CONFIDENTIAL

INSTRUCTION MANUAL 2028

for

ENGINE GENERATOR UNIT

RD-13

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SECURITY INFORMATION

CONFIDENTIAL

INSTRUCTIONS

for

E N G I N E G E N E R A T O R U N I T

RD-13

25X1

November 5, 1952

RECORD OF CORRECTIONS MADE

Change No.	Date	Signature

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S A F E T Y N O T I C E

The attention of all personnel is directed to the hazardous conditions that may result from the operation, maintenance, or storage of the ENGINE GENERATOR UNIT RD-13. While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

HIGH VOLTAGE:

This equipment generates voltages which are dangerous and may be fatal if contacted by operating personnel. Insure that all connections to the unit have adequate insulation.

HIGH TEMPERATURE:

This equipment operates at a sufficiently elevated temperature to cause burns if contacted by unprotected parts of the body. Asbestos or other suitable gloves must be worn by all operating personnel when handling this equipment.

FIRE HAZARD: EXPLOSIVE HAZARD:

The exhaust gas if directed toward inflammable material constitutes a fire hazard. An inflammable and explosive fuel (gasoline) is used in the unit and must be handled with extreme caution. Dropping of the unit could cause possible rupture of the fuel tank. No open fires should be allowed in vicinity of storage or operation of the unit. Make all electrical connections to the unit prior to starting in order to avoid sparking at the power receptacle.

FATAL OR NOXIOUS FUMES:

Fatal or noxious fumes are given off by the ENGINE GENERATOR UNIT when operating. The unit must be used outdoors or under forced air ventilation if in a restricted area. All precautions relevant to the exhaust gases of gasoline powered units must apply to this unit.

ENGINE GENERATOR UNIT RD-13

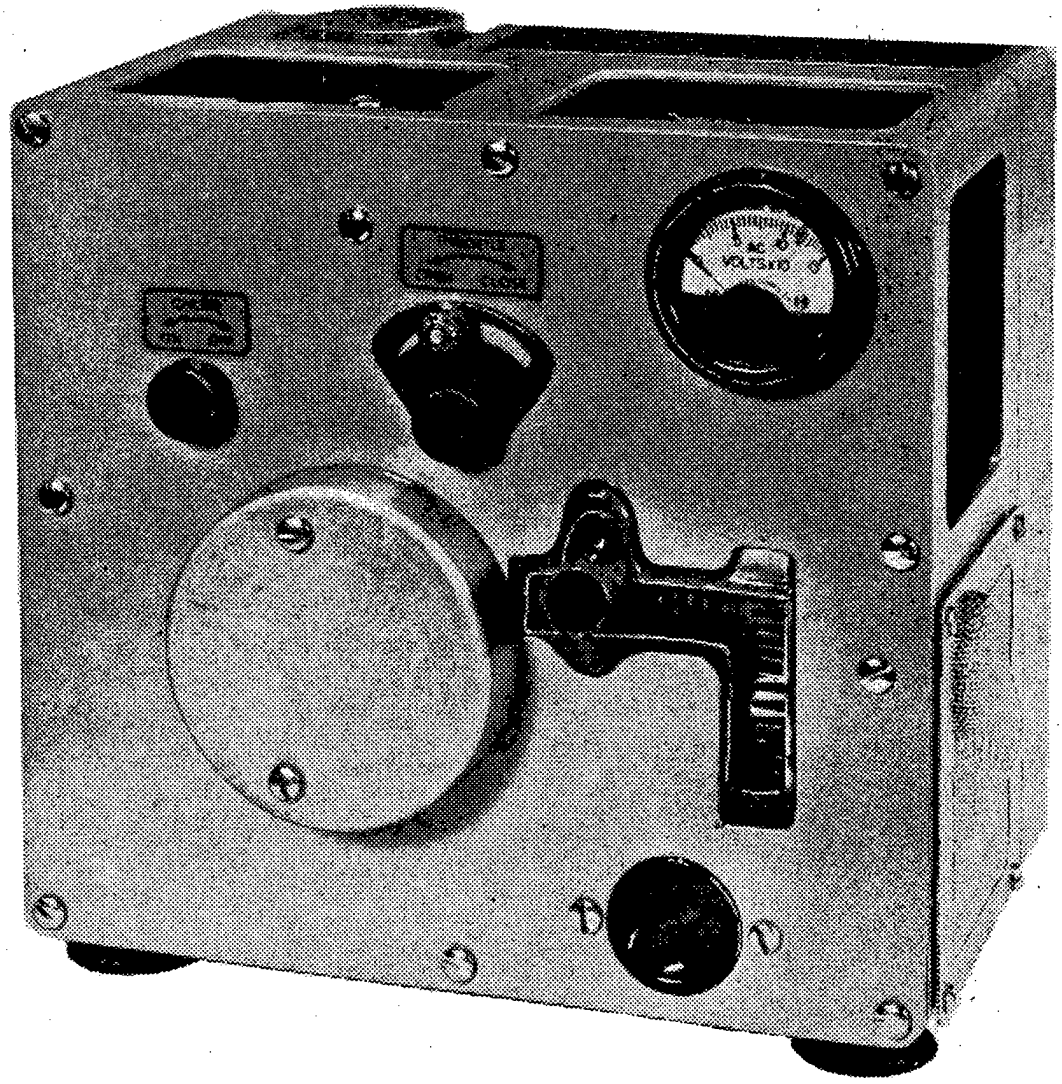


Figure 1-1. Engine Generator Unit **RD-13.**

SECTION 1

GENERAL DESCRIPTION

1. PURPOSE AND FUNCTION OF EQUIPMENT.

The ENGINE GENERATOR UNIT RD-13 (figure 1-1) is a portable gasoline engine and generator for use as an electrical power source. A self-contained fuel tank, ignition system, and engine controls are provided. The generator provides an electrical output of 100 watts at a load power factor of 80%. The nominal voltage output is 115 volts at 400 cycles. The unit is designed to operate over an ambient temperature range of 0° to 110° Fahrenheit and at altitudes to 10,000 feet.

2. DESCRIPTION OF EQUIPMENT.

The ENGINE GENERATOR UNIT RD-13 is a self-contained device in a rectangular case 7-1/8 inches high by 5 inches long by 7-3/4 inches wide. The general construction and location of the controls are shown in figures 1-1, 1-2 and 1-3. Fuel is held in a compartment surrounding the generator housing. Provisions have been made for the storage of a spare spark plug and a set of breaker points within the engine compartment.

a. ENGINE EQUIPMENT.

The prime mover is a gasoline-powered two-stroke cycle engine designed to operate at a speed of 6000 revolutions per minute. Starting is accomplished by a manually operated rope pull. Manual controls are provided for choking and throttling the engine. The fuel tank contains sufficient fuel for approximately two hours of normal operation. Forced air cooling is provided by an internal fan. A muffler, attached externally to the exhaust port, gives approximately 60% noise quieting below the open-exhaust condition.

b. GENERATOR EQUIPMENT.

The generator is an eight pole alternator with a permanent magnet rotor. No external electrical excitation is required. The output is single phase with a nominal voltage rating of 115 volts

at 400 cycles. A power receptacle is provided on the unit for connection of the load. The generator is directly connected to the engine shaft, and the generator output voltage adjustment is made by the engine throttle. A meter, on the outside case of the unit, indicates the a-c terminal voltage.

c. IGNITION EQUIPMENT.

The ignition system consists of two transformers, five capacitors, a selenium rectifier, a distributor and a spark plug. It is powered by an electrical connection to the generator. This system is self-regulating and no adjustments are required. Timing of the spark is accomplished by the distributor, a cam and breaker point assembly mounted on one end of the engine shaft. The ignition system is adequately shielded to prevent excessive r-f noise interference to radio receiving equipment.

3. REFERENCE DATA.

a. NOMENCLATURE.--ENGINE GENERATOR RD-13.

b. CONTRACTOR NUMBER AND DATE.--

c. [redacted] 25X1

d. COGNIZANT INSPECTOR.--

e. NUMBER OF PACKAGES PER SHIPMENT.--One package of equipment.

f. TOTAL CUBICAL CONTENT.--Equipment; crated 1000 cubic inches, uncrated 300 cubic inches.

g. TOTAL WEIGHT.--Equipment; crated 30 pounds, uncrated 12 pounds.

h. MAXIMUM OPERATING SPEED.--6000 RPM

i. NOMINAL VOLTAGE.--115 volts, 400 cycles per second, single phase.

j. POWER OUTPUT.--100 watts at a load power factor of 80%.

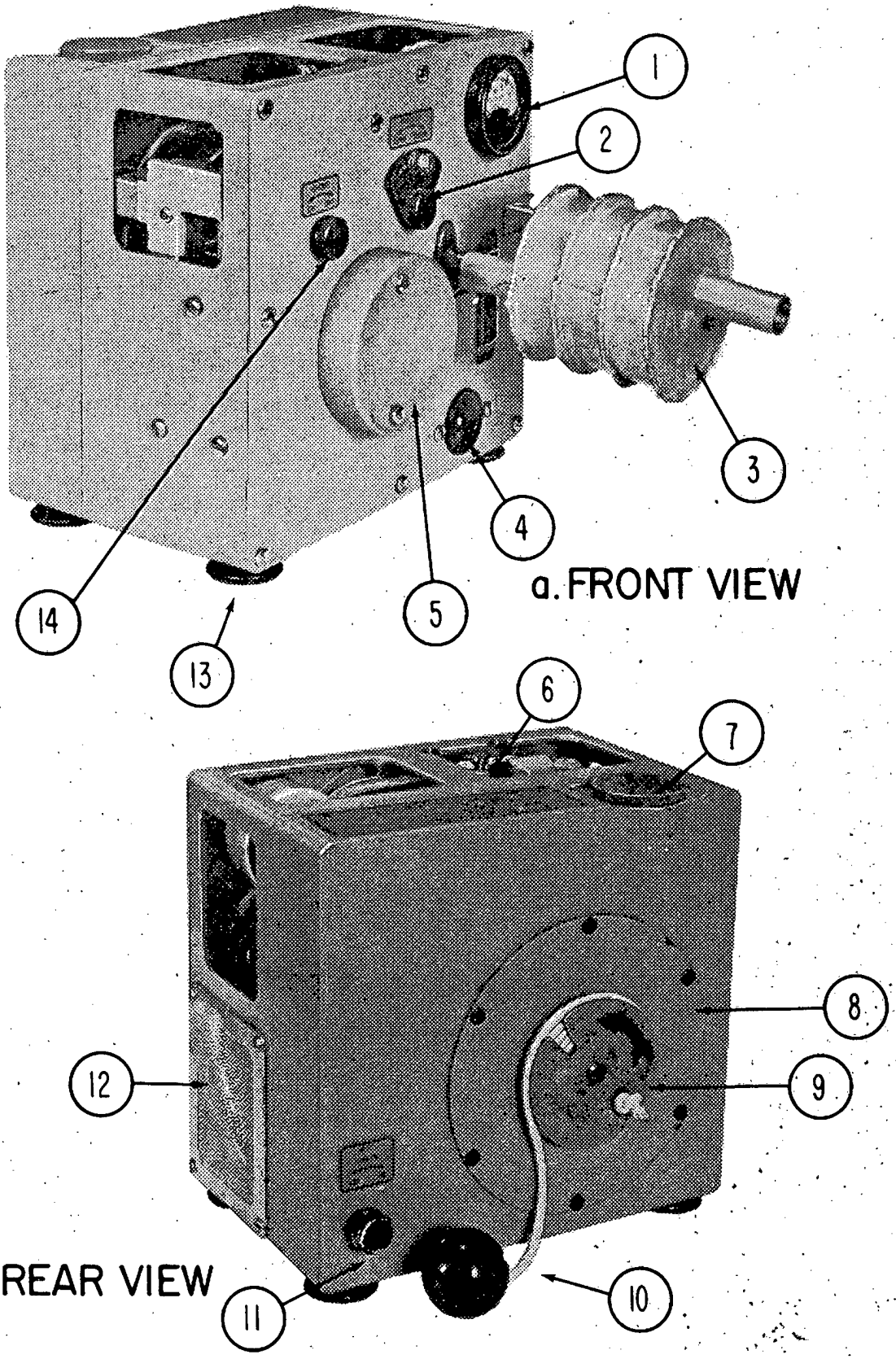


Figure 1-2. Front and Rear Views, **RD-13**.

