This in turn decreases the magnetic pull on the iron armature attached to the moving arm and allows the coil spring to begin closing (in sequence) more of the silver buttons. This action shorts out, in small steps, additional portions of the regulating resistance, which being connected in the field circuit, causes the field current to be increased and the voltage raised back to its normal value. When the voltage is restored to its normal value, the moving arm of the regulator is again in a balanced state. However, the moving arm has changed its position to correspond to the change in load on the machine.

(*g*) In case some load is taken off the machine and the voltage rises, the sequence described in (*f*) above, is reversed. The rise in voltage increases the current and magnetizing effect of the regulator coil. This increases the pull on the armature and moves it in opposition to the pull of the coil spring, to start opening, in sequence, more of the silver buttons. This action inserts additional steps of the regulating resistance in the field circuit, thereby decreasing the field current and reducing the voltage to its normal value. With normal voltage restored, the moving arm is again in a balanced state in its new position.

(*h*) From the foregoing description of operation, it becomes apparent that the regulator can increase the excitation to its ceiling value (ceiling voltage of exciter) where necessary. Also, the excitation can be quickly reduced to the lowest value required. The maximum travel of the moving arm, being only a fraction of an inch, permits the regulating resistance to be very quickly varied from maximum to practically zero when operating conditions require such control.

(5) *Damping transformer.* (*a*) To stabilize the regulated voltage and prevent excessive swinging under various conditions of excitation change, a damping effect is introduced into the regulator coil circuit by means of a damping transformer. The use of this device eliminates the need for dashpots or similar mechanical antihunting devices, which require adjustment and maintenance.

(*b*) The damping transformer is a special type, having a small air gap in the laminated iron magnetic circuit. One winding is connected across the field of the generator whose voltage is being regulated. The other winding is connected in series with the regulator coil. When there is a change in excitation voltage, as a result of the regulating action of the regulator, there is an induced transfer of energy from one winding to the other of the damping transformer. The energy thus introduced into the circuit of the regulator coil acts by reason of its direction, magnitude, and time to electrically dampen excessive action of the moving arm, thus preventing the moving arm from carrying too far the change in regulating resistance and the consequent change in excitation. Since the damping transformer operates only when the excitation of the alternator is changing (remember that the excitation circuit is direct current), the damping transformer has no effect when the regulated voltage is steady and the regulator is in a balanced condition. The damping transformer is arranged for mounting separate from the regulator.

(6) *Voltage-adjusting rheostat.* A small voltage-adjusting rheostat is included in the regulator assembly and provides a convenient means of setting the voltage at the value at which it is to be regulated. The rheostat knob is located outside the regulator cover where it is always accessible. The rheostat has a range which makes it possible to change the value of the regulated voltage approximately 10 percent above or below normal on this type of regulator.

(7) *Assembly and mounting.* The main control element, with its moving arm and required number of silver button assemblies, and the voltage-adjusting rheostat are mounted on the front of a metal plate, which serves as a base. A second metal plate is attached to the rear of the base and held a short distance behind it by means of a post at each corner. The regulating resistor is mounted in the space between the base and the rear metal plate. The top and sides of this space are inclosed by a perforated removable cover. Each of the projection mounting-type regulators is provided with a protective removable cover, which fits on and incloses the front of the regulator and is held in place by thumbnuts. A gasket of long-life, flexible material, around the edge of the cover, provides a dust-tight fit which protects against dust and dirt collecting in the main assembly.

(8) *Installation.* The method of mounting the regulator, and the fact that only four to six wires are connected to it, makes it easy to install. Since all internal adjustments are made in the factory, it is also easy to place the regulator in operation. The usual field rheostat (exciter field rheostat) is normally left in the circuit in series with the regulating resistance of the regulator. Setting the field rheostat in the proper position to permit the regulator to take control, places the regulator in service.

(9) *Accessories.* (*a*) On this type regulator, a full wave copper-oxide rectifier is used. The function of this unit is to rectify the single phase a-c supply to the regulator over to a proportional value of d-c energy, since the regulator element is a d-c operated device. The rectified d-c energy is, to all practical purposes, independent of frequency changes, and the a-c regulator is correspondingly free from frequency error due to small changes in speed of the a-c machine. The unit is completely dry and requires no maintenance.

Figure 21. Rear view of 225-ampere circuit breaker.

Figure 22. Damping transformer used with the a-c regulator.

(*b*) A damping transformer is supplied with each regulator. This transformer functions to stabilize the regulated voltage by acting as an electrical anti-hunting device. This device does not require any adjustment or maintenance.

(*c*) The rectifier and damping transformer are mounted on a steel plate to form a single unit as shown in figure 22. This unit is arranged for mounting separate from the regulator and is designed so that it can be readily mounted at the rear of a switchboard panel or in any convenient location. The sides of the steel plate are bent to form flanges and mounting holes in both the base and flanges to facilitate mounting. The damping transformer and the rectifier are wired to a terminal block mounted at the bottom of the steel plate.

d. Circuit Breaker. (1) The circuit breaker is a 225-ampere unit, mounted in a 600-volt a-c frame. The main contacts in this frame are of pure silver. Additional arcing contacts of silver tungsten are also provided. (Silver-tungsten is a tungsten alloy with distinctive arc-resisting and nonwelding characteristics.)

(2) All triggers and latches are made of hardened rust-resisting nitride steel. All bearings have at least two noncorrosive parts, out of a maximum of three. These features give the operating mechanism a higher degree of protection against corrosion than that afforded the usual breaker.

(3) All moulded parts are black; all copper or copper-alloy parts are either tinned or nickel-plated; and all steel parts are cadmium plated. This arrangement produces a pleasing black and white contrast and at the same time provides adequate protection against corrosion for the metal parts.

(4) The rear view (fig. 23) shows the three terminal lugs in the square holes for front connection or box mounting. When rear connected, these terminals are removed and the square openings closed by sliding fitted shutters into slots arranged for the purpose on the inside edges of the base. Threaded studs are then placed into the inserts moulded in the recessed base; these provide rear-connection studs similar to those used on air circuit breakers. The inserts are recessed, making it possible to bolt the breaker against a flat surface even though it is a conductor. They are threaded all the way through, either to receive the bolt on the inside (where the tube terminal is held), or to receive the stud from the bottom. Removal of the terminal bolt allows the stud for rear connection to be screwed all the way in to the breaker terminal. Four mounting bolt holes are provided at both top and bottom.

(5) Figure 24 shows the details of the 250-volt a-c arc quencher, used in the 225-ampere frame. The V-shaped conductor shown at the extreme left is insulated and arranged so that the power, flowing through the arc from the stationary arcing tip, must also pass up, around, and down through the center of the plates, through the stud, and out to the line.

(6) The magnetic field set up in the chamber draws the arc into the center where it rotates at high speed; the single arc is broken up by the plates into a series of short arcs. When the current passes through zero, the arc does not reestablish.

r. FIELD RHEOSTAT. (1) *Construction.* (*a*) The exciter field rheostat is a type WL unit. In the manufacture of these rheostats, a pressed-steel plate forms a light but durable rigid base. After the entire surface is sandblasted to remove foreign particles,

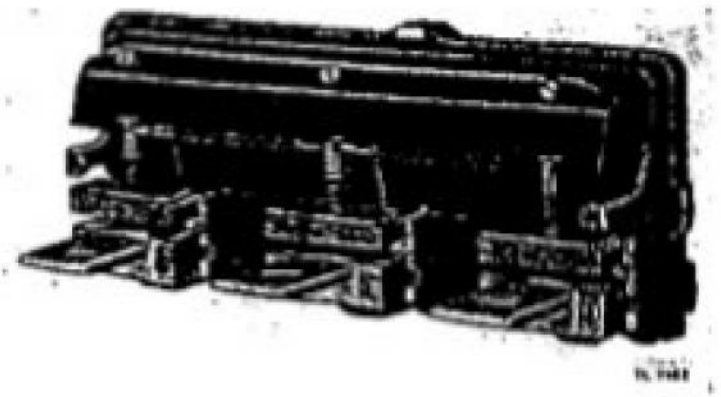


Figure 24. Arc quencher arrangement used on 250-volt a-c circuit breaker.

the cleaned plate is covered with a ground coat which protects the surface of the plate and forms an electrical-insulating, heat-conducting surface upon which to mount the resistance elements of approximately zero temperature-coefficient wire. To these wires the heavy contacts are fastened by a patented process which gives a mechanically and electrically perfect joint. Vitrohm insulation is applied over the resistance wire. It holds the wire and contacts securely and protects them against corrosion and mechanical injury. The complete plate is formed by a porcelain terminal block, a movable contact arm with its bearing, a back cover, and a handwheel.

(*b*) When looking at the handwheel side, the all-out or high-capacity step is reached by turning the handwheel counterclockwise. Clockwise rotation cuts resistance into the circuit.

(2) *Adjustable stop.* Each rheostat is provided with an adjustable arm stop, which consists of a movable angle piece clamped in a slot on the rear cover. To control the maximum voltage of a generator, set the clamp to limit the clockwise rotation. To control the speed of a motor, set the clamp to limit clockwise rotation. After the clamp has been adjusted, it can be held in position by tightening the set screw securely.

(3) *Rating.* The ampere rating stamped on the name plate is calculated on the premise that the hottest spot temperature on the enamel does not exceed 250° C. rise, which is the NEMA standard for imbedded resistors. It is permissible to use a rheostat on voltages lower than the name plate rating, providing the maximum current is not exceeded.

SECTION IV

MAINTENANCE

22. Routine Maintenance

a. Daily. Following are the maintenance operations that should be performed on this equipment daily:

(1) See that only clean fuel is put into the tank from a clean container.

(2) Keep the radiator full of clean water.

(3) Turn the water pump grease cups down snug.

(4) See that the oil is up to the FULL mark on the dipstick; use the oil recommended.

(5) Keep the cylinder head and crankcase breathers free from dirt.

(6) Clean the air cleaner and, on oil-bath types, maintain the oil level. (See instructions on air cleaner.)

(7) Lubricate the clutch throw-out collar.

(8) Lubricate the governor.

(9) Service the oil filter.

b. Weekly. Following are the maintenance operations that should be performed on this equipment weekly (150 hours service):

(1) Check the spark-plug and magneto-point gaps.

(2) Lubricate all the accessories. (Battery-charging generator, starting motor, etc.)

(3) When the lubricating oil becomes badly discolored or diluted, the oil should be changed. The interval between oil changes depends entirely on operating conditions and the quality of oil used. Renew the oil filter element.

(4) Valve adjustment should be checked to guard against low compression (loss of power). The clearance between the valve stems and the push-rod adjusting screws should be 0.015 inch hot and 0.018 inch cold. Do not set too close, as this causes burned and warped valves.

(5) Check adjustment of the fan belt. The fan belt should be kept tight enough at all times to prevent its slipping.

(6) Inspect and tighten any nuts that may have worked loose on the cylinder head and cylinder block.

c. Monthly. Following are the maintenance operations that should be performed on this equipment monthly (600 hours service):

(1) Test the compression by cranking the engine over slowly on each compression stroke. Should the engine turn over easily on all cylinders (showing poor compression), the cylinder head should be removed and the valves reground. If one or two cylinders only lack compression, carefully inspect the valve and tappet clearances on these cylinders before removing the head. Insufficient valve clearance will cause burned valves and lack of compression.

(2) If the valves are pitted, regrind them.

(3) The oil pan (sump) should be thoroughly cleaned, removing all traces of sludge.

(4) Remove the oil-strainer screen from the oil pan and wash it in gasoline.

(5) Remove the coupling guard, check the coupling, and tighten the nuts if necessary.

d. Semiannually. After 6 months (3,000 hours service), the entire engine should receive a thorough general inspection by a competent mechanic.

23. Cooling System

a. Dirt and Sludge. To clean the cooling system of dirt and sludge, perform the following operations:

(1) Drain the cooling system by opening the drain cocks in the lower radiator connection, in the manifold, and in the cylinder block (drain cocks located in the cylinder block beneath the carburetor). Allow the system to drain, then close the cocks.

(2) Fill the cooling system with a solution of 2 1/2 pounds of ordinary washing soda mixed with 9 gallons (U. S. measure) of water (cooling system capacity).

(3) Leave the radiator filler cap off and run the engine until the water is hot; then drain and flush the system with clean water.

(4) Refill with clean water.

b. Radiator Care. Overheating is often caused by bent or clogged radiator fins. If the spaces between the fins become clogged, clean them with an air hose. When straightening bent fins, be careful not to injure the tubes, or break the bond between the fins and tubes.

c. Fan Belt Adjustment. Adjust the tension of the fan belt by changing the width of the groove in the fan pulley. (See fig. 25.) To do this, loosen the lock screws and move the pulley flanges together

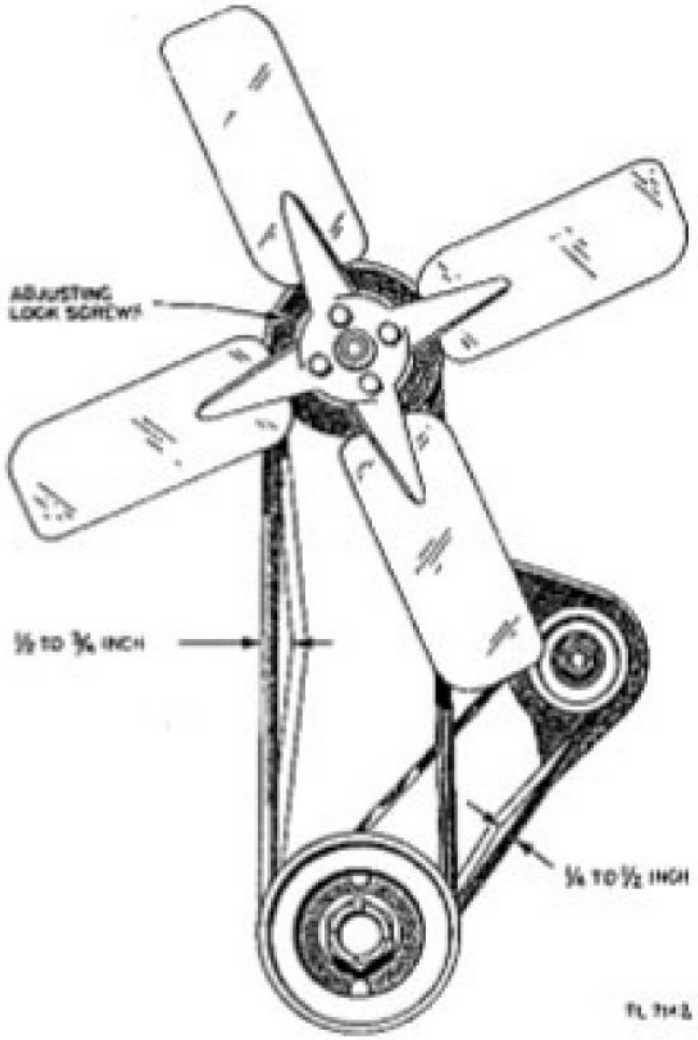


Figure 25. Correct V-belt tension.

or apart, as required. Retighten the lock screws after the correct tension is obtained.

d. Removing Fan Belt. To remove the fan belt, loosen the lock screws in the fan-pulley hub and move the flange out as far as possible. Start the belt over the outer flange of the lower pulley and pry it out with a light bar or rod. Slowly crank the engine at the same time and the belt will work off the pulley.

e. Replacing Fan Belt. Whenever the fan belt becomes soaked with grease, or when it becomes so badly worn that it does not drive the fan at the proper speed, replace the belt with a new one. When replacing the belt, reverse the procedure outlined in *d* above, except that, when replacing the belt, it can be started on the lower pulley by hand. Slowly crank the engine, and the belt will move into the correct position. Adjust to proper tension.

f. Water-pump Packing. The water pump may leak after considerable use. When leaking occurs, it is necessary to replace the seal assembly because there is no adjustment that can be made.

24. Carburetor (Zenith Model 62A10)

a. Removal. The carburetor may be removed in the following manner:

(1) Disconnect the air cleaner from the carburetor.

(2) Disconnect the choke wire and remove the lever from the end of the governor-operating cross shaft.

(3) Disconnect the fuel inlet line.

(4) Remove parts of carburetor as far as the manifold cap screws. Then remove the carburetor by pulling away from the engine; be certain not to damage the cross shaft or bushings.

b. Replacement. The carburetor may be replaced in the reverse order of removal. Make certain that the gasket is in good condition and the connections are tight.

c. Disassembly. To properly repair the carburetor, use the following routine (fig. 11):

(1) Loosen the clamp screw and remove the throttle lever.

(2) Remove the idling adjusting screw (7) and the spring.

(3) Remove the assembly screws, using a screw driver, or a 5/16-inch wrench.

(4) Raise the throttle body slightly and loosen the gasket from the bowl assembly.

(5) Lift the throttle body and gasket clear of the bowl without damaging the float.

(6) Turn the throttle body upside down on the bench.

(7) Remove the body as far as the bowl gasket.

(8) Remove the float axle, using a small screw driver to push the axle from the slotted end of the float-hinge bracket; use the fingers to remove it the rest of the way.

(9) Remove the float and the fuel-valve needle.

(10) Remove the fuel-valve seat and gasket, using the C161–85 service tool.

(11) Remove the secondary venturi(3) and main venturi (1) as a unit.

(12) Remove the idling jet(6), using a small screw driver with 3/16-inch blade.

(13) Remove the economizer jet and gasket, using a screw driver. (This jet is located in the lower face of the throttle body, directly under one of the throttle-shaft bearings.)

(14) Before removing the throttle plate, read note 3 which follows below. Then proceed as directed and remove the throttle-plate screws, plate, and shaft.

(15) Remove the throttle stop-lever taper pin, using a small punch and a light hammer.

(16) Drive the throttle shaft out of the stop-lever hub, using a small drift and a light hammer.

(17) Remove the throttle shaft packing retainers

and packings, using a screw driver to pry out the retainers. (See NOTE 6.)

(18) Remove the well vent(5), using a small screw driver.

(19) Remove the main discharge jet(4) and gasket, using the C161-9 service tool.

(20) Remove the lower plug (or main jet adjustment (8)), using a 1/2-inch open-end wrench.

(21) Remove the main jet (2) and gasket, using C161-1 service tool (or suitable screw driver).

(22) Remove the air-shutter lever-retainer nut, using a 5/16-inch wrench.

(23) Remove the air-shutter lever.

(24) Remove the air-shutter bracket-retainer screw and bracket, using a 1/2-inch wrench.

(25) Remove the air-shutter screws and lock washers.

(26) Remove the air-shutter and shaft.

(27) Remove the air-shutter shaft-hole plug, using a 1/2-inch wrench.

(28) Remove the air-shutter shaft-packing retainers and packings.

(29) Clean the bowl and throttle body castings in oil, fuel, Diesel or solvent, dry cleaning, and run compressed air through each channel.

d. REASSEMBLY OF CARBURETOR. The carburetor may be reassembled in the following manner:

(1) Install air-shutter shaft packings and packing retainers.

(2) Install the air-shutter shaft and the air shutter. (See NOTE 5.) Be sure the air-shutter valve is correctly located and that the air shutter is properly centered before tightening the screws and lock washers securely.

(3) Install the air-shutter shaft-hole plug and gasket, using a 1/2-inch wrench.

(4) Hold the air-shutter bracket in position and install the retainer screw, using a 1/2-inch wrench.

(5) Install the air-shutter lever with the retainer nut and lock washer, using a 5/16-inch wrench.

(6) Check for complete closing and full opening of the air shutter and change the position of the lever on the shaft, if necessary, to obtain correct operation.

(7) Replace the main jet (2) and a new gasket, using the C161-1 service tool.

(8) Install the lower plug (or main jet adjustment) and a new gasket, using a 1/2-inch open-end wrench for 9 and 10 size carburetors, and a 5/8-inch wrench for the 12 size.

(9) Replace the main discharge jet (4) and a new gasket, using the C161-9 service tool.

(10) Replace the well vent (5), using a small screw driver (no gasket required).

(11) Place new throttle-shaft packings in the retainers.

(12) Install the throttle-shaft packing retainers (with packings), using a light hammer.

(13) Install a new throttle shaft and throttle plate as described in NOTE 3. Be sure the shaft is installed so that the economizer valve milling on the shaft coincides with the economizer channels in the casting. Use new throttle-plate screws.

(14) Adjust the throttle stop-screw to hold the throttle just slightly open as a preliminary adjustment.

(15) Install the stop-lever assembly on the shaft so that the stop lever is resting against the stop pin when the throttle plate is wide open (straight up and down in the barrel).

(16) Drill and pin the stop-lever hub to the shaft, using a No. 45 drill and a CT63-2 taper pin.

(17) Replace economizer jet and new gasket, using a small screw driver (1/4-inch blade).

(18) Replace the idling jet (6), using a small screw driver (3/16-inch blade). No gasket is required.

(19) Place the main venturi (1) in position with the locating groove on the locating pin.

(20) Place secondary venturi (3) in slots provided in main venturi.

NOTE 1. Do not remove the identification disk (riveted to the bowl cover), the throttle stop, the venturi-locating pin, the priming plug, the float-hinge bracket, or the channel plugs.

NOTE 2. Do not remove the air-shutter stop-pin, bowl-vent channel-plug, or drip plug.

NOTE 3. The location of the priming-hole plug in relation to the throttle plate is extremely important for uniform idling and part throttle operation. To maintain a uniform relation between the priming-hole plug and the throttle plate, the manufacturer assembles the throttle shaft and plate in the throttle body before drilling the body for the priming-hole plug. The hole is located in a definite relation to the throttle plate in each case. It is readily apparent from the above that throttle plates and throttle bodies cannot be interchanged indiscriminately. When it becomes necessary to replace the throttle shaft or throttle plate, use the following routine.

a. Unscrew the throttle-stop screw to permit closing of the throttle plate.

b. Hold the throttle in a tightly closed position and mark the inside of the throttle body, close to the throttle plate, with a steel scriber.

c. Using this scribed line as a guide, replace the throttle shaft or plate. If the new plate used shows a noticeable variation from the old one, select another new plate until one is obtained that fits very close to the scribed line.

d. If the throttle body has to be replaced, obtain a complete throttle-body assembly, including shaft, plate, priming-hole plug, etc., built to the outline number which appears on the identification tag on the bowl cover.

NOTE 4. A round identification tag riveted to the carburetor-bowl cover specifies the assembly outline number to which the carburetor was originally built. When ordering special parts, such as throttle bodies, throttle lever, and stop-lever assemblies, throttle plates, or throttle shafts, be sure to specify the outline number of the carburetor to prevent errors in selecting parts required.

NOTE 5. The air-shutter bracket and lever assemblies can be installed on either side of the air inlet. Be sure to assemble on the same side and in the same position as when received for overhaul.

NOTE 6. Rebushing the throttle-shaft bearings is an operation that should not be attempted unless the shop is properly equipped for such work. Bushings must be line-reamed after installation. If facilities for this are not available, replace the entire throttle-body assembly.

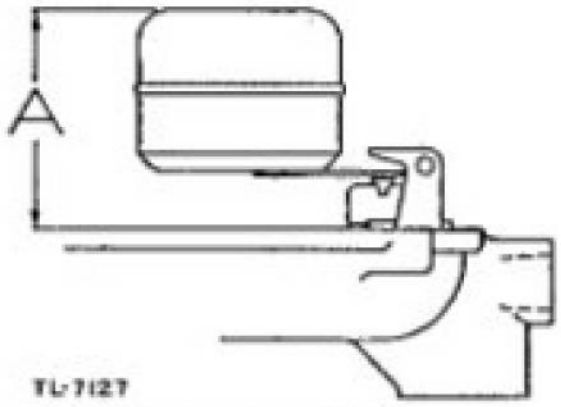


Figure 26. Carburetor float adjustment.

(21) Replace the fuel-valve seat and a new gasket, using the C161-85 service tool.

(22) Replace the fuel-valve needle.

(23) Replace the float assembly and float axle, using the handle end of a screw driver to drive the float axle into the slotted end of the float-hinge bracket.

(24) Check the position of the float assembly for correct fuel level. The "A" dimension shown in figure 26 should be 1 39/64 inches plus or minus 3/64 inch. Float should move freely on its axle.

(25) Place a new bowl to the body gasket in position on the throttle body. Be sure that the economizer channel in the throttle body coincides with the hole in the gasket.

(26) Place the bowl assembly in position on the throttle body; be careful not to damage the float.

(27) Install the assembly screws and lock washers. Be sure to tighten the screws evenly and securely, using a screw driver, or a 5/16-inch wrench.

(28) Install the idling adjusting screw (7) and spring. Adjust it to one full turn open as a preliminary adjustment.

(29) Install the throttle lever and tighten the clamp screw.

25. Fuel Pump

a. Repairs made without Disturbing Pump Installation. If there is evidence of a lack of fuel in the carburetor, or if the carburetor is flooding, check the float and needle valve for proper functioning. Examine the gas line for leaks, split seams, kinks, or obstructions. Check the following sources of trouble:

(1) *Lack of fuel at carburetor.*

Cause	*Remedy*
Gasoline tank empty.	Refill.
Leaky tubing or connections.	Replace the tubing and tighten all pipe connections at the fuel pump and gasoline tank.
Loose valve plug.	Tighten the valve plug securely, replacing valve-plug gasket if necessary.
Bent or kinked tubing.	Replace tubing.
Dirty screen.	Clean the screen. Make certain that cork gasket is properly seated when reassembling.
Dirty or warped valves.	Remove valve plugs and valves. If valves are damaged or warped, replace them. Examine valve seats to make certain there are no irregularities which prevent proper seating of valves. Place valves in valve chambers. Reassemble valve plugs and springs, making certain that springs are around the lower stems of the valve plugs properly. Use new gaskets under valve plugs if necessary.

(2) *Fuel leakage at edge of diaphragm.*

Cause	*Remedy*
Loose cover screws.	Tighten cover screws alternately and securely. Also check the inlet and outlet pipe connections.

Note. Check if a leak occurs at pipe fittings, thus allowing fuel to run down the pump to the flange and appear to originate there. Do not use shellac or any other adhesive on the diaphragm.

b. Repairs Requiring Removal and Disassembly of the Pump (*fig.* 26.) *Fuel pump trouble chart follows.*

Trouble	*Evidence*	*Remedy*
Broken rocker arm.	Visible.	Replace rocker arm.
Broken rocker-arm spring.	Visible.	Replace rocker-arm spring.
Defective or worn links.	Pump does not supply sufficient fuel.	Replace links. Also check for air leaks.
Broken diaphragm return spring.	Does not supply fuel to carburetor.	Replace spring.
Punctured or worn-out fuel pump diaphragm.	Fuel leaking through vent hole in body.	Replace complete diaphragm. Do not attempt to replace just one or two layers.
Leakage around pull rod.	Fuel leaking through vent hole in body.	Replace pull-rod gasket, tightening pull-rod nut securely.

Note. Mark the top cover and the body before disassembling so that they can be placed back in the same position when being reassembled.

c. Assembling Procedure. (1) *Body, rocker arm, and link assembly.* The links used with the rocker arm are assembled together by a link pin. (They are assembled in the hole nearest the larger rocker-arm pin hole.) The movement of the linkage and pull rod is procured by the rocker arm striking this link pin.

(*a*) Assemble the two side pieces making up the linkage by using the link pin and clips.

(*b*) Attach the linkage to the pull rod using the link pin and clips. Make certain that the sheared corners of the two side pieces are assembled upward.

(*c*) Insert the rocker-arm pin through the holes of the pump body, linkage, and rocker arm. Place the washer over the counterbored end of the pin and then swedge the pin over against the washer.

(*d*) Check the assembly to see that the rocker arm and linkage move freely on the rocker-arm pin.

(2) *Diaphragm assembly.* (*a*) With the fuel pump body held in a bench vise, place the pull-rod gasket over the threaded end of the pull rod, seating the gasket against the shoulder of the pull rod.

(*b*) Place the lower diaphragm washer over the threaded end of the pull rod; keep the cup side down.

(*c*) Place the diaphragm over the threaded end of the pull rod.

(*d*) Line up the holes in the diaphragm with the screw holes in the body of the diaphragm flange.

(*e*) Place the upper diaphragm protector washer over the threaded end of the pull rod; keep the cup side up.

(*f*) Place the hexagon-shaped diaphragm alignment washer over the end of the pull rod. Assemble the lock washer and pull-rod nut, using a special wrench to hold the diaphragm alignment washer stationary and to prevent the diaphragm from twisting or turning. Tighten the pull-rod nut securely.

Note. It is extremely important that the diaphragm be held exactly in alignment while the pull-rod nut is being tightened. If it is allowed to twist or become distorted, unsatisfactory operation of the pump will result.

(3) *Valve assembly.* (*a*) Blow out each valve chamber and make certain that no foreign particles are present which might prevent the valves from seating properly. Also observe that no burs or irregularities exist in the valve seats and that the valve seats are securely held in place in the upper cover.

(*b*) Place the valves in proper position in the valve chambers. Make certain that the valves lie flat against the valve seats and are not standing on edge or tipped.

(*c*) Insert the valve springs on top of the valves.

(*d*) Place the fiber gaskets on the valve plugs, and then place the stems of the valve plugs into the valve plugs into the valve springs and tighten the plugs securely. Be certain that the stems of the valve plugs do not distort the valve spring but fit properly inside of them.

(4) *Cover assembly.* The position of the diaphragm when the fuel pump cover is assembled is the most important single item to be observed in repairing and assembling fuel pumps. If the diaphragm is not in the proper position when the top cover screws are

tightened, the pump will not function correctly when replaced on the engine. Observe the following instructions:

(*a*) Lay the cover on the pump in the proper position, determined by marks made before the pump was disassembled.

(*b*) Insert screws from the top through lock washers, upper cover, and diaphragm.

(*c*) Tighten the screws until they barely engage the lock washers.

(*d*) Pull the priming lever up as far as possible. This forces the diaphragm to its highest position; while it is held in this position, the cover screws should be tightned alternately and securely.

(5) *Bottom cover assembly.* (*a*) Hold the pump bottom-side up; then place the rocker-arm spring cap and diaphragm spring cap in their proper positions, over the end of the pull rod and the projection on the rocker arm.

(*b*) Place the gasket between the pump body and lower cover.

(*c*) Locate the springs for the diaphragm and rocker arm in their proper position on bosses in the lower cover; then carefully assemble the lower cover to the pump body, making certain that the spring caps and spring remain in their proper positions.

(*d*) Tighten the screws securely.

(6) *Final assembly.* (*a*) Assemble the screen in the pump cover. Make certain that it fits snugly around the gasoline inlet and edges of the casting.

(*b*) Place the bowl gasket next to the screen; then complete the assembly of the bowl, bail, and screw.

(7) *Service hints.* Never stretch or change the tension of the valve springs, as this will change the pressure of this spring against the valve and reduce the capacity of the pump, particularly under extreme conditions. Always use new valve springs if the old springs are at all questionable.

(8) *Valves.* Do not replace the fiber valves with make shift valves, such as steel balls, metal disks, etc. The fiber valve has proven superior to all other types of valves under every condition.

(9) *Gum in gasoline and sticking valves.* There have been some reports in the field that fuel pump operation is often impaired because of a gumlike substance forming on the valves and making it impossible to operate the pump properly. When this happens, it is necessary to thoroughly clean and polish the pump valves, valve seats, and gas-strainer parts.

26. Air Cleaner

a. Proper functioning of the air cleaner is important in obtaining the maximum power from the engine. A restricted air cleaner will cause a loss of power. Keep connections tight at all times. The entire filter unit should be dismantled and cleaned periodically, depending on operating conditions.

b. The oil bowl should be removed daily (every 24 hours service) and checked for dirt accumulation. To clean, remove the oil bowl and dump out dirty oil; rinse the bowl in oil, fuel, Diesel; dry thoroughly; refill the bowl with clean oil to level of the bead; reassemble. Maintain correct oil level at all times.

27. Timing Gears

a. With the engine front cover removed, the timing-gear train is accessible. The camshaft gear operates directly off the crankshaft gear and drives the accessory shaft drivegear. These three gears must be in their proper places to have the engine timed properly. When installing the camshaft gear, make certain the timing marks are aligned as illustrated in figure 27.

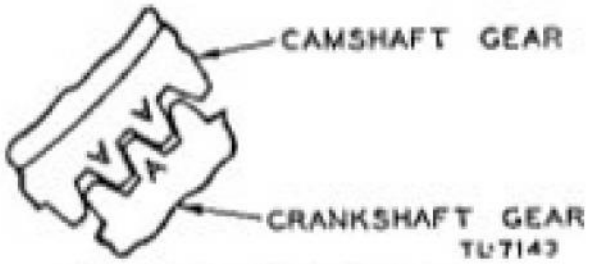


Figure 27. Correct position of timing gears.

b. Before meshing the accessory shaft drivegear, it is necessary to turn the crankshaft until the impulse mark on the flywheel is aligned with the dead center mark on the bell housing, when the No. 1 cylinder is in firing position. (See fig. 28.) To get the No. 1

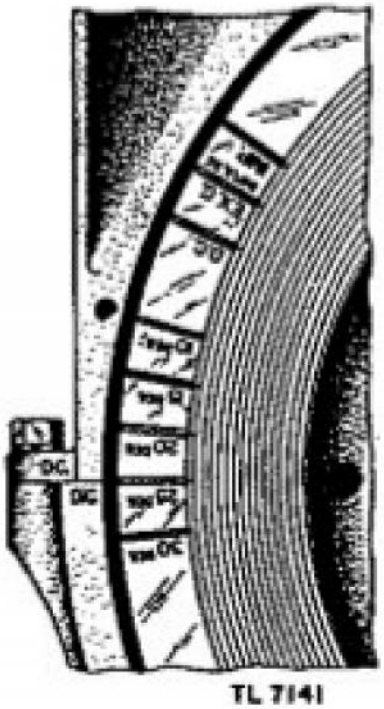


Figure 28. Flywheel timing marks.

cylinder into firing position, turn the engine over until the No. 4 exhaust valve just closes. This will bring the flywheel markings into position. After the crankshaft is in the position described, move the accessory shaft drivegear until the No. 1 impulse fires, then move back approximately one-fourth turn and mesh the gears without further movement. After installation is made, it is best to check the position by removing the No. 1 spark plug and reconnect the wire. Ground the plug, but do not install it in the cylinder head. Rotate the flywheel towards the impulse position. As the impulse mark is reached, the spark plug should fire as the flywheel is moved in the direction of rotation. If it does not fire in this position, the magneto will have to be rotated on its flange mountings. Make certain the magneto flange capscrews are tightened securely after the proper setting is reached. If the proper setting can not be obtained by flange adjustment, the accessory shaft gear position will have to be reset.

c. The front gear cover can be removed after taking off the cranking jaw and fan drive pulley. Care should be taken so as not to damage the oil seal when the cover is removed. In replacing the engine front cover, make certain the oil seal and gaskets are in good condition; if they are damaged in any way, replace them.

28. Cylinder Sleeves

a. General. The engine is designed with removable cylinder sleeves, making reboring unnecessary. Each sleeve is sealed with rubber rings at the bottom end, to prevent leakage of water at that point. New rings should always be used when new sleeves are installed, or when, for any reason, the original sleeves are removed. The danger of a water leak into the crankcase is too great to risk the use of the rings a second time.

b. INSTALLATION. (1) Remove the cylinder head, oil pan, and the piston and connecting rod assemblies. If no puller is available, the cylinder sleeves can be driven out by using a piece of hard wood and a hammer. The lower ends of the sleeves carry rubber sealing rings, and the cylinder block should be cleaned thoroughly at both this and the upper contact point before the sleeves are inserted.

(2) Clean the sleeves thoroughly at the contact points and place the rubber rings in position on the sleeves; then cover them with a thin coat of soft soap. Set the sleeve in the bore of the block with the sealing ring end down, and press the sleeve into place. Be sure the sleeve is pressed down straight into the block to avoid damaging the rubber sealing rings and cause a water leak into the crankcase.

(3) When the cylinder sleeve is in place, the top end will project a few thousandths of an inch above the top surface of the cylinder block. This permits the cylinder head to clamp the cylinder-head gasket tightly against the top of the sleeve, holding it in place, and sealing it at the upper end.

(4) On account of the removable sleeve construction in the cylinder block, oversize pistons and rings are not necessary. When appreciable wear occurs, new standard size parts should be installed.

29. Cylinder Head

a. REMOVAL. Remove water connections and manifold, cylinder-head cover, oil lines, and rocker-arm mechanism. Disconnect the spark plug wires, carburetor, and accessories. Withdraw the push rods and remove the cylinder-head stud nuts; then lift off the cylinder head. The valve seat inserts, which are standard for the exhaust-valve ports, minimize valve regrinding.

b. REPLACEMENT. Before replacing the cylinder head, make certain that the surfaces of the cylinder block and head, where the gasket rests, are absolutely clean. It is important to securely tighten the cylinder head whenever it is replaced. This must be carefully done to prevent damage to the copper-asbestos gasket between the cylinder head and the cylinder block. When installing the cylinder-head gasket, place it on the cylinder block with the beaded side up. In tightening the cylinder-head stud nuts, start with the two center studs and work outward, alternately tightening the nuts toward each end. Cylinder-head stud nuts, tightened when the engine is cold, must be retightened when the engine is hot.

30. Piston Assemblies

The pistons are of cast iron and have a clearance of from 0.005 to 0.007 inch. Miscellaneous information about parts of the piston assembly is listed below:

a. PISTON RINGS.

Total required	4
For compression	3
For oil control	1
Width, compression	1/8 in.
Width, oil control	3/16 in.
Gap	0.015 to 0.025 in.

b. PISTON PIN.

Type	Clamped in rod
Length	3 15/16 in.
Diameter	1.500 in.
Clearance in bushing	0.0015 to 0.002 in.

c. Assembly. When assembling the piston to the connecting rod, place the rod in the piston and slide the piston pin through the bushings. Tighten the clamp bolt in the connection rod securely and lock it in place. Fit the piston rings into the bore and assemble them to the piston, making certain that the rings are free in their grooves and that the gaps are staggered. Oil the piston before replacing it in the engine. The pistons are numbered and should be reassembled into the correct cylinders (No. 1 starts at the front of the engine).

crankcase. A torque-tension wrench should be used when pulling down the main bearing nuts. The correct tension for this is 100 foot-pounds.

(2) To remove the crankshaft from the engine, remove the entire crankcase assembly from the base. The shaft then can be easily removed. Remove the bolts from the flywheel and remove the flywheel and bell housing. Remove the engine front gear cover. Then remove the rear oil-retainer assembly, disconnect the connecting rods, and remove the main bearing caps.

31. Connecting Rod

a. Specifications.

Connecting rod, length, (center to center)	12 1/2 in.
Crank, pin, diameter	2.875 in.
Bearing, material	Babbit-steel back
Bearing, length	2.075 in.
Bearing, running clearance	0.0025 to 0.004 in.
Bearing, end clearance	0.012 to 0.020 in.
Bolts	4
Bolts, material	Nickel-steel, heat-treated
Bolts, size (special)	7/16 by 3 1/16 in.
Are removable from top of block	

b. Assembly. The connecting-rod bearing material is of Babbit metal with a steel back. The bearings are not adjustable and when clearance becomes excessive, replacement is necessary. Connecting rods should be free from twist and parallel with the pistons. Connecting rods and caps are numbered with the number of the cylinder bore; make certain that the proper cap is assembled to each rod and also that the numbers correspond (No. 1 starts at the front of the engine). Assemble the numbered side away from the camshaft. When installing the bearings, be sure the bearing backs and rod surfaces are absolutely clean, smooth, and free from oil. Bearings have a nib engaging the milled notch in the rod and cap. Do not scrape shell bearings or file the connecting rod or connecting rod cap-parting faces. Install the cap and turn the nuts down tightly. By turning the engine over by hand, make sure that the cap does not bind on the crank pin. Adjustment is correct when the nuts are tight and the crankshaft may be rotated by hand with the starting crank. (Be certain to replace all cotter pins and locking wires.)

32. Crankshaft

a. Description. (1) The crankshaft is drilled for pressure lubrication of the connecting rod and main bearings. Each bearing cap bears a number which corresponds to a number stamped on the side of the

(3) The crankshaft can now be lifted out of the crankcase. When replacing the crankshaft, be sure the bearing caps, bearings, crankshaft journals, and crankcase are all clean and absolutely dry. Before installing the crankshaft, oil the bearing surfaces.

b. Oil Seals. (1) The front oil seal is made of Neoprene. The seal is located in the engine front gear cover and is assembled with the lip pointing inward toward the engine. Installation should be made with the aid of a thin metal sleeve inserted inside of the seal; slip the seal and the sleeve over the crankshaft and remove the sleeve. Make certain the seal is not scratched or marred. The sleeve can be made of shim stock that can be bent into position. The rear oil seal is a split type, and the rear main bearing cap and the rear oil retainer must be removed to replace it.

(2) If the oil leaks behind the flywheel, check the fit of the welch plug at the rear of the camshaft, replace the felt oil seal and check the rear main bearing for excessive wear.

c. Bearings. (1) The three bearings are not adjustable; when clearance becomes excessive, replace the bearings. The end thrust of the crankshaft is taken up by thrust washers on either side of the rear main bearing. Correct end clearance is 0.002 to 0.012 inch; this clearance should be maintained. Bearings may be replaced without removing the crankshaft. To remove the upper half of the bear-

ing shell, insert a cotter pin or its equivalent, which has had its rounded head flattened to a form of a T in the crankshaft-journal oilhole; then rotate the crankshaft to push out the bearing liner. The cap and bore are milled to receive a projection on back of the bearing liner. The projection end is removed first.

(2) When replacing, rotate the shaft and see that the projection end enters last. Bearing backs, crankcase bore, and cap bore should be absolutely clean and dry when replacing the shells. The bearing-journal diameter is 3 inches.

(2) In order to complete the assembly of the camshaft, put the thrust plate on the shaft, put in the key and press on the gear (72 teeth.) Then put on the lock washer and the nut. The camshaft assembly is attached to the motor block by means of two capscrews 5/16 by 3/4 inch, with lock washers accessible through holes in the flange of the gear. After assembly, the camshaft is put in place in the engine. It is necessary to rotate the gear slightly forward or backward in order to install the capscrews.

(3) The drilled holes in the camshaft center-

33. Camshaft

a. Specifications.

Bearings	3
Bearing, material	Bronze
Bearing, journal diameter (front and center)	2.250 in.
Bearing, journal diameter (rear)	2.250 in.
Bearing, running clearance	0.002 in.
Bearing, length (front and center)	3 in.
Bearing, length (rear)	2 in.
Thrust plate material	Bronze
End clearance	0.005 to 0.009 in.
Service bushings	Reamed to size
Camshaft drive	Helical gear
Number of teeth in gear	72
Lubrication	Pressure

b. Assembly. (1) The camshaft rests in three bearings. For replacement, the bearings are furnished reamed to size; all that is necessary is to press them into place. Make certain, however, that the oil holes are lined up with the holes in the crankcase. For sizes and running clearance, refer to the table above.

bearing journal give a metered oil supply to the valve-rocker mechanism. Valve tappets may be removed and replaced when the camshaft is removed.

(4) When installing the camshaft, make certain that the marked teeth on the gear meshes with the marked teeth on the crankshaft gear, as shown in figure 27.

34. Valves

a. Specifications.

Valve seat, width	3/32 in.
Valve seat, angle	45°
Valve seat, insert	Exhaust only
Valve-stem guides (replaceable) material	Grey iron
Valve stem, diameter	0.434 in.
Vlave stem clearance in guide (intake)	0.0025 to 0.004 in.
Valve stem clearance in guide (exhaust)	0.0045 to 0.006 in.
Valve clearance, hot	0.015 in.
Valve clearance, cold	0.018 in.
Rocker-arm shaft, diameter	0.998 to 0.999 in.
Rocker-arm bushing, diameter	1.001 to 1.0015 in.

b. Intake Valves.

Material	SAE 3140
Head, diameter	1 7/8 in.
Port, diameter	1 11/16 in.
Valve opens	5° after top dead center
Valve closes	40° after bottom dead center

c. Exhaust Valves.

Material	Thompson XCR
Head, diameter	1 3/4 in.
Port, diameter	1 11/16 in.
Valve opens	42.5° before bottom dead center
Valve closes	8.5° after top dead center

d. Assembly. (1) Valve-stem guides are furnished as service parts but are not finished reamed to size. It is necessary to press them into place and ream. After new valve guides are installed, it is necessary to recut the valve seats.

(2) When service inserts are to be installed, it is necessary in most cases, to use oversize inserts and to remachine the insert seat for a true fit. Allow approximately 0.004 to 0.005 inch for a press fit of the insert. Do not drive the insert into place as this will invariably cause trouble. A recommended practice is to pack the inserts in dry ice for approximately 10 minutes, then drop them into position. After the inserts reach atmospheric temperature, make certain that they are seated squarely. If a furling tool is available, it should be used. It is not necessary to pean the head, since peaning does not insure a tight fit. Extreme care should be given in making this replacement. The bushing in the rocker arms can be replaced. Be sure the bushing lines up with the hole in the rocker arm. Rocker arms can be removed as outlined for the cylinder head. Recheck the valve tappet settings after removing the rocker mechanism or head. The push rods are of tubular steel. Tappets are fitted in the crankcase, which can be removed from the bottom after remov-

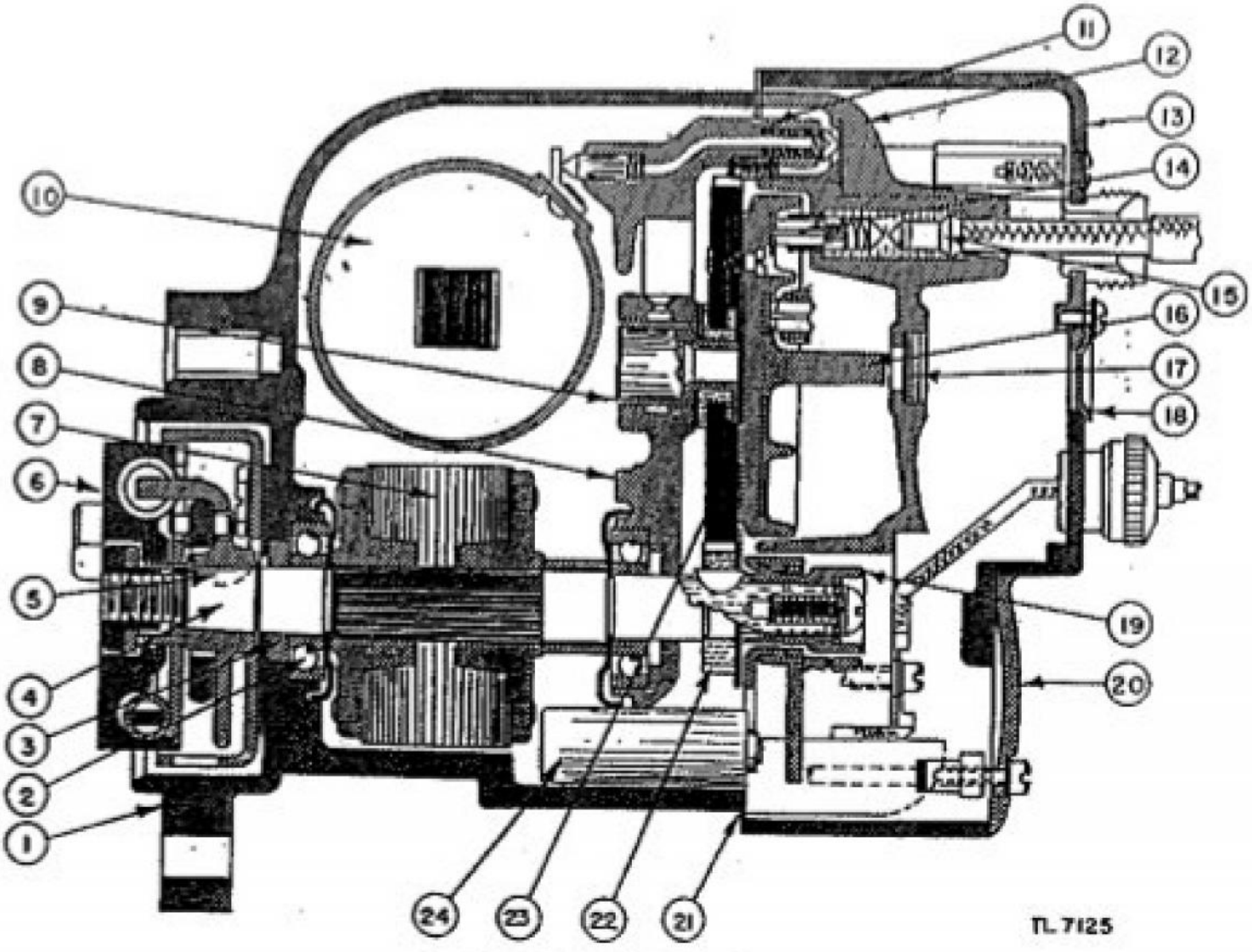


Figure 29. Longitudinal section through magneto.

ing the camshaft. Lubrication to the tappets is by the splash method and by returning oil from the rocker mechanism.

35. Governor

a. Speed variations of the engine can usually be used to detect faults in the operation of the governor. When improper speed variations appear, the following inspection should be carried out:

(1) Check the load to be sure that the speed changes observed are not the result of load fluctuations.

(2) If the load is uniform, carefully check the engine to be sure that all cylinders are firing properly.

(3) See that the governor is properly installed; that no bind exists in any part of the governor control mechanism or the operating linkage between governor and engine; be sure that no bind exists in the fuel mechanism on the engine.

b. If the speed variations are large and erratic, and unaffected (except, perhaps, in magnitude) by change of speed droop adjustment, or if the governor simply fails to control at all, it is probably defective.

c. If the speed variations are erratic but small in magnitude, the fault may lie in the governor drive. Excessive backlash in the coupling or the drive gears, or too tight a meshing of the gears, may cause this trouble. No amount of adjustment or other work on the governor can correct this fault. A new governor must be installed.

d. If it is decided that the governor is defective, it should be removed from the engine and returned to the engine manufacturer.

36. Ignition

a. Magneto (figs. 29 and 30.) (1) *Installation.* The magneto, which produces an ignition spark only at certain definite points in the rotation of the magnet rotor (7), must be connected to the engine in such a manner that the spark is available at the instant it is required in the cylinder (about top dead center of the compression stroke, with the magneto set in the retard position.)

Note. It is unnecessary to remove the distributor plate when timing this magneto to the engine.

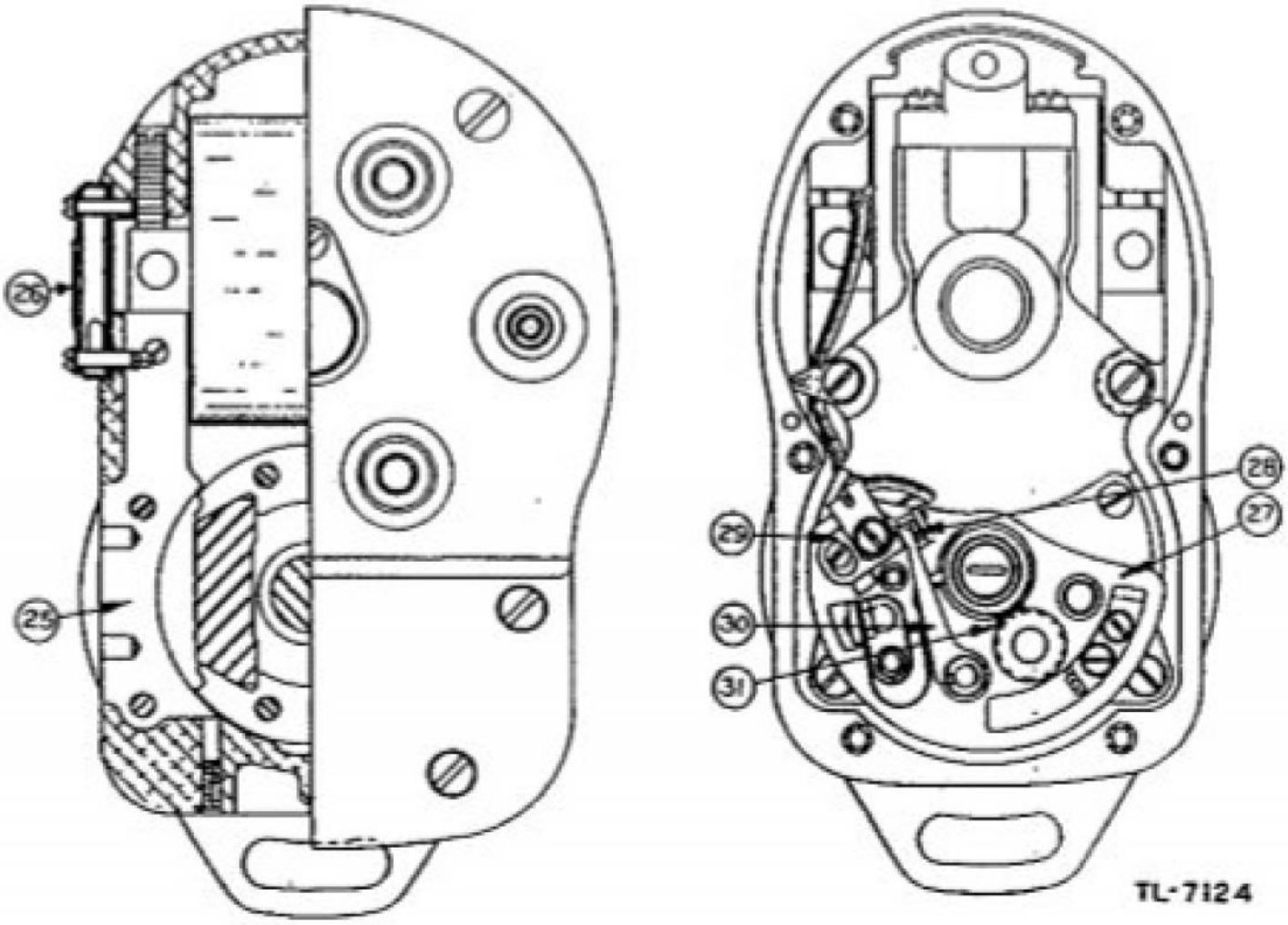


Figure 30. Cross section through magneto.

(2) *Timing the magneto.* Proper operating results are obtained by timing the engine and the magneto as follows:

(*a*) *Positioning the contacts.* Remove the cap (20) from the radio shield cover (13). Rotate the impulse coupling (6) in the opposite direction to that which the magneto is to be driven (this is to prevent the engagement of coupling weights), passing through the contacts-open point to a position slightly beyond the point where the contacts (28) close. Then rotate the coupling (6) in the correct direction of rotation, until the contacts (28) are just separating. With the piston of the No. 1 cylinder in the firing position of the compression stroke, both the engine and magneto are in their correct relation for firing. Connect the magneto drive to the engine.

(*b*) *Connecting the Cables.* The arrow visible through the observation cover (18) of the radio shield (13) and window (17) of the distributor plate (12) points to the cable outlet which is to be connected to the No. 1 cylinder (the cylinder nearest the radiator.) Complete the installation by connecting the remaining cables of the magneto to the spark plugs in the proper firing order (generally marked on the engine block.) The firing sequence on the distributor, or high tension end of the magneto, follows the opposite direction of rotation from that indicated by the arrow on the magneto name plate, and must be taken into consideration when cables are connected to the spark plugs. Replace the cap.

(3) *Trouble shooting.* In case of defective ignition, it must first be determined whether or not the fault is in the magneto. Generally, when only one cylinder misfires, the fault is in the spark plug. The following are the most common plug difficulties:

(*a*) *Plug gap too wide.* The distance between the electrodes of the spark plug varies according to the engine. Normally, the gap should not be less than 0.025 inch. Too wide a gap increases the electrical resistance and interferes with the operation of the engine at low speed; it causes difficulty in starting, and frequent missing at low speed, and has a tendency to burn the electrodes. It is especially important that the plugs be examined occasionally to see that the gap is not too great; any difficulty due to this cause may be readily overcome by readjusting the electrodes.

(*b*) *Plug short-circuited.* This is usually caused by a cracked or porous insulator, or by fouling of the electrodes or insulator. Any of these conditions may cause misfiring by permitting the current to stray from its intended path.

(*c*) *Cables.* Misfiring of one cylinder, either continuous or intermittent, may be due also to a chafed or broken cable, or to a loose cable connection. The metal terminals of the cables must not come into contact with any metal parts of the engine or the magneto, except those designated as being correct according to the instructions.

(*d*) *Irregular firing.* If the cables and plugs are in good condition, and yet the ignition is irregular, the trouble is probably with the magneto. In this case the interrupter assembly (27) should be carefully examined; be sure that the interrupter lever (30) moves freely and the contacts (28) are clean and in correct alignment.

(*e*) *Damaged insulating parts.* It sometimes happens that the distributor plate and control-arm-cap of the magneto are damaged through accident or carelessness. Such parts should also be carefully examined for possible disarrangement or damage which might permit leakage of current.

(4) *Service adjustments.* The interrupter contacts (28) should be adjusted to an opening of 0.014 inch to 0.016 inch when the interrupter-lever (30) fiber bumper rests on the top of the cam (19). This is done by means of the adjustable contact bracket (29) which can be shifted by an eccentric screw until the correct opening has been reached. After adjustment, the bracket (29) must be secured by means of its fastening screws. Contact points (28) must be free from oil or grease and be in proper alignment, so that the full surfaces of both contacts meet squarely. Pitted contacts (28) can be either filed flat or cleaned on a suitable stone. When point renewal becomes necessary, replace both the interrupter lever and the contact bracket at the same time.

b. Spark Plugs. (1) *Adjustment.* Remove the spark plugs every 200 to 300 working hours, or oftener if necessary, for cleaning and checking the gaps between electrodes. A gap of 0.025 to 0.030 inch should be maintained at all times. When making this adjustment, always bend the outer electrode. Never bend the center electrode; bending will damage the insulator. If the gap between electrodes is too great, due to improper setting or burning off the ends, the engine will misfire, be hard to start, and may produce radio interference.

(2) *Cleaning.* The recommended method of cleaning spark plugs is sand-blasting. Never scrape or clean the insulator with anything which will scratch the porcelain, because scratched porcelain allows carbon and dirt to accumulate much faster.

(3) *Marking cables.* If the spark plug cables are removed for any reason, mark or tag the number of each cable with reference to the magneto distributor cap.

37. Cranking Motor

a. Servicing. (1) No lubrication is required since

all three bushings are the oilless type. However, whenever the cranking motor is disassembled for cleaning, put a few drops of light engine oil in each bushing.

(2) Remove the cover band and inspect the commutator and brushes at regular intervals. (Approximately once every 3 months.)

(3) If the commutator is dirty, clean with No. 00 sandpaper. *Never use emery cloth.*

(4) If the commutator is rough, out of round, or has high mica, turn down in a lathe.

(5) Replace the worn brushes. Check for high brush spring tension, rough commutator, or high mica, if rapid brush wear is experienced.

(6) Burned commutator bars indicate open-circuited armature coils. Inspect soldered connections at the riser bars, resolder if necessary, then turn down the commutator.

(7) The magnetic switch will require no servicing except tightening the connections and checking the cover plug to keep it securely in place.

b. Faulty Motor Operation. (1) Check battery, battery cables, and connections.

(2) Remove the cover plug from the magnetic switch to make sure the plunger is pulling in to close the cranking motor to the battery circuit when the control switch is operated.

(3) Check the commutator and brushes as above.

(4) Check for tight or dirty bushings, bent shaft, or worn bushings which would allow the armature to drag on the pole shoes.

(5) If the above inspections have not disclosed the trouble, remove the cranking motor, inspect the drive, and check the cranking motor specifications; these specifications should be as follows:

(*a*) Clockwise rotation viewing drive end.

(*b*) Brush spring tension 36 to 40 ounces.

(*c*) No load test, 80 amperes at 11.2 volts at 4,500 rpm.

(*d*) Stall torque test, 670 amperes at 5.35 volts give 32 pounds feet torque.

38. Charging Generator

a. Servicing. (1) Add 8 to 10 drops of light engine oil to each hinge-cap oiler every 100 hours of operation.

(2) Remove the cover band and inspect the commutator and brushes at regular intervals. (Approximately once every 3 months.)

(3) If the commutator is dirty, clean it with No. 00 sandpaper. *Never use emery cloth.*

(4) If the commutator is rough, out of round, or has high mica, turn down in a lathe and undercut the mica.

(5) Replace worn brushes, check for high brush spring tension, rough commutator, or high mica if the brush wears rapidly.

(6) Burned commutator bars indicate open-circuited armature coils. Inspect soldered connections at the riser bars, resolder if necessary, then turn down the commutator and undercut the mica.

(7) Be sure all leads are in good condition and all connections are tight.

(8) Generator specifications are as follows:

(*a*) Clockwise rotation viewing drive end.

(*b*) Brush spring tension, 16 ounces.

(*c*) Output at operating temperature, 6 to 8 amperes at 14.1 to 14.5 volts at 2,400 rpm.

(9) Voltage control specifications are as follows:

(*a*) Cut-out relay closes, 12.9 to 13.9 volts.

(*b*) Voltage control points open (to cut down generator output), 14.1 to 14.7 volts.

(*c*) Voltage control points close (to permit output to increase), 12.0 volts maximum.

Note. No attempt should be made to test or adjust any part of the generator circuit without the proper testing equipment. Never operate the generator on open circuit (circuit between the generator and battery disconnected). To do so will cause damage to the generator. It is possible to operate with the circuit open between the generator and battery if the lead is disconnected from the F terminal of the generator.

b. Removing Generator Belt. To remove the generator belt, loosen the bracket and move the generator inwards toward the engine until the belt can be slipped off the pulley. The fan belt must be removed before the generator belt can be removed.

39. Storage Battery (Exide Model 133)

a. Care of Battery. (1) Keep the electrolyte at the proper level at all times.

(2) Keep the vent hole in the battery filler caps open.

(3) Inspect the battery once a week, or oftener, to keep the water at the correct level and to maintain the correct specific gravity. A specific gravity reading of about 1.250, corrected to 80° F, should be maintained. (See battery testing chart.)

Note. If water is added to the battery when the temperature is near the freezing point (32° F.), always run the engine long enough to mix the water and the electrolyte so that the water in the battery does not freeze.

(4) Acid or electrolyte should never be added except by a skilled battery man. Under no circumstances should any special "dopes," solutions, or powders be added.

(5) The electrolyte in each cell should be approximately 1/2 inch above the plates. When the electrolyte is below this level, distilled water should be added. Never use hydrant water, or any water

which has been in a metal receptacle. Keep a glass jar of distilled water for battery use only. Use a clean syringe to put water in a cell.

(6) The battery cable terminals must be clean and tight. Use hot water to remove any terminal corrosion, and for cleaning the top of the battery. Brighten the terminal contact surfaces with wire wool, apply a light coat of vaseline and reassemble. Be sure the terminals are clamped tightly and the battery is clamped securely in place.

5. Battery Testing Chart.

Condition	Cause	Procedure	Remedy
Hydrometer test shows all cells over 1.250 specific gravity and readings practically equal (within 10 or 15 points.	Battery is probably in good condition.	Battery does not require a recharge in summer months, but may require a boosting charge in cold weather.	Examine battery terminals to see that they are tight and clean; ascertain charging rate of generator.
Hydrometer test shows all cells reading 1.250 or less, and readings practically equal (within 10 or 15 points).	Demand from battery greater than input from generator.	Recharge battery.	Make a thorough check on electrical system for short circuits, loose connections, and charging rate of generator. Recommend an increase in charging rate to suit conditions.
Cells unequal (20 or more points variation) and highest reading over 1.225 specific gravity.	Short circuit in low cell or cells. Evaporation caused by overcharging. Unnecessary addition of acid. Loss of electrolyte by leakage.	Make momentary high rate test on each cell.	If high rate test shows all cells are within 1 to 10 volts of each other, recharge battery until gravity of electrolyte remains constant for 4 hours. Adjust gravity of all cells by adding water or small amount of acid (1.400 specific gravity or less).
Cells unequal (20 or more points variation) and highest cell reading 1.225 or less.	Short circuit in low cell or cells. Evaporation caused by overcharging. Unnecessary addition of acid. Loss of electrolyte by leakage.	Recharge battery, if possible, and then make momentary high rate discharge test on each cell.	If battery takes a recharge and high rate test shows all cells within 1 to 10 volts adjust gravity of all cells by adding water or small amount of acid (1.400 specific gravity or less).

Condition	Cause	Procedure	Remedy
Hydrometer tests show cells with gravity readings over 1.300 at 80° F.	Unnecessary addition of acid to cells.	If battery has not been operated for a long period or at an excessively high gravity, this condition may be remedied by careful treatment.	Drain out all solution from cells. Refill with dilute (1.100 specific gravity) electrolyte and charge at a low rate of current until gravity of electrolyte remains constant for 4 hours. Then drain cells again and refill with 1.285 specific gravity electrolyte and after 3 hours charging adjust gravity to 1.285. Continue charge until the gravity of all cells is constant for a period of 2 hours.
	Addition of battery compounds commonly known as battery *dope* solutions.	No positive assurance can be given that conditions arising from the use of battery compounds can be remedied. A number of battery manufacturers construe the use of battery *dope* solutions as grounds for canceling their warranty.	Treat as described above. *Under no circumstances should battery compound be introduced into a battery.*
Battery is fully charged but hydrometer tests show gravity to be 1.265 or less at 80° F.	Excessive evaporation, usually caused by overcharging.	Adjust gravity of electrolyte to proper limits by adding small amount of acid (1.400 specific gravity or less).	Ascertain charging rate of generator and reduce the rate if necessary.
Frequent additions of water to all cells of battery.	Excessive overcharging.	.....	Reduce charging rate of generator.
Container cracked, causing frequent additions of water to one cell of battery.	Loose installation. Stone bruise. Frozen battery.	.....	Replace with new container.
Bulge in battery container.	Excessive temperature, probably caused by overcharging.	Same as for condition No. 3 or No. 4.	If high rate test indicates any weak cells, the battery probably is beyond repair. In all cases, ascertain charging rate and reduce the rate if necessary.
Corrosion on battery terminals.	Excessive charging rate, causing spray of acid on terminals. Lead coating destroyed on terminals.	Remove terminals from posts. Clean posts on terminals thoroughly. Replace terminal cable if corroded excessively.	Grease terminals and posts thoroughly to prevent access of acid to terminals, bolts, and nuts. Ascertain charging rate and reduce rate if necessary.

Condition	Cause	Procedure	Remedy
Broken terminal posts.	Loose battery installation. Terminal cable too short.	Remove battery and build up new terminal post.	Replace terminal cable with one of proper length; tighten battery in carrier and also battery terminals on posts.

c. Testing Equipment. To diagnose the conditions stated in the foregoing chart, the battery station must have the following tools:

(1) An accurate hydrometer, graduated to read from 1.100 to 1.325, with divisions to indicate differences in gravities within 10 points.

(2) An accurate thermometer, graduated to read as high as 115° F. (Many batteries are damaged because of high temperatures; this condition can only be determined by means of a thermometer.)

(3) A single-cell type voltmeter, having a 3-volt scale, with divisions showing 1/10 volt (possibly an additional scale reading 15 volts in order to be able to read total battery voltage).

(4) A high-rate discharge tester; this instrument may be either a single-cell tester or a more elaborate type adapted to test the complete battery.

d. Charging Instructions. Regular starting and lighting batteries should be charged at a current rate not exceeding 1 ampere per positive plate. A rate of 4 or 5 amperes is usually suitable for the majority of batteries. During the charge, a thermometer should be used to check the temperature of the electrolyte in the cells. If the temperature exceeds 110° F., reduce the charging rate immediately, or else discontinue the charge until the battery temperature is less than 90° F. Charge the battery until all cells gas freely and the specific gravity of the electrolyte remains constant for 4 hours. Adjust the gravity of the cells to the proper limits at the end of the charge. The specific gravity of a fully charged battery should be between 1.275 and 1.295 at a temperature of 80° F.

e. Conditions within Battery. No battery should be returned to the manufacturer nor be opened for inspection before its condition is diagnosed in accordance with the procedure given in this chart. When readings differ considerably more than 1/10 volt, when taken with the high-rate tester, it is proper to open the battery. The separators may be found to be worn thin, or broken, or split. If the plates in such a battery are in good condition, the separators may be replaced with new separators and the battery recharged. If the positive plates are badly buckled or the positive grids are broken, the battery is not in condition for further service. Such a battery either was badly overcharged or else may have been in service for a long period of time.

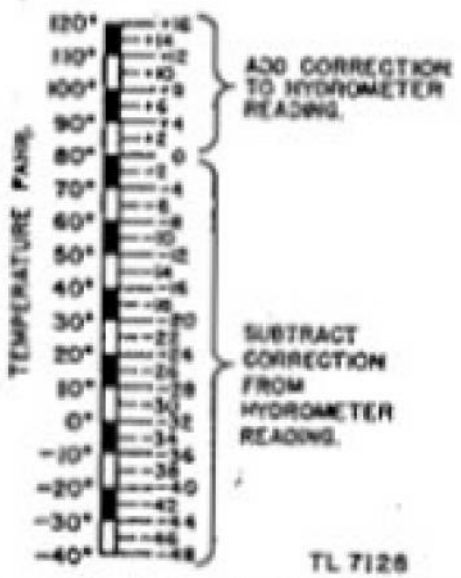


Figure 31. Corrections for hydrometer readings when the battery temperature is above or below 80° F.

Example: A battery cell has a hydrometer reading of 1.245 at 10° F. What is the specific gravity at 80° F.? From the correction scale, illustrated in figure 31, it can be seen that the correction is minus 28 points in gravity. Subtracting 28 points from the hydrometer reading gives the correct specific gravity of the battery, in this case 1.217 at 80° F.

40. Power Take-off

a. Coupling. The engine and alternator are connected by means of a Thomas No. 312 type DF full metallic coupling. The only field service required on the coupling is the occasional replacement of the disks. If the alignment is maintained and the nuts on the coupling bolts kept tight, there will be practically no service replacements of these items. The method of removal of disks for service is obvious upon examination of the coupling.

b. Alignment. (1) The alternator shaft is brought within 0.003 inch of concentricity with the inner bore of the engine flywheel, with the subbase level and is kept free of strains. Shims are placed under the

alternator feet. Mark the alternator feet when removing so that they can be replaced in the exact manner as in the original assembly.

(2) Alignment is maintained by dowels in the engine base and the generator feet. Remove the dowels before attempting to remove the engine or the generator; replace the dowels before reassembly. When installing the completely assembled unit in a truck or on a floor, shims must be placed around each foundation bolt so that when the foundation bolts are tightened, the subbase will not be distorted.