k. REGULATION.-- Voltage drops 10% from a 40% load to a 100% load, with constant throttle setting.

l. OPERATING TIME.-- Approximately two hours per tank of fuel.

m. FUEL CAPACITY.-- Approximately 1/8 gallon or 1 pint.

n. FUEL MIXTURE.-- Gasoline and oil mixture in the ratios of 14 parts gasoline to 1 part oil by volume. Commercial grade gasoline from 60 to 80 octane and commercial grade oil of SAE viscosity from #10 to #40 are acceptable.

o. AMBIENT TEMPERATURE.-- 0° to 110° F.

p. MAXIMUM ALTITUDE.-- 10,000 feet.

q. STARTING METHOD.-- Detachable rope pull.

r. RADIO FREQUENCY NOISE.-- Radiated noise; 2.5 microvolts maximum. Conducted noise; 50 microvolts maximum between 300 and 1600 kilocycles, 5 microvolts maximum between 1.6 and 20 megacycles.

s. GENERATOR SYNCHRONOUS IMPEDANCE.-- 16 ohms.

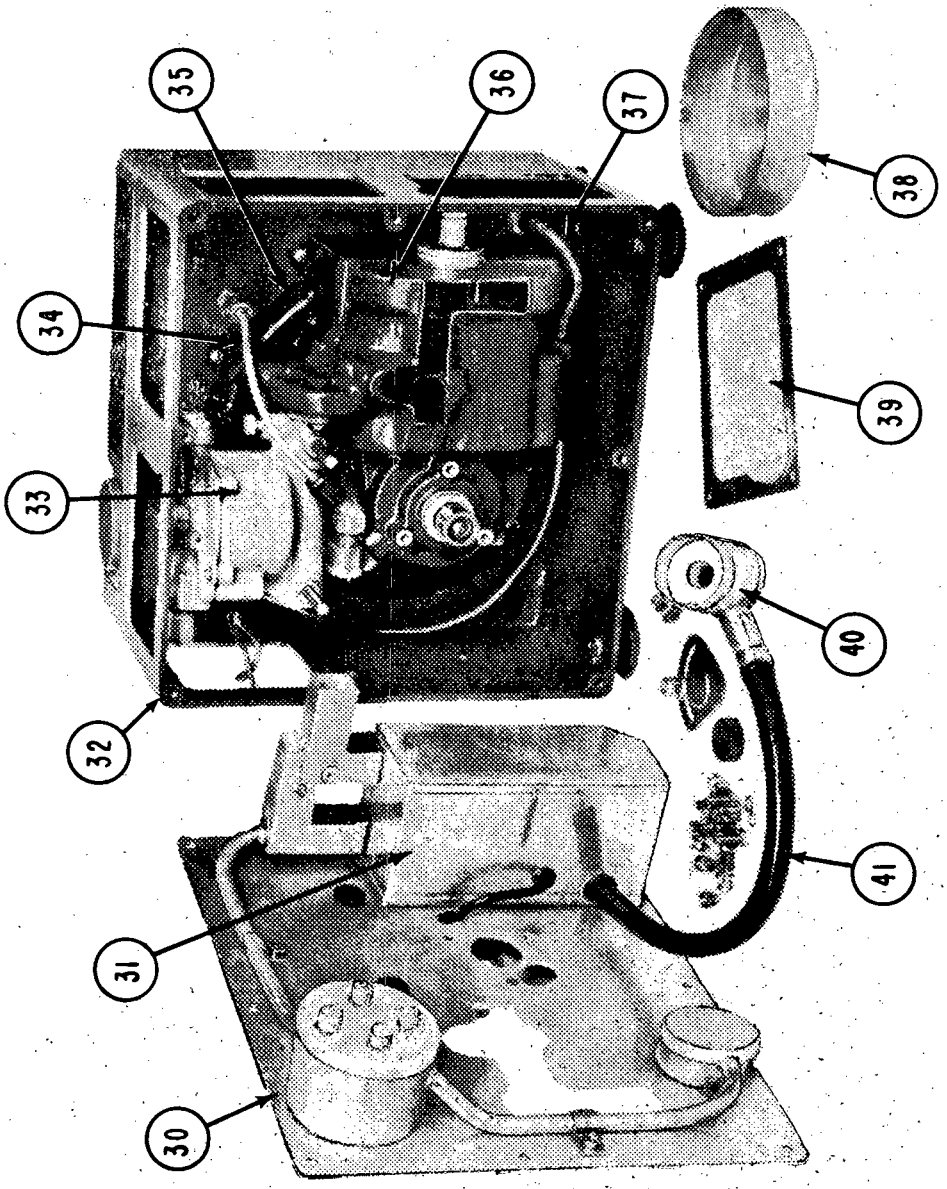


Figure 1-3. Internal view, front half of unit

TABLE 1-1. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	TYPE DESIGNATION	OVER-ALL DIMENSIONS(INCHES) HEIGHT WIDTH LENGTH	VOLUME (CUBIC INCHES)	WEIGHT (LBS)
1	Engine Generator Unit	RD-13	7-1/8 5 7-3/4	300	12
1	Instruction Manual		11 8-1/2		
1	Muffler		3 6	22	0.2
1	Spare Spark Plug				
1	Spare Set of Breaker Points				

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

QUANTITY PER EQUIPMENT	NAME	TYPE DESIGNATION	REQUIRED USE	REQUIRED CHARACTERISTICS
1	Volumetric Flask	Commercial Grade	To meter fuel and oil prior to filling tank	
1	Gasoline	Commercial Grade	Fuel	Octane rating 60 to 80
1	Oil	Commercial Grade	Lubrication	SAE viscosity #10 to #40

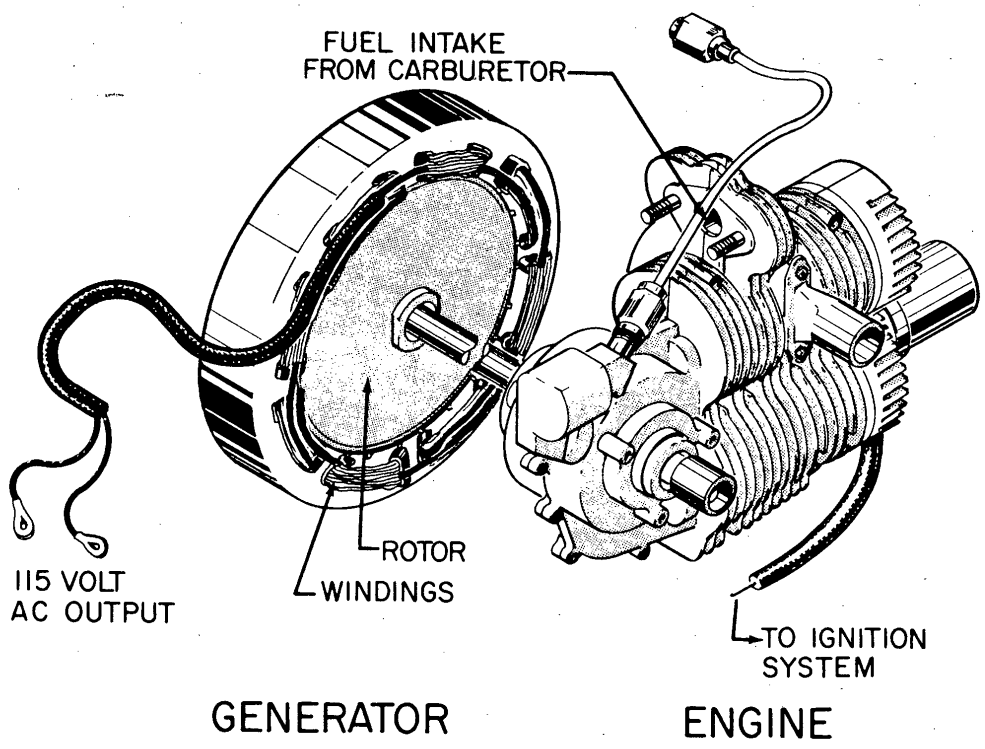


Figure 2-1. General operating principle of Engine Generator Unit RD-13.

SECTION 2

THEORY OF OPERATION

1. GENERAL.

The general operation of ENGINE GENERATOR UNIT RD-13 is illustrated in figure 2-1.

Rotational energy of the prime mover (engine) is converted to electrical energy in the generator by means of a rotating permanent-magnet field. The voltage developed by the generator is a function of the engine speed and the power factor of the load. The generator is designed to give 115 volts with a 100 watt, 80% lagging power factor load when operating at a speed of 6000 RPM or 400 cycles per second. With the same throttle setting of the engine the voltage will rise to approximately 122.5 volts at a 40 watt load, 80% lagging power factor. The regulation over this range computed from the voltage rating of 115 volts is 7.5%. Figure 2-2 shows how the output terminal voltage rises as the load current is decreased. As the voltage is usually a more important factor than the frequency, the engine speed may be manually throttled to give the desired voltage.

2. ENGINE.

The engine has two cylinders that are positioned horizontally. Figure 2-3 indicates the general construction of the engine which is known as the U-cylinder type. Both pistons operate from a common crank shaft eccentric. One piston has a master connecting rod, with a bearing on the crankpin, the other a link rod which is hinge-jointed to an arm extending at right angles from the long end of the master connecting rod. The two-stroke principle of operation is utilized.