41. Service Chart

Troubles and possible causes are as follows:

a. Engine Hard to Start. (1) *Battery.* (*a*) Battery not fully charged.
(*b*) Loose battery terminals.
(*c*) Solution low.
(2) *Magneto.* (*a*) Worn brushes.
(*b*) Oil or water soaked.
(*c*) Coil damaged.
(*d*) Brushes sticking.
(*e*) Magnets weak.
(*f*) Capacitor faulty.
(*g*) Points worn or pitted. (See instructions herein.)
(*h*) Points sticking.
(3) *Fuel systems.* (*a*) No fuel in tank.
(*b*) Fuel flow obstructed.
(*c*) Air vent in fuel tank filler-cap clogged.
(*d*) Fuel-pump filter clogged.
(*e*) Too much fuel. Carburetor flooded.
(*f*) Water in fuel supply.
(*g*) Improper fuel mixture.
(*h*) Valves and jets clogged with gum from fuel.
(4) *Miscellaneous.* (*a*) Loose or defective wiring.
(*b*) Spark plugs cracked or shorted by external dirt.
(*c*) Spark plugs fouled.
(*d*) Cables connected to wrong plugs or coated with paint.
(*e*) Throttle or governor valves loose on shafts.
(*f*) Intake manifolds or gaskets leaking.
(*g*) Valves not seating.
(*h*) Improper timing of ignition or valves.
(*i*) Improper tappet clearance.
(*j*) Muffler clogged.

b. Faulty Carburetion. See carburetor instructions herein.

c. Excessive Smoke from Exhaust. (1) Too much oil in crankcase.
(2) Carburetor needle valve open too far.
(3) Carburetor float sticking or leaking.
(4) Lubricating oil too thin to seal piston rings.
(5) Worn bearings, rings, cylinders, and valve guides.

d. Explosion in Muffler. (1) Spark retarded.
(2) Weak spark.
(3) Valves not seating or out of time.
(4) Exhaust valves warped.
(5) Missing on one or more cylinders.

e. Engine Overheating. (1) Lack of water.
(2) Fan belt slipping.
(3) Water hose obstructed.
(4) Water hose collapsing.
(5) Carburetor choke control partially pulled out.
(6) Improper fuel mixture.
(7) Radiator clogged.
(8) Cylinders limed.
(9) Improper ignition timing.
(10) Valves leaking.
(11) Oil badly diluted.
(12) Lack of oil.

f. Engine Lacks Power. (1) Valves warped or sticking.
(2) Valve seats worn.
(3) Cylinders or pistons badly worn or scored.
(4) Piston rings weak or worn.
(5) Piston rings sticking.
(6) Improper fuel mixture.
(7) Improper timing of ignition or valves.
(8) Muffler clogged.
(9) Governor or throttle levers loose on shafts.
(10) Oil badly diluted.
(11) Air cleaner requires cleaning.
(12) Fuel not suited to engine.

g. Engine Knocks. (1) Excessive carbon deposits in combustion chambers.
(2) Loose main bearing.
(3) Loose connecting-rod bearing.
(4) Valve tappet clearances too great.
(5) Valves not free in guides.
(6) Worn pistons, piston pins, or cylinders.
(7) Engine overheated.
(8) Tight pistons or pins.
(9) Loose flywheel.
(10) Lack of oil or water.
(11) Worn timing gears.
(12) Spark advanced too much.
(13) Fuel not suited to engine. Octane rating too low.

h. Engine Missing. (1) Spark plugs fouled.
(2) Spark plugs cracked or shorted by external dirt.
(3) Improper spark plug gap.
(4) Defective wiring.
(5) Ignition breaker points sticking.
(6) Improper breaker-point gap.
(7) Faulty capacitor.
(8) Cylinder-head gasket leaking.

(9) Intake manifold or gaskets leaking.
(10) Valves warped or broken.
(11) Valves or tappets sticking.
(12) Valve tappets improperly adjusted.
(13) Valve springs weak or broken.
(14) Dirt or water in fuel system.

i. Explosion in Carburetor or Intake Manifold. (1) Fuel mixture too lean. (See carburetor instructions herein.)
(2) Valves or tappets sticking.
(3) Intake-valve springs weak or broken.
(4) Intake valves warped or broken.
(5) Intake tappets set too close.
(6) Incorrect timing of ignition or valves.
(7) Intake manifold or gaskets leaking.
(8) Cylinder-head gasket leaking.

j. Poor Compression. (1) Valves not seating.
(2) Valves or tappets sticking.
(3) Valve tappets set too close.
(4) Valves incorrectly timed.
(5) Weak valve springs.
(6) Piston rings sticking, weak, or worn.
(7) Loose or cracked spark plugs.
(8) Cylinder-head gasket leaking.
(9) Oil too thin to seal piston rings.
(10) Scored or worn pistons or cylinders.

42. Alternator

a. Insulation Resistance. (1) The insulation resistance of windings is measured, usually, with an instrument called a megger.

(2) No new machine should have an insulation resistance of less than 1 megohm.

(3) Insulation resistance of machines in service should be checked periodically to determine possible deterioration of the windings.

(4) This measurement gives an indication of the condition of the insulation, particularly with regard to moisture and dirt. The actual value of resistance varies greatly in different machines, depending on the size and voltage. The chief value of the measurement, therefore, is in the relative values of resistance of the same machine taken at various times. During a drying-out run, for example, the insulation resistance rises as the winding dries out, although it may fall appreciably at first. When measurements are made at regular intervals, with the machine at the same temperature as part of the maintenance routine, it is possible to detect an abnormal condition of the insulation and take steps to remedy it before a failure occurs.

(5) The insulation resistance of stator windings of machines in good condition is computed as follows:

$$\text{Resistance (ohms)} = \frac{\text{Machine voltage}}{\frac{\text{Rated kva}}{100} + 1{,}000}$$

b. Protection. (1) The machine should be protected carefully against moisture, both before and after erection. Water or steam from leaking pipes, rain, snow, or condensation from the atmosphere should be excluded. It is particularly important to keep the windings dry, since moisture lowers the insulation resistance and increases the likelihood of a breakdown. If a machine is brought from cold surroundings into a warm room, it should be kept covered until its temperature has risen to room temperature, to prevent condensation on the windings and other parts.

(2) Care should be taken in transporting and handling the machine to see that the windings are not damaged. A blow upon any part of the windings is liable to injure the insulation and result in a burnout of a coil.

c. Collector Rings and Brushes. (1) If sparking between the brushes and the collector ring occurs, the following points should be checked:

(*a*) Brush pressure; it may be that the pressure on the brushes is insufficient to make them follow the ring surface.
(*b*) Brush-holder vibration.
(*c*) Brush chatter.
(*d*) Oil vapor.
(*e*) Collector ring rough.
(*f*) Spotted rings; may be cured in certain cases by the use of a more abrasive brush.

(2) Selective action between brushes is generally aggravated by any of the causes of sparking at the brushes, and if the same remedies are applied, it can generally be improved.

d. Slip Rings. (1) Slip rings should be maintained smooth and true. Grind or turn them if necessary to restore a smooth and true surface.

(2) Occasionally ring trouble will arise from a ring not being of uniform hardness, and wearing unevenly. Such a ring should be replaced.

(3) Collector ring trouble is seldom due to high-current density, as the maximum current density, 40 amperes per inch, or less, is well below the maximum density specified for the brushes.

(4) The brushes used should be light in weight, with a fairly high current capacity and should con-

tain a slight amount of abrasive material. A suitable grade is furnished with the machine, and for the best results this grade should always be used.

e. Brushes. (1) Brushes should make good contact with the slip rings along the whole face of the brush. If necessary, grind in the new brushes with fine sandpaper. Maintain a free sliding fit between the brushes and the brush holder by cleaning both thoroughly.

(2) There are two collector rings made of bronze alloy. Brushes supplied on these machines are metal graphite and should have a brush pressure of approximately 3 pounds per square inch. There are two brushes per ring.

f. Operation and Care of Ball Bearings. Quietness and life of ball bearings depend largely on cleanliness and proper lubrication.

g. Inspection. (1) When the generator is installed, make certain that the rotor turns easily, particularly if the generator is not installed until some months after being shipped.

(2) Never open the bearing housing under such conditions in which dirt might enter.

(3) External inspection of the generator at the time of the first greasing, soon after it is put into operation, will determine whether the bearings are operating quietly and without undue heating. Further inspection will not be necessary except at infrequent intervals, probably at greasing periods.

(4) If practicable, it is desirable for the most satisfactory service to open the bearing housings once a year, or after 5,000 hours operation, to check the condition of the bearings and grease. If difficult to inspect the pulley or pinion-end bearing, the condition of the bearing of the opposite end will usually be representative of both.

(5) If grease deterioration has occurred, or if dirt has gained entrance to the housing, the bearing and the housing parts should be thoroughly cleaned out and new grease added.

h. Cleanliness. (1) Because ball bearings are sensitive to small amounts of dirt, they must be protected at all times. If necessary to dis-assemble the bearing housing, first thoroughly remove all dirt from adjacent parts, so no dirt will fall upon the bearing or interior of the housing. Cover the bearing and interior of the housing with clean wrapping material, if they are to be left dismantled and exposed.

(2) If dirt or deteriorated grease is found in the housing or bearing, the parts should be thoroughly cleaned with carbon tetrachloride (avoid allowing this liquid to remain on adjacent generator windings). In some cases, it may be necessary to remove entirely the bearing from the shaft, in order to clean it properly.

i. Mechanical Damage. (1) In mounting or removing bearings, pressure should be applied only against the inner race, always using a sleeve or another intermediate piece, if mounting or removal is accomplished by hammer blows. Cover the bearing carefully during these operations if there is danger of flying particles getting in among the bearings. Never attempt to remove a ball bearing by exerting pressure against the outer race; this can cause serious damage to the bearing.

(2) In mounting or removing pulleys, couplings or pinions, the bearing must not be subjected to axial pressure, especially hammer blows (driving accessories on the shaft with a mallet). Any pressure of this kind should be taken by supporting the opposite end of the shaft against a stop of some kind.

j. Spare Parts. The electrical spare parts on this set consist of exciter and alternator brushes. When the brushes have become so worn that correct spring pressure cannot be obtained, new brushes should be installed. When new brushes are installed, follow instructions as listed under brushes.

k. Flashing Exciter Field. (1) If the exciter field loses its residual magnetism due to vibration or other causes, this may be restored by passing direct current through the field. The 12-volt battery may be used for this purpose. First, raise the brushes in the brush holders and place a piece of heavy, dry paper between each brush and the commutator. The field leads are marked F1 and F2. The positive terminal of the battery should be connected to F1 and the negative to F2.

(2) If either battery terminal is grounded, it is not necessary to remove the ground; however, the corresponding field lead should be grounded. Touch the other field lead to the other battery terminal; hold it there for a few seconds and then release. Repeat this operation about 10 times. Tapping the exciter frame with a hammer during the application will help to restore the residual magnetism.

l. Rewinding-material Classifications. A careful analysis of what constitutes rewinding material has been made, and the following classifications for different types of rewinding material have been prepared. These classifications will meet all conditions.

Class 3	Complete rewinding material plus mechanical details and moulded mica parts		3
		2	
Class 2	Complete rewinding material		
		1	
Class 1	Cut winding insulation		

Subclassifications	Material included[1]	Material included[1]	Material included[1]
A Cut core insulation	All cut insulating material used to prepare the ends of the core for winding, such as treated cloth caps, moulded paper rings, fiber rings, canvas caps, and coil support.		
B Slot and end insulation	All cut insulating material used when winding, such as cells, fillers, wedges, spacing blocks, wood-bracing blocks, micarta tubes, etc.	Cut winding insulation (class 1) plus all bulk materials such as tapes, twines, varnishes, solder, soldering flux, and *banding wire.*	Complete rewinding material (class 2) plus all necessary cleats, bolts, tie rings, formed copper connectors, and brace or support arms.
C Connecting material for a-c stators or rotors	All cut material used when winding, such as cable for leads, and for star or parallel rings and jumpers, or sleeve connectors, wooden wedge blocks for soldering, canvas caps, etc.		All molded mica rings and parts.
or Cross-connecting material for d-c armatures	All cut material used for cross-connections, such as cable, wood-supporting or spacing blocks, micarta tunes, mica washers, etc.		The following parts are supplied, when used: wiring details of temperature—indicating coil, wood-forming blocks for closing the open end of shove-through coils.
D Cut banding material[2]	All cut insulating material necessary to install the bands, and segmental bands with keys and wedges; wood wedge blocks for soldering riser neck commutators, and tin clips. (For banding wire, see class 2).		

Notes 1. Cut insulating material means any item that is cut to a definite size or shape. It does not include bulk material.

[1]Any desired combination may be obtained by combining the class number and subletter. For example, 1–B includes the slot and insulation only, or 2–B includes 1–B plus the bulk material pertaining to 1–B. Similarly, 3–A includes the cut core insulation (1–A) plus the necessary material of classes 2 and 3 for installing it.

[2]Part set orders for any class will include only the items necessary to install the number of coils involved, except: cut banding material (3–D) which will be supplied in whole sets only.

2. Always give the complete name plate reading and state definitely the classification or subclassification desired.

Table I. Fuel and lubricant recommendation chart

Part requiring fuel or lubricant	Place	Type	Amount	Refs and references	Below −10° F.	−10° F. to +32° F.	Above +32° F.
Gas tank.	Filler spout top (Rear of engine)	Gas	15 gallons.		62 to 68 octane 72 to 78 octane advance spark		
Crankcase.	Oil filler spout on handhole cover.	OE	28 quarts.	A–B–C–D	SX_1	S_1	S_3
Air cleaner (air maze model 37U–OBF).	Left side of engine.	OE	1 pint.	B–C	S_1	S_1	S_3
Oil pressure gauge.	Right side under gas tank.		20 to 30 pounds.	G			
Oil filter (Briggs No. G400)	Right side of engine.	OE	2 quarts.	C			
Cylinder head breather.	Top valve cover.	Dry	Clean in oil, fuel, Diesel.	B			
Crankcase breather.	Oil filler spout.	Dry	Clean in oil, fuel, Diesel.	B			
Carburetor and governor linkage.	Oil can points.	OE	2 drops each point.	B			
Water pump.	Grease cup.	WP	Turn down snug.	A		V_1	
Magneto.	Cam felt wick.	OE	2 to 3 drops.	C	S_1	S_1	S_3
Charging generator.	Two cap oilers.	OE	8 to 10 drops.	C			
Armature bearings.	Grease plug, apply to bearings.	WB BR	3 ounces add. 1/2 full.	E–F	V	V	V_2

NOTES 1. A—Every 8 hours service; B—Every 32 hours service; C—Weekly, 128 hours service; D—Monthly, 512 hours service; E—Semiannually or 2,048 hours service; F—Annually or every 5,000 hours of service; G—Engine oil, low-pressure automatic stop. Investigate before further operation. OE = Engine oil, U.S. Army 2-104B; SAE 10 = S_1; SAE 30 = S_2; SAE 50 = S_3; and SX_1 = Winterized oil. WP = Water pump grease, U.S. Army 2-109 No. 4 = V_3; BR = Bearing grease AXS-637 = V; WB = U.S. Army 2-108 No. 2 = V_2.

2. If unit is housed, use warmer grade lubricant.

43. Lubrication

See table I, *page 44*, for complete lubrication data.

a. Oil-Pressure Gauge. Normal oil pressure for the engine is 20 to 30 pounds under average conditions. Extreme temperature or load conditions may cause these pressures to vary.

b. Engine Crankcase. The oil in the engine should be replenished daily, in order to maintain the level to the full mark on the dipstick. It is essential that the oil is drained and refilled with new oil at various intervals. Draining the oil while hot will aid in the removal of sediment. After draining, refill to the proper level.

c. Cleaning Oil Pan. (1) It is recommended that the crankcase handhole covers be removed for inspection at monthly intervals or after 512 hours of service. The oil-pass and oil-pump screws should be thoroughly cleaned of all sludge. Use a brush for cleaning; no rags should be used as the remaining lint may cause clogging.

(2) The formation of sludge in the oil pan is due to oil contamination caused by exhaust gases which pass the pistons and come in contact with the oil, condensing and forming an acid. *This condition will be found more often and to a greater extent when an engine is operated at too low a temperature.* When draining the oil, if it appears to be thick and congealed, the oil pan should be thoroughly cleaned of all sludge.

d. Oil Filter. Renew the oil filter element and inspect the bottom support plate and top case every 128 hours of service, or whenever the oil begins to get black and dirty. Remove the drain plug, and clean it thoroughly to insure a complete seal when the new refill cartridge is inserted. Run the engine for at least 10 minutes, then check the fittings and the cover for leaks. Check the oil level in the engine crankcase and, if necessary, add oil to bring the amount in the crankcase up to the proper level.

e. Lubrication of Water Pump. Turn the grease cup down snugly at regular intervals as required. Use high-temperature or soft, water pump grease (waterproof) V_3.

f. Lubrication of Governor. The only part that requires lubrication is the connecting linkage to the carburetor. The internal parts of the governor are lubricated by oil introduced into the governor housing from the engine.

g. Lubrication of Magneto. The cam-lubricating wick is saturated with U. S. Army 2-108 No. 2 grease at the factory and should be relubricated periodically with a small quantity of SAE 50 oil.

The magneto rotor ball bearings are packed only at the time of overhaul with the high temperature U. S. Army 2-108 No. 2 grease, and require no lubrication between overhaul.

h. Lubrication of Air Cleaner. Unscrew the wing nut, remove the assembly, and the entire device will be open for inspection. Dispose of the accumulated dust in the sump, and refill to the lower bead with the same grade of oil used in the crankcase. Clean the filter element in oil, fuel, Diesel.

Note. Do not use gasoline to clean the element.

i. Lubrication of Alternator and Starter Motor. Add 8 to 10 drops of oil to each hinge-cap oiler of the alternator every 128 hours of operation. *Starting motors* have three oilless bushing bearings and require no lubrication. However, when disassembled for cleaning, add a few drops of light oil to each bushing.

j. Lubrication of Alternator. Every 6 months or 2,048 hours of operation, a charge of grease should be added. If experience indicates that these quantities result in a surplus of grease in the bearings, the quantity should be reduced or the greasing periods lengthened, or both. The ideal condition is to have the bearing housing be from one-third to one-half full of grease. The surplus grease sump below the bearing should be kept empty at all times.

k. Alternator Inspection. If practicable, it is desirable to open the bearing housings once a year or after 5,000 hours of operation, to check the condition of the bearings and grease. If grease deterioration has occurred, the bearings and housing should be thoroughly cleaned and new grease added.

l. Excessive Lubrication. (1) A small amount of lubricant, sufficient to maintain a film of lubricant over the surface of the balls and races, is essential. Too much grease will cause churning, overheating, and grease leakage. If grease leakage occurs, the bearing has been overfilled, or the grease used is not suitable for that particular application.

(2) If high pressure guns are used, great care should be taken to avoid overlubrication.

(3) New grease is introduced at the side of the bearing farthest from the body of the alternator. A sufficient charge will force the old grease through the rolling members and out a partially restricted escape port during operation.

m. Lubrication Schedule. (1) At the beginning of operation, or every 8 hours, perform the following inspections and operations:

(*a*) Check oil level, keep to the full mark on the dipstick.

(*b*) Grease water pump, turn down one complete turn on grease cup.

(2) After every 32 hours of service, perform the following inspections and operations:

(*a*) Check the air cleaner, and maintain the oil level to the bead.

(*b*) Refill water-pump grease cup if necessary, and turn down snugly.

(*c*) Lubricate governor to carburetor connections.

(*d*) Keep the cylinder head and crankcase breathers free from dirt; when necessary remove, wash in gasoline, and dry thoroughly.

(3) After operating the engine 1 week or after every 128 hours of service, perform the following operations:

(*a*) Saturate magneto wick with SAE 50 oil.

(*b*) Lubricate battery-charging alternators and inspect battery terminals, clean corrosion and apply vaseline on terminals.

(*c*) Change crankcase oil. Drain while oil is warm.

(*d*) Wash carburetor air cleaner (filter element may be rinsed)in thin oil if necessary.

(*e*) Clean oil filter and exchange cartridge.

(4) After operating the engine 1 month or after every 512 hours of service, clean the oil pan of sludge and clean the oil-strainer screen on the oil pumps.

(5) Semiannually, or after 2,048 hours of service, lubricate the alternator ball bearings.

(6) Annually, or after every 5,000 hours of service, perform the following:

(*a*) General inspection of power unit.

(*b*) Inspect alternator bearings, clean, and repack with new grease.

SECTION V

SUPPLEMENTARY DATA

44. Table of Replaceable Parts

a. Engine.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(1) *Crankshaft (Le Roi part numbers).*					
1		Crankshaft assembly	Includes next three items	Transmit power	A5-372
2		Stud	Crankshaft flange	Fasten crankshaft to flywheel	105-338
3		Key	Crankshaft gear, Woodruff No. A	Fasten gear to shaft	09-15
4		Gear	Crankshaft	Drives camshaft gear	26-325
5		Key	Crankshaft pulley, Woodruff No. A	Fasten pulley to shaft	09-15
6		Pulley	Crankshaft	Drives fan and generator belts	36-518
7		Jaw	Cranking	For manual starting	96-27
(2) *Crankcase (Le Roi part numbers).*					
12		Crankcase assembly	Parts B105-43 to 019-40, incl.	Inclose moving parts of engine	A100-149-5
12		Crankcase assembly	Parts B105-43 to 61-44, incl.	Inclose moving parts of engine	1A100-149-5
12		Crankcase assembly	Parts B105-43 to 74-41, incl.	Inclose moving parts of engine	3A100-149-5
13		Stud	Main bearing (used up to serial No. 159681)	Secure bearing cap	B105-43
13		Cap screw	Main bearing (used on serial No. 159681 and up)	Secure bearing cap	34-217
16		Cap	Bearing, front main	Support bearing shell	4-177

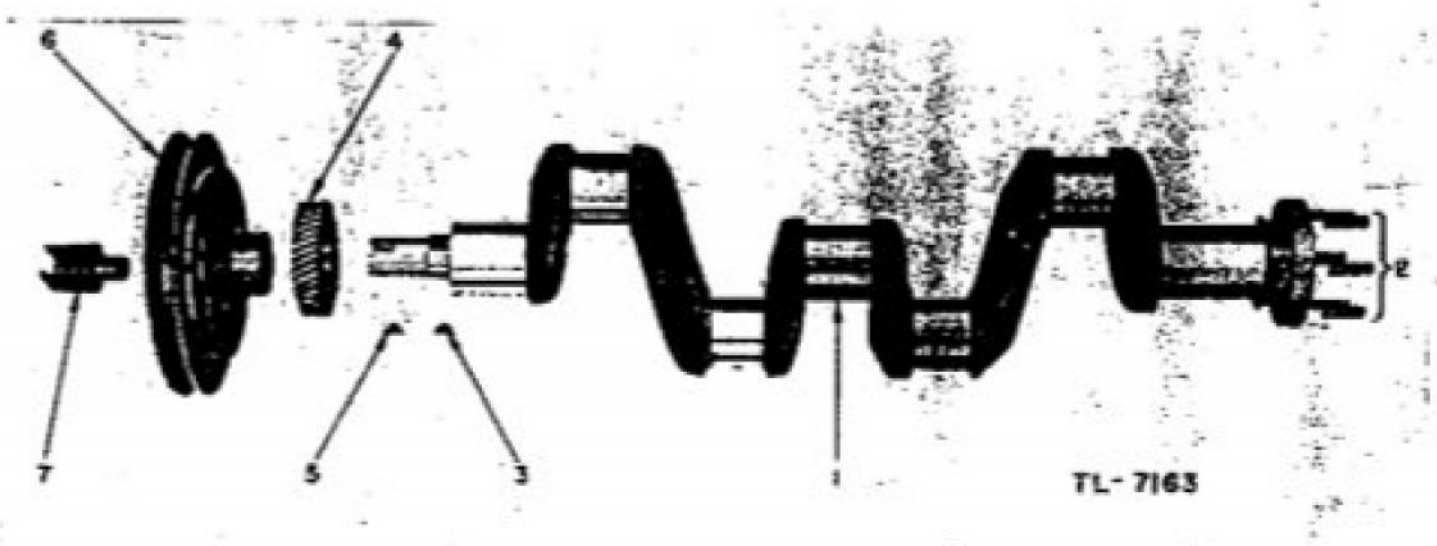


Figure 32. Crankshaft parts view.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
16A		Cap	Bearing, center main	Support bearing shell	4-181
16B		Pin	Dowel, for rear bearing cap		17-400
17		Cap	Bearing, rear main, includes part No. 17-299	Support bearing shell	A4-178
19		Pin	Thrust washer	Secure thrust washer	17-299
20		Nut	5/8", 18 hexagonal, castelated	Secure bearing cap	B53-26
21		Tube	Rear oil	Carry oil to rear bearings	55-397
22		Tube	Front oil	Carry oil to front bearings	55-398
23		Bushing	Front and center camshaft	Front and center camshaft bearing	11-134
24		Bushing	Rear camshaft	Rear camshaft bearing	11-133
25		Plug	Welch, 3"	Prevent oil leakage	019-40
...		Screw	Parker Kalon, No. 2x3/16", type U		03-2001
26		Plate	Name		62-48
30		Stud	Cylinder head, 1/2"x5 1/4"	Secure cylinder head	105-232
31		Stud	Cylinder head, 1/2"x5 3/4"	Secure cylinder head	B105-31
32		Stud	Oil cleaner, 5/16"x1"	Secure oil cleaner	B105-39
33		Stud	Water pump bracket, 3/8"x1 5/6"	Hold water pump assembly	105-245
34		Stud	Ignition wire bracket, 5/16"x1"	Hold ignition wire assembly	B105-39
34		Shell	Bearing, front main, 1/2"	Support crankshaft journal	21-348
35		Shell	Bearing, center main, 1/2"	Support crankshaft journal	21-347
36		Shell	Bearing, rear main, 1/2"	Support crankshaft journal	21-349

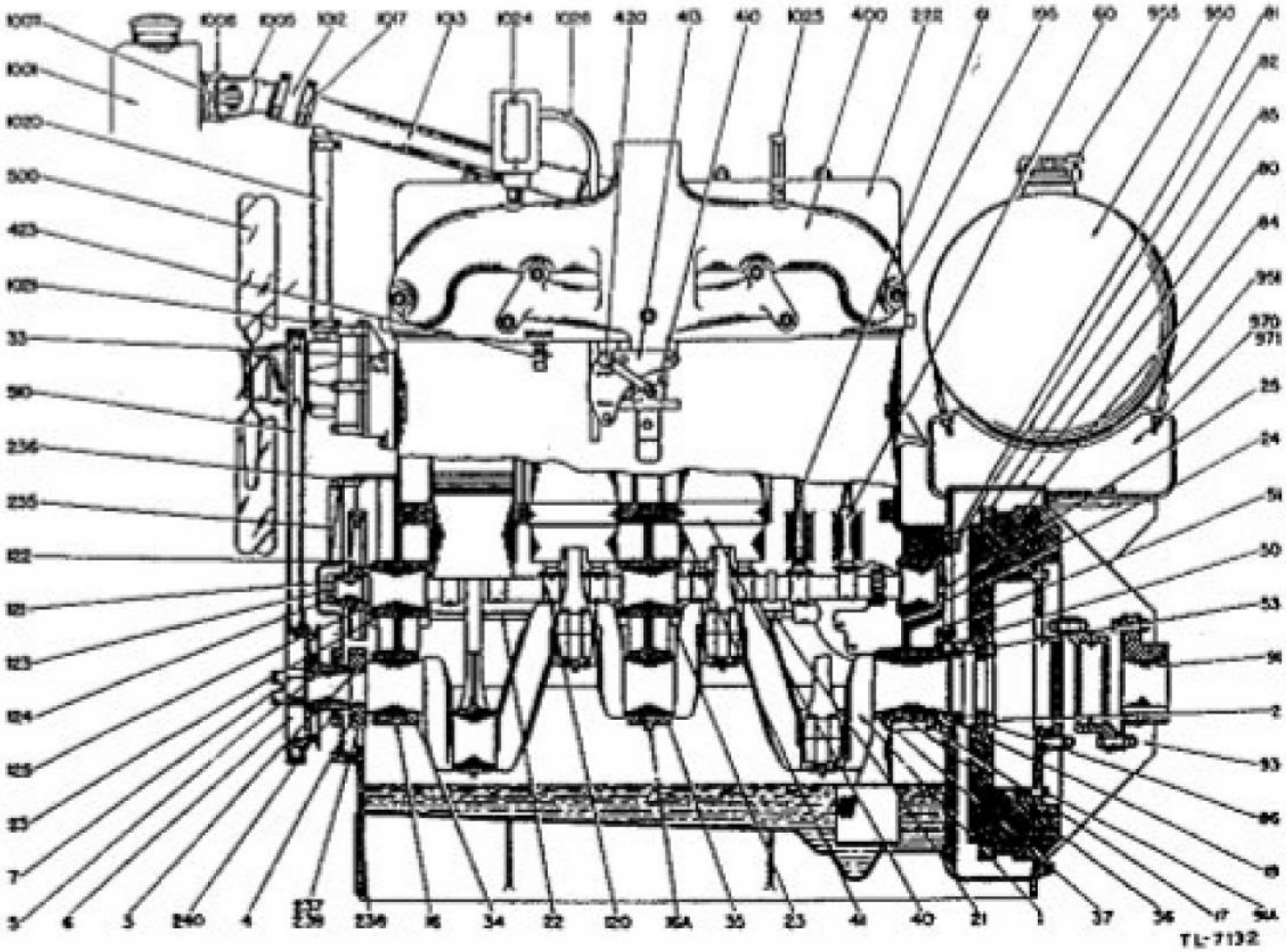


Figure 33. Longitudinal section through engine.

Ref. No.	Stock No.	Name	Description	Function	MS's part No.
37		Washer	Thrust, rear main bearing	Take up end thrust	20-370
38		Bushing	Governor cross shaft	Support governor cross shaft on carburetor	21-324
39		Wire	Locking, main bearing		61-44
40		Sleeve	Cylinder	Cylinder lining	175-6-1
41		Packing	Cylinder sleeve	Seal the sleeves	74-41
43		Cock	Drain, 1/4", male and female pipe thread	Drain cooling system	15-338
...		Decal	Water drain		62-109
50		Retainer	Oil	Retain oil	31-325-1
51		Gasket	Oil retainer	Prevent oil leakage	16-777

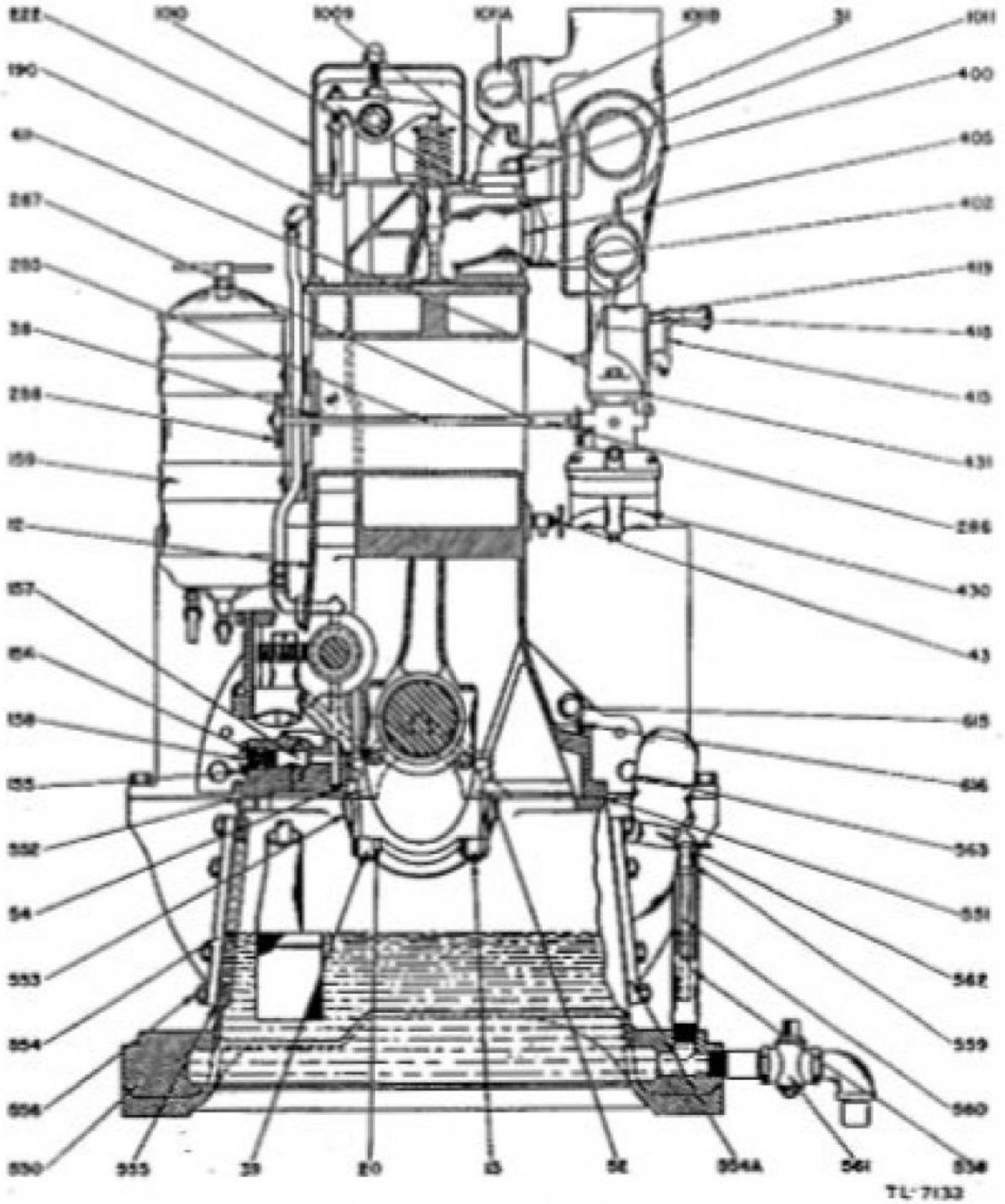


Figure 31. Cross section through engine.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
52		Gasket	Oil retainer parting	Prevent oil leakage	16-907
...		Cap screw	5/16"-18x7/8" hexagonal		02-19
...		Lock washer	5/16"		05-50
53		Seal	Oil, felt	Prevent oil leakage	125-67
55		Plug	Pipe, 1/8"		011-1
59		Plug	Pipe, 3/8" countersunk, special		011-103
60		Tappet	Valve	Transmits motion from cam to valve	23-12
61		Rod	Push	Operates rocker arm	99-72
...		Plate	Instruction		62-110
...		Screw	Parker Kalon, No. 2, 3/16", type U		62-2001
...		Stud	Oil line clamp, 5/16"x1"		B105-39
(3) *Bell housing, flywheel, and coupling (Le Roi part numbers).*					
80		Housing	Bell, upper half	House flywheel	37-221
81		Cap screw	3/4"-16x1 1/2" hexagonal	Fasten bell housing	34-37
82		Wire	Locking	Lock cap screw in place	61-44
...		Cap screw	1/2"-13x1 1/4" hexagonal		02-70
...		Lock washer	1/2"		05-53
84		Flywheel assembly	Includes ring gear	Equalize torque on rotating parts	A9-486-3
85		Gear	Ring, 8/10 pitch	Connects with cranking motor gear	26-270
86		Nut	1/2", 20 hexagonal, slotted		B53-25
...		Pin	Cotter, 3/32"x1"		07-23
...		Cap screw	3/8"-16x1 1/4" hexagonal		34-209
...		Lock washer	3/8"		05-51
92		Key	Furnished with alternator	Connect alternator shaft to coupling	09-213
93		Guard	Coupling	Enclose coupling	156-116
...		Cap screw	3/8"-16x5/8" hexagonal		02-33
...		Lock washer	3/8"		05-51
91		Coupling	Thomas flexible No. 312, includes next seven items	Connect engine shaft to alternator shaft	A28-256
...		Plate	Flywheel adapter		30702

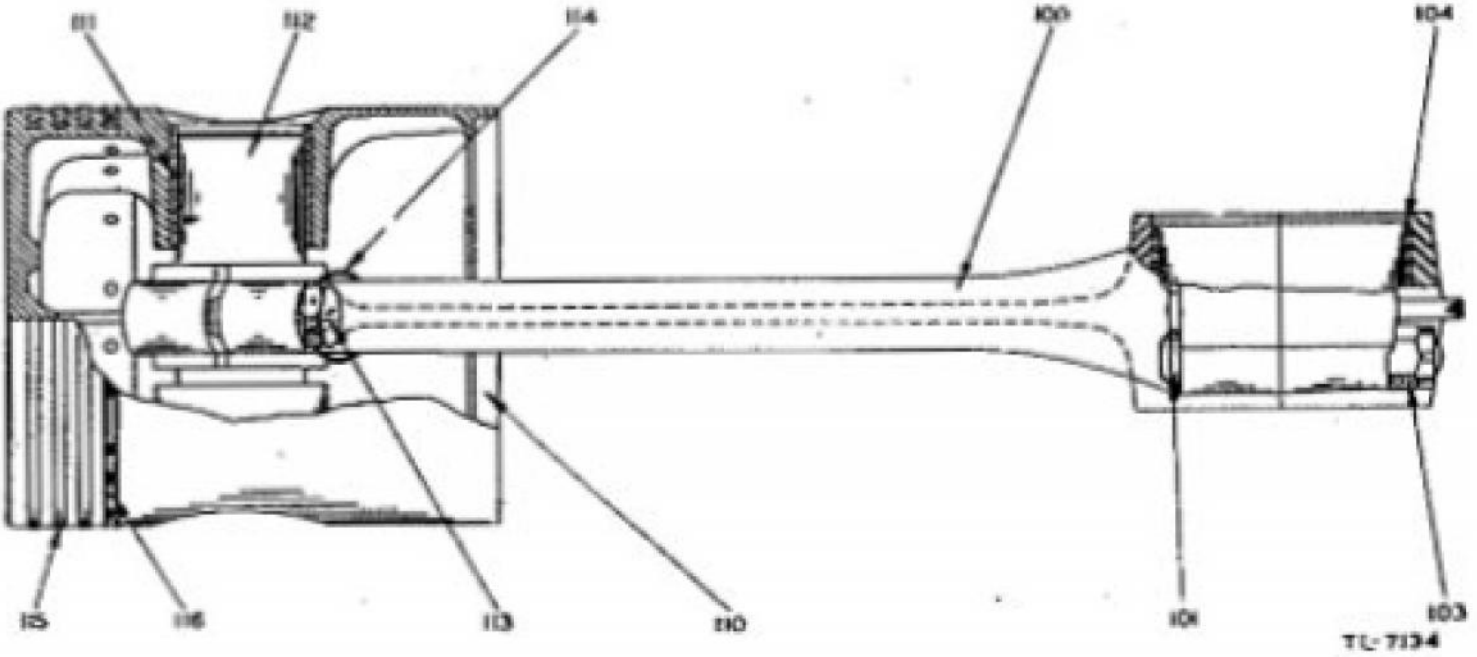


Figure 33. Connecting rod and piston assembly.

Ref. No.	Stock No.	Name	Description	Function	MV's part No.
...		Ring	Center		20752
..		Hub	Rear flange, 2 5/8" bore, special		21188
...		Rings	Laminated, flexible (20 pieces)		10957
..		Bolt	1/2"-20x2", special		10966
..		Washer	Beveled, 1/2"		10965
...		Nut	1/2"-20, "Stay-on"		11118-6

(4) *Connecting rod (La Roi part numbers).*

100	Connecting rod assembly	Includes parts 34-201 to 07-23	Transmit power	1A7-74
101	Bolt	Connecting rod	Hold bearing shell halves together	34-201
103	Nut	Connecting-rod bolt, 7/16"—20 hexagonal, special	Fasten connecting-rod bolt in place	33-31
104	Shell	Bearing, connecting rod, 1/2", A	Fasten connecting rod to crankshaft	21-350
105	Cap screw	Piston-pin clamp	Fasten piston-pin clamp to piston pin	835-8
106	Wire	Lock	Lock cap screw in place	61-5-3
...	Pin	Cotter, 3/32"x1"		07-23

Figure 36. Piston parts view.

(5) *Piston (La Roi part numbers).*

110	Piston assembly	Includes pin and bushings, 4 1/2" bore, 6 to 1 ratio	Transmit power	1A8-208-3
111	Bushing	Piston pin	Bearing for piston pin	21-334
112	Pin	Piston	Holds connecting rod in piston	B17-17
115	Ring	Compression, P.C., 4 1/2"x1/8"	Seals power	18-233
117	Ring	Oil, P.C., 4 1/2"x3/16"	Seals power	18-114

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.

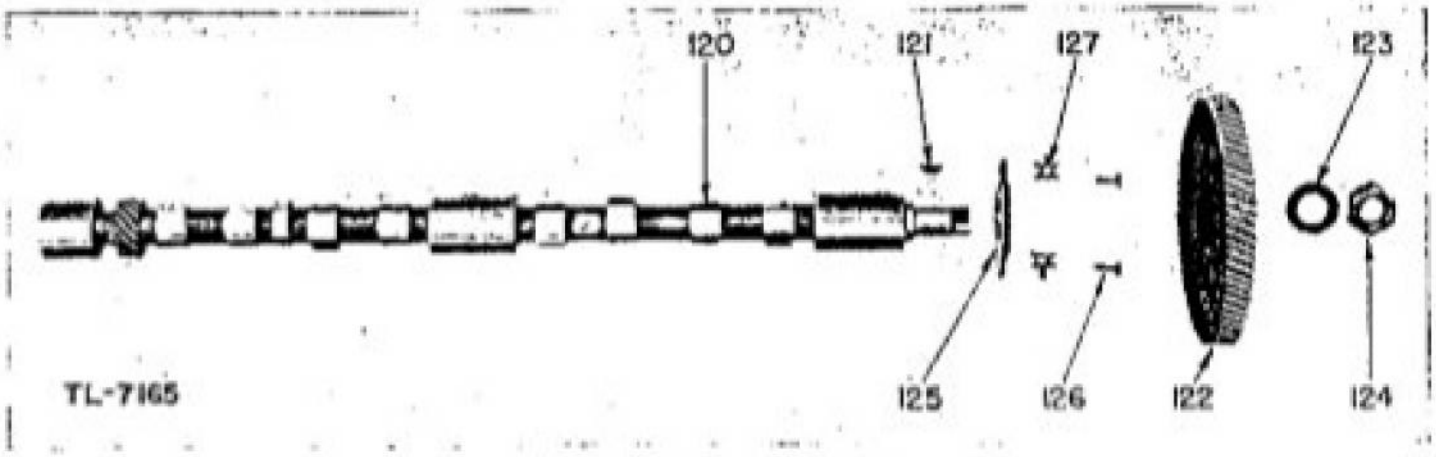


Figure 37. Camshaft parts view.

(6) *Camshaft (Le Roi part numbers).*

120	Camshaft		Supports cams and gear	6-132
121	Key	Camshaft gear, Woodruff No. 13	Locks gear to shaft	09-17
122	Gear	Camshaft	Drives camshaft	26-326
123	Lock washer	Camshaft gear, special	Locks nut in place	20-276
124	Nut	Camshaft gear, 1 1/8"-12 special	Fastens gear to shaft	53-171
125	Retainer	Camshaft	Adds support to gear	31-327
126	Cap screw	5/16"-18x3/4", hexagonal	Fasten retainer to gear	02-18
127	Lock washer	5/16", special	Lock cap screw	20-274

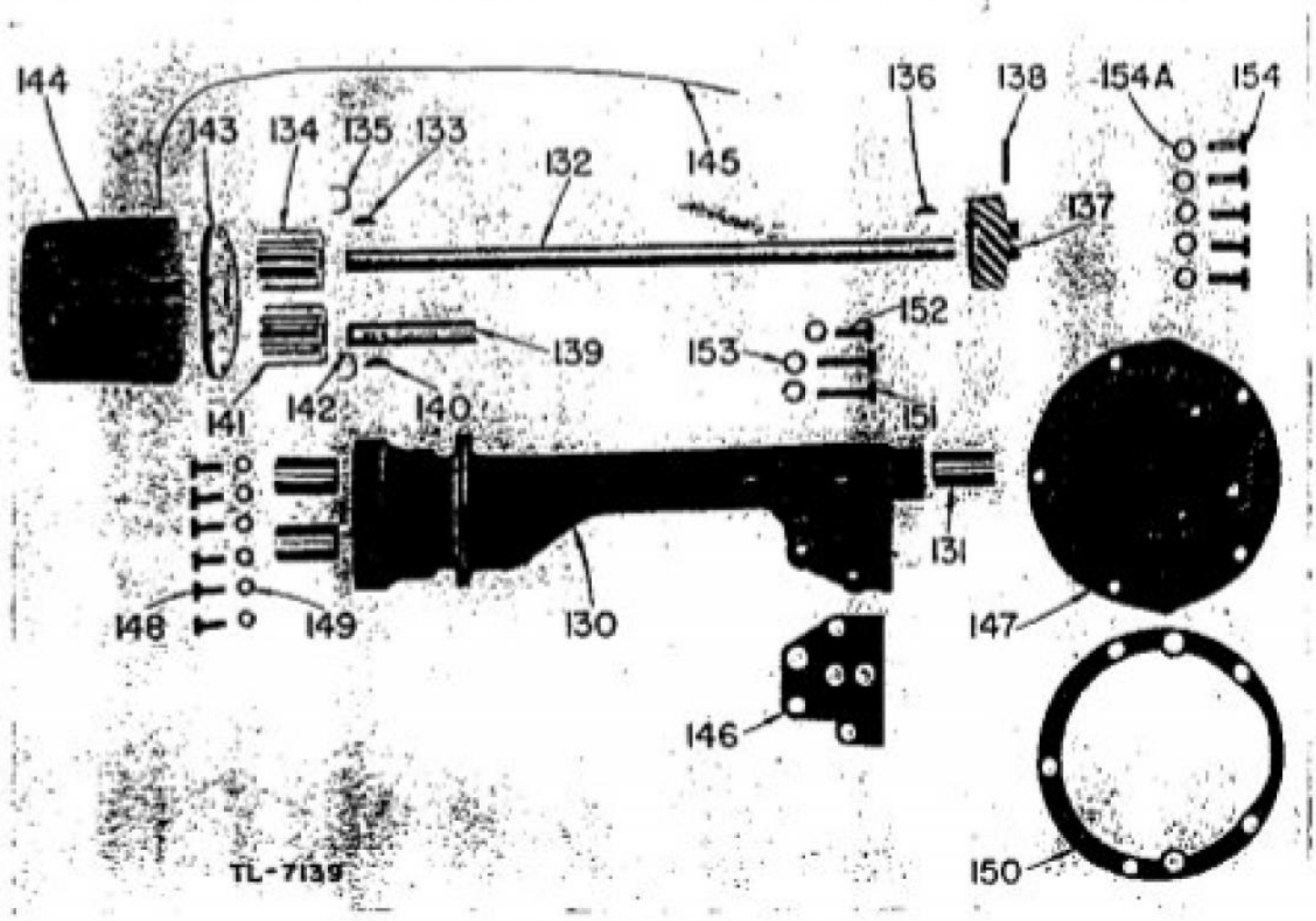


Figure 38. Oil pump assembly.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(7) *Lubrication, oil pump, lines, and filter (Le Roi part numbers).*					
130		Oil pump assembly	Includes 1A13-260-2, plus parts 27-250 to 19-13	Pump oil	2A13-260-2
130		Oil pump assembly	Includes bushings	Pump oil	1A13-260-2
131		Bushing	Oil pump body	Bearing for oil pump shaft	21-370
132		Shaft	Oil pump	Transmit power	27-850
136		Key	Pump drive gear, Woodruff No. 6	Lock drive gear to shaft	09-6
137		Gear	Pump drive	Drive pump shaft	26-327
138		Pin	Taper, pump drive gear, No. 2, 1" long	Hold drive gear in place	010-29
139		Shaft	Oil pump idler gear	Support idler gear	27-1337
133-140		Key	Oil pump gear, Woodruff No. 6	Lock pump gear to shaft	09-6
134-141		Gear	Oil pump	Pump oil	26-519
135-142		Wire	Lock, oil pump gear	Hold pump gear in place	64-29
143		Cover	Oil pump	Inclose pump assembly	14-538
148		Cap screw	1/4"-20x5/8" hexagonal	Fasten cover to pump	02-3
149		Lock washer	1/4"	Lock cap screws in place	05-49

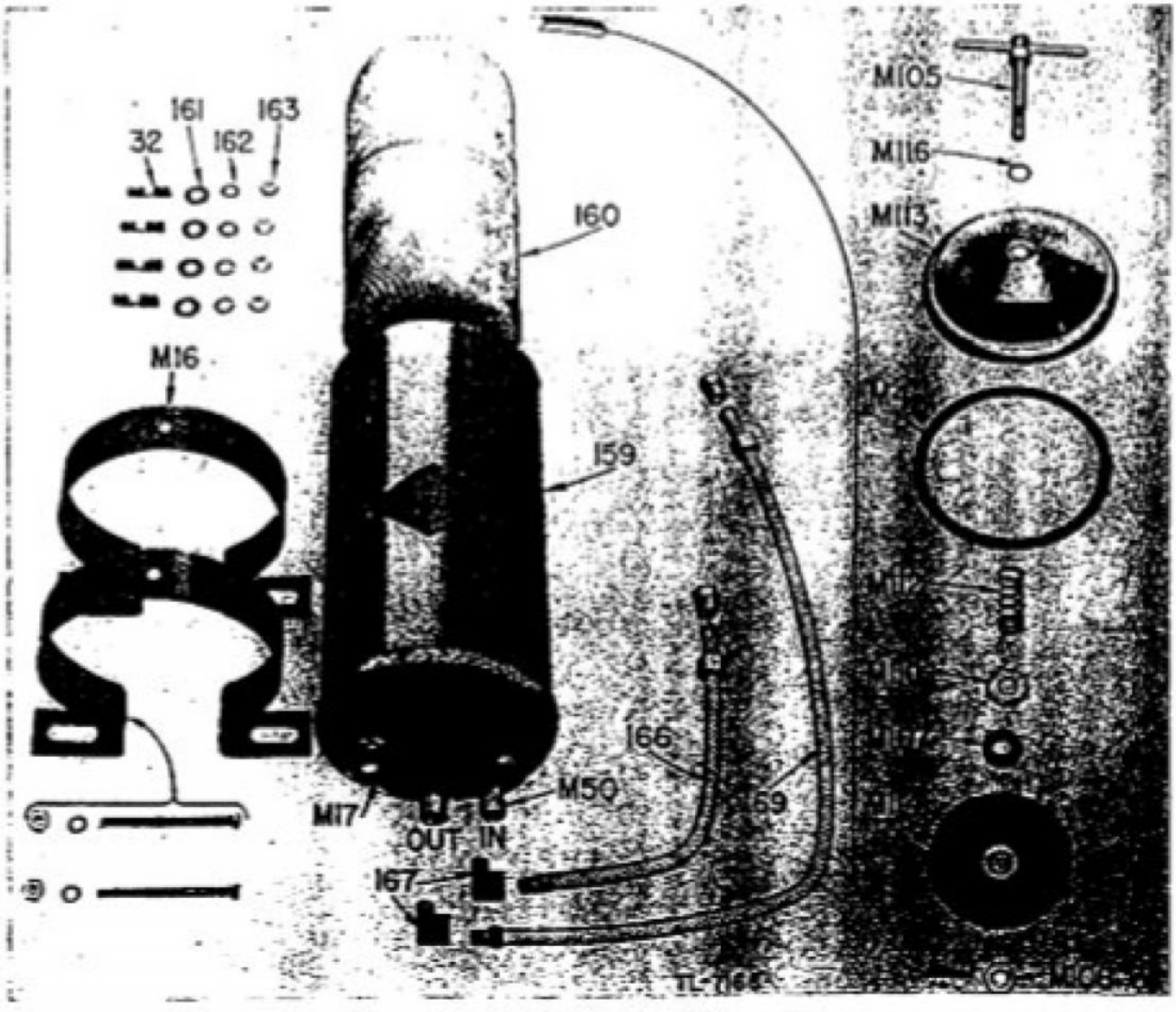


Figure 31. Oil filter parts view.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
144		Screen	Oil pump	Filter oil	43–70
145		Wire	Oil pump screen	Attach screen to pump	61–5–2
146		Gasket	Oil pump body to cover	Prevent oil leak	16–636
151		Cap screw	5/16"–18x1 1/4" hexagonal		02–21
152		Cap screw	5/16"–18x3/4" hexagonal		02–18
153		Lock washer	5/16"		05–50
147		Cover	Oil pump	Inclose pump assembly on drive gear end	14–536–1
...		Plug	Pipe, 1/8", slotted		19–13
150		Gasket	Oil pump cover flange	Prevent oil leak	16–635
154		Cap screw	5/16"–18x3/4" hexagonal	Fasten cover to pump	02–18
154A		Lock washer	5/16"	Lock cap screws in place	05–50
...		Plug	Pipe, 1/4" countersunk		011–102
155		Plug	Oil relief		53–150
156		Spring	Oil-relief plunger		24–236
157		Plunger	Oil relief		25–54
158		Gasket	Oil-relief plug		B16–117
159		Oil filter assembly	Briggs Model G400, includes following parts marked*	Container for filter unit	A77–176
160		*Element	For oil filter, Briggs model G–41	Filters oil	A77–180–1
M–4		*Gasket	For top cover, Vellum	Prevents entry of dirt and dust	Briggs M–4
M–16		*Strap	Mounting	Attach filter to engine	Briggs M–16
M–17		*Plug	Drain, sump	Drain filter	Briggs M–17
M–50		*Fitting	Restrictor, brass	Connects to brass street ell	Briggs M–50
M–105		*Cap screw	Bar handle	Fasten top cover assembly	Briggs M–105
M–107		*Washer	Cork	Seal for top hold-down plate	Briggs M–107
M–108		*Nut	Check	Fasten top cover and top hold-down plate assembly	Briggs M–108
M–110		*Washer	Steel	Bearing surface for spring	Briggs M–110
M–112		*Spring	Hold down	Supplies pressure on top of hold-down plate	Briggs M–112
M–113		*Cover	Top	Covers filter	Briggs M–113
M–114		*Plate	Top, hold down	Holds filter element in place	Briggs M–114
M–116		*Washer, copper		Bearing surface for bar handle	Briggs M–116
32		Stud	Oil filter support, 5/16"x1"	Hold filter support	B105–39
161		Washer	Plain, 5/16"		06–3
162		Lock washer	5/16"		05–50
163		Nut	5/16", 24 hexagonal, for No. B105–39		04–602
166		Line	Oil, filter inlet, Titeflex metal, 10 1/4" long	Conducts dirty oil to filter	A55–642–5
167		Connection	1/8", 90° brass street ell	Connects oil line to filter	33–542
169		Line	Oil, filter outlet, Titeflex metal, 21 1/2" long	Conducts clean oil from filter	A55–642–7
171		Connection	Filter lines, 1/8" brass nipple	Connect filter lines	33–544
172		Line	Oil, to cylinder head, Titeflex metal hose, 16 1/4"	Conduct oil to cylinder head	A55–642–4
173		Connection	Cylinder-head oil line, 1/8", 90° brass street ell	Connect cylinder-head oil line	33–542
174		Connection	Cylinder-head oil line, 1/8" brass close nipple	Connect cylinder-head oil line	33–544
175		Connection	Oil line crankcase, 1/8" brass close nipple	Connect crankcase oil line	33–544
176		Connection	Oil line, 1/8" cross	Connect oil line	54–101
164		Gauge	Oil pressure	Record oil pressure	60–80
177		Line	Oil, to oil gauge, Titeflex metal hose, 29 3/4" long	Conducts oil to gauge	A55–642–8
178		Connection	Oil line to oil gauge, 1/8" brass close nipple	Connects oil line to gauge	33–544

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
179		Line	Oil, to governor, Titeflex metal hose, 22 1/2" long	Conducts oil to governor	A55-642-6
...		Connection	Oil line to governor, 1/8", 90° brass street ell	Connects oil line	33-542
180		Connection	Oil line to governor, 1/8" close nipple	Connects oil line	33-544
181		Clamp	Oil line		83-49
...		Lockwasher	5/16"		05-50
...		Nut	5/16"-24 hexagonal		04-602
...		Tee	Brass, 1/8"x1/8"x1/8"		33-554
...		Elbow	Brass, 1/4"x1/8", special reducing		33-547
...		Line	Oil, pressure switch to gauge, Titeflex metal hose, 11 5/8" long		A55-642-13
...		Nipple	Brass, close, 1/8"		33-544
(8) *Cylinder head (Le Roi part numbers).*					
190		Cylinder head assembly (optional)	Includes parts 64-33 to 105-315, incl.	Inclose moving parts of cylinder head	1A2-149-3
190		Cylinder head assembly (optional)	Includes parts 64-33 to 20-279, incl.	Inclose moving parts of cylinder head	2A2-149-3
190		Cylinder head complete assembly (optional)	Includes parts 64-33 to 61-59, incl.	Inclose moving parts of cylinder head	3A2-149-3
191		Insert	Seat, exhaust valve	Protects valve	64-33
192		Guide	Intake valve	Guides valve	58-26
193		Guide	Exhaust valve	Guides valve	58-27
194		Stud	Rocker-arm bracket	Supports rocker arm shaft bracket	105-216
195		Stud	Manifold	Support manifold	105-191
...		Stud	Spark plug shield (not illustrated)		105-315
196		Valve	Intake	Controls flow of fuel to combustion chamber	15-200
197		Valve	Exhaust	Controls exhaust gases	15-201-1
198		Spring	Valve	Seat valves	B24-26
199		Washer	Valve spring	Retains valve spring	20-278
200		Lock washer	Valve stem, special	Locks valve stem to washer	20-279
201		Line	Oil, rocker arm to cylinder head 3/16"x8"	Conducts oil	A55-51-24
205		Rocker-arm shaft assembly	Includes sleeve and plugs	Mounts rocker arms	1A27-839
205		Rocker-arm shaft assembly	Includes 1A27-839, plus parts A98-19-2 to 61-59, incl.	Mounts rocker arms	4A27-839
206		Sleeve	Rocker-arm shaft	Connection for oil line	63-41
207		Plug	Rocker-arm shaft	Seal shaft	19-87
210		Rocker-arm assembly	Intake includes bushing and parts B34-25 and B53-8	Operates valves	A98-19-2
212		Bolt	Valve adjusting	Adjust rocker arm position	B34-25
213		Nut	Lock, valve-adjusting bolt	Lock bolt in position	B53-8

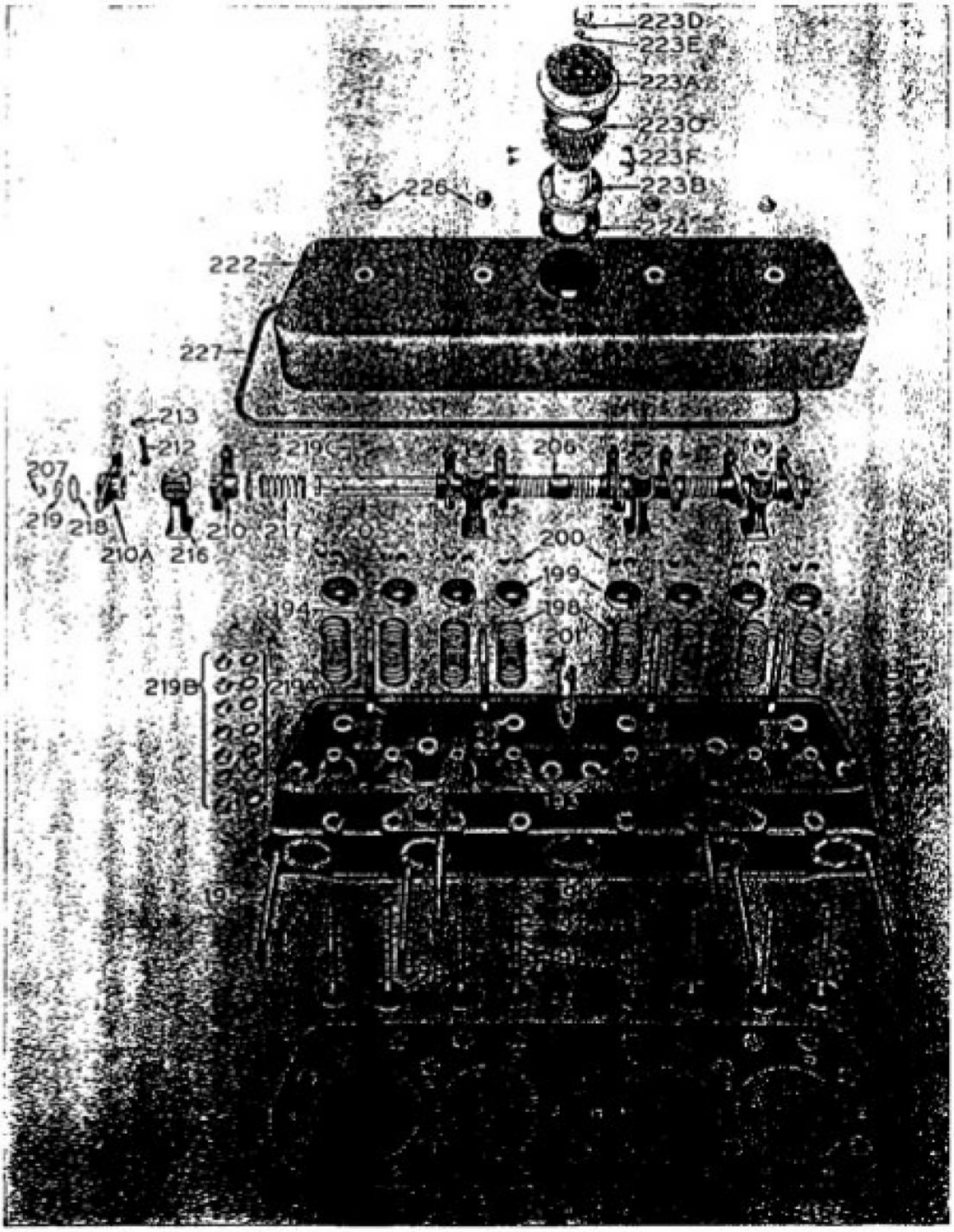


Figure 40. Cylinder head parts misc.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
210A		Rocker-arm assembly	Exhaust, includes bushing and parts B34-25 and B53-8	Operates valves	A98-19-3
212		Bolt	Valve adjusting	Adjust rocker arm position	B34-25
213		Nut	Lock, valve-adjusting bolt	Lock bolt in position	B53-8
216		Bracket	Rocker-arm shaft	Supports rocker-arm shaft	40-795-2
217		Spring	Rocker-arm shaft	Provide torque on shaft	24-86
218		Washer	Rocker-arm shaft	Bearing for springs	20-74
219		Wire	Lock	Lock shaft	61-59
219A		Washer	Cylinder-head stud, 1/2"	Bearing for nut	B20-1
219B		Nut	Cylinder-head stud, 1/2"-20 hexagonal	Fasten cylinder head to cylinder block	04-603
219C		Nut	Rocker arm bracket	Fasten bracket to cylinder head	04-604

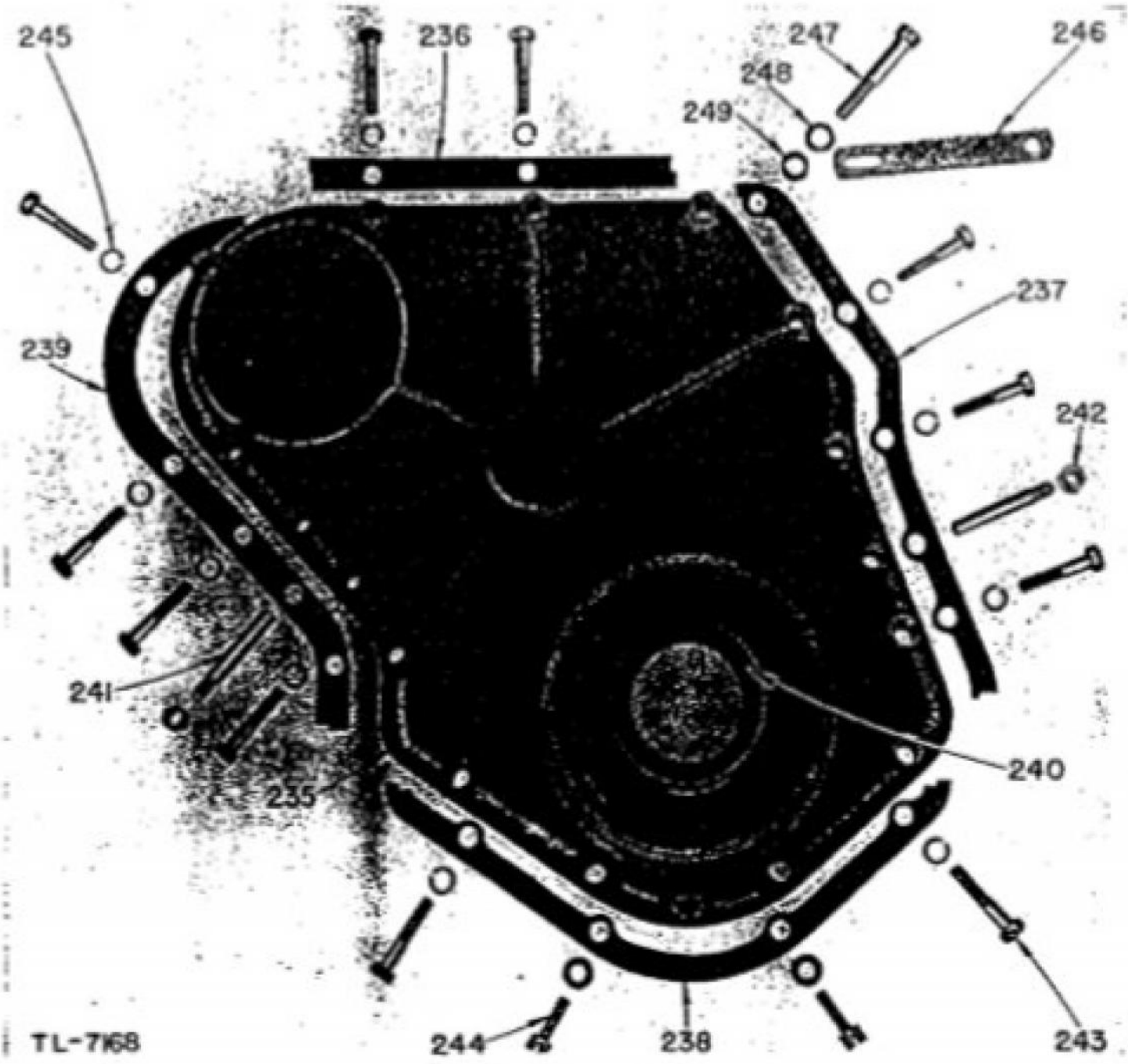


Figure 37. Valve cover parts view.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
...		Washer	Rocker-arm bracket stud, 7/16" plain		06-70
221		Gasket	Cylinder head	Prevent gas leakage	16-629
...		Cylinder-head cover assembly	Includes parts 14-535 to 16-643, incl.		A14-535
222		Cover	Cylinder head	Cover cylinder head parts	14-535
223		Breather	Air-Maze ZOH, includes parts 223A-223F.	Filters air intake into engine	A77-137
223A		Breather top	Includes name plate No. ZO-3	Holds breather element	ZO-001
223B		Breather base		Holds breather element	ZO-003
223C		Breather element		Filters dirt and dust from air intake into engine	ZO-18
223D		Nut	Wing, 3/8" standard 3/8"	Fastens top in place	04-1002
223E		Lock washer		Bearing for wing nut	03-51
223F		Screw	Breather, Parker Kalon, type Z stove head, No. 10, 3/8"		03-1538
224		Gasket	Breather	Dirt seal	16-643
226		Nut	Cylinder head cover, 7/16"-20 Acorn	Fasten cover to cylinder head	04-1129
227		Gasket	Cylinder head cover	Dirt seal	16-634