In a conventional two-stroke engine, using symmetrical timing, the exhaust port is always opened before the intake transfer port. This gives the cylinder a chance for scavenging from the pressure at the end of the effective expansion stroke. During the latter part of the charge-transfer period the exhaust port is still wide open, so it is easy for some of the fresh charge to escape through it. In the second place, even after the transfer port has closed the exhaust port remains open, and the continuing outward motion of the piston tends to force more of the combustion-chamber contents

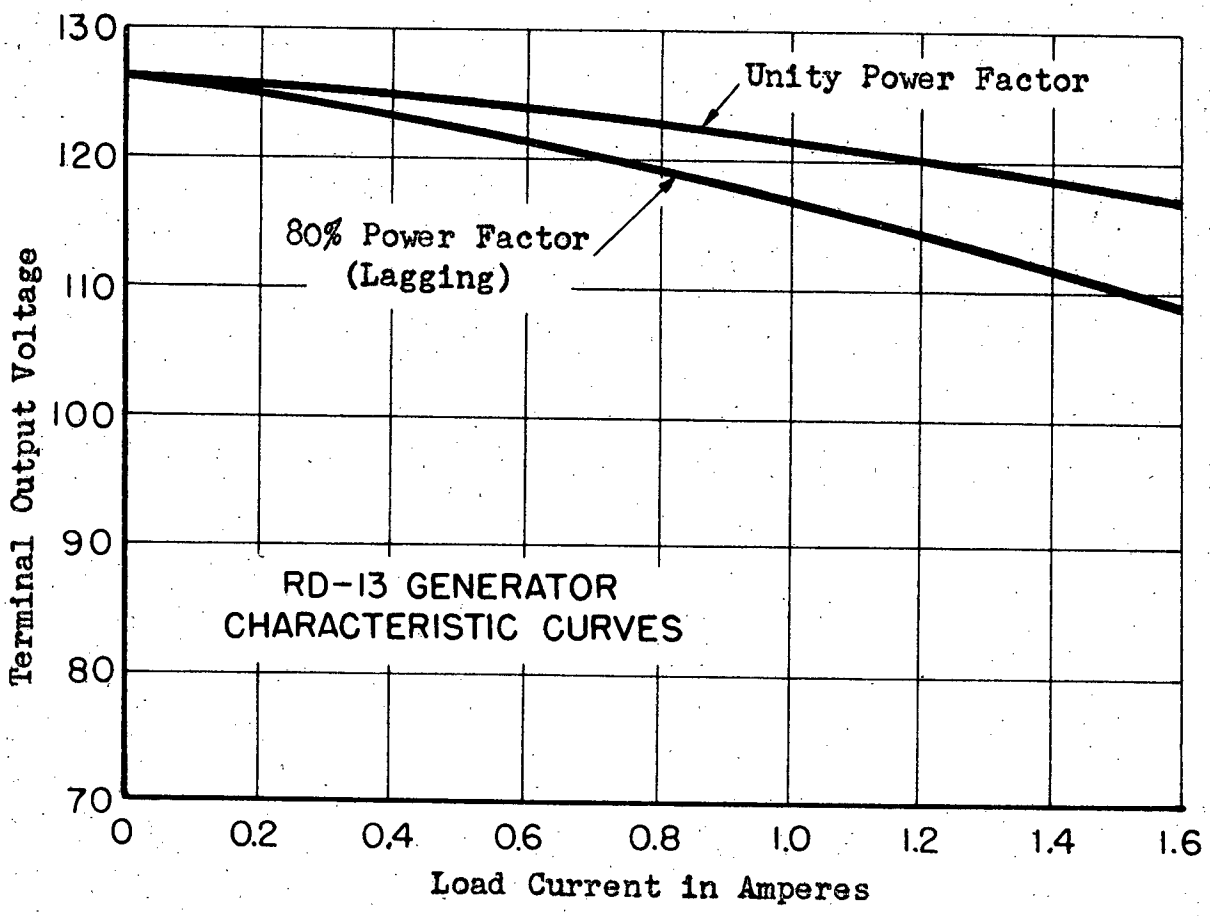


Figure 2-2. RD-13 generator characteristic curves.

out through it. The RD-13 engine overcomes these disadvantages by the use of unsymmetrical timing. Both cylinders have a common combustion chamber. The exhaust ports are completely uncovered by one piston before the intake starts to open due to the action of the other piston, (see fig. 2-4). When the exhaust is closed the intake is wide open. This allows a higher atmospheric pressure to be maintained in the combustion chamber after closing of exhaust port. Thus the intake and exhaust functions are separated by the common cylinder wall. Better efficiencies are realized by this type of construction.

The carburetor is located above the crank case. The function of the carburetor is to prepare a mixture of air and fuel vapor in the proper proportion for efficient combustion. Both air and fuel are drawn through the carburetor and into the engine cylinder by suction created by the upward motion of the pistons. This suction

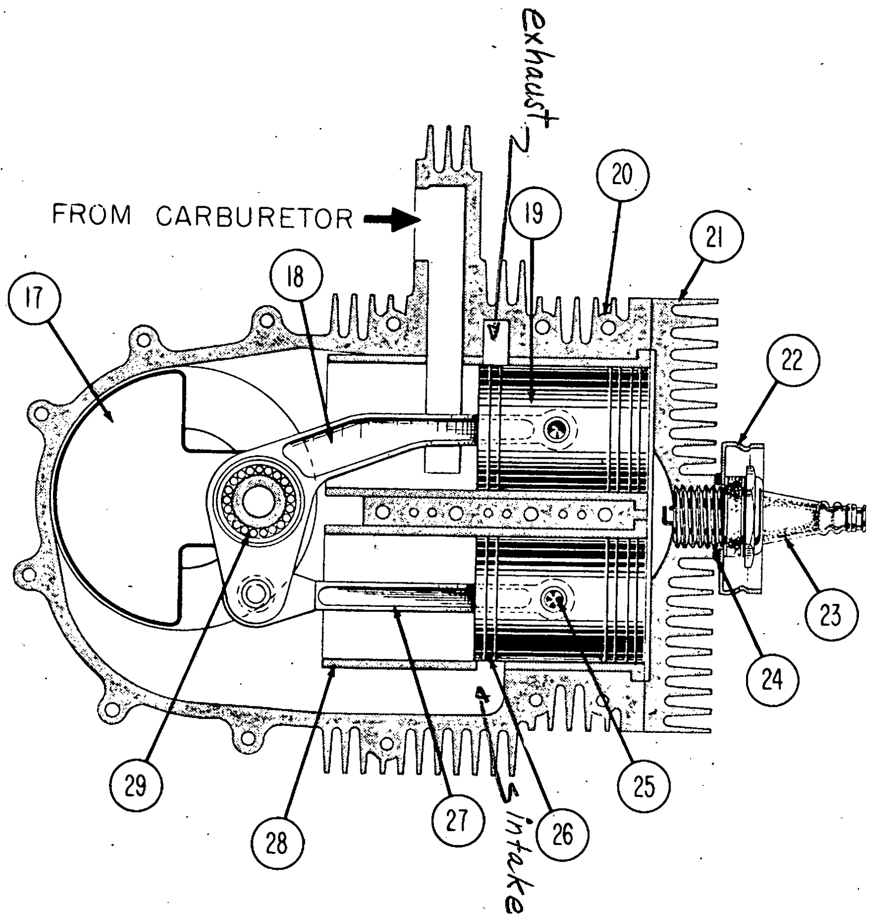


Figure 2-3. RD-13 engine cross-sectional view.

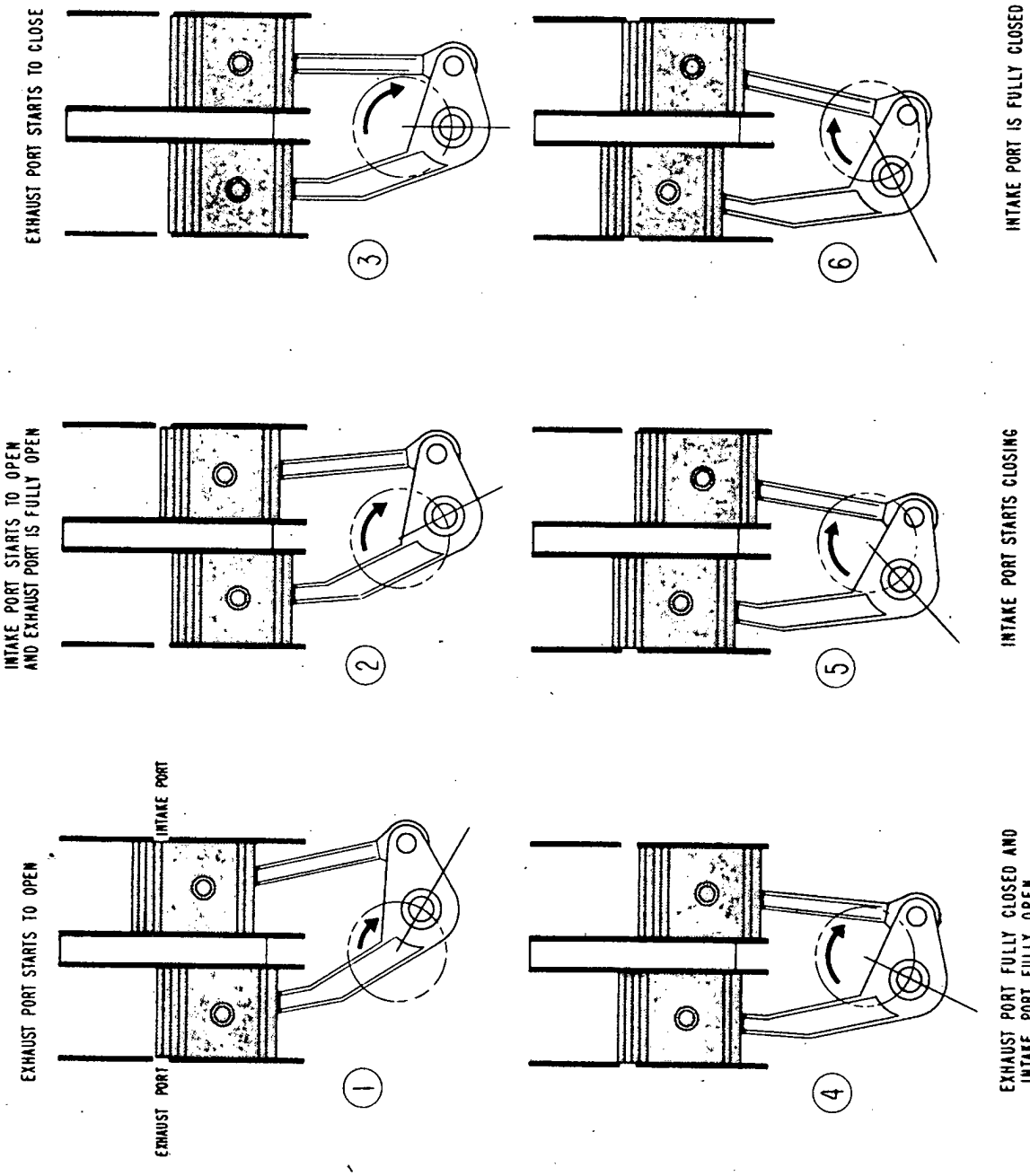


Figure 2-4. Intake-exhaust timing diagram.

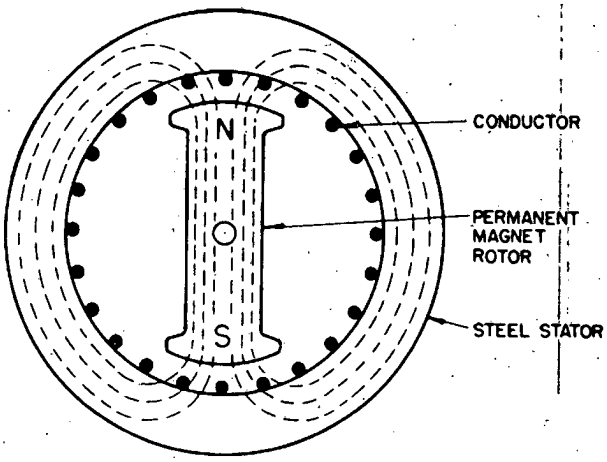
is due to an increase in the volumetric displacement of the crankcase and a consequent decrease in the gaseous pressure in this chamber. It is the difference between the pressure of the atmosphere and the reduced pressure in the crankcase which causes both air and fuel to flow into the chamber. The carburetor is provided with a choke valve in the air intake, to make it possible to get a rich mixture for starting the engine cold, and to "lean down" the mixture gradually as the engine warms up. This control is located on the engine side of the unit, see figure 1-1. The adjustment screw located on top of the carburetor is a needle valve for controlling the fuel-air mixture over a wide range of ambient temperatures and air pressures at different elevations.

To insure a uniform flow of fuel into the carburetor, the fuel tank is pressurized. Pressurizing is accomplished by means of a tube connecting the fuel tank to the crankcase. A check valve in the tube line prevents fuel from feeding back into the crankcase.