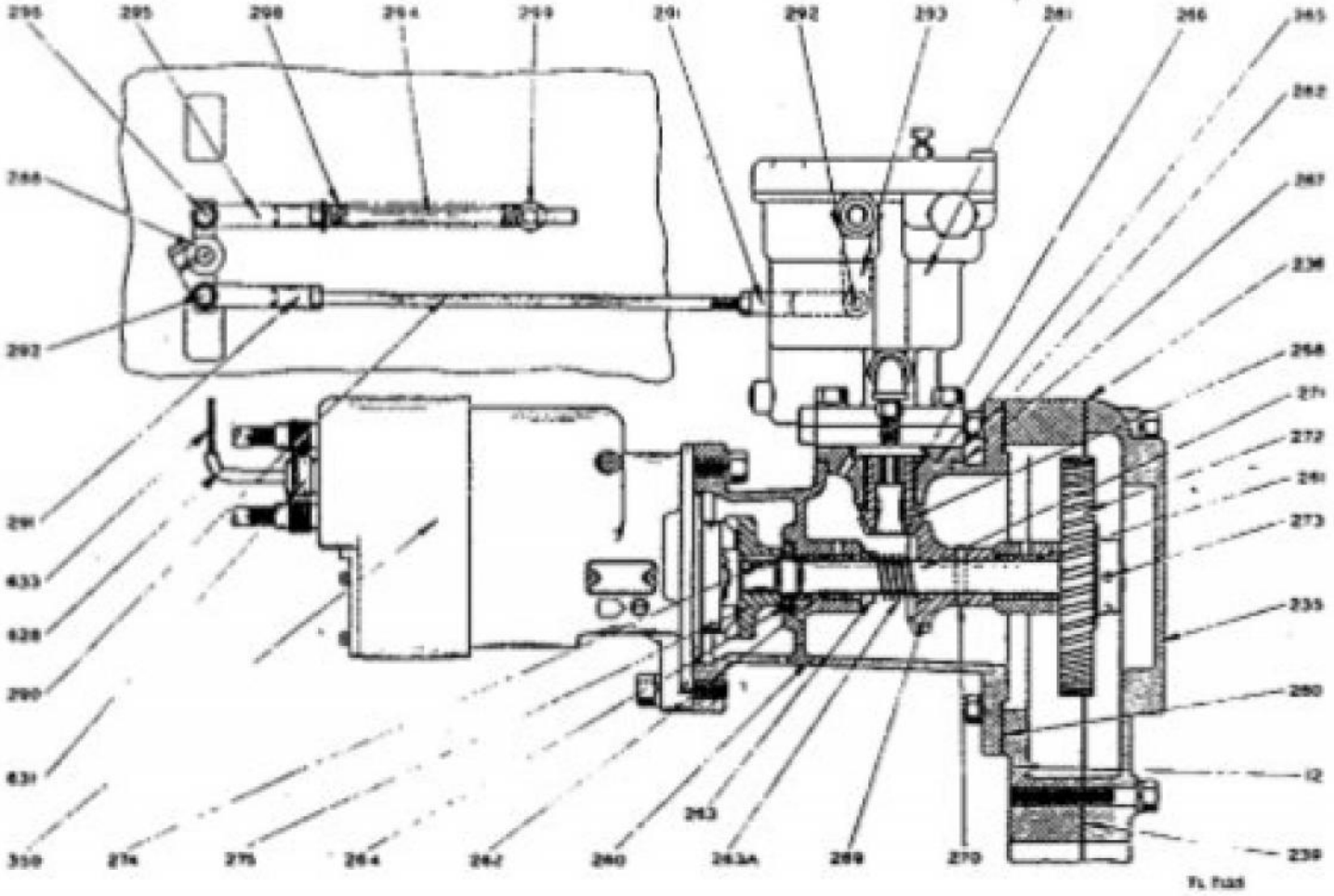


Figure 42. Governor assembly.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(9) *Gear cover (Le Roi part numbers).*					
235		Cover	Gear	Inclose gears	14–540–2
236		Gasket	Gear cover (upper)	Seal gear housing	16–650
237		Gasket	Gear cover (manifold side)	Seal gear housing	16–651
238		Gasket	Gear cover (lower)	Seal gear housing	16–652
239		Gasket	Gear cover (magneto side)	Seal gear housing	16–653
240		Retainer	Oil, 2 1/2", ID	Prevent oil leakage	125–58–1
243		Cap screw	3/8"–16x1 3/4" hexagonal	Attach gear cover	02–39
244		Cap screw	3/8"–16x1 1/2"	Attach gear cover	02–38
245		Lock washer	3/8"	Lock cap screws	05–51
241		Pin	Taper, No. 7, 2" long		010–315
242		Nut	3/8"–24 hexagonal		04–603
(10) *Governor drive assembly (Le Roi part numbers).*					
260		Governor drive assembly (optional)	Includes parts 116–51 to 28–159, incl.	Drive governor	2A116–51
260		Governor drive assembly (optional)	Includes parts 116–51 to 16–873, incl.	Drive governor	1A116–51
260		Governor drive assembly (optional)	Includes parts 116–51 to 125–56, incl.	Drive governor	A116–51
260		Body	Governor drive	Inclose governor drive parts	116–51
261		Bushing	Governor shaft, front	Bearing for governor shaft	21–339
262		Bushing	Governor shaft, rear	Bearing for governor shaft	21–354
263		Slinger	Oil	Lubricate shaft bearings	202–1
263A		Spring		Hold oil slinger in place	24–310
264		Seal	Oil	Prevent oil leakage	125–56–1
265		Bearing cap assembly	Includes bushing	Mounts governor	A4–167
266		Bushing	Governor drive pinion	Bearing for governor drive pinion	21–327
267		Gasket	For bearing cap	Seals bearing cap	16–873
268		Pinion	Bevel, governor drive	Drives governor	26–504
269		Gear	Bevel, governor drive shaft	Transmits power to pinion from drive shaft	26–503
270		Pin	Taper, for bevel gear, No. 3, 1 1/4" long	Fastens gear to shaft	010–42
271		Shaft	Accessory drive	Transmit power	27–1325
272		Gear	Accessory drive shaft	Drives accessory drive shaft	26–334–2
273		Pin	Taper, governor drive gear, No. 3, 1 1/4" long	Fastens gear to shaft	010–42
274		Key	Magneto coupling, Woodruff No. 6	Locks magneto coupling to accessory drive shaft	09–6
275		Coupling	Magneto	Couplet magneto to shaft	28–159
---		Cap screw	For drive shaft bracket, 3/8"–16x1" hexagonal	Supports drive shaft bracket	02–36
---		Lock washer	3/8", for No. 02–36	Locks cap screw	05–51
280		Gasket	Drive shaft bracket	Seals bracket connection	16–669
(11) *Governor controls (Le Roi part numbers).*					
285		Cross shaft assembly	Governor operating, including next five items		A27–1152
285		Shaft	Cross		27–1152
286		Coupling	Cross shaft	Connects cross shaft	28–232

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
287		Pin	Taper, for coupling No. 000x 1/2"	Fastens coupling to shaft	010-201
---		Screw	For No. 48-493, No. 10-24x1/2"		03-92
288		Lever	Governor-operating cross shaft	Transmits motion	48-493
290		Rod	Governor operating	Transmits motion	47-264
291		End	Clevis, governor rod	Adjust length of rod	031-2
---		Nut	For No. 031-2, 1/4", 28 hexagonal		04-601
292		Pin	Clevis	Pivot for clevis	031-62
---		Pin	Cotter, 1/16"x7/16"		07-2
294		Rod	Governor control spring	Mounts spring	47-524
295		End	Clevis, spring rod	Adjust length of rod	031-2
---		Nut	For No. 031-2, 1/4"-28 hexagonal		04-601
296		Pin	Clevis	Pivot for clevis	031-62
---		Pin	Cotter, 1/16"x7/16"		07-2
298		Spring	Governor control	Supply cushioning force	24-300
299		Guide assembly	Governor spring rod, includes bushing	Support governor spring rod	A38-38
300		Bushing	For guide	Bearing for governor spring rod	21-345
---		Nut	For guide, 5/16"x18"		04-102

(12) *Manifold (Le Roi part numbers).*

---		Manifold assembly	Includes Welch plugs	Houses intake and exhaust manifolds	A10-355-1
---		Plug	Welch, 1 1/4" diameter		019-19
401		Gasket	Intake	Prevent leakage	16-630
402		Gasket	Exhaust center	Prevent leakage	16-885
403		Gasket	Exhaust end	Prevent leakage	16-632
404		Washer	Plain, 1/2"		B20-1
405		Collar	Manifold center outlet	Connection for manifold	63-94
---		Nut	1/2"-20 hexagonal		04-605
410		Valve	Butterfly	Open and close manifold	15-329
411		Shaft	For butterfly valve	Turns valve	27-1327
---		Screw	1/8"-40 flat head		34-187
413		Bracket assembly	Includes stop pin for start and stop control	Mounts valve control	A116-52
---		Cap screw	For control bracket, 1/4"-20 x2" hexagonal		02-10
415		Lever	Control	Operates valve shaft	48-489
---		Screw	For control lever, No. 10-24x 1/2" long fillister head		03-92
418		Rod	For control lever		47-542
419		Spring	For control lever rod		24-308
420		Handle	For control lever	Operates control lever	50-88
422		Plug	Pipe, 1/8", slotted		19-13
---		Cock	Drain, 1/4" male, 1/4" female		15-338

(13) *Muffler (Le Roi part numbers).*

800		Muffler assembly		Houses muffler baffles	78-73
802		Pipe	Exhaust	Provides exhaust for gases	33-178-23
803		Packing	Retainer muffler		31-426
804		Packing	Muffler, 3/8"x24"		16-886

Ref. No.	Stock No.	Name	Description	Function	Mil's part No.
(14)	*Water pump and fan (Le Roi part numbers).*				
...		Water pump assembly	Includes A13-360-1, plus items marked †	Pump cooling water	1A13-360-1
470		Body	Water pump, includes next four items	Frame for pump	A13-360-1
471		Bushing		Bearing for pump shaft	21-368
472		Washer	Thrust	Bearing surface for shaft	20-378
473		Bushing		Bearing for shaft	21-367
474		Pin	Bushing	Fastens bushing in place	17-418
475		†Shaft	Water pump	Mounts impeller and fan hub	27-1381
476		†Washer	Seal	Bearing for bellows seal assembly	20-379
477		†Bellows seal assembly		Prevents water leakage	125-68
478		†Impeller	Water pump	Forces water through pump	101-28
480		†Hub	Fan	Mounts fan blades and pulley	132-73
481		†Pin	Taper, fan hub, No. 4, 1"	Fastens fan hub to shaft	101-28
482		†Gasket	Pump body	Prevents leakage	16-734
483		†Bracket	Pump body	Mounts water pump assembly	40-1075
...		†Cap screw	5/16"-18x1 3/4"	Fastens pump body to bracket	02-23
...		†Lock washer	5/16"	Locks cap screw	05-50
...		†Ell	Street, 1/8"x45"		013-531
...		†Cup	Grease, 1/8" male pipe thread	Supplies lubricant	017-11
484		Nipple	1/2x2 1/2" thread, one end		33-114-21
490		Gasket	Water pump bracket to cylinder	Prevents leakage	16-638
...		Nut	Hexagonal, 3/8"-24	Fastens water pump bracket to cylinder	04-603
...		Lock washer	3/8"	Locks nut	05-51
495		Fan pulley assembly		Drives water pump and fan	1A36-249
510		Belt	Fan	Drives fan pulley	41-235

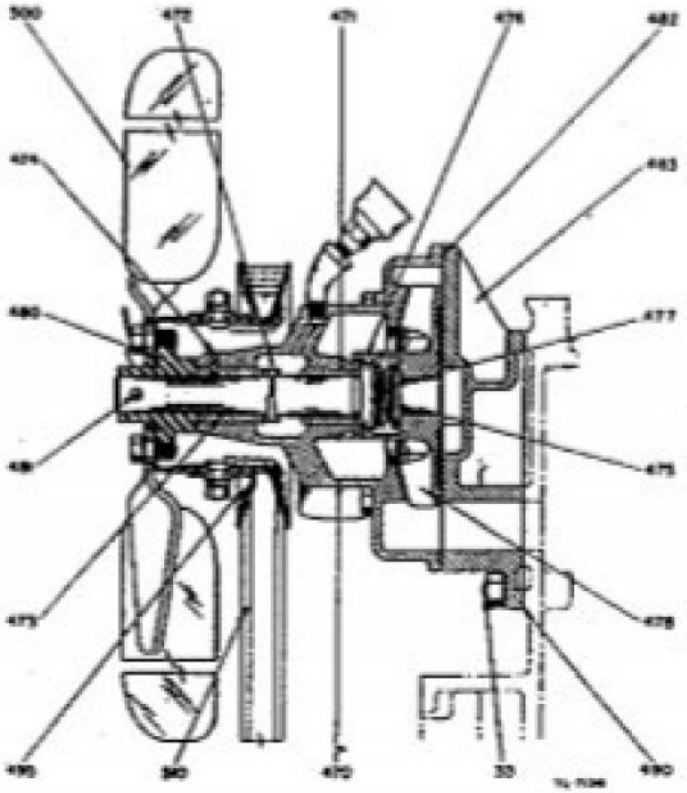


Figure 11. Water pump assembly.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
500		Fan blade assembly		Provides air circulation	42-107
...		Cap screw	Fan blade, 5/16"-18 hexagonal	Attaches fan blade to hub	02-18
...		Lock washer	For No. 02-18, 5/16"	Locks cap screw	05-50
(15) *Cooling group (Le Roi part numbers).*					
1001		Radiator assembly		Cools water	A71-243-9
1002		Packing	Radiator	Prevents leakage	B74-4
....		Cap screw	For radiator, 5/8"-11x1 1/2"		02-10
....		Washer	Plain, 5/8"		06-73
....		Lock washer	5/8"		05-55
1003		Guard	Fan	Guards fan blades	156-170
1003A		Guard	Radiator	Protects radiator	156-169
....		Binding head	No. 10, 3/8", roundhead		Standard hardware
....		Screws	Machine, 1/4"-20x1/2"		Standard hardware
....		Nut	Square, 1/4", 20		Standard hardware
....		Washer	Flat, 1/4"		Standard hardware
....		Ell	Street, 1/4", 45°		013-532
1004		Cock	Drain, 1/4" male and female pipe thread	Drain radiator	15-338
1005		Inlet connection	Radiator	Connect hose line to radiator	65-626
1007		Thermostat		Control water temperature	116-54
1008		Gasket	Inlet connection	Prevent leakage	B16-123
....		Cap screw	Inlet connection, 7/16"-14x1"		02-54
....		Lock washer	7/16"	Connect hose line to cylinder head	05-52
1009		Connection	Cylinder head, water	Prevent leakage	65-624
1010		Gasket	Cylinder-head water connection		16-646
1011		Washer	Plain		R20-1
....		Nut	1/2"-20 hexagonal		04-605
....		Cap screw	Cylinder-head water connection to manifold, 1/2"-13x1 1/4"		02-70
....		Lock washer	1/2"		05-53
1011A		Connection	Manifold water outlet		65-625
1011B		Gasket	Connection		16-146
....		Cap screw	Outlet connection to manifold, 3/8"-16x1"		02-36
....		Lock washer	3/8"		05-51
1012		Hose	Outlet connection to radiator, 1 3/4"x2 1/2"	Connect hose line to radiator	73-5-20
1013		Connection	Outlet, to radiator	Conduct water to radiator	65-627
1015		Tube	Radiator to pump connection		55-208-8
1016		Hose	Radiator to pump, 1 3/4"x3"		73-5-14
....		Hose	Clamp assembly		83-93
1020		Hose	Bypass, 3/4"x11 1/2"	Bypass cooling water	73-29-8
1021		Hose	Clamp assembly	Connect bypass hose to pump	83-92
....		Thermometer		Record water temperature	60-146
....		Screen	Bug		43-131
....		Spring	Bug screen		24-311
....		Clamp	Tubing		83-91
....		Cap screw	3/8"x1/2" hexagonal head		02-32
....		Lock washer	3/8"		05-51

Ref. No.	Stock No.	Name	Description	Function	MW's part No.
(16) *Engine base—oil pan group (Le Roi part numbers).*					
550		Base	Engine (oil pan)	Supports engine	118-250-1
551		Gasket	Engine base flange, carburetor side	Prevent oil leakage	16-647
552		Gasket	Engine base flange, magneto side	Prevent oil leakage	16-648
553		Gasket	Engine base, rear	Prevent oil leakage	16-649
...		Cap screw	Engine base flange, 3/8"-16x 1 1/4" hexagonal		02-37
...		Lock washer	3/8"		05-51
554		Cover	Hand hole	Covers hand hole	14-807
554A		Cover	Hand hole, includes oil filter tube	Covers hand hole and supports tube	14-804
...		Lock washer	3/8"		05-51
...		Nut	3/8"-24 hexagonal		04-603
555		Gasket	Hand hole cover	Prevent oil leakage	16-359
556		Stud	For hand hole cover	Fasten hand hole cover	105-61
558		Nipple	For dip stick		33-101-2
559		Bushing	For dip stick	Holds dip stick	21-355
560		Dip stick	Oil level gauge	Measures oil level	A60-43-19
561		Valve	Oil drain, 3/4", bronze	Drain oil pan	15-349
...		Line	Oil drain, 3/4"x2 1/2"		013-131
...		Ell	Street, oil drain, 3/4", 90°		013-505
...		Nipple	Oil drain, 3/4"x1 1/2" thread, one end		33-101-7
562		Tube	For oil breather	Connects oil breather to oil pan	49-43
563		Breather	Oil pan	Air entry for oil pan	A49-44-1
(17) *Bedplate engine and alternator (Le Roi part numbers).*					
925		Bedplate	Engine and alternator	Foundation for engine and alternator	118-465
...		Cap screw	Engine to base, 3/4"-10x2" hexagonal	Fastens engine to bedplate	02-118
...		Lock washer	For No. 02-118, 3/4"	Lock cap screws	05-57
...		Cap screw	Generator to base, 1"-8x3" hexagonal	Fasten generator to base	02-150
...		Lock washer	For No. 02-150, 1"	Lock cap screws	05-59
926		Pin	Dowel, No. 9, 3"		010-325
927		Shim	For generator base, .005" thick	Make generator support level	22-190-1
928		Shim	For generator base, 0.15" thick	Make generator support level	22-190
928A		Shim	For generator base, .025" thick	Make generator support level	22-190-2
929		Support	Radiator	Support radiator	39-1377
...		Cap screw	Radiator support, 3/8"-16x 7/8" hexagonal	Fasten radiator support	02-35
...		Lock washer	For No. 02-35, 3/8"	Lock cap screws	05-51
930		Support	Starting crank	Support starting crank	39-1225
...		Cap screw	For crank support, 1/2"-13x 1 1/2" hexagonal	Fasten crank support	02-71
...		Lock washer	For No. 02-71, 1/2"	Lock nut	05-53
...		Nut	1/2"—13 hexagonal	Fasten cap screws	04-105
931		Cover	Front, for support		14-802
...		Screw	For cover, 5/16"-18x3/4" button head machine		03-628
...		Lock washer	5/16"		05-50
932		Cover	For battery	Protect battery	14-828
933		Support	For control cabinet	Support cabinet	39-1258
...		Cap screw	For support, 5/8"-11x1 1/4" hexagonal	Fasten support in place	02-100
...		Lock washer	For No. 02-100, 5/8"	Lock cap screw	05-55
934		Mounting	Rubber, for cabinet	Insulate cabinet from vibration	39-1180-1

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
---		Cap screw	For rubber mountings, 1/4"-20x1/2" hexagonal	Fasten mountings	02-2
---		Lock washer	For No. 02-2, 1/4"	Lock cap screws	05-49
934A		Wire	Cabinet to ground	Ground cabinet	61-451
---		Cap screw	1/4"-20x1/2" hexagonal		02-2
---		Washer	Plain, 1/4"		06-69
---		Cap screw	For rubber mountings, 3/8"-16x2" hexagonal	Fasten mountings	34-205
---		Washer	Plain, 3/8"		06-69
---		Nut	3/8"-16 castel		04-303
---		Pin	Cotter, 3/32"x1"		07-23
935		Plate	Name, serial number		62-118
---		Decalcomania	Installation instruction		62-148
936		Rivet	For name plate		08-1005
---		Decalcomania	Instruction for water capacity		62-113

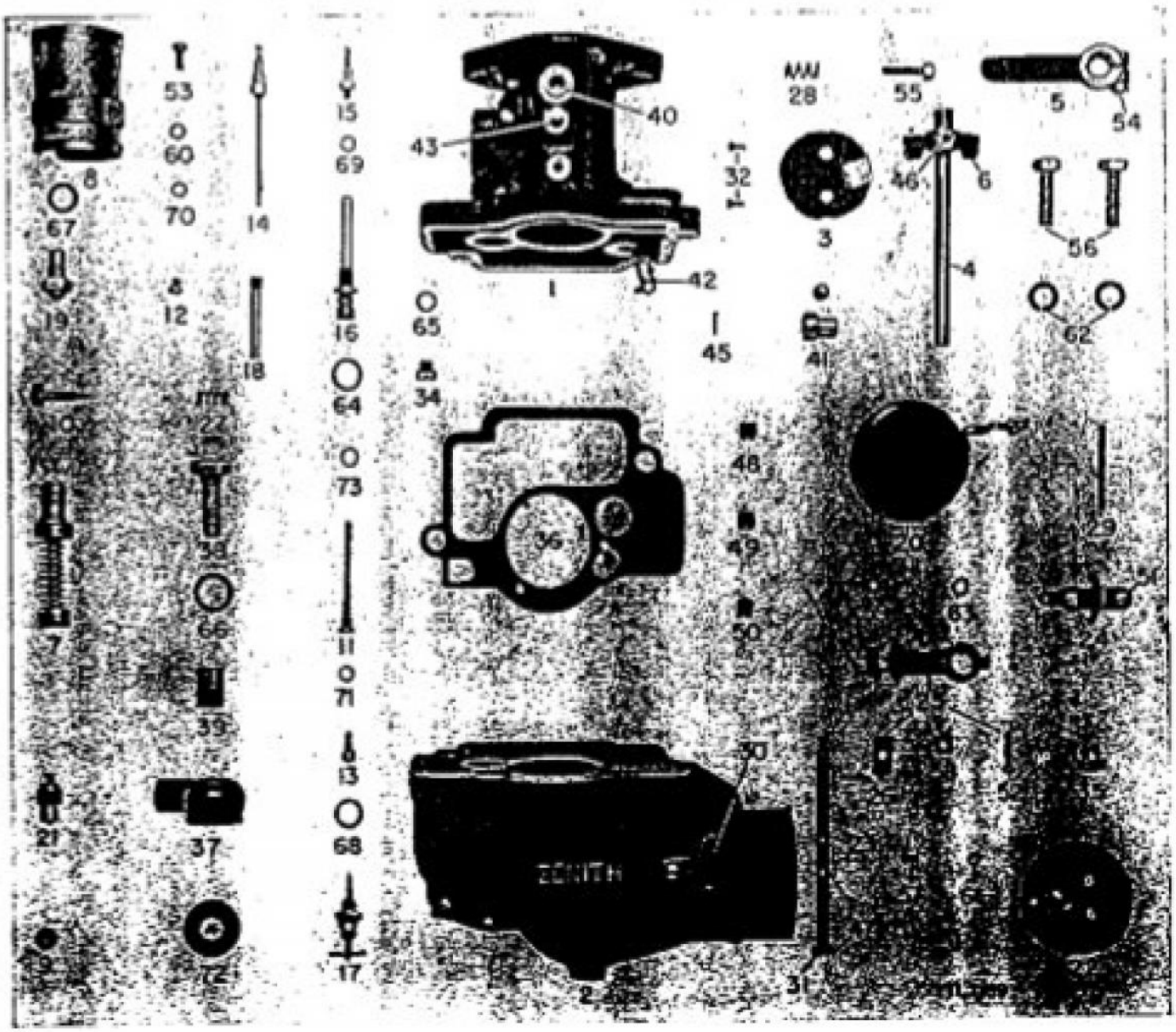


Figure 44. Parts view of Zenith model 450 series carburetor.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
. .		Decalcomania	Instruction for water drain		62-109
. .		Decalcomania	Instruction for weight		62-116
938		Lug	For ground		121-31
. . .		Cap screw	5/16"-18x1/2"		02-16
. . .		Lock washer	5/16"		05-50
. . .		Decalcomania	Oil capacity		62-115

(18) *Carburetor, Zenith model 830 series (Le Roi part numbers).*

1		Throttle body assembly		Enclose throttle parts	82-178-1
2		Fuel bowl assembly		Maintain constant gasoline level	83-17F
3		Plate	Throttle	Controls flow of fuel	C21-34
4		Shaft	Throttle	Locates and operates throttle plate	C23-322
6		Lever	Throttle stop	Limits movement of throttle	C28-67Ax3
7		Pump	Vacuum	Force fuel into air stream	C36-12
8		Venturi	No. 23	Accelerate flow of atomized fuel	638-40A
9		Check valve assembly		Prevents fuel from being forced back into fuel bowl	C41-9
10		Screw	Idle adjusting	Adjust idling needle valve	C46-6
11		Jet	Accelerating, No. 11	Control richness of fuel mixture	C51-3
12		Compensator	No. 24	Gives constant flow of fuel	C52-3
13		Jet	Main, No. 23	Determines amount of fuel for high speed operation	C52-6
14		Jet	Idle, No. 12	Supplies fuel for idling	C54-1
15		Jet	Cap, No. 23, 3	Supplemental jet	C57-1x3
16		Discharge tube assembly		Contains power and accelerating jet	C66-5
17		Adjustment	Main jet	Adjust main jet setting	C71-30
18		Well	Progressive		C76-21
19		Fuel valve assembly	No. 55	Controls fuel level	C81-3
20		Float assembly		Controls fuel level	C85-6
21		Power jet valve assembly		Provides additional fuel for full power	C97-10
22		Air shutter assembly		Controls air intake	C101-22
23		Shaft	Air shutter	Mounts air shutter assembly	C105-86
24		Air shutter lever assembly		Controls air shutter shaft	C106-2
25		Bracket	Air shutter	Mounts air shutter assembly	C109-2
26		Clamp	Tube		C110-1
27		Spring	Idle-adjustment screw	Prevents screw from turning	C111-17
28		Spring	Throttle stop screw	Prevents screw from turning	C111-62
29		Axle	Float	Pivots float	C120-3
30		Pin	Bracket locating	Locates bracket	C120-9
31		Washer	Air shutter shaft thrust	Bearing for air shutter shaft	C130-4
32		Screw	Throttle plate	Attach throttle plate to shaft	C136-3
		Screw	Channel		C138-61
34		Screw	Bracket assembly	Fasten bracket	C140-2
36		Gasket	Bowl to body	Prevent leakage	C142-31

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
37		Body	Union		C148-9A
38		Plug	Filter	Plug filter	C149-17
39		Screen	Filter	Filter fuel	C150-1
40		Bushing	Throttle shaft	Bearing for throttle shaft	CR9-3
42		Bracket	Float	Mount float assembly	CR88-2
43		Pin	Throttle stop	Checks throttle movement	CR121-10
..		Swivel	Air shutter lever		CR134-1
45		Plug	Throttle shaft hole	Plug throttle shaft hole	CR137-20
46		Pin	Throttle stop-lever taper	Fastens lever to throttle shaft	CT63-2
47		Pin	Thrust washer taper		CT63-2
48		Plug	Bowl drain	Plug bowl drain hole	CT91-1
49		Plug	Vacuum spark boss		CT91-1
50		Plug	Intake drain	Plug intake drain	CT91-1
51		Screw	Swivel		T1S8-6
52		Screw	Tube clamp	Fasten tube clamp	T1S8-10
53		Screw	Venturi set		T1S10-6
55		Screw	Throttle stop	Adjust throttle stop	T8S10-13
56		Screw	Bowl to body	Attach bowl to body	T8S31-16
57		Screw	Air shuttle plate	Fasten air shutter plate to shaft	T15B6-4
58		Nut	Tube clamp screw	Fasten tube clamp screw	T21S8
59		Nut	Air shutter shaft	Fasten air shutter shaft	T22S8
60		Lock washer	Venturi set screw	Lock set screw	T41-10
61		Lock washer	Air shutter screw	Lock air shutter screw	T43-6
62		Lock washer	Bowl to body screw	Lock bowl to body screws	T43-103
63		Lock washer	Shaft nut	Lock shaft nut	T45-8
64		Washer	Discharge tube		T56-2
65		Washer	Channel screw		T56-5
66		Washer	Filter plug		T56-15
67		Washer	Fuel valve		T56-23
68		Washer	Main jet adjustment		T56-23
69		Washer	Cap jet		T56-24
70		Washer	Compensator		T56-24
71		Washer	Main jet		T56-24
72		Washer	Union body		T56-36
73		Washer	Power jet		T56-48
...		Pin	Float bracket	Fasten float bracket	T73-15
(19)	*Carburetor-Zenith model 62A10.*		(a) *Le Roi part numbers.*		
430		Carburetor assembly	Zenith No. 62A10	Supply fuel to engine	A84-546-3
431		Gasket	Carburetor flange	Prevent leakage	16-27
---		Cap screw	Carburetor mounting, 3/8"-16x1"		02-36
---		Lock washer	For No. 02-36, 3/8"		05-51
(b)	*Zenith part numbers.*				
1		Throttle body		Inclose throttle parts	B2-104
2		Fuel bowl, assembly		Maintain constant gasoline level	B3-37C
3		Plate	Throttle	Controls flow of fuel	C21-79
4		Shaft	Throttle	Locates and operates throttle plate	C-23164
5		Lever	Throttle	Operates throttle shaft	C24-7
6		Venturi	Main (size 23)	Accelerate flow of atomized fuel	C38-24
7		Venturi	Secondary	Provides maximum acceleration of fuel flow	C39-7
8		Needle	Idle adjusting	Controls amount of air admitted to idling system	C46-38

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
9		Jet	Economizer (blank)	Controls suction for part throttle operation	C52-1
10		Vent	Well (size 19)	Controls flow of fuel from main jet	C52-2
11		Jet	Main (size 27)	Determines amount of fuel for high speed operation	C52-6
12		Jet	Idling (size 13)	Supplies fuel for idling	C55-7
13		Jet	Main discharge (size 60-1)	Controls flow of fuel from main jet	C66-25-1
14		Adjustment	Main jet	Adjust setting of main jet	C71-21
15		Fuel valve assembly	Size 45	Meter fuel	C81-1
16		Float assembly		Controls fuel level	C85-26
17		Plate	Air shutter	Controls air intake	C101-2
18		Shaft	Air shutter	Mounts air shutter plate	C105-18
19		Lever	Air shutter	Turns air shutter shaft	C106-2
20		Bracket	Air shutter	Supports air shutter shaft	C109-2
21		Spring	Idle-adjusting needle	Cushions idle-adjusting needle	C111-17

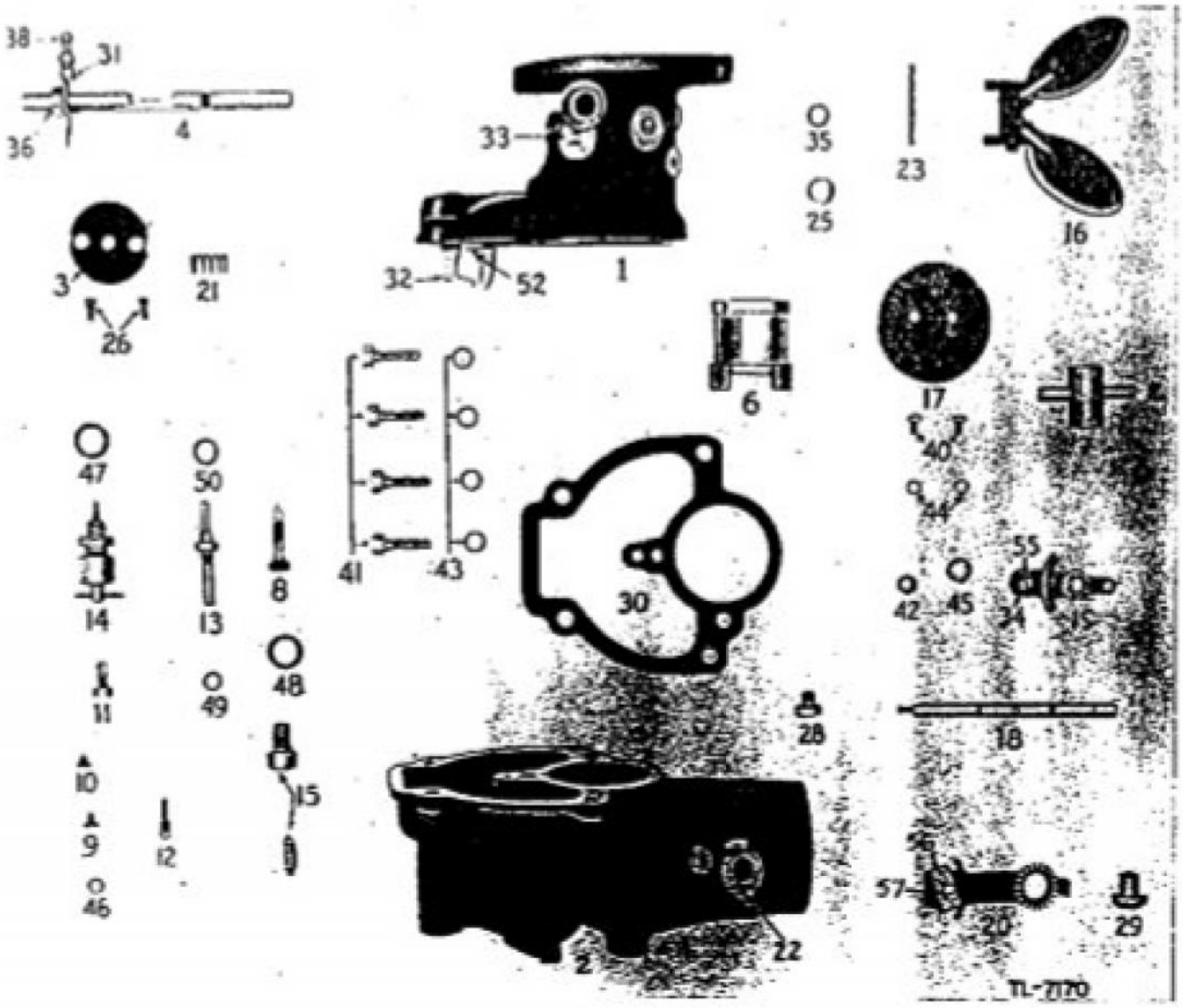


Figure 35. Parts view of Zenith model 63139 carburetor.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
22		Pin	Bracket locating	Locates bracket	C120-9
23		Axle	Float	Pivots float	C120-15
25		Retainer	Packing		C131-3x3
26		Screws	Throttle plate	Attach throttle plate to shaft	C136-3
28		Plug	Air-shutter shaft hole	Plug air-shutter shaft hole	C138-24
29		Screw	Air-shutter bracket	Fasten bracket	C140-7
30		Gasket	Bowl to body	Prevent leakage	C142-15
31		Lever	Throttle stop	Limit throttle travel	CR28-28
32		Bracket	Float	Mounts float	CR88-7
33		Pin	Throttle stop	Checks throttle movement	CR121-8
34		Swivel	Air-shutter lever		CR134-1
35		Washer	Throttle shaft packing	Bearing for packing	CT57-8
36		Pin	Taper		CT63-2
37		Plug	Pipe (not illustrated)		CT91-3
38		Screw	Throttle stop	Adjust throttle stop	T1S8-10
40		Screw	Air-shutter plate	Fasten air-shutter plate to shaft	T15B6-4
41		Screw	Bowl to body	Attach bowl to body	T18S12-12
42		Nut	Air shutter shaft	Fasten air shutter shaft	T22S8
43		Lock washer	Bowl to body screw	Lock bowl to body screws	T41-12
44		Lock washer	Air-shutter screw	Lock air-shutter screws	T43-6
45		Lock washer	Air-shutter shaft nut	Lock nut	T45-8
46		Washer	Economizer jet		T56-4
47		Washer	Main jet adjusting or lower plug		T56-23
48		Washer	Fuel valve		T56-23
49		Washer	Main jet		T56-24
50		Washer	Main discharge jet		T56-48
51		Pin	Secondary venturi locating	Locate secondary venturi	T73-8
52		Pin	Float bracket	Locate float brackets	T73-9
54		Washer	Swivel (not illustrated)		CT52-1
55		Screw	Swivel (not illustrated)		T1S8-6
...		Packing	Air-shutter shaft (not illustrated)	Prevent leakage	.....

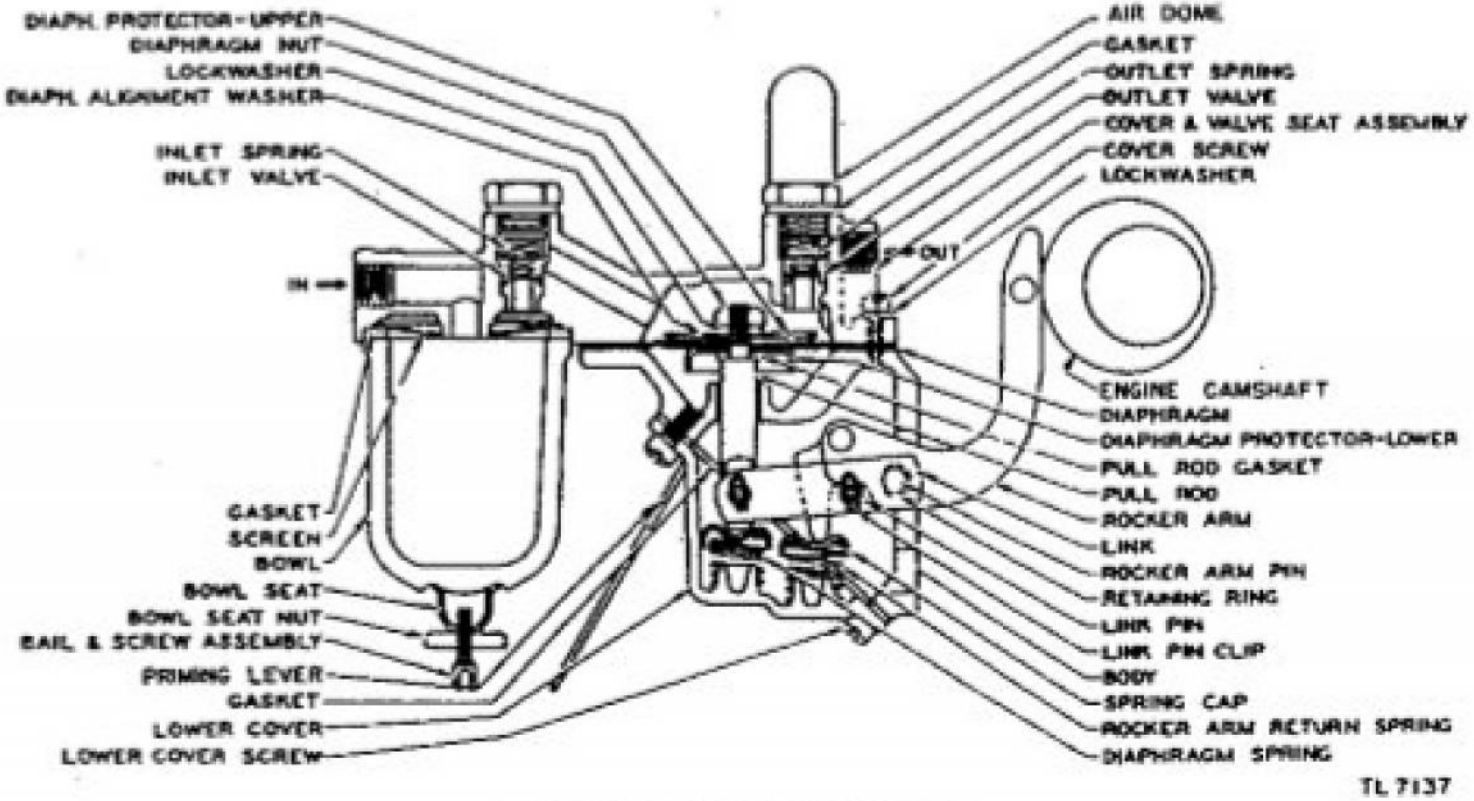


Figure 46. Cross section through fuel pump.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
...		Retainer	Packing (not illustrated)	Hold packing in place	.....
...		Screen	Filter (not illustrated)	Filter fuel	C150-12
...		Washer	Filter screen (not illustrated)	Bearing for filter screen	T56-10
(20) *Fuel pump.* (a) *Le Roi part numbers.*					
445		Fuel pump assembly	A. C. No. 1523019	Pump fuel	AB1-99-4
446		Gasket	Fuel pump flange	Prevent leakage	16-229
...		Cap screw	Fuel pump mounting, 5/16"-18x3/4" hexagonal		02-18
...		Lock washer	For No. 02-18, 5/16"		05-50
(b) *A. C. part numbers.*					
		Dome	Air	Stores air	855918
		Plug	Valve	Shuts off valve	855281
		Gasket	Valve plug and air dome	Prevent leakage	855282
		Spring	For valve	Hold valve closed	856270
		Valve		Fuel intake and outlet	855279
		Top	Cover and valve seat assembly	Outlet for fuel	855761
		Screen	Le Roi No. 43-135	Filter fuel	1523603
		Gasket	For bowl (Le Roi No. 16-921)	Prevent leakage	854003
		Bowl	Fuel sediment, glass (Le Roi No. 184-2)	Settling chamber for fuel sediment	854004
		Seat	For bowl	Support for bowl	854005
		Nut	Bail thumb	Adjusts bail and screw assembly	855763
		Bail and screw		Fasten bowl to fuel inlet assembly	854016
		Protector	Diaphragm, lower	Protect diaphragm	1521720
		Protector	Diaphragm, upper	Protect diaphragm	855274
		Nut	Pull rod	Fasten pull rod	855213
		Lock washer	For No. 855213	Lock pull rod nut	855390
		Washer	Diaphragm alignment	Center diaphragm	855029
		Gasket	For pull rod	Prevent leakage	855012
		Diaphragm	5 pieces (Le Roi No. 186-9)	Pumps fuel	855389
		Rod	Pull	Operates diaphragm	855250
		Arm	Rocker	Operates link, diaphragm and pull rod assembly	1523020
		Pin	Rocker arm	Pivots rocker arm	1521289
		Washer	For No. 1521289	Bearing for pin	1521288
		Link	Rocker arm	Transmits motion to pull rod	855574
		Pin	Link	Makes contact with rocker arm	855016
		Clip	Link pin	Fasten link pin	855017
		Body	Fuel pump	House pump mechanism	855674
		Cap	Spring	Cover for spring	855532
		Spring	Rocker arm	Keep rocker arm in contact with camshaft	855253
		Gasket	Bottom cover	Prevent leakage	855585
		Cover	Bottom	Cover opening in body	855573
		Screw	Bottom cover	Attach cover	132108
		Spring	Diaphragm, lower	Put return pressure on diaphragm	1521266
		Lever	Priming	Prime pump	1522280
		Screw	Top cover	Fasten top cover	855493
		Lock washer	For No. 855493	Fasten top cover screw	855064
		Plug	Pipe		103877

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(21) *Air cleaner (Air-Maze model 37U-OBF). (a) Le Roi part numbers.*					
453		Air cleaner	Oil bath, Air-Maze, model 37U-OBF	Clean intake air to carburetor	A77-145-1
455		Connection	Air cleaner to carburetor	Connect air cleaner to carburetor	65-620
456		Gasket	Air-cleaner connection	Prevent entry of dirt and dust	16-908
...		Cap screw	Connection to cylinder block 3/8"-16x3/4"		02-34
...		Lock washer	For No. 02-34		05-51
457		Connection	Hose, 2" diameter x 3"	Conduct air from cleaner to carburetor	73-1-16
...		Clamp	Hose	Fasten hose	83-94
(b) *Air-Maze part numbers.*					
		Assembly	Upper		AP-1128U
		Assembly	Top and skirt		AP-112U
		Element	Filter	Filter dirt and dust from air	AP-18
		Bowl	Lower	Supports filter element and holds oil	AP-137F
		Plate	Baffle	Forms passage for air	AP-17F
		Felt liner and retaining spring			AP-137Z
		Clamp	Assembly		AP-22F
		Nut	Wing	Fasten upper assembly to lower bowl	AP-15
		Decalcomania	Instruction		AP-4

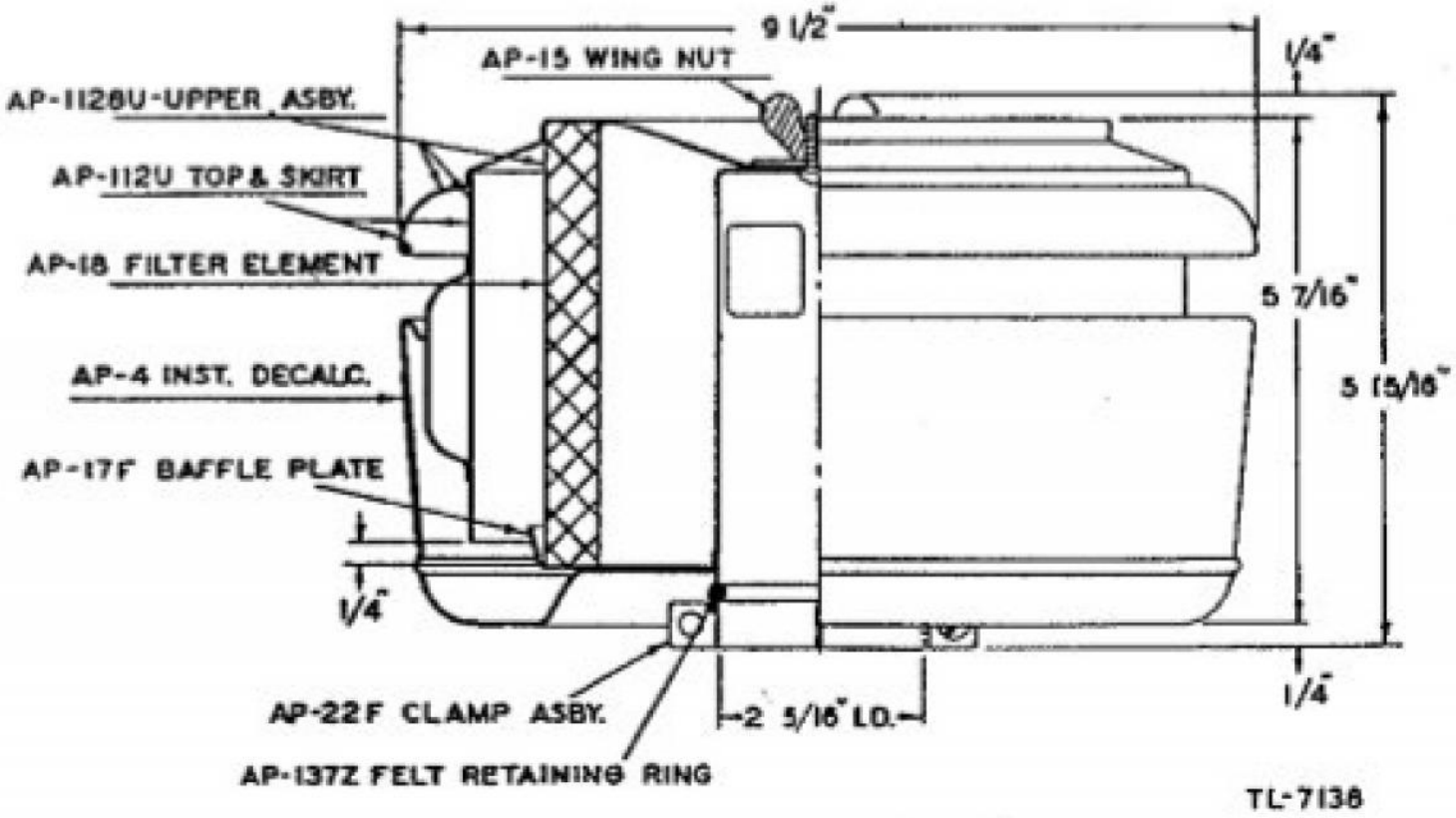


Figure 47. Cross section of air cleaner No. 37U-OBF.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(22) *Air cleaner (Air-Maze Unimaze type No. 4-MA).*					
		Cleaner, air	Unit complete	Clean intake air to carburetor	4-MA
		Cleaner, air	Complete except base		4-NB
		Top			BJ-51
		Element	Filter only	Filters air	BJ-18
		Filter element	With spreader		BJ-184
		Nut	Wing, only	Fastens top to base	BJ-52
		Stem			BJ-53
		Spreader			BJ-54
		Base	2 5/8" inside diameter		BJ-567
		Plate	Name		BJ-3
		Decalcomania	Instruction only		BJ-8
		Gasket			BJ-6
(23) *Fuel tank, lines, etc. (Le Roi part numbers).*					
950		Assembly	Fuel tank, 15 gal. U. S. capacity	Holds fuel supply	69-186
951		Strap	Fuel tank, hold down	Fastens tank to engine	83-37
...		Nut	For No. 83-37, 3/8"-16 hexagonal		04-103
...		Lock washer	For No. 04-103, 3/8"		05-51
955		Assembly	Cap, for fuel tank	Covers tank intake	A4-129
957		Plug	Drain, brass, 1/4" square head	Plug tank drain hole	011-252
958		Nipple	1/4" brass, close		33-546
959		Elbow	Reducing, 1/4"x1/8", 90°		33-547
...		Nipple	1/8" brass, close		33-544
960		Line	Fuel, tank to valve, Titeflex—11"-3/4"	Conduct fuel from tank to valve	A55-643-3
961		Line	Fuel, pump to valve, Titeflex—23"	Conduct fuel from pump to valve	A55-643-4
962		Line	Fuel, pump to carburetor, Titeflex—38"	Conduct fuel from pump to carburetor	A55-643-6
963		Nipple	1/8"x2", brass		33-545
964		Ell	Street 1/8", 90°, brass		33-542
965		Ell	Street, 1/8", 45°, brass		33-543
967		Clamp	For fuel line	Secure fuel line	83-44
...		Cap screw	For No. 83-44, 1/4"-28x1/2"	Fasten clamp	02-502

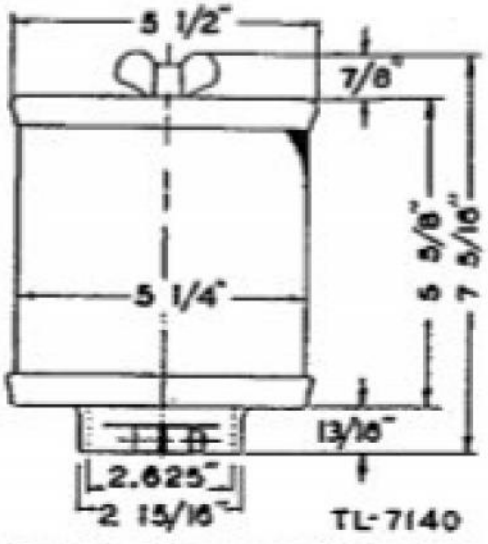


Figure 35. Unimaze type air filter No. 4-MA.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
...		Lock washer	For No. 02-502, 1/4"	Lock cap screw	05-49
...		Nut	For No. 02-502, 1/4"-28 hexagonal	Fasten cap screw	04-601
966		Control	Choke		120-2-9
968		Valve	Needle, brass, 1/8" point		15-321
970		Support	Fuel tank, (carburetor side)	Support fuel tank	39-1253
971		Support	Fuel tank, (magneto side)	Support fuel tank	39-1256
...		Cap screw	For supports, 3/8"-16"x1" hexagonal	Fasten supports	02-36
...		Lock washer	For No. 02-36, 3/8"	Locks cap screws	05-51
...		Decalcomania	Instruction		62-101
974		Hose	Gasoline, flexible, 35'	Connect engine to fuel drum	73-253-8
975		Coupling	1"x1/4" reducing		33-548
(24)	*Governor assembly.*		(a) *Le Roi part numbers.*		
281		Assembly	Governor, Woodward Model SGX No. 040348, includes next three items	Control fuel supply to engine	1A116-84
...		Lever	Governor operating	Transmit motion	48-508-1
...		Pin	Taper, for operating lever, No. 000x1/2"	Fasten lever	010-201
...		Screw	For operating lever		03-92
282		Gasket	Governor flange	Prevent leakage	16-873
...		Cap screw	Governor flange, 5/16"-15x1 1/4" hexagonal	Fasten governor flange	02-21
...		Lock washer	5/16"	Lock cap screws	05-50

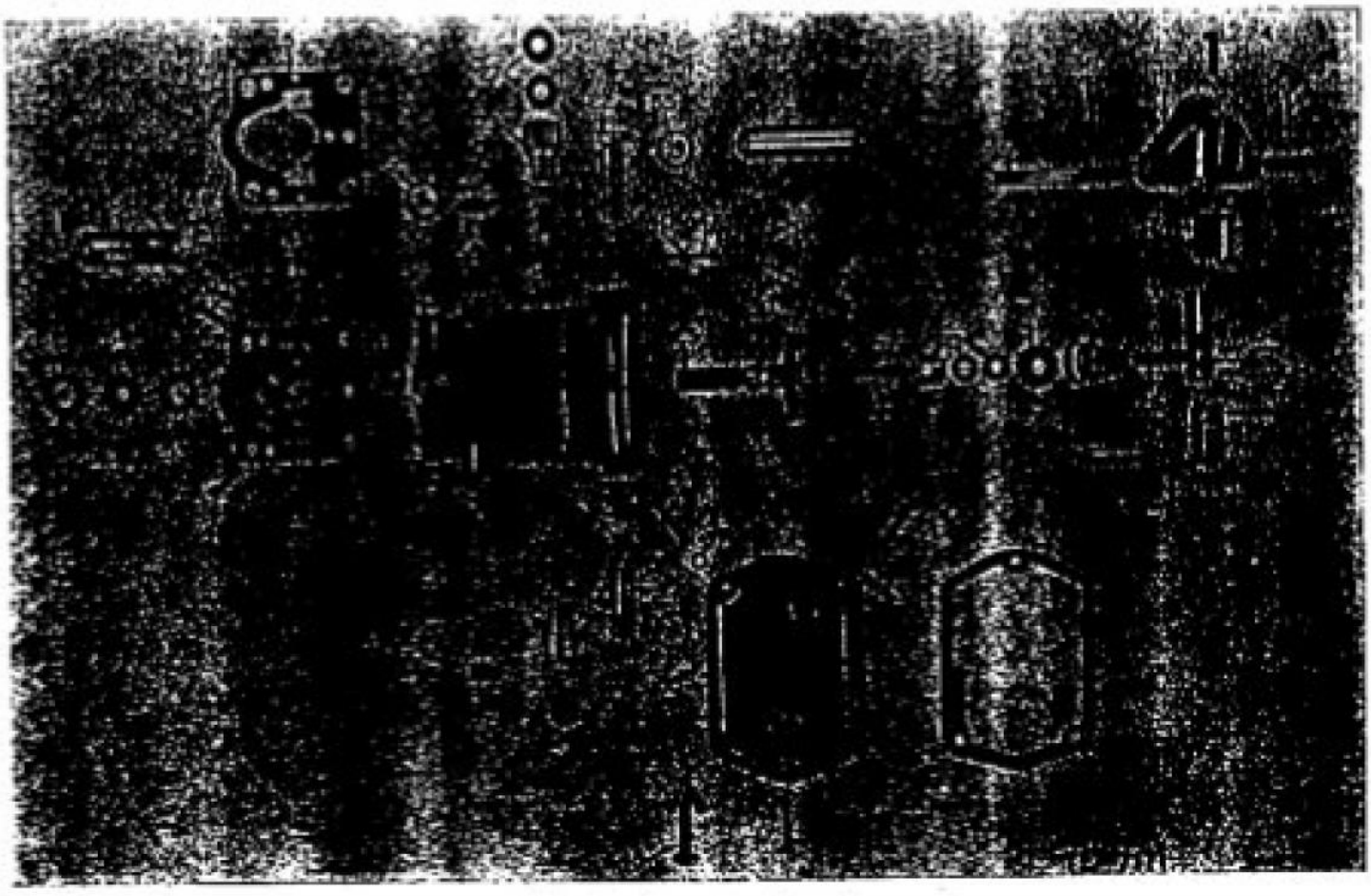


Figure 51. Governor parts lay-out.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(b) *Woodward part numbers.*					
1		Piston	Servo	Operates terminal lever	040005
2		Plunger	Pilot valve	Regulates amount of oil admitted under power piston	040041
3		Plunger	Relief valve	Opens and closes relief valves	040042
5		Gasket	Base	Prevent leakage	040149
6		Gasket	Cover	Prevent leakage	040156
8		Pin	Spring fork	Attach floating lever to spring fork	040307
10		Stud	Idler	Fasten idler gear	040310
11		Pin	Speed adjusting lever	Attach lever to speed adjusting shaft	040384
12		Sleeve	Terminal	Contains terminal shaft bushing	040316
14		Base	Governor	Support governor	040319
16		Case	Governor	House governor parts	040326
17		Cover		Cover governor housing	040328
18		Seat	Spring	Bearing for spring	040331
19		Lever	Terminal	Transmits motion of lower piston to terminal shaft	040338
20		Shaft	Terminal, short	Supports one end of lever mechanism	040340
21		Shaft	Terminal, long	Causes fuel setting of engine to vary	040341
22		Cap	Spacer		040342
24		Screw	Droop adjusting	Holds droop adjusting bracket	040346
25		Fork	Spring	Holds floating lever	040350
26		Bearing	Thrust	Bearing for ball arm assembly	180004
27		Seal	Neoprene oil	Prevent leakage	182079
29		Bushing	Oilite	Bearing for terminal shaft	183180
28		Bushing	Oilite	Bearing for terminal shaft	183181
30		Pin	Ball arm	Pivot for ball arm	184000
31		Pin			184001
32		Pin	Dowel, base	Locate base	184008
33		Pin	Cotter, 1/16" x3/8"		184100
36		Pin	Cotter, 3/32", 1" diameter		184362
35		Pin	Cotter, 1/16", 5/8" long		184229
37		Collar	Drive shaft	Support drive shaft bearing	186003
38		Plug	Pipe	Fits in oil supply line fitting	187034
39		Plug	Welch	Cover end of short terminal shaft	187109
40		Nut	Speed limit	Lock high limit adjustment screw	188041
41		Screw	Base	Fasten governor to base	188116
42		Screw	Cover	Fasten cover to governor	188118
43		Washer	Shakeproof No. 10	Lock cover screw	188138
44		Screw	Cover	Fasten cover to governor	188144
45		Screw	Low limit adjustment	Limit minimum speed setting	188147
46		Nut	Wing, cadmium plated	Lock low limit adjustment screw	188148
47		Screw	High limit adjustment	Limit maximum controlling speed	188149
48		Screw	Drive No. 2	Fasten name plate	188216
50		Spring	Speeder	Determines speed adjustment	191441
49		Spring	Relief valve	Acts against relief valve plunger	191369
51		Plate	Name		193000
54		Gear	Idler	Pumps oil	204361
53		Gear	Pump	Pumps oil	204362
55		Gasket	Copper washer	Bearing for spacer cap	206000
56		Plug			040126
23		Head	Ball	Supports ball arms	040352

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
13		Lever	Floating	Transmits motion	040353
9		Shaft	Speed adjusting	Causes speed adjusting lever to raise or lower floating lever	040354
7		Lever	Speed adjusting	Raise or lower floating lever	040355
4		Sleeve	Relief valve	House valve parts	040359
52		Flyball		Furnish centrifugal force	196000
57		Assembly	Droop adjustment bracket, includes droop rivet pin	Vary speed droop setting	040364

Note. When ordering replacement parts for governor be sure to include the following information:
1. Governor serial number. (See governor name plate.)
2. Part name and number. (See list herein.)
3. Governor part number. (See governor name plate.)

h. Electrical Components. (1) *Cranking motor.* (*a*) *Le Roi part numbers.*

600	Motor	Cranking, Delco Remy model 412, 12-volt	Crank engine	A107-37
...	Cap screw	Cranking motor mounting, 3/8-16x1" hexagonal	Attach cranking motor to engine	02-36
...	Lock washer	For No. 02-36, 3/8"	Lock cap screw	05-51

(*b*) *Delco Remy part numbers.*

...	Plate	Bearing	Support bearing	16199
...	Housing	Drive	Inclose drive mechanism	16999
..	Strip	Insulation	Insulate field coil from motor frame	33345
...	Spring	Brush	Supply pressure for brushes	34846

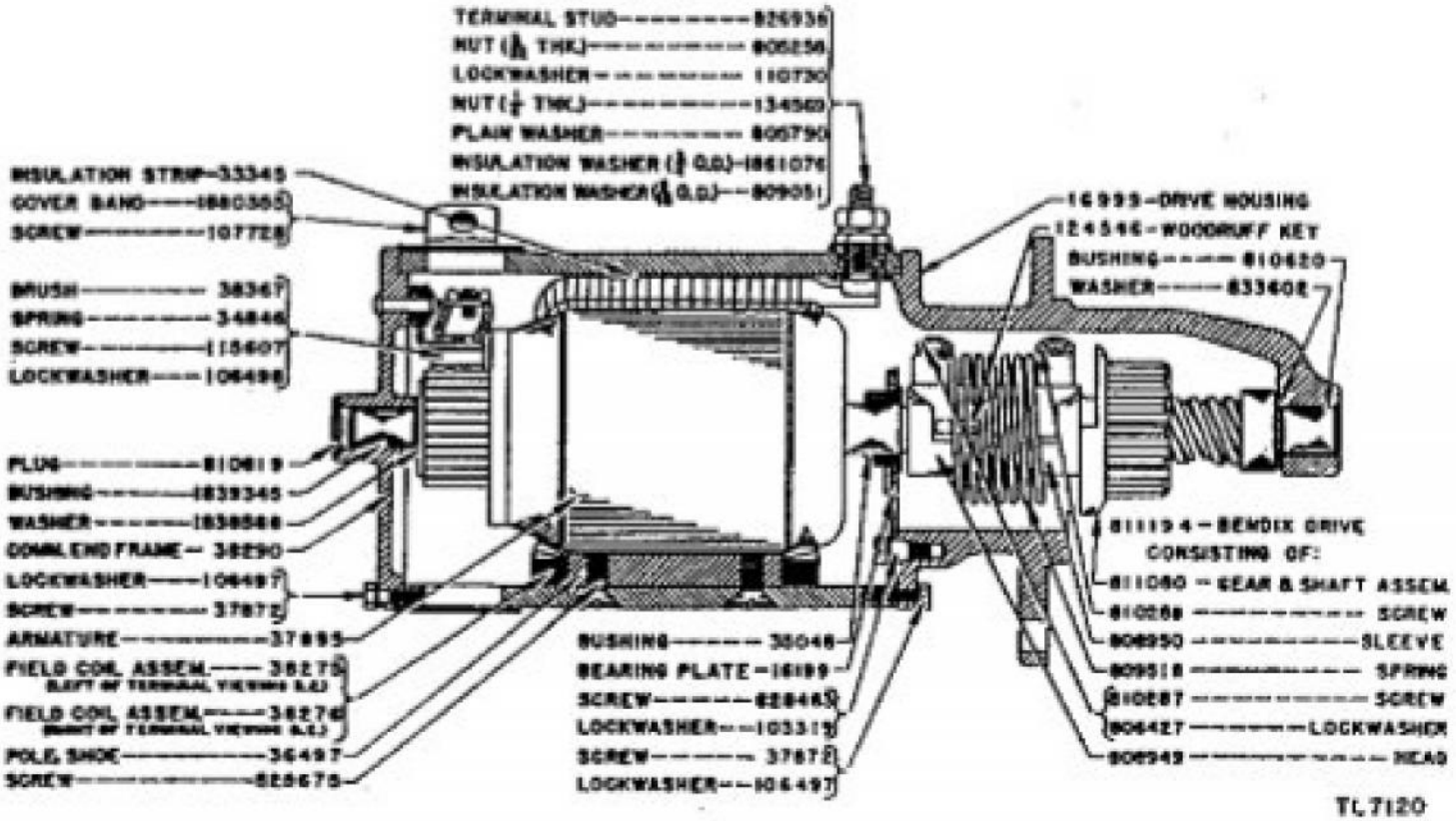


Figure 90. Cranking motor.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
...		Bushing		Bearing for armature shaft	35048
		Shoe	Pole	Supply magnetic force	36497
.		Cap screw		Fasten drive housing to motor frame	37872
		Armature		Drives motor shaft	37895
		Field coil assembly	Left	Carry field current for pole	38275
		Field coil assembly	Right	Carry field current for pole	38276
.		Frame	Commutator end	Carries armature shaft bushing and incloses motor frame	38290
..		Brush		Supplies current to commutator	38367
...		Lock washer		Lock bearing-plate screw	103319
...		Lock washer		Lock brush screw	106496
...		Lock washer		Lock end-frame cap screw	106497
...		Screw		Fasten cover band	107728
...		Lock washer		Lock nut (5/32" thick)	110730
...		Screw		Fasten brush leads	115607
...		Key	Woodruff	Fasten drive mechanism to shaft	124546
...		Nut	1/4" thick	Fasten terminal stud to frame	134569
...		Nut	5/32" thick	Lock terminal stud fastening	805258
...		Washer		Bearing for nut (1/4" thick)	805790
...		Lock washer		Lock drive-mechanism screw	806427
...		Head			808949
...		Sleeve			808950
...		Washer	Insulation, 9/16" outside diameter	Insulate terminal stud hole	809051
...		Spring		Absorb starting torque	809518
...		Screw	Head	Fastening for drive mechanism	810287
...		Screw	Sleeve		810288
...		Bushing		Bearing for drive shaft	810620
...		Plug		Seal bearing in commutator end frame	810819
...		Gear and shaft			811080
...		Drive	Bendix	Connect starting motor to engine	811194
...		Stud	Terminal	Terminal for motor connections	826938
...		Screw		Fasten bearing plate to drive housing	828483
..		Screw		Fasten pole shoe to motor frame	828675
...		Washer		Seal for drive shaft bushing	833602
...		Washer		Seal for armature shaft bushing	1838568
.		Bushing		Bearing for armature shaft	1839345
..		Washer	Insulation, 3/4" outside diameter	Insulate terminal stud and nut from frame	1861076
..		Band	Cover	Cover opening to commutator	1880355

(2) *Magnetic switch.* (a) *Ex Rio part numbers.*

601	Switch	Magnetic, Delco Remy model 1422	Start cranking motor	A76-46
601A	Spacer	For magnetic switch		22-189
	Cap screw	Magazine switch mounting, 1/4"-20x1" hexagonal	Fasten switch to engine	02-6
	Lock washer	For No. 02-6, 1/4"	Lock cap screw	05-49

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.

(*b*) *Delco Remy part numbers.*

---		Lock washer		Lock terminal nuts	110730
---		Nut		Fasten base screw	120614
---		Nut	Terminal	Fasten terminal	120622
---		Nut	Thick	Lock nut on terminal assembly	134569
---		Lock washer		Prevent lock nut from turning	802731
---		Nut	Thin	Fasten terminal studs	805258
---		Washer		Bearing surface for lock washer	805790
---		Insulation	Bent	Insulate terminal studs	811492
---		Washer	Outside	Bearing for connecting wire	813731
---		Bushing	Insulation	Insulate connecting stud	816863
---		Plug	Cover	Seal plunger end	820657
---		Stud		Terminal for wire leads	822205
---		Spring		Releases plunger when current is shut off	825227
---		Plunger		Moves push rod and contact	825228
---		Pin		Fastens push rod to plunger	825229
---		Washer	Inside	Bearing for connecting wire	826319
---		Lock washer		Locks terminal nuts	826498
---		Washer	Insulation	Insulate connection stud	1838591
---		Push rod and contact		Make and break electrical connection	1843456
---		Case and bracket		Attach magnetic switch to motor	1843458
---		Stud	Terminal	Fasten stationary contacts	1843464
---		Insulation	Base	Insulate base	1843465
---		Strip	Insulation		1843466
---		Coil		Provide magnetic force to operate plunger	1862901
---		Screw		Fasten base to frame	1866970
---		Stop and base		Limit plunger travel	1869463
---		Base and terminal assembly		Assembly for stationary contacts	1869467

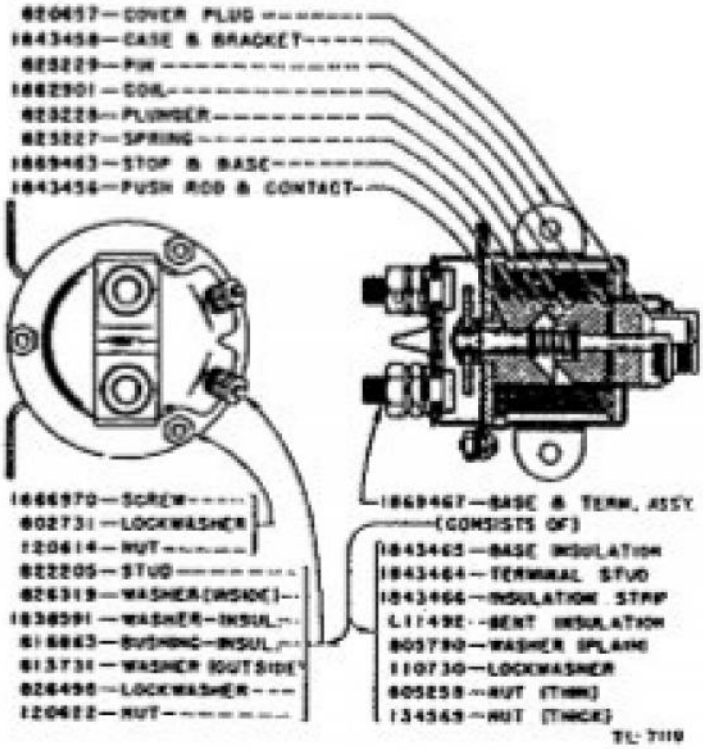


Figure 51. Magnetic switch.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(3) *Generator, 12-volt.* (*a*) *Le Roi part numbers.*					
602		Generator and regulator assembly	Delco Remy Model 1101747	Charge battery	A108–87
603		Support	For generator	Support generator	39–1353
		Cap screw			02–34
		Lock washer	For No. 02–34, 3/8"		05–51
		Cap screw			02–20
		Lock washer	For No. 02–20, 5/16"		05–50
		Nut	For No. 02–20, 5/16", 18		04–102
604		Support	Adjusting		39–1354
606		Pulley	Generator drive	Drive generator	36–519
607		Belt	Generator drive	Drive generator pulley	41–229
(*b*) *Delco Remy part numbers.*					
		Control unit		Control generator output	5849
		Lock washer		Lock screw No. 186280	106495
		Lock washer		Lock screw No. 186833	106496
		Lock washer		Lock screw No. 141543	106497
		Screw		Fasten cover band	107728
		Lock washer		Lock through bolt No. 815018	108579
		Key	Woodruff	Fasten pulley to shaft	124545