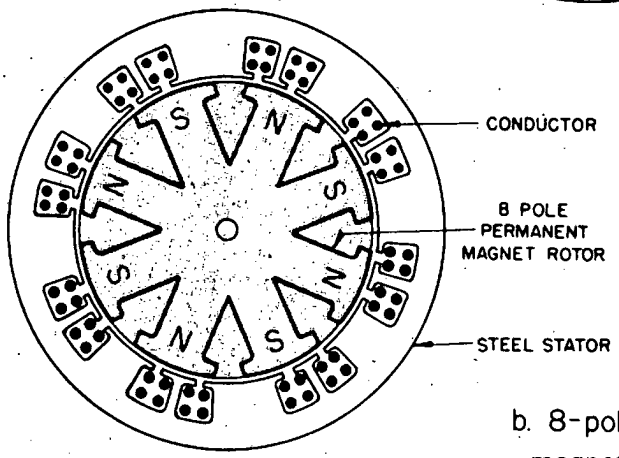
Ignition of the combustible mixture occurs at "top dead center" of the number one piston (located adjacent to the exhaust outlet). A spark plug centrally located in the combustion chamber ignites the mixture. Timing of the spark is accomplished by a cam operated breaker-point assembly directly connected to one end of the crank shaft. No automatic spark advance is incorporated since the engine operates with a constant speed and load.

3. GENERATOR.

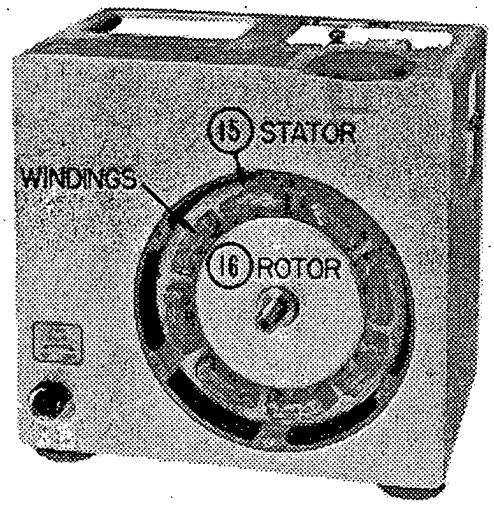
The generator (figure 2-5c) converts the rotary engine motion into electrical energy. It consists fundamentally of a permanent magnet rotor, arranged to rotate in a wound steel stator. External field excitation is not required. Generator action depends upon the principle that a voltage is induced in a conductor being cut by magnetic flux lines. Figure 2-5a shows a two-pole permanent magnet arranged to revolve within a wound stator frame. The lines of magnetic flux are shown by dashed lines. As the rotor revolves, its lines of flux cut the conductors wound around the stator and voltage is induced. In this equipment the stator has an eight-pole single-phase winding; the rotor has eight permanent-magnet salient poles. Magnetic induction in the stator windings results from rotating the permanent magnet assembly by a direct connection with the engine shaft, see figure 2-5b. One rotation of the crank shaft induces four cycles, and the nominal speed of 6000 RPM results in a generator frequency of 400 cycles per second. The waveform of the generator voltage is sinusoidal.



a. Simple 2-pole permanent magnet generator.



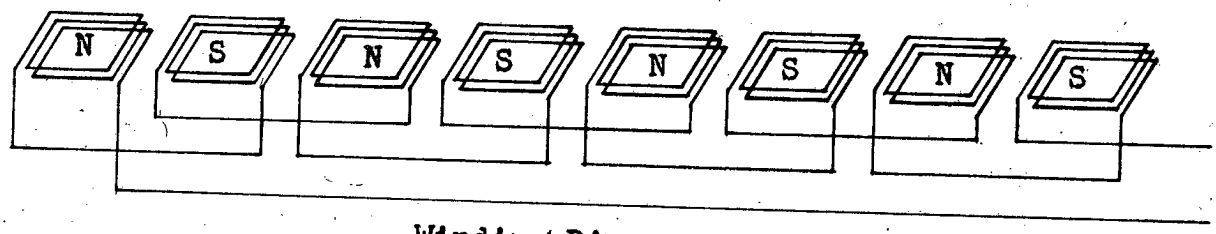
b. 8-pole permanent magnet generator.



c. RD-13 generator.

Figure 2-5. Generator operation and construction.

The permanent magnets in the rotor are "keeper stabilized"; i.e., they will become partially demagnetized if removed from the unit. Normal operation or an accidental short circuit of short duration will not effect the magnets adversely. However,



Winding Diagram

Number of Coils	8
Turns per Coil	43
Wire Data (Copper)	#24 HF
Total Resistance of Windings	3.73 ohms

Figure 2-6. Permanent Magnet Generator stator winding data and diagram, Engine Generator Unit, RD-13.

external excitation to the generator by means of another power source of lower synchronous impedance could completely demagnetize the field. In order to avoid this, the ENGINE GENERATOR UNIT RD-13 should not be used in parallel with other units or operated on lines which are subject to other excitation.

The power factor of the load alters the terminal voltage of the generator as shown in figure 2-2. Armature reaction due to a lagging power factor load causes the terminal voltage to decrease while a leading power factor load causes the terminal voltage to increase. Best regulation of the generator can be realized when the load is maintained at unity power factor.

4. IGNITION SYSTEM.

Figure 2-7 shows a complete schematic diagram of the ignition system which ignites the combustible mixture by an electric spark produced between the points of a spark plug. The ignition system

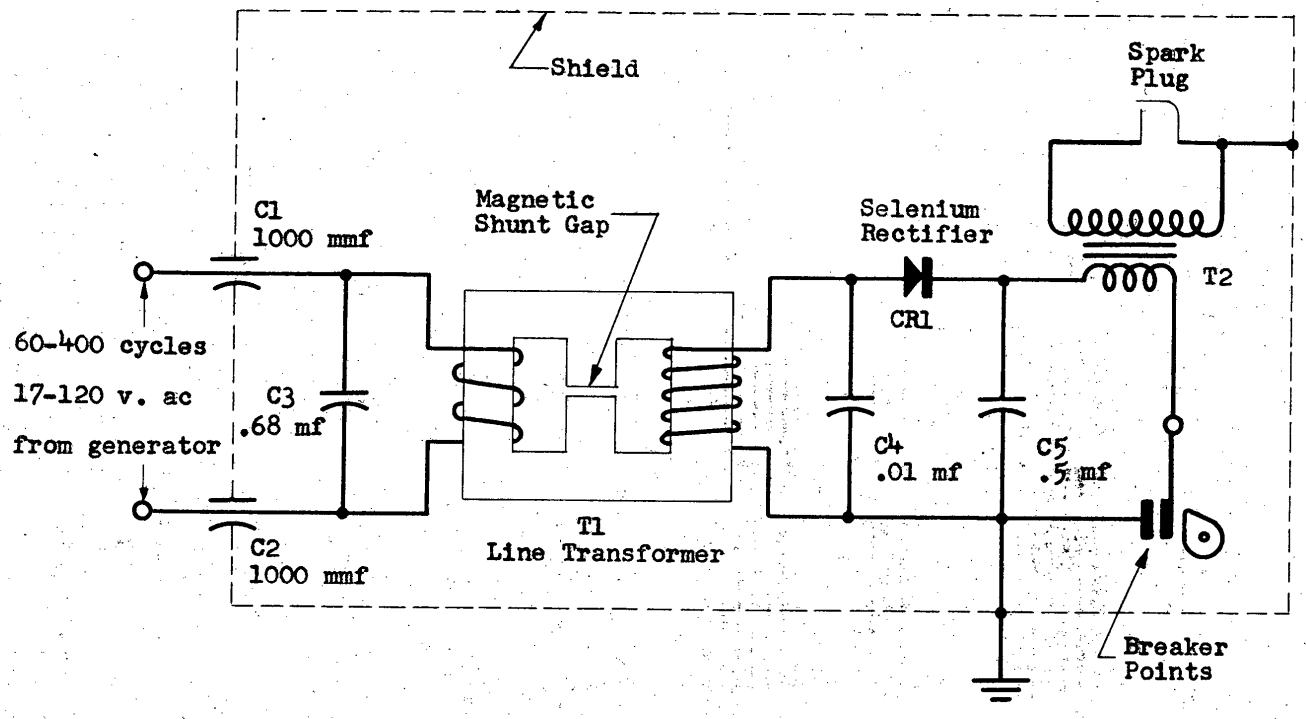


Figure 2-7. Ignition system, schematic diagram.

is powered by an electrical connection to the generator. As one ignition spark is required per four cycles of generator voltage, electrostatic energy is stored in capacitor C5. This capacitor is then discharged once each revolution into spark transformer T2 by means of the breaker-point assembly. The spark plug fires after the breaker-points close during the high rate of current change in the spark transformer. "Line transformer" T1 connects the ignition to the generator voltage. The usual cranking speed gives a generator output of approximately 50 volts while the nominal running speed voltage is 115 volts. T1 automatically regulates for the difference between starting and running voltage of the generator. The line transformer is similar to a constant current transformer in that a large amount of leakage inductance is employed. A magnetic shunt path is used between the primary and secondary to increase the leakage flux. In the interest of conserving power under the running condition, the spark energy is reduced to approximately two-thirds that of starting by action of the line transformer at operating frequency. Capacitor C4 tunes or peaks the secondary winding of T1 and improves ignition operation at starting speeds.

The voltage from the secondary of the line transformer is rectified by selenium rectifier CR1 and applied to the storage capacitor, C5. Once each revolution of the engine, the breaker-points close and discharge capacitor C5 into the spark transformer. No spark suppression capacitor is required on the points as the primary inductance of the spark transformer is sufficient to cause no current flow at the instant of contact. Shortly after the points close a high rate of primary current change induces a secondary voltage that is sufficient for spark over in the spark plug. The useful spark discharge has a duration of approximately 100 microseconds. The breaker-points at normal speed have a 210 microsecond or 30° period of closure so that the current broken by the points upon opening is approximately the short circuit current of the line transformer or 20 milliamperes. Charging of the storage capacitor takes place during the 330° period when the breaker-points are open. Three half-wave voltage pulses charge the storage capacitor.

The generator input to the ignition system is (for running) 5.75 watts at a power factor of 50%. The power factor is improved by the use of capacitor C3. Capacitors C1 and C2 serve to reduce electrical or r-f "hash" created by the ignition system.

5. POWER WIRING AND NOISE FILTER.

Figure 2-9 shows a schematic diagram of the power wiring system and the noise filter. In order to reduce the radio noise to a minimum, complete conduit shielding for the power wiring is used

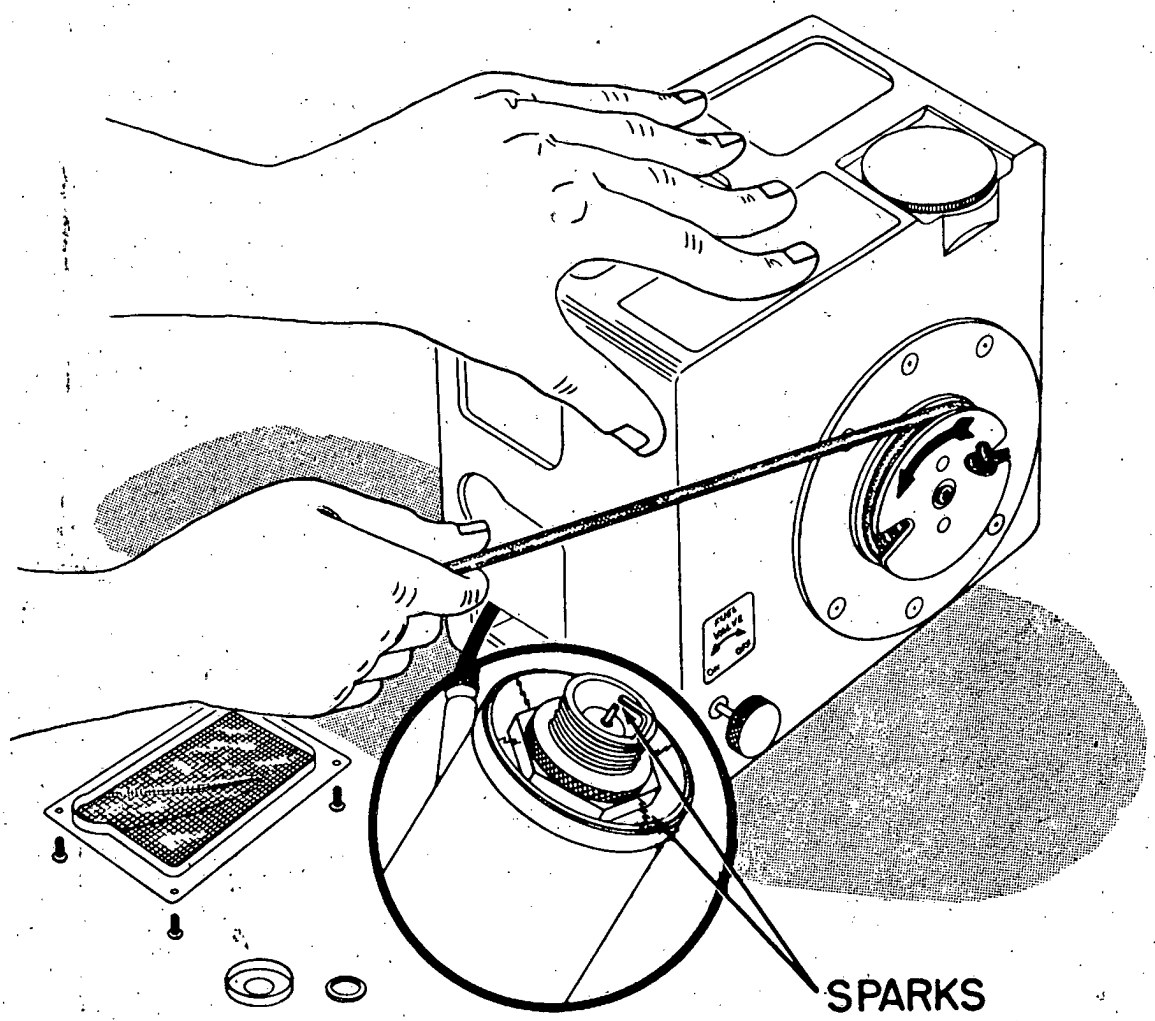
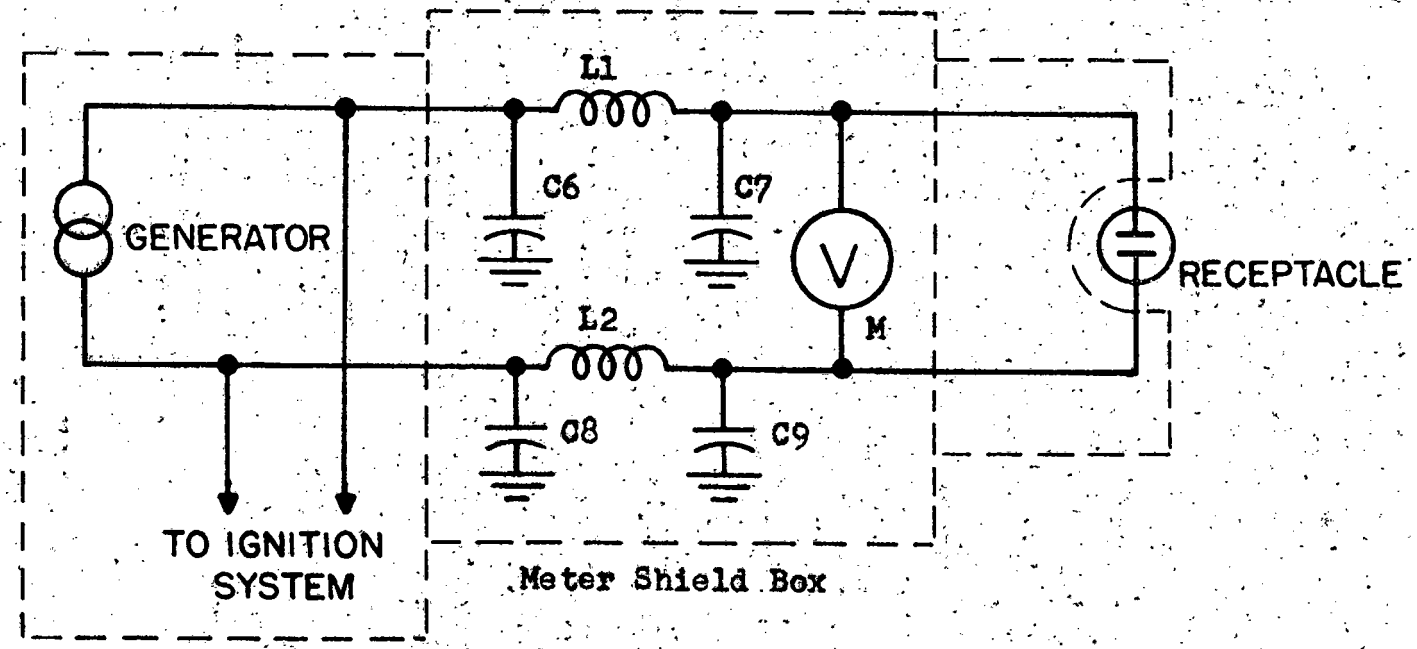


Figure 2-8. Performing ignition test.

throughout the unit. The filter circuit for removing conducted noise on the power line consists of a combination of capacitors and choke coils. All filter components are located on the lid at the rear of the meter shielding case (Item 30).



Part No.	Description	Note
C6	0.1 mfd, 600-volt, paper	Part of Item 42
C7	0.1 mfd, 600-volt, paper	Part of Item 42
C8	0.1 mfd, 600-volt, paper	Part of Item 42
C9	0.1 mfd, 600-volt, paper	Part of Item 42
L1	255 microhenries	Part of Item 42
L2	255 microhenries	Part of Item 42
M	Voltmeter, 0-150 volts ac	Part of Item 1

Figure 2-9. Power schematic diagram.

S E C T I O N 4

O P E R A T I O N

1. GENERAL.

The ENGINE GENERATOR UNIT RD-13 has a self-contained gasoline engine and generator for use as an electrical power source. The electrical output of the generator is brought out to a power receptacle on the front panel of the unit (see figure 1-2). This generator develops a nominal voltage of 115 volts ac at 400 cycles per second. The rated load is 100 watts.

> CAUTION!
>
> Do not apply any form of external electrical excitation to the power receptacle as damage to the generator may result. This caution includes the operation of two or more RD-13 UNITS on the same distributing lines.

The two-stroke cycle engine is powered by a fuel mixture of gasoline and oil. An internal fuel tank is accessible for refueling from the top of the unit by means of the fuel tank cap. Approximately two hours of operation from the unit may be obtained from one tank of fuel. The nominal engine speed is 6000 RPM, controlled by the throttle knob projecting from the front panel.

2. CONTROLS.

The controls which the operator will use are illustrated in figure 1-2.

The fuel shut-off valve knob is accessible at the rear, figure 1-2b. Normally during storage or handling of the unit the fuel shut-off valve will be closed. To open the fuel valve prior to operation of the unit, turn the valve knob counterclockwise two to three full revolutions. Clockwise rotation to the internal stop shuts off the fuel supply. The carburetor float well holds sufficient fuel for approximately 2 minutes of normal operation. If the unit is to be returned to storage, allow the unit to use the float well fuel supply by running with the fuel shut-off valve closed.

The engine choke control is shown in figure 1-2a. The choke control is manually operated by turning the choke knob. Positions indicated are ON and OFF with intermediate positions unmarked. The choke control governs the fuel-to-air ratio and will normally be used only during the starting procedure; see paragraph 4, Starting Procedure.

The throttle is controlled from the front panel by the throttle knob quadrant, figure 2-1a. Clockwise rotation closes the throttle, counterclockwise rotation opens the throttle. During operation the throttle setting governs the speed and consequently the voltage of the generator. Turn the throttle knob counterclockwise to increase the generator voltage and clockwise to decrease it.

The voltmeter, located on the front panel, meters the generator voltage (see figure 1-2a).

A detachable pull rope is shown wound on the pull rope pulley in figure 1-2b. This rope is used for starting the RD-13 unit. Wind the rope counterclockwise around the pulley as the operating rotation is in this direction.

3. PREPARATION OF FUEL.

The fuel mixture is 14 parts gasoline to one part oil by volume. Commercial grade gasoline from 60 to 80 octane rating and commercial grade oil of SAE viscosity from #10 to #40 may be used. If available, non-leaded gasoline and #40 oil are preferable.

In a clean vessel mix 14 volume units of gasoline and add 1 volume unit of oil. Stir the mixture until homogenous and transfer to the fuel tank. If evidence of water or other foreign matter is present in the mixture, strain through a chamois skin before transferring to the fuel tank.

4. STARTING PROCEDURE.

The fuel-to-air ratio for starting the two-stroke cycle engine is critical. Unsuccessful starting attempts may usually be attributed to "loading up" (raw gasoline being deposited on the spark plug and cylinder walls). Normal starting from the "cold" condition will require two pulls of the pull rope. One pull to prime the engine and a second pull to start the engine. Starting the engine from the "hot" condition will normally require one pull, and the procedure is different than that of the "cold" condition. By "hot" condition is meant that the unit was previously operating but shut down momentarily before restarting. The "cold" condition

implies that the unit has established temperature equilibrium with the surroundings, or approximately so. Optimum starting performance can only be achieved by strict compliance with the following procedures.

Note: Always steady the unit with one hand while pulling the pull rope with the other hand as the weight of the unit is not sufficient for counter-action, see figure 2-8.

CAUTION!

ALL OPERATING PERSONNEL ARE DIRECTED TO READ THE SAFETY NOTICE IN THE FRONT MATTER OF THIS INSTRUCTION BOOK.

a. STARTING FROM "COLD" CONDITION.

1. Open fuel shut-off valve (Item #11, Figure 1-2) by turning knob counterclockwise.

2. Remove fuel tank cap and blow into tank. Hold pressure in tank about 20 seconds. Replace fuel tank cap and screw down tightly.

3. Set throttle (Item #2, Figure 1-2) one-quarter open.

4. Open mixture control valve one-half turn counterclockwise. This control is located on top of the carburetor.

5. Close choke (Item #14, Figure 1-2).

6. Connect load to generator outlet (Item #4, Figure 1-2).

7. Wind the pull rope around the pull rope pulley in the direction of rotation. Pull the pull rope sharply.

8. As the engine speeds up open the choke control to full open. The engine may start but it will quickly die if the choke control is not eased open soon enough.

9. As the engine warms up the mixture control valve can be brought back to the normal position (clockwise rotation of screw).

10. Adjust the motor speed by the throttle until the proper generator voltage is indicated. Do not exceed 115 volts with a

11. "Touch up" the mixture control until the engine runs smoothly at the rated voltage with full load.

12. If the engine fails to start, repeat item 7. Make no further adjustments to the choke until unit starts and continues to run.