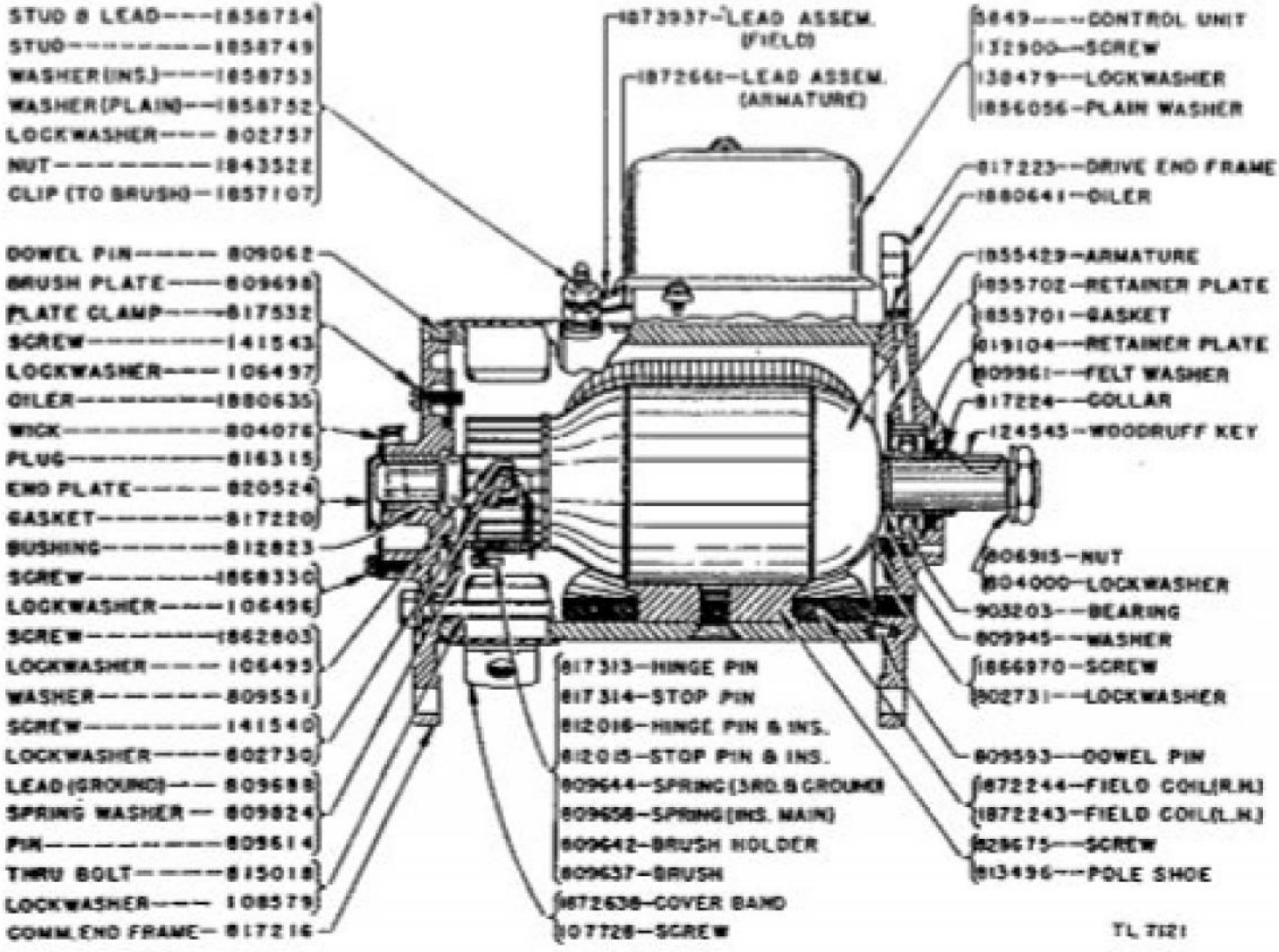


Figure 52. Charging generator.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
---		Screw		Fasten control unit	132900
---		Lock washer		Lock screw No. 132900	138479
---		Screw		Terminal for wire lead to brush	141540
---		Screw		Fasten brush plate	141543
---		Lock washer		Lock screw No. 141540	802730
---		Lock washer		Lock screw No. 1866970	802731
---		Lock washer		Lock nut No. 1843522	802757
---		Lock washer		Lock nut No. 806915	804000
---		Wick		Contains oil for lubricating armature bearing	804076
---		Nut		Fasten pulley to shaft	806915
---		Pin	Dowel	Locate commutator and frame to housing	809062
---		Washer		Bearing for screw No. 1862803	809551
---		Pin	Dowel	Locate drive end frame to housing	809593
---		Pin			809614
---		Brush		Conduct current from commutator	809637
---		Holder	Brush	Hold brush in place	809642
---		Spring	3d and ground		809644
---		Spring	Insulating, main	Supply tension to hold brush to commutator	809658
---		Lead	Ground	Conduct current to ground	809688
---		Plate	Brush		809698
---		Washer	Spring	Lock ground lead	809824
---		Washer		Hold bearing No. 903203	809945
---		Washer	Felt	Prevent leakage of lubricant	809961
---		Stop pin and insulation			812015
---		Hinge pin and insulation			812016
---		Bushing		Bearing for armature shaft	812823
---		Shoe	Pole	Supply magnetic force	813496
---		Bolt	Through	Fasten end frames to generator housing	815018
---		Plug			816315
---		Frame	Commutator end	Cover commutator end of housing	817216
---		Gasket		Prevent dust and dirt from entering bushing	817220
---		Frame	Drive end	Cover drive end of housing	817223
---		Collar		Support retainer plate and washer	817224
---		Pin	Hinge	Hinge brush arm	817313
---		Pin	Stop	Stop for brush arm	817314
--		Clamp	Plate	Clamp brush plate	817532
--		Plate	Retainer	Retainer bearing	819104
--		Plate	End	Seal shaft at commutator end	820524
--		Screw		Fasten pole shoe to housing	828675
--		Bearing	Ball	Bearing for drive end of shaft	903203
--		Nut		Fasten lead assembly	1843522
-		Armature		Generate current	1855429
--		Gasket		Seal retainer plate fastening	1855701
--		Plate	Retainer	Prevent leakage of lubricant from bearing	1855702
--		Washer			1856056
-		Clip	To brush	Connection to brush	1857107

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
. . .		Stud	Field	Connection for field lead assembly	1858749
. . .		Washer		Bearing for connecting wire	1858752
. . .		Washer	Insulation	Insulate stud	1858753
. . .		Armature	Stud and lead	Connection to brush	1858754
. . .		Screw			1862803
. . .		Screw		Fasten retainer plate	1866970
. . .		Screw		Fasten end plate	1868330
. . .		Coil	Field (left-hand)	Provide magnetic force	1872243
. . .		Coil	Field (right-hand)	Provide magnetic force	1872244
. . .		Band	Cover	Cover commutator opening	1872638
. . .		Lead	Armature	Connection from brush	1872661
. . .		Lead	Field	Connection from field coils	1873937
. . .		Oiler		Supply lubricant for bushing	1880635
. . .		Oiler		Supply lubricant for ball bearing	1880641
(4) *Battery.* (a) *Le Roi part numbers.*					
608		Battery	Globe-Union No. 133, 12-volt	Supply starting current	A117-33
608A		Strap	Battery	Fasten battery	83-90
. . .		Lock washer	For No. 83-90, 3/8"		05-51
. . .		Nut	For No. 83-90, 3/8" 16 hexagonal		04-103
609		Spacer	Rubber, for battery		22-191

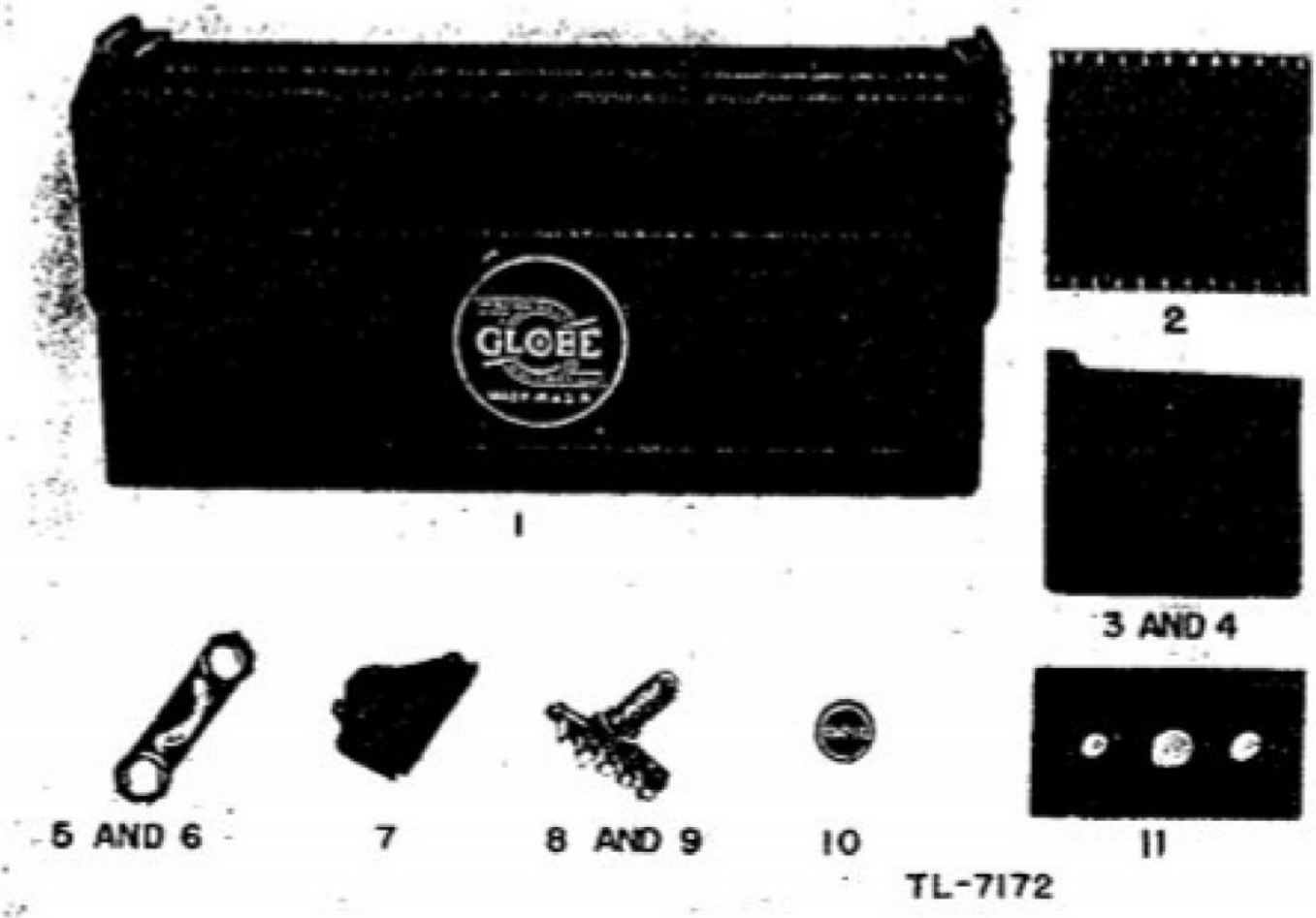
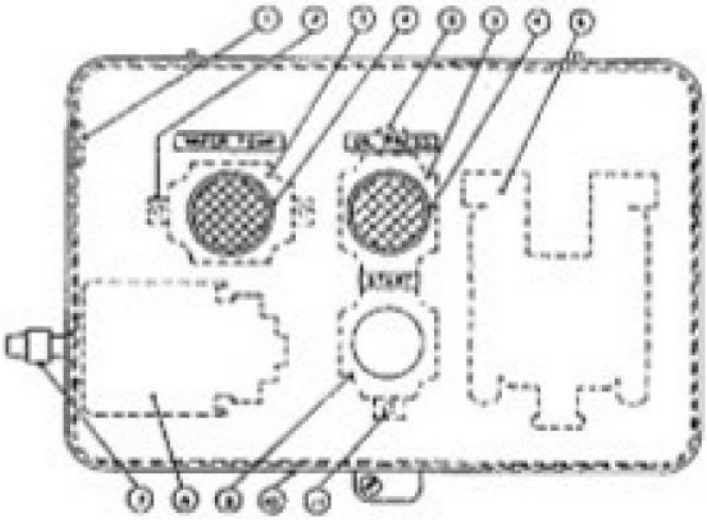
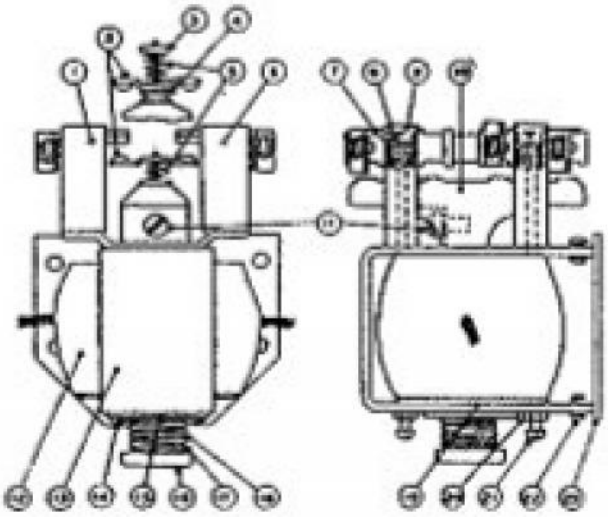


Figure 33. Battery parts.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(b) *Globe-Union part numbers.*					
1		Container	Hard rubber, with drop handle	Contains battery solution and plates	SH1563
2		Separator	Spintex rubber, with fiberglas mat	Prevent plates from touching	LB-BG
. . .		Separator	Port Orford cedar wood, with fiberglas mat	Prevent plates from touching	BB-G
3		Plate	Formed positive	Acts as positive electrode	BB POS
4		Plate	Formed negative	Acts as negative electrode	BB NEG
5		Link	Globe, for end cells	Connect cells	1D
6		Link	Globe, for intermediate cells	Connect cells	4B
7		Compound	Battery sealing	Seal battery	
8		Strap	Positive plate	Connection for positive plates	15BB POS
9		Strap	Negative plate	Connection for negative plates	15BB NEG
10		Plug	Globe vent	Cover all openings	G





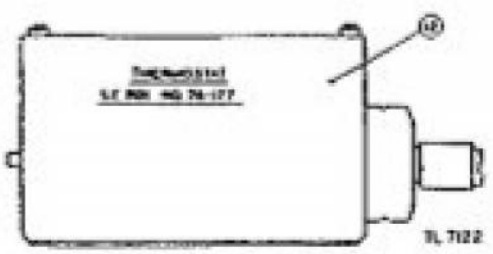


Figure 52. Control switch box assembly.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
11		Cover	Hard rubber cell	Prevent solution from spilling	1678
Not shown		Acid	Battery, 1.285 specific gravity, (7/8 gallon in bottle packed for shipment; 3 bottles needed to fill battery)	For electrolytic solution in cells	
(5) *Control switch box assembly.* (a) *Le Roi part numbers.*					
640		Control switch box assembly	Allen-Bradley No. X-84446	Control engine operation	A76-176
...		Machine screw	Control box mounting, 1/4"-20x1/2"	Fasten mounting	03-619
...		Lock washer	For No. 03-619, 1/4"	Lock machine screw	05-49
(b) *Allen-Bradley part numbers.*					
1		Grommet	Rubber	Provide tight seat for cover	F-13342
2		Strap	Mounting	Mount pilot light unit	A-22509
3		Pilot light unit (with lamp)		Indicate high water temperature	X-49323
...		Lamp	12-volt	Lights when water temperature is too high	X-84317
4		Lens	Red	To distinguish water temperature lamp	X-70103
5		Strap	Mounting	Mount oil pressure switch	A-22508
7		Adapter			X-67988
8		Switch	Pressure	Stops engine when oil pressure fails	X-62153
9		Button	Push	Connects cranking motor to circuit	X-49579
10		Cabinet	For two pilot lights	House control parts	X-84561
...		Cabinet	For one pilot light	House control parts	X-84562
11		Screw	With M-1100 washer	Fasten starter switch	M-718
12		Thermostat	Le Roi No. 76-177	Shuts down engine when water temperature is too high	X-66847
(6) *Control switch box relay (Allen-Bradley part numbers).*					
1		Contact	Left-hand, stationary	Conduct current	X-48686
2		Contact	Movable, twisted	Conduct current	X-68997
3		Washer	Cup	Seat for spring	M-2429
4		Spacer			E-8394
5		Spring	Contact	Insure tight closure of contacts	E-10113
6		Contact	Right-hand, stationary	Conduct current	X-48687
7		Spring			B-8590
8		Washer	Iron	Bearing for spring	M-1689
9		Screw	No. 4-40 x 1"	Fasten stationary contact mounting	M-2066
10		Bar	Cross	Mount moving contacts	X-44849
11		Washer	Special	Attach cross bar to solenoid plunger	M-2240
..		Washer	Spring		M-1100
...		Screw			M-2355
12		Coil	Solenoid	Provide magnetic force	RJ-4605
13		Frame assembly		House solenoid coil and plunger	X-52884

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
14		Screw	No. 6-32 x 1/4"	Fasten frame assembly	M-1496
15		Washer		Seat for spring	E-9512
16		Washer	Cup	Seat for spring	M-1932
17		Spring		Cushion plunger travel	B-11234
18		Core and plunger assembly		Operate movable contacts	X-52864
19		Washer			E-1933
20		Nut			M-990
21		Screw	No. 6-32 x 3/8"		M-256
22		Lock nut			B-8446
23		Plate	Mounting	Fasten solenoid coil in place	A-18459
(7) *Cables, wires, etc.* (*Le Roi part numbers*).					
610		Cable	Ground, battery, positive, to base	Ground battery positive terminal	A61-430
610A		Cable	Battery, negative, to magnetic switch	Connect battery negative terminal to magnetic switch	A61-75-7
611		Ammeter		Record current	A113-28
614		Clamp	For cable	Fasten cable	83-51
613		Cable	Magnetic switch to starter	Connect magnetic switch to starter motor	A61-75-8
615		Conduit	For wires	Inclose wires	55-653
616		Clamp	Conduit	Fasten conduit	83-38
617		Conduit	For wires	Inclose wires	55-659

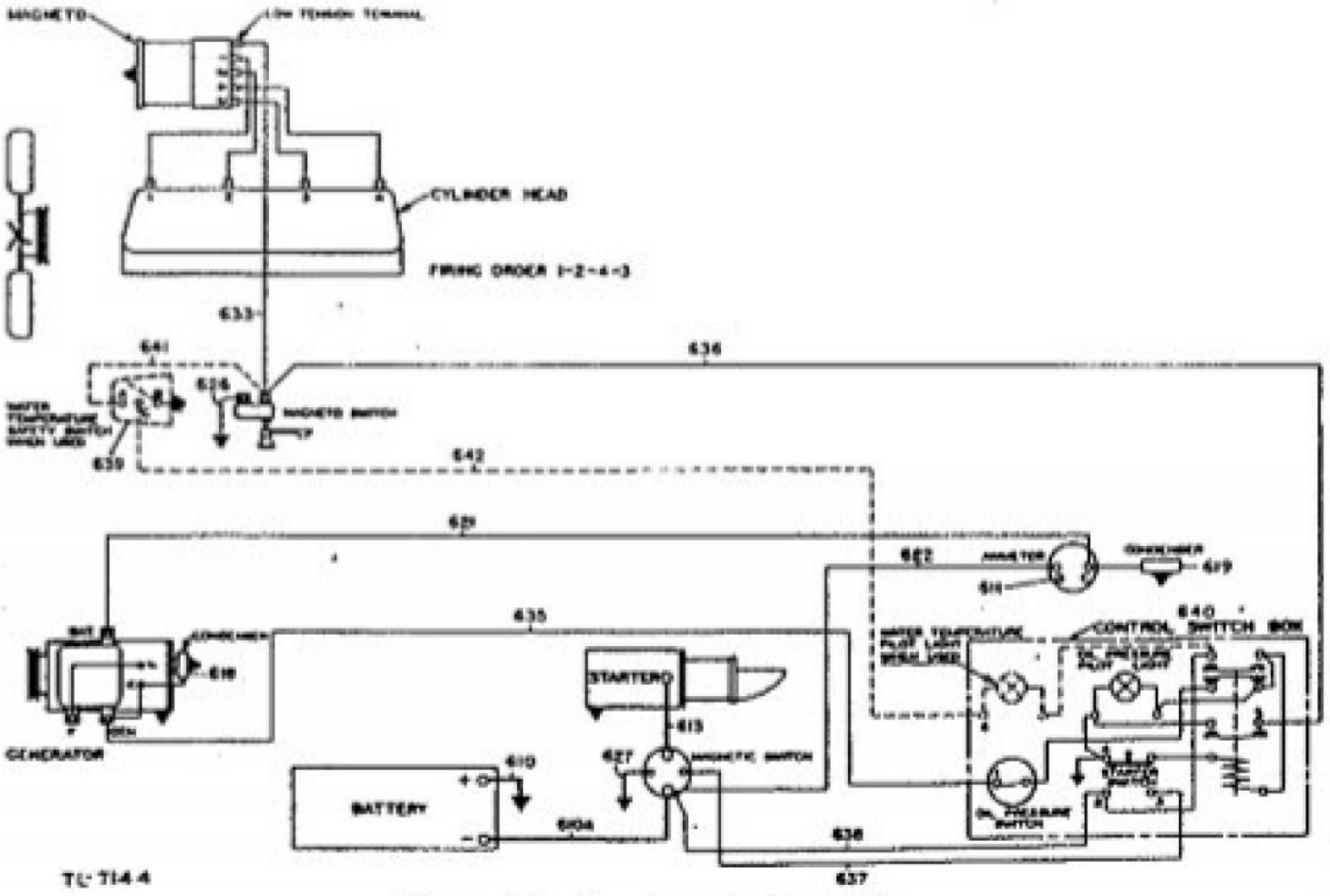


Figure 55. Wiring diagram of ignition and control circuit.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
...		Cap screw	For conduit clamp, 3/8"-16x1/2" hexagonal	Fasten clamp	02-32
...		Lock washer	For No. 02-32, 3/8"	Lock cap screw	05-51
618		Capacitor	5 mfd, 200-v, generator	Ground cut-out relay	167-6
619		Capacitor	5 mfd, 200-v, ammeter	Ground ammeter	167-6
621		Wire	Generator to ammeter, No. 10x59"	Connect generator to ammeter	A61-416-3
622		Wire	Ammeter to magnetic switch, No. 10x32"	Connect ammeter to magnetic switch	A61-416-2
626		Wire	Micro switch to ground, No. 14x2 1/2"	Ground micro switch	A61-5-4
627		Wire	Magnetic switch to ground, No. 14x2 1/2"	Ground magnetic switch	A61-5-4
628		Tube assembly	Micro switch to magneto. Includes items marked ‡		1A55-29-55
628		Tube assembly	Includes ferrule		A55-29-55
629		‡Ferrule	For No. A55-29-55, American Bosch		FP84832
630		‡Insulating bushing	American Bosch		1B84016
631		‡Nut	American Bosch		NT571
632		‡Ferrule	American Bosch		FP84020
633		‡Wire	Micro switch to magneto, No. 14 gauge x 30"	Connect micro switch to magneto	A61-306-33
635		Wire	Generator to (No. 1) pressure switch	Connect generator to pressure switch	A61-306-35
...		‡Terminal			121-5
636		Wire	Micro switch to (No. 3) relay	Connect micro switch to relay	A61-306-39
637		Wire	Starter switch (No. 3) to magnetic switch	Connect starter switch to magnetic switch	A61-416-18
638		Wire	Starter switch (No. 2) to magnetic switch	Connect starter switch to magnetic switch	A61-416-19
639		Switch	Safety, water temperature, Allen-Bradley No. X-66847		76-177
641		Wire	Temperature safety switch to micro switch	Connect temperature safety switch to micro switch	A61-306-37
642		Wire	Temperature safety switch to control box	Connect temperature safety switch to control box	A61-306-38
...		Tube	Wire conduit	Protect wire	55-674
...		Clamp	For tube	Fasten tube	83-91
...		Cap screw	3/8"x1/2" hexagonal	Fasten clamp	02-32
...		Lock washer	3/8"	Lock cap screw	05-51
c. IGNITION PARTS. (1) *Magneto.* (a) *Le Roi part numbers.*					
350		Magneto assembly	American Bosch Model MJB4A-314; includes impulse coupling 1CA2A2	Supply ignition current	A85-99-4
...		Cap screw	Magneto mounting, 3/8"-16x1 1/4"	Fasten mounting	02-37
...		Plain washer	For No. 02-37, 3/8"	Bearing for cap screw	06-4
...		Lock washer	For No. 02-37, 3/8"	Lock cap screw	05-51
(b) *American Bosch part numbers.*					
1		Plate	Distributor, with window and grounding cable assembly	Frame for window, distributor plate and grounding cable assembly	DP 52328

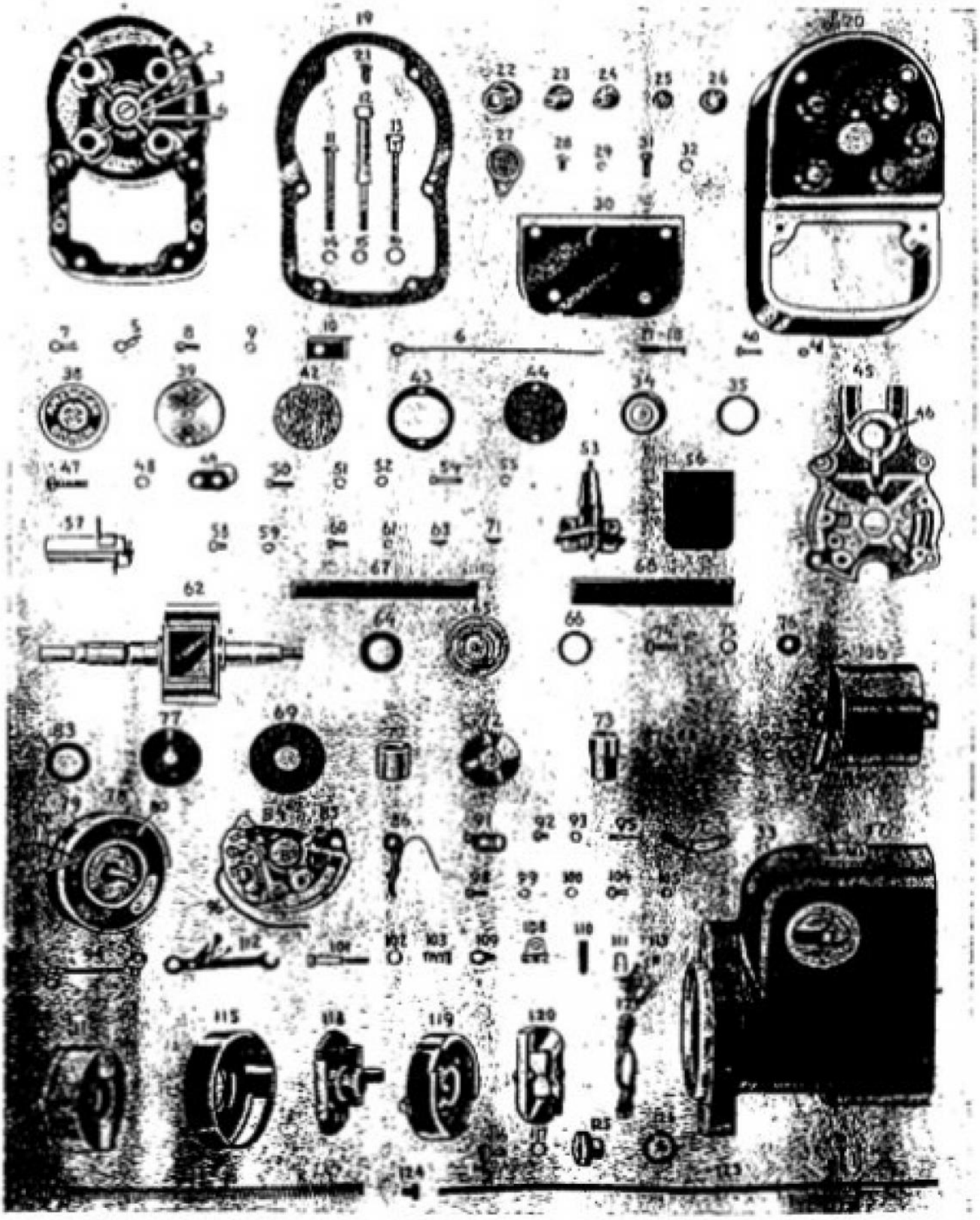


Figure 35. Magneto parts lay-out.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
2		Window	Observation	Facilitate tuning of the magneto to the engine	WN 521
3		Ring	For window	Hold window in place	SP 1001 CA
4		Gasket	Window	Seal the window	GA 1003
5		Clip	For grounding cable (terminal block end)	Fasten cable	EC 1003
7		Clip	For external grounding cable	Fasten cable	EC 1001
8		Screw	Fastening, grounding cable to distributor plate	Fasten cable to distributor plate	SC 23-6 CA
9		Lock washer	For fastening screw	Lock screw	WA 6-5
10		Insulation	Under cable clip		IS-5257
11		Plate	Distributor fastening screw	Fasten distributor plate	SC 1003 CA
12		Post	Cover supporting, long	Furnish support for radio shield cover	SD 527
13		Post	Cover supporting, short	Furnish support for radio shield cover cap	SD 526
14		Lock washer	For fastening screw and cover supporting post	Lock fastening screw	WA 288
15		Washer	Plain, for fastening screw and cover supporting post	Bearing for fastening screw	WA 98922
16		Washer	Sealing, for fastening screw and cover supporting post	Seal fastening	WA 5280
17		Plate	Distributor, center brush and spring	Conduct current from plate	SA 82736
18		Plate	Distributor, brush and spring	Conduct current from plate	SA 82876
19		Plate	Metal, between frame and distributor plate		PL 5232
20		Radio shield cover		Prevent radio interference	CV 5224
21		Screw	Cover fastening, upper	Fasten cover	SC 78-7 CA
22		Nut	Round, for low-tension terminal outlet		----------
23		Ferrule	Terminal outlet, small	Protect wire at outlet	FP 84020
24		Ferrule	Terminal outlet, large	Protect wire at outlet	FP 84832
25		Bushing	Insulation, for low-tension terminal outlet	Protect insulation	IB 84016
26		Bushing	Cable outlet, insulation	Protect insulation	IS 524
27		Cover	Observation	Cover opening to window	CV 5287
28		Screw	Fastening, for observation cover	Fasten observation cover	SC 39-5 CA
29		Lock washer	For fastening screw	Lock screw	WA 6-4
30		Cap	For radio shield cover	Cover opening in cover	CP 5223
31		Screw	Cap fastening	Fasten cap	SC 24-7 CA
32		Screw	Fastening, lock washer	Lock screw	WA 5-5
33		Magneto housing		Hold magneto parts	HG 527
34		Seal	Oil, leather, drive end	Prevent leakage of lubricant	PK 521
35		Washer	Under oil seal		WA 1071
36		Plate	Name, for type designation		NP 521
37		Screw	Name plate fastening		SC 121-6 CA
38		Plate	Name plate on ventilator cover		NP 522
39		Cover	Ventilator	Cover ventilator opening	CV 52128
40		Screw	Covering fastening	Fasten cover	SC 1096
41		Lock washer	Fastening screw	Lock screw	WA 6-3 CA
42		Gasket	Ventilator, felt	Seal ventilator cover	GA 5210
43		Washer	Ventilator		WA 5269
44		Screen	Ventilator, wire	Keep out dust and dirt	SN 526
45		Bracket	Gear, with bearing	Support distributor	BK 527
46		Bearing	Bearing	Support distributor shaft	BG 521

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
47		Screw	Bracket fastening	Fasten bracket	SC 25-12 CA
48		Lock washer	Fastening screw	Lock fastening screw	WA 6-6
49		Block	Terminal, on gear bracket		BL 522
50		Screw	Terminal block, fastening	Fasten terminal block	SC 21-8 CA
51		Lock washer	Fastening screw	Lock fastening screw	WA 6-4 CA
52		Screw	Fastening, plain washer	Bearing for screw	WA 72613
53		Conductor	High-tension	Connect high-tension coil to distributor	EC 5212
54		Conductor	Fastening screw	Fasten conductor	SC 21-10 CA
55		Lock washer	Fastening screw	Lock fastening screw	WA 6-4 CA
56		Insulation	Conductor	Insulate high-tension conductor	IS 5226
57		Capacitor	With bracket		CW 524
58		Screw	Fastening capacitor	Fasten capacitor	SC 21-6 CA
59		Lock washer	Fastening screw	Lock fastening screw	WA 6-4 CA
60		Screw	Lead-fastening capacitor	Fasten capacitor lead	SC 42-5 CA
61		Lock washer	Fastening screw	Lock fastening screw	WA 76919 CA
62		Rotor	Magnet	Generate current	RT 5217
63		Key	Woodruff, drive end	Fasten impulse coupling	KY 11-4
64		Washer	Felt, for magnet rotor, interrupter end	Oil seal for ball bearing	WA 81751
65		Bearing	Ball	Support rotor shaft	BB 60226
66A		Shim	Bearing (0.0126")		WA 61
66B		Shim	Bearing (0.0071")		WA 106
66C		Shim	Bearing (0.004")		WA 107
66D		Shim	Bearing (0.0197")		WA 1009
67		Strip	Packing, for magnet rotor ball bearing	Seal bearing	IS 504
68		Washer	Bearing paper		IS 222
69		Thrower	Oil, for ball bearing	Keep lubricant in bearing	CV 522
70		Spacer	On rotor	Hold rotor in place on shaft	SR 1023
71		Key	Woodruff, for gear	Lock gear to shaft	KY 11-3
72		Gear	Magnet, rotor	Drive distributor gear	GE 5212
73		Cam			CA 522
74		Screw	Cam fastening	Fasten cam to shaft	SC 43-10 CA
75		Lock washer	Fastening screw	Lock fastening screw	WA 22-6
76		Washer	Cam retaining	Bearing for cam shoulder	WA 5241
77		Washer	Indicating		WA 522
78		Gear and rotor assembly	Distributor	Drives distributor	GE 528
79		Gear	Distributor	Drives distributor rotor	GE 5247
80		Rotor	Distributor	Connects spark plugs in definite sequence to high-tension coil	RT 525
81		Screw	Distributor rotor, fastening	Fastens gear to rotor	SC 521
82		Washer	Plain, for screw	Bearing for screw	WA 1005 CA
83		Washer	Distributor gear, spacing		WA 78682
84		Interrupter assembly	Complete with platinum point	Open and close ignition circuit	IN 5223
85		Plate	Interrupter, with riveted parts and support plate	Mount interrupter parts	PL 52119
86		Lever	Interrupter, with platinum point	Mounts moving contact	LE 5220
87		Washer	Plain, for lever stud		WA 86678
88		Pin	Cotter, interrupter lever	Fasten lever to stud	FP 84791
89		Screw	Interrupter lever spring, fastening	Fasten spring	SC 1004 CA
90		Lock washer	Fastening screw	Lock screw	WA 5-4
91		Bracket	Adjustable contact, with platinum point	Mount stationary contact	BK 5236
92		Screw	Contact bracket, fastening	Fasten bracket to plate	SC 104347

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
93		Lock washer	Fastening screw	Lock screw	WA 6-4
94		Cable	Interrupter, grounding	Ground interrupter	CB 5227
95		Brush and spring	Interrupter, grounding		BR 521
96		Cable	Between interrupter and clip on terminal block	Connect interrupter to clip	CB 5223
97		Plate	Stop		PL 528
98		Plate	Stop, fastening screw	Fasten stop plate	SC 21-6 CA
99		Lock washer	Fastening screw	Lock fastening screw	WA 6-4 CA
100		Washer	Fastening screw, plain	Bearing for screw	WA 72613
101		Stud	Stop plate		SD 1001 CA
102		Washer	Plain, for stud		WA 98904
103		Spring	For stud		SP 525
104		Screw	Fastening, for interrupter support plate	Fasten support plate	SC 1029 CA
105		Lock washer	Fastening screw	Lock screw	WA 6-4 CA
106		Coil	High-tension	Generate high potential for ignition circuit	CL 524
107		Cable	For coil (specify length)	Connection for coil to distributor	KL 100657
108		Clip	Terminal, for interruper and coil cables	Connect cables	EC 5214
109		Clip	For retaining coil cable	Connect cable	EC 1002
110		Screw	Lock, for mounting high-tension coil	Fasten coil	SC 1060
111		Clip	Terminal, for distributor plate high-tension cable	Fasten cable	FP 81953
112		Wrench	Magneto		WR 521
113		Screw	Set, for edge distance holes		SC 1040
114		Member	Impulse assembly	Connect magneto shaft to drive shaft	HG 73118
115		Plate	Arrester assembly		PL 7365
116		Plate	Arrester fastening screw	Fasten arrester plate to housing	SC 732
117		Lock washer	Fastening screw	Lock fastening screw	WA 1116
118		Hub	Impulse member	Mount member on magneto shaft	HB 7328
119		Housing	Impulse member	Inclose impulse member	HG 73120
120		Member	Impulse weight		SA 65972
121		Cam			CA 739
122		Spring	Spiral		SP 736
123		Wick	Felt, spring		PK 734
124		Pin	Spring		PN 731
125		Coupling	Shaft securing nut		NT 731
126		Lock washer	Coupling		WA 5-16
(2) *Ignition cables, conduits, etc.* (*Le Roi part numbers*).					
351		Clamp	Ignition cable	Fasten ignition cable	83-40
...		Lock washer	5/16"	Lock nut	05-50
...		Nut	5/16"-24 hexagonal	Fasten clamp	04-602
354		Cable	Ignition, No. 1 cylinder	Carry current from distributor to spark plug	A61-1-51
357		Conduit assembly	No. 1 cylinder	Protect cable	A55-644-3
358		Cable	Ignition, No. 2 cylinder	Carry current from distributor to spark plug	A61-1-52
361		Conduit assembly	No. 2 cylinder	Protect cable	A55-644
362		Cable	Ignition, No. 3 cylinder	Carry current from distributor to spark plug	A61-1-53
365		Conduit assembly	No. 3 cylinder	Protect cable	A55-644-1