> NOTE
>
> IN VERY COLD CLIMATES IT MAY BE NECESSARY TO USE MORE CHOKE IN ITEM EIGHT; i.e., CHOKE CONTROL ONE-EIGHTH OPEN. UNDER MOST CONDITIONS IT IS BETTER TO USE THE NORMAL PROCEDURE UNLESS EXPERIENCE WITH THE UNIT DICTATES OTHERWISE.

b. STARTING FROM "HOT" CONDITION.

1. Open fuel shut-off valve (Item #11, Figure 1-2) by turning knob counterclockwise.

2. Open the choke control (Item #14, Figure 1-2) one-half open.

3. Open the throttle (Item #2, Figure 1-2) halfway.

4. Connect load to generator outlet (Item #4, Figure 1-2).

5. Wind the pull rope around the pull rope pulley in the direction of rotation. Pull the pull rope sharply.

6. The engine should start and continue to run. Slowly open the choke as the engine approaches running temperature until full open.

5. UNSUCCESSFUL STARTING.

A certain amount of operator technique and familiarity with the unit is required for optimum starting success. A sharp pull applied to the pull rope initially will repay many-fold in manual effort saving over weak pulls.

If, for any reason, the starting procedures were not followed correctly or five to ten starting attempts prove futile, future attempts will probably be useless. Malfunctioning of the engine may not be indicated. In most cases the engine is "loaded up" or "flooded"; i.e., an improper mixture too rich for combustion is present in the combustion chamber. The operator may verify this condition by noting a wet vapor sufficient to dampen a piece of paper when placed near the exhaust outlet while cranking. If this condition is present, the following procedure is recommended;

1. Close the fuel tank cap.

2. Close the fuel shut-off valve.

3. Lay unit over on its front side and allow fuel to drain from the carburetor float well for ten minutes.

4. Upright the unit. Wipe away any spilled fuel.

5. Open the choke full open and crank the unit with the pull rope two times.

6. Proceed with the normal starting method for the "cold" condition.

6. STOPPING THE ENGINE.

To stop the engine after use for subsequent restarting, close the throttle to the stop. If the engine is to be stopped for return to storage, close the fuel shut-off valve and allow engine to operate until fuel in the carburetor float well is depleted. The engine will then stop. Close the fuel tank cap tightly. No other method of stopping the engine is recommended.

SECTION 5

MAINTENANCE

1. OPERATOR'S MAINTENANCE.

The ENGINE GENERATOR UNIT RD-13 is rated for 50 hours life. No lubrication will be required other than the oil used in the fuel mixture. An operating time chart should be started with the bringing of a unit into service in order to keep an accurate account. After 50 hours use, the RD-13 should only be used for standby or emergency service.

a. STARTING MALFUNCTION.

Poor starting success may be the result of insufficient fuel or no fuel at all entering the intake manifold. Insufficient fuel will be indicated by a short run period followed by a sudden drop in speed, possibly recycling itself. No fuel entering the intake will be evidenced by the lack of a gasoline vapor smell at the exhaust outlet. In either case, the probable cause is foreign matter becoming lodged in the carburetor float valve or the mixture control. This condition may usually be corrected by opening the mixture control one turn counterclockwise to allow obstruction to pass through. Tip the unit from side to side and invert momentarily to clear the carburetor float valve. Start the engine following the procedures outlined in Section 4. If insufficient fuel still seems to be the cause of starting malfunctioning, check to see that the fuel tank cap is turned down tight. Any loss of pressure due to a loose cap will affect the engine operation, since the fuel tank is pressurized to provide a uniform flow to the carburetor. Other remedies for this malfunction require disassembly of the unit and they are not recommended for the field.

b. IGNITION MALFUNCTION.

Another cause of poor starting success is insufficient ignition spark or no spark at all. Inspect the wiring for possible shorts or damaged insulation. Remove the breaker point dust cover, by means of the two machine screws. Inspect the breaker point arms and spring for possible mechanical damage. Clean the breaker points by pulling strips of clean paper back and forth between the closed contacts. To open and close the contacts rotate the pull rope pulley by hand. The points should normally separate by 15 thousandths of an inch. Replace the breaker point dust cover.

c. IGNITION SYSTEM TEST.

To test the ignition system remove the screen cover from the side of the unit to expose the spark plug shield. Remove the spark plug shield and the spark plug. This is accomplished by pulling out the spark plug shield to disengage it from the spark plug and removing the spark plug by means of a spark plug wrench. Do not lose the copper washer at the base of the spark plug. Insert the spark plug in the spark plug shield and lay to one side in such a fashion that the metal base of the spark plug is not in contact with the case of the unit. Engage the rope pull and give a sharp pull. Normal ignition voltage will cause the spark to jump from the metal base of the spark plug to the spark plug shield, see figure 2-10. If the preceding checks were satisfactory and the latter test unsatisfactory, the ignition system is malfunctioning. The ignition system is replaced as a unit, but this replacement is not recommended in the field.

When replacing the spark plug turn down to only a moderate tightness. Damage may result if the plug is tightened too much, since the engine head is constructed of aluminum. If a torque wrench is available, the recommended value is a 6 ft-lb torque. The correct spark plug gap is between 16 and 20 thousandths of an inch.

2. PERIODIC INSPECTION.

Periodically the operator should inspect the ENGINE GENERATOR UNIT RD-13 for mechanical and electrical security. It is recommended that the inspection be undertaken once for every five hours use. Thoroughly inspect all exposed machine screws and nuts for tightness. Wipe away any accumulation of dust and oil.

3. TECHNICAL MAINTENANCE.

At the end of each 25 hours of running time, the carbon should be removed from the cylinder head and the exhaust port. The spark plug should be replaced or re-gapped. To clean the carbon from the top of the pistons and from the cylinder head, remove the cylinder head (Item 21, Figure 2-3) from the engine block. This is accomplished by removing the spark plug and the ten Allen head retaining screws in the cylinder head. Carefully remove the cylinder head so as not to tear or damage the gasket. Remove the head gasket without damaging it. Using a screwdriver or flat metal bar, scrape the carbon from the top of the pistons and from the cylinder head. With the same tool, scrape the carbon from the inside of the exhaust

port. Shake any remaining carbon flakes from the engine and wipe clean with a rag. Replace the head gasket, the cylinder head, and the retaining screws. Replace the copper ring and install the spare spark plug. (If the old spark plug is to be re-gapped, see SECTION 5, Paragraph 1c for the correct gap spacing).

Any maintenance required that is not covered in this manual will generally be of such a nature that specialized technical skill must be employed. For example, at the end of each 50 hours of running time, the piston rings should be replaced. This is a major overhaul job and should not be attempted in the field by unskilled personnel.

Item No.	Description	Drawing No.
18	Rod, Master Connecting.	Technical Development Co., C-20007.
19	Piston.	Technical Development Co., C-20042.
20	Block, Engine, Front Half and Rear Half.	Technical Development Co., R-20002 & R-20003.
21	Head, Cylinder.	Technical Development Co., A-20004.
22	Base, Engine Spark Plug Shield.	Hoffman Radio Co., SKS-2136.
23	Spark Plug.	Electric Auto-Light Co., PM-5.
24	Washer, Copper.	Hoffman Radio Co.,
25	Pin, Piston.	Technical Development Co., A-20041.
26	Ring, Piston.	Technical Development Co., B-20016.
27	Rod, Connecting.	Technical Development Co., B-20047.

SECTION 5

MAINTENANCE

1. OPERATOR'S MAINTENANCE.

The ENGINE GENERATOR UNIT RD-13 is rated for 50 hours life. No lubrication will be required other than the oil used in the fuel mixture. An operating time chart should be started with the bringing of a unit into service in order to keep an accurate account. After 50 hours use, the RD-13 should only be used for standby or emergency service.

a. STARTING MALFUNCTION.

Poor starting success may be the result of insufficient fuel or no fuel at all entering the intake manifold. Insufficient fuel will be indicated by a short run period followed by a sudden drop in speed, possibly recycling itself. No fuel entering the intake will be evidenced by the lack of a gasoline vapor smell at the exhaust outlet. In either case, the probable cause is foreign matter becoming lodged in the carburetor float valve or the mixture control. This condition may usually be corrected by opening the mixture control one turn counterclockwise to allow obstruction to pass through. Tip the unit from side to side and invert momentarily to clear the carburetor float valve. Start the engine following the procedures outlined in Section 4. If insufficient fuel still seems to be the cause of starting malfunctioning, check to see that the fuel tank cap is turned down tight. Any loss of pressure due to a loose cap will affect the engine operation, since the fuel tank is pressurized to provide a uniform flow to the carburetor. Other remedies for this malfunction require disassembly of the unit and they are not recommended for the field.

b. IGNITION MALFUNCTION.

Another cause of poor starting success is insufficient ignition spark or no spark at all. Inspect the wiring for possible shorts or damaged insulation. Remove the breaker point dust cover, by means of the two machine screws. Inspect the breaker point arms and spring for possible mechanical damage. Clean the breaker points by pulling strips of clean paper back and forth between the closed contacts. To open and close the contacts rotate the pull rope pulley by hand. The points should normally separate by 12 thousandths of an inch. Replace the breaker point dust cover.

c. IGNITION SYSTEM TEST.

To test the ignition system remove the screen cover from the side of the unit to expose the spark plug shield. Remove the spark plug shield and the spark plug. This is accomplished by pulling out the spark plug shield to disengage it from the spark plug and removing the spark plug by means of a spark plug wrench. Do not lose the copper washer at the base of the spark plug. Insert the spark plug in the spark plug shield and lay to one side in such a fashion that the metal base of the spark plug is not in contact with the case of the unit. Engage the rope pull and give a sharp pull. Normal ignition voltage will cause the spark to jump from the metal base of the spark plug to the spark plug shield, see figure 2-10. If the preceding checks were satisfactory and the latter test unsatisfactory, the ignition system is malfunctioning. The ignition system is replaced as a unit, but this replacement is not recommended in the field.

When replacing the spark plug turn down to only a moderate tightness. Damage may result if the plug is tightened too much, since the engine head is constructed of aluminum. If a torque wrench is available, the recommended value is a 6 ft-lb torque. The correct spark plug gap is between 12 and 15 thousandths of an inch.

2. PERIODIC INSPECTION.

Periodically the operator should inspect the ENGINE GENERATOR UNIT RD-13 for mechanical and electrical security. It is recommended that the inspection be undertaken once for every five hours use. Thoroughly inspect all exposed machine screws and nuts for tightness. Check all electrical wiring. Wipe away any accumulation of dust and oil.

3. TECHNICAL MAINTENANCE.

At the end of each 25 hours of running time, the carbon should be removed from the cylinder head and the exhaust port. The spark plug should be replaced or re-gapped. To clean the carbon from the top of the pistons and from the cylinder head, remove the cylinder head (Item 21, Figure 2-3) from the engine block. This is accomplished by removing the spark plug and the ten Allen head retaining screws in the cylinder head. Carefully remove the cylinder head so as not to tear or damage the gasket. Remove the head gasket without damaging it. Using a screwdriver or flat metal bar, scrape the carbon from the top of the pistons and from the cylinder head. With the same tool, scrape the carbon from the inside of the exhaust

port. Shake any remaining carbon flakes from the engine and wipe clean with a rag. Replace the head gasket, the cylinder head, and the retaining screws. Replace the copper ring and install the spare spark plug. (If the old spark plug is to be re-gapped, see SECTION 5, Paragraph 1c for the correct gap spacing).

Any maintenance required that is not covered in this manual will generally be of such a nature that specialized technical skill must be employed. For example, at the end of each 50 hours of running time, the piston rings should be replaced. This is a major overhaul job and should not be attempted in the field by unskilled personnel.

Item No.	Description	Drawing No.
1	Voltmeter; 0-150 volts ac. Cup, Meter Shielding. Cover, Meter Shielding Cover.	International Instruments Co., Model 150-W. Hoffman Radio Co., AS-1339. Hoffman Radio Co., AS-1340.
2	Quadrant, Throttle.	Technical Development Co., B-21833.
3	Muffler.	Technical Development Co., C-21832.
4	Receptacle, Power.	Amphenol Co., 61-MIP-61F.
5	Breaker-Point Assembly. (Distributor)	Technical Development Co., C-20244.
6	Fuel-Air Mixer Valve.	Part of Item #33.
7	Cap, Fuel Tank.	Technical Development Co., B-20292.
8	Cover, Power Unit Generator.	Technical Development Co., B-20212.

Item No.	Description	Drawing No.
9	Pulley.	Technical Development Co.,
10	Pull Rope Assembly.	Technical Development Co., B-21831.
11	Valve, Fuel Shut-off.	Technical Development Co., Ref. Dwg. D-20316.
12	Shield Assembly, Secondary Spark Plug.	Hoffman Radio Co., AA-743 and AS-1240.
13	Feet, Rubber Suction.	Technical Development Co.,
14	Knob, Carburetor Choke.	Technical Development Co., Ref. Dwg. C-20010.
15	Stator, PM Generator.	Ruckstell Hayward Engine Co.,
16	Rotor, PM Generator.	O'Keefe & Merritt Co., 102,612, 100,440, & 100,635. Technical Development Co., A-20119.
17	Crankshaft, Front and Rear Halfs.	Technical Development Co., C-20019.

Item No.	Description	Drawing No.
18	Rod, Master Connecting.	Technical Development Co., C-20007.
19	Piston.	Technical Development Co., C-20042.
20	Block, Engine, Front Half and Rear Half.	Technical Development Co., R-20002 & R-20003.
21	Head, Cylinder.	Technical Development Co., A-20004.
22	Base, Engine Spark Plug Shield.	Hoffman Radio Co., SKS-2136.
23	Spark Plug.	Electric Auto-Light Co., PM-5.
24	Washer, Copper.	Hoffman Radio Co.,
25	Pin, Piston.	Technical Development Co., A-20041.
26	Ring, Piston.	Technical Development Co., B-20016.
27	Rod, Connecting.	Technical Development Co., B-20047.

Item No.	Description	Drawing No.
28	Liner, Master Cylinder. Liner, Articulated Cylinder.	Technical Development Co., C-20015. Technical Development Co., C-20014.
29	Bearing, Needle Roller.	Torrington Co., W-394-Q.
30	Cover (with Shielding Assembly for Power Circuit).	Hoffman Radio Co., AA-749.
31	Box Assembly, Ignition. Shield, Terminal.	Hoffman Radio Co., AA-706. Hoffman Radio Co., AS-1349.
32	Housing, Power Unit.	Technical Development Co., D-20206.
33	Carburetor.	Technical Development Co., D-20008, C-20010, & A-20037.
34	Tubing Assembly, Pressure Line.	Technical Development Co.,
35	Housing, Fan. Fan, Cooling.	Technical Development Co., R-20011. Technical Development Co., B-20005 & B-20121.

Item No.	Description	Drawing No.
36	Cover, Engine Assembly.	Technical Development Co.,
37	Tubing Assembly, Fuel Line.	Technical Development Co.,
38	Cover, Breaker-Point Assembly.	Part of Item #5.
39	Shield Assembly, Secondary Spark Plug.	See Item #12.
40	Shield Assembly, Engine Spark Plug.	Hoffman Radio Co., SKS-2136.
41	Cable, High Tension Shielded.	Hoffman Radio Co.,
42	Filter, Noise	Hoffman Radio Co., DI-145

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AN ANALYSIS OF THE ELECTRICAL PROPERTIES

OF THE

GP-1 PRODUCTION PROTOTYPE

(HOTSHOT)

COMMUNICATIONS DEVELOPMENT LABORATORY

SECRET
Security Information

2028-52-16

copy ____ of ____

AN ANALYSIS OF THE ELECTRICAL PROPERTIES OF THE GP-1 PRODUCTION PROTOTYPE (HOTSHOT)

25X1

Submitted by

Reviewed by

Approved by

Released by

15 August 1952

This document is part of an integrated file. If separated from the file it must be subjected to individual systematic review.

SECRET
Security Information

1. INTRODUCTION

The production prototype of the GP-1 (HOTSHOT) miniature gasoline-driven alternator, under Contract RD-13, was delivered to the Analysis and Appraisal Unit, Research and Development Branch, for testing. Since there was only one unit available, it was deemed inadvisable to dismantle the unit for a complete mechanical investigation at this time. This report, therefore, is concerned mainly with the electrical and operational properties of the alternator.

2. SUMMARY

The GP-1 is a compact, portable, gasoline-driven alternator which measures 7½ by 8¼ by 6½ inches and which weighs 12 pounds when filled with gasoline. The gas tank capacity is 20 fluid ounces, sufficient for 3 1/3 hours operation with a 100 watt load. Although rated at 100 watts, 115 volts, and 400 cps at 6000 rpm, the unit is capable of delivering 150 watts at temperatures of 90 degrees F. and at the atmospheric pressures encountered at sea level. This amount of power is more than adequate for the operation of most agent communication equipment. Operationally, the starting characteristics and speed regulation with constant load are excellent.

3. DESCRIPTION AND EVALUATION

3.1. Mechanical

(Note: As explained in the introduction, much of the information in this section will be compiled at a later date when an engine break-down is authorized.)

3.1.1. Specifications

3.1.1.1. Engine

3.1.1.2. Ignition

3.1.1.3. Carburetion

3.1.1.4. Muffling

3.1.1.5. Cooling

3.1.1.6. Lubrication

3.1.1.7. Accessories and Spares

The following spares were received with the unit as shipped:

(1) One set of breaker points
(2) One spark plug
(3) One spare length of pull rope
(4) One pull rope and handle

3.1.1.8. Size and Weight

Size - 7½ inches high by 8¼ inches wide by 6½ inches deep
Weight - 12 pounds with fuel

3.1.2. Construction

3.1.3. Operation

The GP-1 has four operational controls; a fuel shut-off valve, a throttle, a choke, and a mixture control.

To start the engine when cold, the gas tank cap is securely tightened, the choke is placed in the ON position, the throttle is opened to one-third, the fuel shut-off is opened, and the engine is pulled through sharply. It is important that the pull rope be wound on the starting pulley in the direction indicated by the arrow; otherwise, the engine will start and run in reverse but cannot be loaded. Instead of a gravity fuel-feed system requiring a vented fuel tank, this engine operates on a pressure feed, requiring that the gas tank cap be seated tightly.

The first pull on the starting rope creates sufficient pressure in the tank for starting. For the second or starting pull, the choke is opened half way and the throttle advanced half way.

Once the engine has started, the choke is turned OFF and the throttle is set for a speed of 6000 rpm. With a 100 watt load, this speed corresponds to the red mark on the voltmeter mounted on the front panel. When the engine has been stopped but is still hot, it will normally start with one pull, if the choke is closed part way.

3.1.3. The mixture control, a screwdriver adjustment atop the carburetor, needs readjustment only when the load is changed. There is a proper setting for each load, which is determined while adjusting the throttle. The following are optimum conditions: smooth running with an absence of popping and vibration, a speed of 6000 rpm, and a gray colored exhaust.

The engine is stopped by turning the fuel shut-off valve to OFF and closing the throttle when the speed has decreased slightly.

Flooding will be experienced if the choke is not turned OFF as soon as possible after the engine starts, or if the choke is turned ON while the engine is running. To remedy this situation, the spark plug must be removed from the cylinder head and the engine "pulled through" a half dozen times. The spark plug should be wiped dry and placed in the cap so that it will fire when the engine is pulled through and prevent break-down within the ignition transformer. The spark plug and ignition cable are replaced and the starting procedure is resumed.

It should be noted that the voltage indicator on the front panel can be used in lieu of a tachometer only when the load is 100 watts. For other loads a tachometer is required to set the speed to 6000 rpm, assuring a frequency of 400 cps and proper mechanical timing.

3.1.4. Maintenance

3.1.5. Tests

3.1.5.1. Rate of Fuel Consumption

When loaded to 100 watts, 80 per cent lagging power factor, at a speed of 6000 rpm, the GP-1 will run for 1 3/4 minutes on 5 milliliters of fuel.

3.1.5.2. Gas Tank Capacity

The gas tank capacity is 20 fluid ounces, or approximately 590 milliliters.

3.1.5.3. Running Time

The total running time per tank-full of fuel when loaded to 100 watts, 80 per cent lagging power factor at a speed of 6000 rpm, is approximately 3 1/3 hours.

3.1.5.4. Operating Temperatures

The following temperatures were recorded after the unit had been delivering 40 watts for a period of thirty minutes.

Throttle control	130	Degrees F.
Choke control	130	
Gas tank cap	118	
Spark plug cap	190	
Carburetor cap	130	
Breaker point cap	160	
Muffler	235	
Exhaust gas	190	
Exhaust air	215	
Intake air (ambient)	90	

3.2. Electrical

3.2.1. Specifications

Voltage	115 vac at 100 watts, 80% lagging power factor
Power	100 watts
Frequency	400 cps at 6000 rpm
Phase	single phase
Field excitation	permanent magnet
Stabilization	keeper stabilized rotor
Number of poles	8 poles
Rotor speed	6000 rpm

3.2.2. Construction

Since the internal inspection of the alternator involves an extensive tear-down of the GP-1, it was decided to inspect the alternator at a future date when the unit will be completely dismantled for the mechanical examination.

3.2.2. However, a superficial examination of the electrical system indicates that satisfactory protection has been afforded all wiring and component parts. The use of conduit and junction boxes for all cabling and electrical connections, together with a potted ignition transformer and saturable reactor, protects the electrical system from damage due to water, gasoline, and oil.

Note : This alternator is of the keeper stabilized type and should never be dismantled by inexperienced personnel.

3.2.3. Ignition System

The GP-1 ignition system is a parasitic type, consuming about 6 watts. A line transformer with a great amount of leakage inductance is connected across the alternator output. The inherent regulatory action of this type transformer is the key to the excellent starting characteristics of this unit. As much spark is developed at cranking speeds when the alternator is delivering 20 volts as is developed at the running speed of 6000 rpm when the output voltage is 115 volts.

The voltage from the secondary of this line transformer is rectified and applied to the storage capacitor. For each revolution of the engine, the breaker points close and discharge the capacitor into the spark transformer. Shortly after the points close, the current change in the primary is sufficiently great to cause a voltage to be generated in the secondary of great enough magnitude to arc over at the spark plug. The use of a capacitor across the points is unnecessary, the inductance of the primary being sufficiently large to prevent current flow at the instant of contact.

3.2.4. Tests

3.2.4.1. Terminal Voltage as a Function of Load and Power Factor at 6000 rpm

See curve.

3.2.4.2. Terminal Voltage as a Function of Speed and Load at Unity Power Factor

See curve.

3.2.4.3. Speed Regulation

When loaded to a constant 100 watts with the correct mixture setting, the GP-1 consistently maintains speed to within plus or minus 2 parts in 60, or plus or minus 3 per cent.

3.2.4.4. Radio Interference

Radiated noise measurements taken in accordance with JAN-I-225, between the limits of 0.3 and 20 megacycles, indicate that the unit does not meet specifications. The noise is particularly objectionable between 5.0 and 14.0 megacycles.