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
366		Cable	Ignition, No. 4 cylinder	Carry current from distributor to spark plug	A61-1-54
369		Conduit assembly	No. 4 cylinder	Protect cable	A55-644-2
375		Plate	Shield, spark plug	Shield spark plug	A156-130
...		Nut	Wing, for shield plate, 5/16"-18	Fasten shield plate	04-1001
376		Nut	Knurled, for spark plug shield, special	Connect cable conduit to shield	53-219
377		Insulator	Spark plug shield	Insulate shield	124-11
378		Connection	Spark plug	Make contact between cable and spark plug	188-17
381		Terminal	Spark plug	Conduct current from cable	121-42
382		Shield	Terminal	Protect terminal	124-15
370		Spark plug	18-mm, AC No. 83, special	Provide spark for ignition	86-9-6
385		Connection	Terminal, AC No. 841549	Connect terminal to spark plug	188-21
371		Gasket	Spark plug, 18-mm	Bearing for spark plug	16-796
383		Switch	Micro, magneto	Connect magneto low-tension terminal to control-switch box	76-161
...		Screw	Switch mounting, No. 6-32x 7/8"	Fasten switch mounting	03-61
...		Lock washer	For No. 03-61	Lock screw	05-23
...		Cap screw	Battery ground, 3/8"-16x3/4"	Fasten battery ground lead	02-34
...		Lock washer	For No. 02-34, 3/8"	Lock cap screw	05-51
...		Nut	For No. 02-34, 3/8"-16" hexagonal	Fasten cap screw	04-103

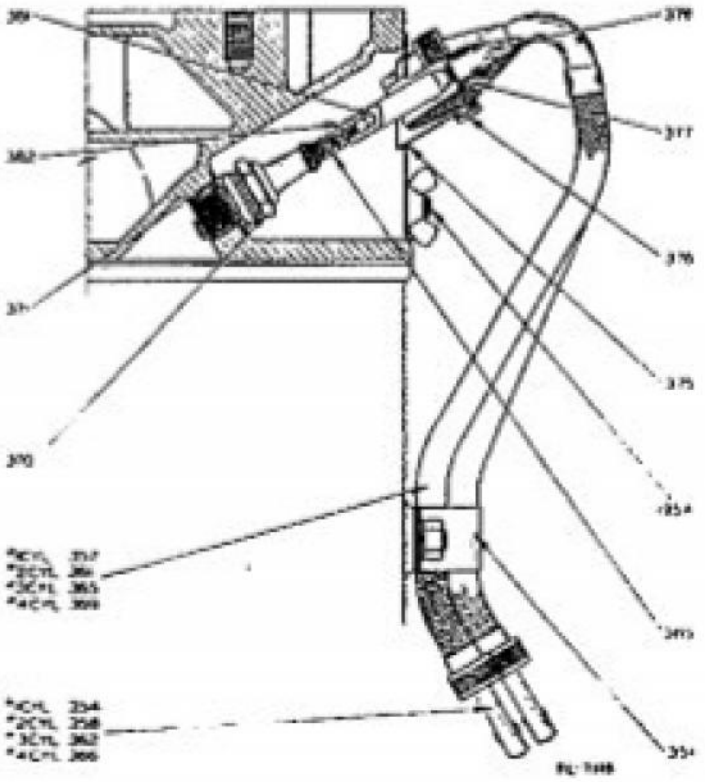


Figure 57. Ignition-radio shielding.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
d. ALTERNATOR AND CONTROLS. (1) *Alternator (Westinghouse part numbers.)*					
1		Alternator	Complete with exciter	Supply alternating current	S.O.287550
2		Field assembly	Complete with shaft	Furnish magnetic force	1287924
3		Coil	Open, field, complete with pole and damper		1287922
4		Coil	Crossed field, complete with pole and damper		1287923
. .		Bolt	1/4"-20x5/8" hexagonal head, steel bolt	To connect damper segments	Standard hardware
.		Nut	Steel lock, for bolt, 1/4"-20	Fasten bolt	Standard hardware
.		Lock washer	1/4", for nut	Lock nut	Standard hardware
5		Spider	Laminated	Support field pole pieces	1287925
. . .		Key	Pole dovetail to spider	Lock pole to spider	1168061
6		Collector		Connect field to direct current exciter	1092211
7		Terminal	Collector	Connection to exciter leads	11040
8		Nut	Collector terminal, 1/4"-20 hexagonal, brass machine screw	Fasten exciter lead to terminal	Standard hardware
. . .		Tube	Insulation, for collector leads	Insulate leads	124863
. . .		Clamp	For insulation tube and leads	Fasten tube	27395
. . .		Screw	For clamps, No. 10-32 x5/8" fillister head, steel machine	Fasten clamp	Standard hardware
. . .		Lock washer	0.190", for clamp screw	Lock clamp screw	Standard hardware
9		Shaft	With spider key	Alternator drive shaft	1287926

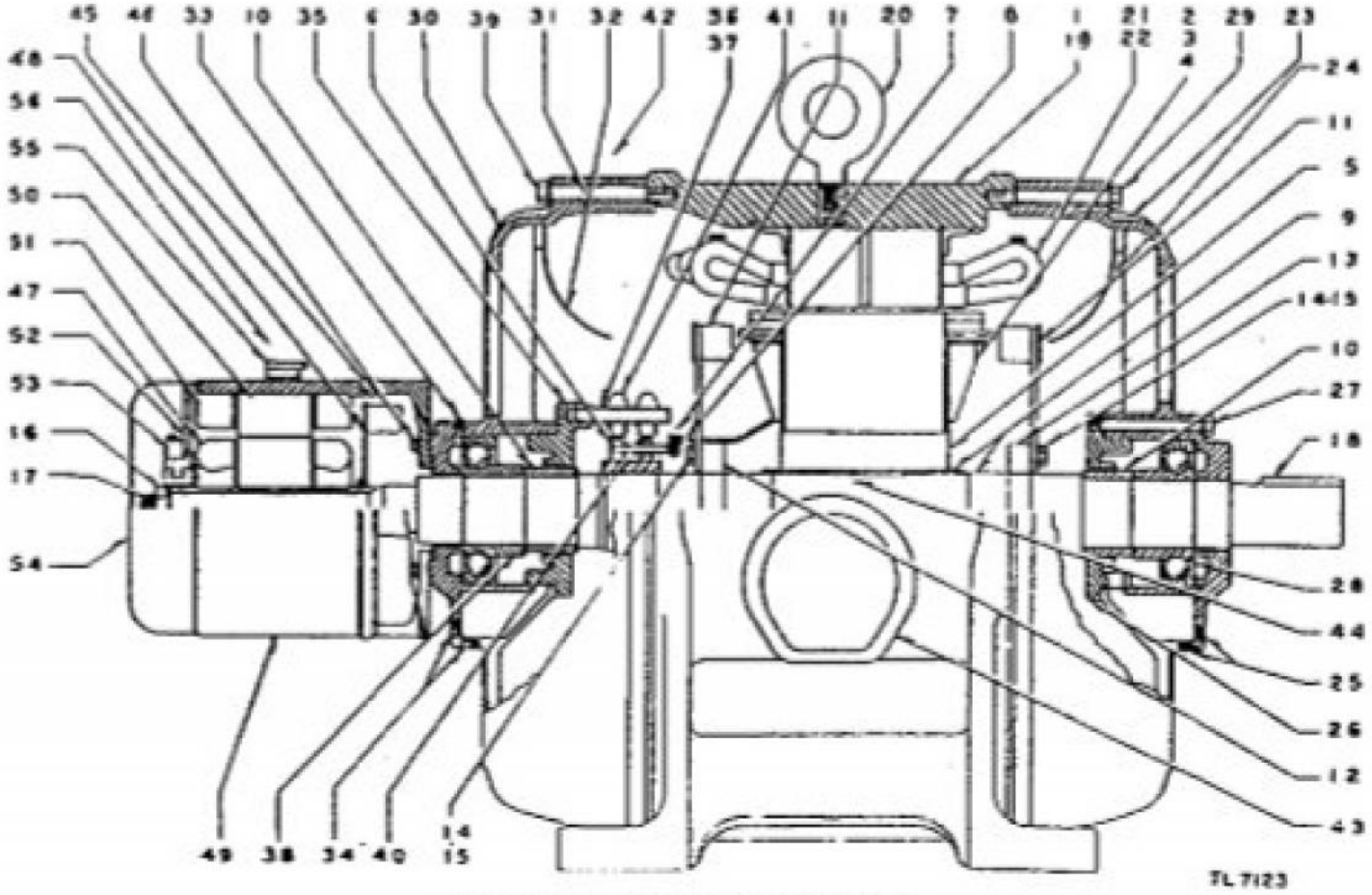


Figure 59. Cross section of alternator (generator).

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
10		Ring	Spacing, for bearings	Fix bearings in place	750162
11		Blower	Complete without hub	Supply ventilation for alternator windings	1287927
12		Hub	Front, blower	Mount blower on alternator shaft	1287928
13		Hub	Rear, blower	Mount blower on alternator shaft	1287928
14		Bolt	For blowers, 1/2"-13x1 1/4" hexagonal head, steel	Fasten blower to hub	Standard hardware
15		Lock washer	For bolt	Lock bolt	295498
16		Bushing	To clamp exciter armature	Fasten armature to alternator shaft	1106568
17		Nut	Jam	Fasten bushing	1168084
...		Pin	Cotter, steel, for jam nut, 1/8"x1 1/2"	Lock jam nut	Standard hardware
18		Key	For shaft extension	Fasten coupling to shaft	1248997
19		Frame	With eye bolt and stator core	Mount stator core and windings	1287929
20		Bolt	Eye, 1" or 1 1/4" as required	For crane hook when lifting alternator	Standard hardware
21		Coil	Stationary armature	Generate alternating voltage	1287930
22		Material	Winding, complete, class No. 3, for the above coils		.....
23		Bracket	Rear	House rear bearing	1239969
24		Shield	Air, rear	Control path of circulating air	458429
...		Screw	To fasten rear air shield to rear bracket, 5/16"-18x1/2" fillister head, steel machine	Fasten rear air shield	Standard hardware
...		Plug	1/8" pipe, for rear bracket		Standard hardware
25		Plug	1/2" countersunk pipe, for rear bracket		Standard hardware
26		Cover	Housing, for rear bearing	Keep dirt from bearing	766706
27		Bolt	To fasten housing cover to rear bracket, 1/2"-13x5" hexagonal head, steel	Fasten housing cover	Standard hardware
28		Bearing	Ball, rear	Mount alternator shaft	664664
29		Bolt	To fasten rear bracket to frame, 5/8"-11x5" hexagonal head, steel	Fasten rear bracket	Standard hardware
30		Bracket	Front	House front bearing	1239970
31		Connector	3/4" straight squeeze, for flexible conduit		1198551
32		Shield	Air, front	Control path of circulating air	458429
...		Screw	To fasten front air shield to front bracket, 5/16"-18x1/2" fillister head steel machine	Fasten front air shield	Standard hardware
33		Plug	1/8" pipe for front bracket		Standard hardware
34		Plug	1/2" countersunk pipe, for front bracket		Standard hardware
35		Cover	Housing, with brush-holder rods and insulation	Protect rear bearing and mount brush-holder rods	1287931
36		Rod	Brush holder	Mount brush holder	817364
37		Rod	Brush-holder, insulation tube	Insulate brush-holder rod	1239831
---		Bolt	To fasten housing cover to front bracket, 1/2"-13x5" hexagonal head steel	Fasten housing cover	Standard hardware

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
38		Bearing	Ball, front	Mount alternator shaft	664664
39		Bolt	To fasten front bracket to frame, 5/8"-11 x 5" hexagonal head, steel	Fasten front bracket	Standard hardware
40		Brush	For alternator, Stockpole WS-86, 3/8"x3/4"x1 1/4"	Provide contact for exciter leads to collector rings	777889
41		Holder	Brush, complete for generator	Hold brushes	884027
...		Spring			444435
...		Screw	To fasten brush shunt to brush holder, No. 10-32x3/8" fillister head, brass machine	Fasten brush shunt	Standard hardware
...		Washer	For shunt screw	Bearing for screw	779354
...		Bolt	To clamp brush holder to rod, 1/4"-20x7/8" hexagonal head, steel	Fasten brush holder	Standard hardware
...		Lock nut	For bolt, 1/4"-20	Lock bolt	Standard hardware
...		Lock washer	1/4", for nut	Lock nut	Standard hardware
...		Terminal	To connect generator field leads to brush holders		229105
...		Terminal	For generator field leads (external)		229105
42		Conduit	For field leads, 14"-3/4" flexible steel	Protect field leads	Standard
...		Connector	Squeeze, for field leads conduit, 3/4"-90°		752747
43		Box	Conduit, complete	House connections to alternator leads	974311
...		Connector	Squeeze, for main leads conduit, 1 1/2"		1198554
44		Conduit	For main leads, 29"-1 1/2", flexible steel	Protect main leads	Standard
...		Connector	Squeeze, for main leads conduit, 1 1/2"—90°		752750
...		Terminal	For main leads		229120
45		Support	Exciter, with cover	Support exciter frame	1239971
...		Cover	Band, for exciter support	Covers opening in support	1042282
...		Screw	To fasten cover to exciter support, No. 10-32x1/2"	Fasten cover	Standard hardware
46		Bolt	Exciter support to front bracket, 3/8"-16x7/8" hexagonal	Fasten exciter support	Standard hardware
...		Bolt	Exciter frame to support, 3/8"-16x1 3/8" hexagonal	Fasten exciter frame	Standard hardware
...		Plate	Name, generator rating		NP-28788
...		Plate	Name, generator lubrication		NP-34630
(2) *Exciter (Westinghouse part numbers).*					
47		Armature	Exciter, complete with quill	Generate direct current for alternator field	1287939
48		Blower		Supply ventilation for exciter windings	359038
49		Frame	Exciter	House exciter field windings	1239962
50		Pole	Exciter	Supply path for magnetic force	452945
...		Bolt	To fasten pole to frame, hexagonal head	Fasten pole to frame	359311
51		Coil	Field, exciter, 4 coils per set	Generate magnetic force	1239963

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
...		Terminal	For field coil lead	Fasten lead	229105
52		Panel	Complete with brushes and brush holder for exciter	Mount brushes and brush holder	1124998
...		Spring	Brush	Supply tension for brush	281633
53		Brush	Exciter, Stockpole WL-21, size 3/8"x3/4"x7/8"	Collect current from commutator	782740
...		Stud	To mount brush panel on exciter frame	Mount panel to frame	559184
...		Nut	Hexagonal brass machine screw, for stud, 1/4"-20	Fasten panel	Standard hardware
...		Washer	Flat, for stud		779355
...		Lock washer	1/4", for stud		Standard hardware
54		Cover	Front, for exciter	Cover commutator and brushes	297421
...		Screw	Fillister head brass machine, for front cover No. 14-24x3/8"	Fasten cover	Standard hardware
...		Lock washer	1/4", for screw	Lock screw	Standard hardware
55		Connector	3/4" straight squeeze, for conduit for exciter leads		1198551
56		Conduit	28" of 3/4" steel, flexible, for exciter leads	Protect leads	Standard
...		Connector	3/4"—90° squeeze, for conduit for exciter leads		752747
...		Terminal	For exciter leads	Fasten leads	229105
...		Plate	Name, exciter		NP-17415
(3) *Control panel (Westinghouse part numbers).*					
...		Ammeter	Type HA, 0-300 amp	Measure alternator current	724215
...		Voltmeter	Type HA, 0-150 volts	Measure alternator voltage	721721
...		Meter	Frequency, type HV, 58-62 cycles	Measure alternator frequency	721766
...		Meter	Total hour, type NH-35, 120 volts	Indicate total hours of alternator operation	1205858
...		Regulator	Silverstat, type SRA-1	Regulate alternator voltage	S. O. 76Y414
...		Breaker	Unit, type AB	Protect alternator from overloads	807003
...		Breaker	Trip unit, type AB	Trip circuit breaker on overloads	807134
...		Rheostat	Type WL	Control exciter field strength	874473
...		Block	Terminal	Mount terminals in panel	MKZ-22070
...		Block			805430
...		Cover			790073
...		Transformer	Current (sold only as an assembly)	Supply current to ammeter	MKZ-22070
...		Receptacle	Female, Hubbell No. WE-22427	Connect alternator leads to load	.....
...		Socket	Lamp	Provide current for trouble lamp	484980
...		Fuse	Plug, pyrex glass, 20-ampere	Fuse lamp socket	PYX-20
(4) *Voltage regulator (Westinghouse part numbers).*					
...		Regulator	Type SRA-1, voltage, complete	Control alternator voltage	S. O. 76Y414
...		Regulator	Without regulating resistor tubes		S. O. 76Y414
1		Device	Contact, complete	Shorts resistance out of exciter field circuit	1151948

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
2		Plate	Contact device (rear support)	Supports contact device	1091989
3		Screw	Pusher	Opens or closes silver button contacts	1092295
4		Block	Magnet, core and armature assembly, includes items 2-8-12-13-14	Supply for to open or close silver button contacts	94B503
5		Stud	3" long	Fasten magnet block to front path	559185
6		Stud	1 1/2" long		361702
7		Spacer	Micarta	Insulate magnet block	1091992
8		Coil	Operating	Operates moving arm	1087327
9		Spring	Control	Provides force against moving arm	1087324
10		Screw	Adjusting, control spring	Adjust spring length	1091987
11		Bracket	Control spring	Mount control spring	1128305
12		Arm	Armature, with spring holder, includes items 1 and 4	Mount pusher screw	94B503
					94B504
13		Hinge	Spring, complete	Mount armature arm	1087322
14		Hinge	Top support	Support top hinge	1092283
15		Hinge	Bottom support	Support bottom hinge	1092286
16		Spring	Hinge		1092287
17		Plate	Front	Mount regulator parts	.....
18		Rheostat		Adjust value of regulated voltage	S. O. 76Y414
19		Knob	Rheostat	Control rheostat	1087334
20		Bracket	Rheostat	Mount rheostat	1247173
21		Board	Terminal	Mount regulator terminals	1091994
22		Cover	Micarta hole, item 3		1B8419
23		Plate	Rear	Inclose resistors	1191990
24		Post	Rear plate, upper	Support rear plate	1084587
25		Post	Rear plate, lower	Support rear plate	1084588
26		Cover	Rear, item 6	Inclose resistors	1A8864
27		Cover	Front	Inclose regulator parts	1190739
28		Gasket	For cover, item 2	Seal cover to prevent entry of dust and dirt	1B6878
29		Nut	Thumb	Fasten cover	196369

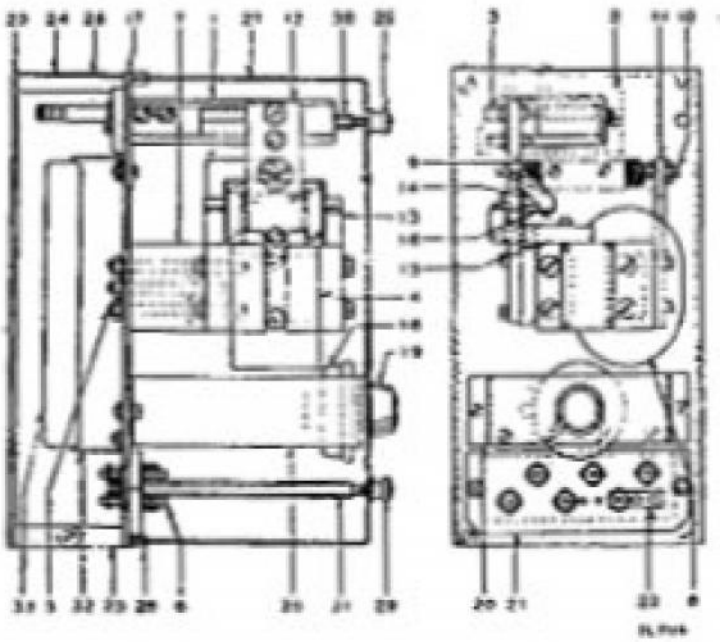


Figure 39. Voltage regulator cross sections.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
30		Stud	Cover, top	Mount cover	1091842
31		Stud	Cover, bottom	Mount cover	1091996
32		Clip	Resistor	Hold resistors	1087230
33		Tube	Regulating resistor, 18.5 ohms	Mount resistor	1081595
33		Tube	Regulating resistor, 31.6 ohms	Mount resistor	1081596
33		Tube	Regulating resistor, 55.8 ohms	Mount resistor	1081597
33		Tube	Regulating resistor, 75.0 ohms	Mount resistor	1081598
---		Transformer	Damping Rectox unit		1190741
---		Transformer	Damping	Stabilize regulated voltage	1190740
---		Unit	Rectox	Supply direct current to coil	967282

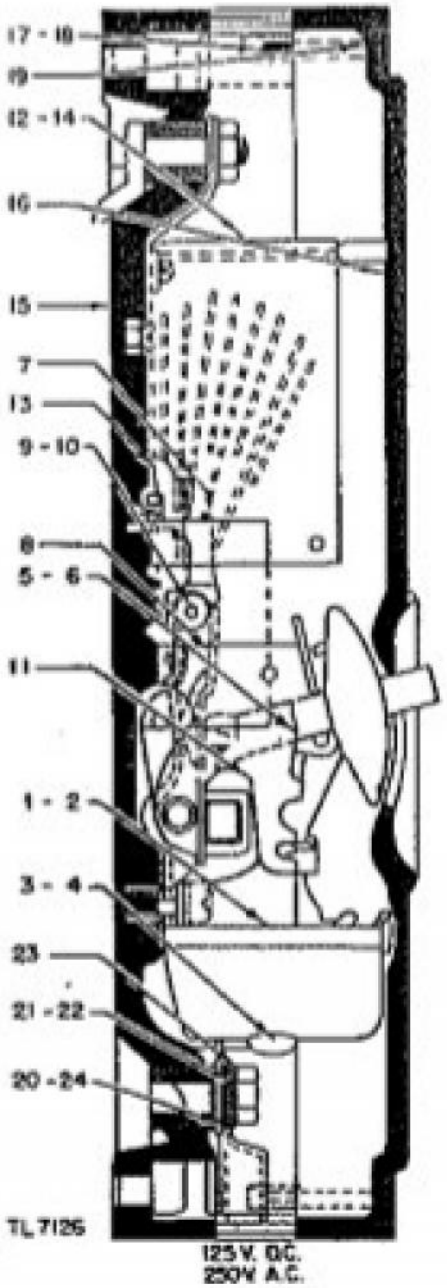


Figure 91. Circuit breaker assembly.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
(5) *Circuit breaker (Westinghouse part number).*					
		Breaker	Complete	Protect alternator from overloads	
1		Unit	Trip, complete	Open breaker contacts on overloads	867 134
2		Cover	For No. 1 in figure 60	Protect trip unit	867 783
3		Screw	Fillister head for No. 2 in figure 60, 0.112"-40x1 1/4"	Fasten cover	Standard hardware
4		Washer	For No. 3 in figure 60	Bearing for screw	3 407
5		Breaker	Frame complete without trip unit	Support breaker parts	867 103
6		Mechanism	Complete with contacts, operating handle, cross bar, and contact holder	Opens alternator circuit on overloads	899 823
7		Contact	Moving and shunt	Makes and breaks circuit	809 813
8		Spring	For No. 7 in figure 60		809 814
9		Pin	Hinge for No. 7 in figure 60	Pivot moving contact arm	706 216
10		Washer	Hinge pin		867 169
11		Mechanism	Complete with operating handle, cross bar, and contact holder		1 680 034
		Handle	Operating	Close circuit breaker	1 020 955
12		Splitter	Arc, complete with stationary contact	Extinguish arc when breaker opens	867 143
13		Contactor	Stationary	Completes circuit with moving contact	809 914
14		Splitter	Arc, complete		809 915
15		Base	Complete		867 137
16		Cover		Enclose breaker parts	867 139
17		Screw	Fillister head, for No. 16 in figure 60, 0.190"-32x1 3/8"	Fasten cover	Standard hardware
18		Lock washer	For No. 17 in figure 60, 0.190"	Lock screw	Standard hardware
19		Washer	For No. 17 in figure 60	Bearing for screw	779 343
20		Terminal	Complete, front connected	Connection for leads to breaker	806 003

Figure 61. Electrical parts location.

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
21		Bolt	Hexagonal head for No. 20 in figure 60, 1/2"x1"	Fasten leads to terminal	Standard hardware
22		Lock washer	For No. 20 in figure 60, 1/2"	Lock bolt	Standard hardware
23		Washer			3 223
24		Terminal	225-ampere		776 342
...		Stud	Complete, rear connected		806 989

(6) *Field rheostat.* (*Westinghouse part numbers.*)

1	Arm	Contact, complete	Mounts moving contact	899 020
2	Arm	Contact		898 988
3	Spring	Contact arm	Provides contact pressure	898 990
4	Block	Insulation	Insulate contact arm	898 991
5	Shaft		Pivot contact arm	898 992
6	Nut	Shaft	Fasten shaft	898 993
7	Washer	Shaft	Bearing for nut	898 994
8	Arm	Drive	Drive contact arm	898 995
9	Washer	Thrust		898 996
10	Pointer		Indicate rheostat setting	896 583
11	Coupling	Short, with tapped hole		898 997
12	Disk	Insulation		898 998
13	Ring	Collector	Connection to moving contact	899 000
14	Coupling	Short		899 016
14	Wheel	Hand	Turn contact arm	882 151
15	Plate	Name, for handwheel		899 001
16	Foot	For single plate		899 002
16	Foot	For two-plate		899 003
16	Foot	For three-plate		899 004
16	Foot	For four-plate		899 005
17	Saddle	For foot		899 010
18	Pan	Back, with adjustable stop		899 013
18	Pan	Back, intermediate		1 257 002
19	Disk	Coupling		889 015
20	Block	Terminal	House terminals for rheostat lead wires	899 018
21	Plate	Complete with element		
22	Stud	Handwheel	Fasten handwheel	970 628
0	Handwheel	Complete, includes 14, 15, and 22		943 865

45. Spare Parts, Tools, and Supplies

a. General.

...	Box	Tool, metal	Hold spare parts and tools	119-123
...	Nut	1/2"-20		04-605
...	Lock washer	1/2"		05-53
...	Padlock		Lock tool box	A178-13
...	Crank	Starting	For manual starting of engine	50-94-1

b. Parts in Bottom of Box.

...	Service	Cylinder head assembly	Spare	3A2-149-3
...	Rod	Push	Spare	99-72
...	Connecting rod and piston assembly		Spare	5A7-74
...	Sleeve	Cylinder, 4 1/2"	Spare	175-6-1
...	Line	Gasoline, 10"	Spare	55-643-7
...	Line	Oil, Titeflex, 1s 1 4"	Spare	A55-642-4
...	Line	Oil, Titeflex, 19"	Spare	A55 642-5

Rel. No.	Stock No.	Name	Description	Function	Mfr's part No.
...		Line	Oil, Titeflex, 22 1/2"	Spare	A55-642-6
...		Line	Oil, Titeflex, 21 1/2"	Spare	A55-642-7
...		Line	Oil, Titeflex, 29 3/4"	Spare	A55-642-8
...		Line	Oil, Titeflex, 11 5/8"	Spare	A55-642-13
...		Elements	Filter, oil	Spare	A77-180
...		Brush holder	Exciter, Westinghouse, No. 1124998	Spare	174-18

c. Tray No. 1.

...		Magneto	Spare	A83-99-4
...		Can	Oil, 8 oz.	Hold lubricant	88-227
...		Grease	5-lb. can	Spare lubricant	204-4
...		Spark plugs	No. 83, AC	Spare	86-9-6
...		Brush holders	Generator, Westinghouse No. 884027	Spare	174-19
...		Valve	Exhaust	Spare	15-201-1
...		Valve	Intake	Spare	15-200
...		Guides	Intake valve	Spare	58-26
...		Guides	Exhaust valve	Spare	58-27
...		Springs	Valve	Spare	B24-26
...		Washers	Retainer, valve springs	Spare	20-278
...		Lock washers	Valve spring	Spare	20-279
...		Hose	Radiator	Spare	73-3-14
...		Hose	Radiator	Spare	73-3-20
...		Clamps	Hose	Spare	83-93
...		Clamps	Hose	Spare	83-92
...		Water pump	Seal bellows assembly	Spare	125-68
...		Fitting	Titeflex	Spare	182-163
...		Fitting	Titeflex	Spare	182-164
...		Fitting	Titeflex	Spare	182-165
...		Fitting	Titeflex	Spare	182-180
...		Rings	Piston, compression, 4 1/2"x 1/8"	Spare	18-233
...		Rings	Piston, oil, 4 1/2"x3/16"	Spare	18-114
...		Bowl	Sediment, fuel pump, A.C., No. 854004	Spare	184-2

d. Tray No. 2—Lower Compartment.

...		Gasket	Water outlet connection	Spare	16-146
...		Gasket	Carburetor flange	Spare	16-27
...		Gasket	Fuel pump, flange	Spare	16-229
...		Gasket	Water outlet connection	Spare	16-646
...		Gasket	Retainer parting	Spare	16-907
...		Gasket	Air cleaner bracket	Spare	16-908
...		Gasket	For sediment bowl, A.C. No. 854003	Spare	16-921
...		Gasket	Radiator inlet connection	Spare	B16-123
...		Oil pump	Body to cover gasket	Spare	16-636
...		Flange	Governor to drive body gasket	Spare	16-873
...		Gasket	Water pump bracket	Spare	16-638
...		Gasket	Breather	Spare	16-643
...		Seal	Rear, oil	Spare	125-67
		Gasket	Crankcase retainer	Spare	16-777
		Packing	Cylinder sleeve	Spare	74-41
		Fuel pump	Diaphragm, A.C. No. 855389	Spare	186-9
		Gasket	Water pump body	Spare	16-754
		Gasket	Flange, oil pump cover	Spare	16-635
		Gasket	Gear cover, upper	Spare	16-650
		Governor	Drive body to crankcase gasket	Spare	16-669

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
---		Gasket	Gear cover, magneto side	Spare	16-653
---		Gasket	Gear cover, lower	Spare	16-652
---		Gasket	Gear cover, manifold side	Spare	16-651
---		Gasket	Oil pan, cover	Spare	16-359
---		Gasket	Oil pan, rear	Spare	16-649
---		Belt	Generator	Spare	41-229
---		Belt	Fan	Spare	41-235
---		Gasket	Flange, oil pan, carburetor side	Spare	16-647
---		Gasket	Flange, oil pan, magneto side	Spare	16-648
---		Gasket	Cylinder-head cover	Spare	16-634
---		Gasket	Cylinder head	Spare	16-629
---		Book	Instruction		
---		Hose	3/4"x11 1/2"	Spare	73-29-8

e. Tray No. 2—R.H. End Compartment.

---	Oil seal	For governor drive body	Spare	125-56-1
---	Oil seal	For gear cover	Spare	125-58-1
---	Ell	Reducing, brass, 1/4"x1/8"—90°	Spare	33-547
---	Ell	Street, brass, 1/8"—45°	Spare	33-543
---	Nipple	Brass, close, 1/8"	Spare	33-544
---	Tee	Brass, 1/8"x1/8"x1/8"	Spare	33-554
---	Ell	Street, brass, 1/8"—90°	Spare	33-542
---	Nipple	Brass, 1/8"x2"	Spare	33-545
---	Cross	Brass, 1/8"	Spare	54-101
---	Washer	Seal, water pump	Spare	20-379
---	Gasket	Oil relief plug	Spare	B16-117
---	Nut	Spark plug terminal	Spare	188-21
---	Gasket	Intake manifold	Spare	16-630
---	Gasket	Exhaust end	Spare	16-632
---	Gasket	Exhaust center	Spare	16-685

f. Tray No. 2—L.H. End Compartment.

---	Packing	Asbestos	Spare	16-886
---	Brushes	Battery generator, Delco Remy No. 809637	Spare	174-14
---	Brushes	Generator, Westinghouse No. 777889	Spare	174-20
---	Brushes	Starter, Delco Remy No. 38367	Spare	174-15
---	Brushes	Exciter, Westinghouse No. 782740	Spare	174-17
---	Strainer	Fuel pump, A.C. No. 1523603	Spare	43-135
---	Points	Magneto, Bosch No. BK-5236	Spare	127-6
---	Points	Magneto, Bosch No. LE-5220	Spare	127-7
---	Capacitor	Magneto, Bosch No. CW-524	Spare	167-13

g. Tray No. 3.

---	Pliers	Gas	General use	88-230
---	Gauge	Feeler	For adjusting valves	88-10
---	Screw driver	Large	General use	88-74
---	Screw driver	Small	General use	88-229
---	Wrench	Crescent, 8"	General use	88-235

Ref. No.	Stock No.	Name	Description	Function	Mfr's part No.
---		Punch	Pin, 3/32"	General use	88-233
---		Punch	Pin, 5/32"	General use	88-232
---		Punch	Pin, 7/32"	General use	88-231
---		Wrench	Socket, spark plug	Remove plugs	88-224
---		Lifter	Valve	Lift valves	88-48
---		Hammer		General use	88-228
---		Wrench	Open end, 3/8" and 7/16"	General use	88-11
---		Wrench	Open end, 1/2" and 9/16"	General use	88-9
---		Wrench	Open end, 9/16" and 5/8"	General use	88-234
---		Wrench	Open end, 11/16" and 15/16"	General use	88-85
---		Wrench	Open end, 3/4" and 7/8"	General use	88-138
---		Wrench	Box socket, double end, 3/4" and 3/4"	General use	88-21
---		Wrench	Auto, adjustable, 11"	General use	88-72
---		Pliers	Combination, 6"	General use	88-73
---		Shellac	Gasket, 1/2-pt can	Seal gaskets	204-1
---		Pins	Cotter, box of assorted	General use	204-2
---		Wire	Spool	General use	204-3
---		Sandpaper	No. 00, sheets	General use	204-5
---		Wrench	For Allen socket screw	General use	88-239

h. Tray No. 4.

---	Shell	Main bearing	Spare	21-349
---	Shell	Center main bearing	Spare	21-347
---	Shell	Front main bearing	Spare	21-348
---	Shell	Connecting rod bearing	Spare	21-350
---	Bushing	Piston pin	Spare	21-334
---	Washer	Thrust, rear main bearing	Spare	20-370

i. Additional Items in Box, Not Classified as "Spare Parts, Tools and Supplies." (1) *Tray No. 1—lower compartment.*

---	Nipple	Exhaust pipe		33-178-23
---	Packing	Muffler		16-886
---	Retainer	Muffler packing		31-426
---	Coupling	Reducing, 1"x1/4", internal pipe thread		33-548

(2) *Tray No. 2—lower compartment.*

---	Hose	Flexible gasoline, 35"	Connect engine to fuel drum	73-253-8

46. **Names and Addresses of Manufacturers**

AC Spark Plug Division	Flint, Michigan
Air-Maze Corporation	Cleveland, Ohio
Allen Bradley Company	Milwaukee, Wisconsin
American Bosch Corporation	Springfield, Massachusetts
Delco-Remy Division	Anderson, Indiana
Diesel Plant Specialties Company	Chicago, Illinois
Fulton Sylphon Company	Knoxville, Tennessee
Globe-Union, Inc.	Milwaukee, Wisconsin
Micro Switch Corporation	Freeport, Illinois
Thomas Flexible Coupling Company	Warren, Pennsylvania
U. S. Gauge Company	Sellersville, Pennsylvania
Westinghouse Electric & Manufacturing Co.	E. Pittsburgh, Pennsylvania Chicago, Illinois
Woodward Governor Company	Rockford, Illinois
Zenith Carburetor Division	Detroit, Michigan