3.2.4.5. Field Test with RS-6

A field test was conducted to investigate RS-6 operation when powered by the GP-1. It was found that except for radio interference the operation of the GP-1 was satisfactory. Through the use of a 100 foot power cable, exhaust noise was reduced to a level comparable and similar to a locust's hum and did not interfere with operation or low level conversation. By moving the power supply progressively closer to the operator, it was found that the noise level at 50 feet is the maximum tolerable with the present muffler.

Voltage regulation after warm-up was excellent with a variation of only plus or minus 2 volts in 115. Because of the ideal load shift characteristic of the RS-6, no change in load occurs when the transmit key is depressed. Objectionable radio interference was experienced in the 5.0 to 14.0 megacycle frequency band.

It was deduced that the major source of interference was radiated rather than conducted noise because removal of the antenna from the RS-6 eliminated the interference.

3.2.4.6. Bench Test with RS-1

The GP-1 proved to be a suitable power supply for the RS-1. The line voltage varied from 122 volts key-up to 102 volts key down; however, this change did not cause the signal to chirp. Radio interference was experienced between 5.0 and 14.0 megacycles.

4. CONCLUSIONS

4.1. Mechanical

4.2. Electrical

The results of these tests indicate that except for (1) Radio interference, (2) Exhaust noise, (3) Hot controls, the GP-1 is acceptable for agent radio station operation with power requirements up to 100 watts. Its compact size and light weight are very desirable features for this type application.

4.2. Easy, reliable starting, good speed and voltage regulation, and 3 1/3 hours' running time per tank-full of fuel are additional desirable characteristics of this unit.

The GP-1, having no flywheel or governor, was designed to power constant loads at a speed of 6000 rpm. When delivering 100 watts with the correct mixture setting, it consistently maintains speed and voltage to within plus or minus 2 parts in 60, or about plus or minus 3 per cent. Light intermittent changes in load, such as are experienced when keying a transmitter, cause decreases in speed and voltage; but in the case of the RS-1, these changes were tolerable and had no detrimental effects on operation.

5. RECOMMENDATIONS

5.1. Mechanical

5.2. Electrical

The following recommendations are offered as suggestions to improve the GP-1:

(1) Radio interference should be decreased in order to meet specifications.

(2) A suitable muffler should be designed to decrease the exhaust noise, permitting operation of radio equipment at a distance of 20 feet or less.

(3) The addition of a radial arm to the throttle control would permit finer adjustment and lower the control's temperature, which at present heats to 130 degrees F.

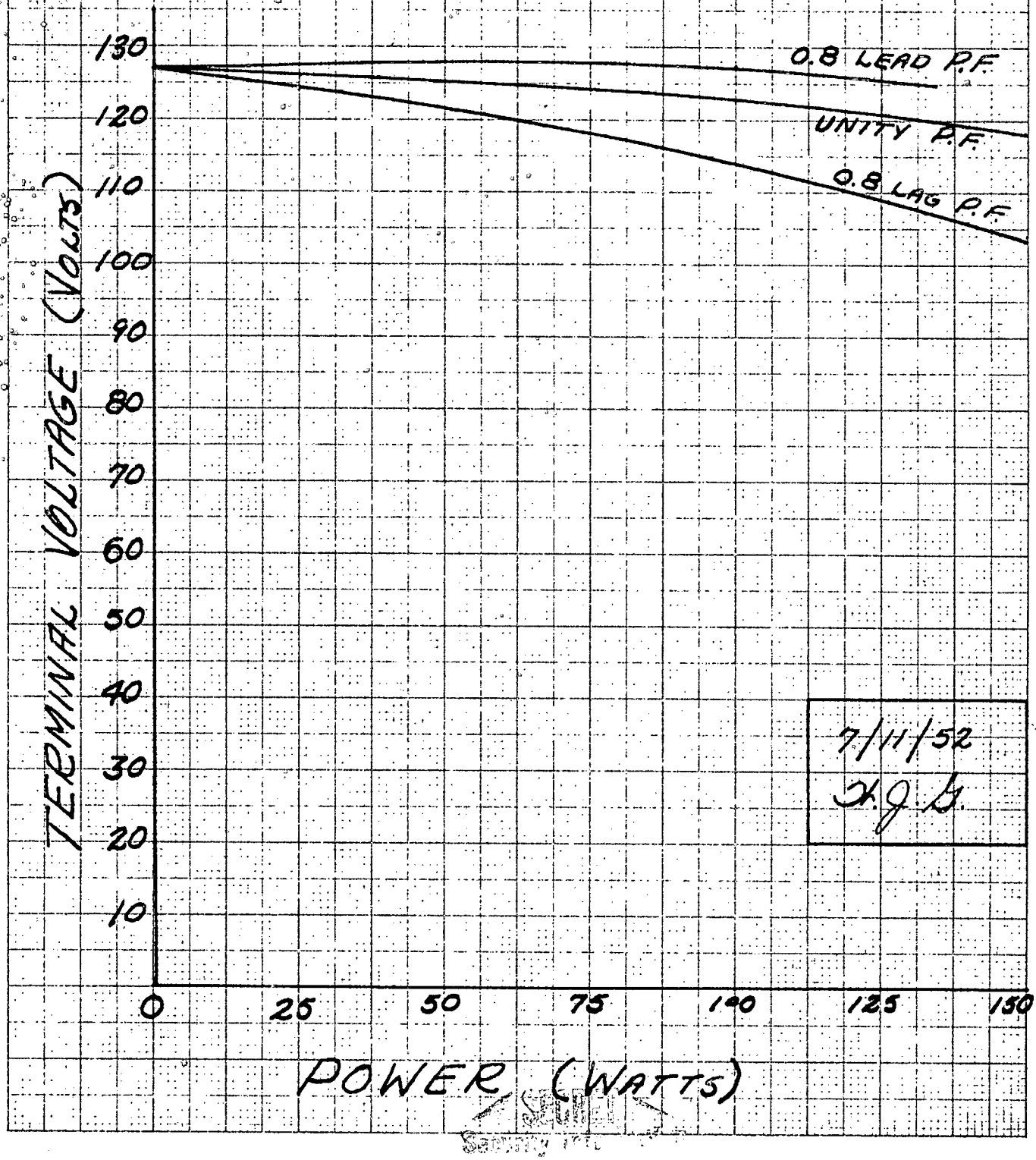
(4) A better gasket is needed for the fuel tank cap to prevent leakage under pressure.

(5) For loads other than 100 watts, the voltmeter needs additional calibration marks. An alternate solution would be the inclusion of a tachometer with the accessories.

(6) There should be a printed notice on the alternator stating that the rotor is keeper stabilized and should not be removed except by qualified personnel.

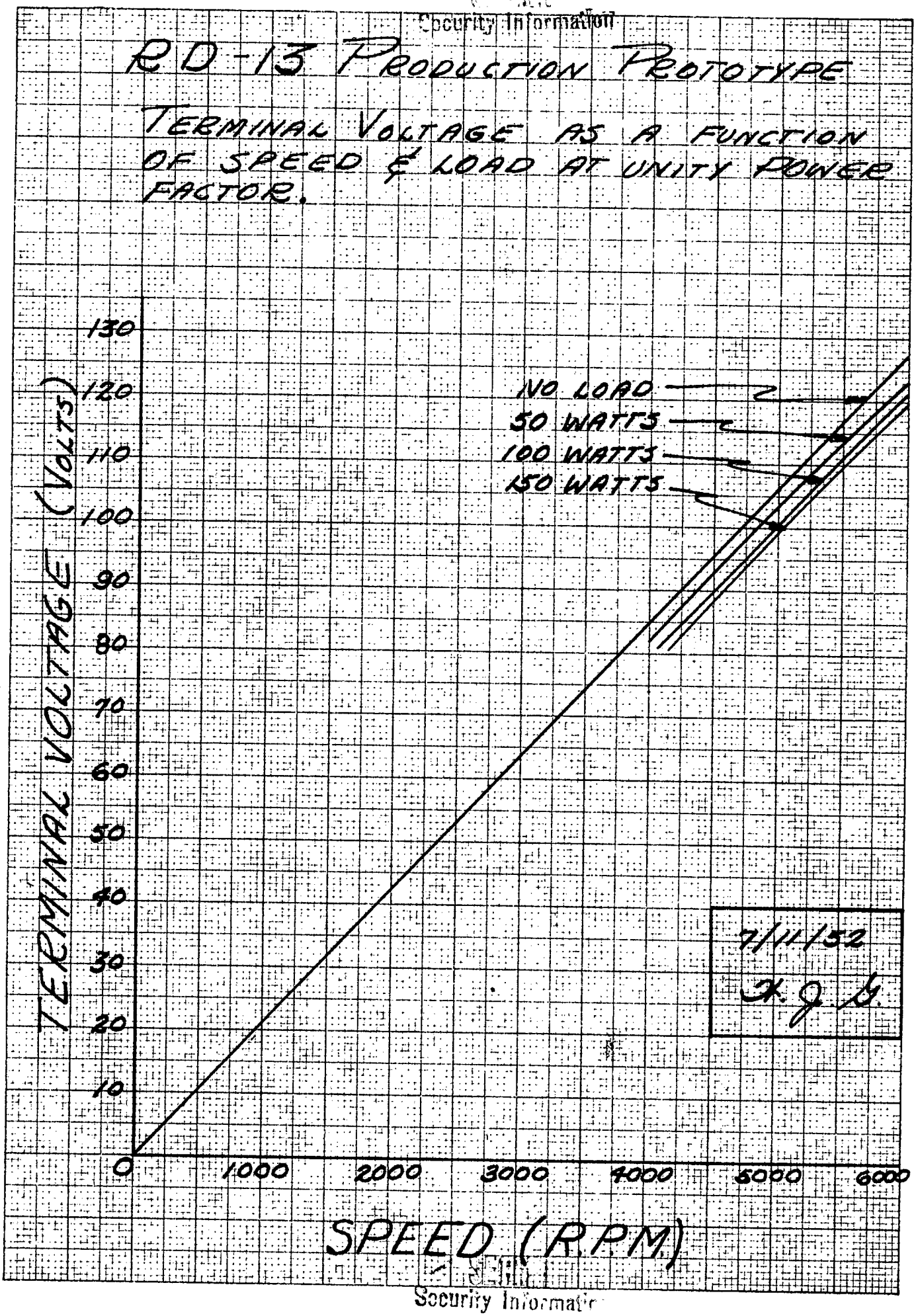
RD-13 Production Prototype

Terminal Voltage as a Function of Load & Power Factor at a Speed of 6000 R.P.M.



RD-13 Production Prototype

Terminal Voltage as a function of speed & load at unity power factor.



Additional Comments and recommendations as a result of break down AUG. 25, 1952

1. Mechanical

1.1 Master rod rubbing against crankcase in Two places.

1.2 Crank shaft counter weights rub against master rod

1.3. Construction is good and the unit is well built.

2. Electrical

2.1 Stator laminations are pressed into housing. This would be adequate if tolerances were maintained to a sufficient degree of accuracy to insure a tight fit.

2.2 A shielded disconnect plug is required if field maintenance is to include carbon removal.

2.3 Breaker points had a deep pit. Running time on unit was approximately 30 hrs. It is claimed that these pts. only break approx. 20 ma. of current; this does not appear to be true from the condition of the pts. Possible that the pts. should have a condenser across them. (There is room for one)

3. Operational

3.1 Improved operation would be obtained with a linkage between the throttle and mixture. (Metering rod arrangement)

3.2 A governor would help - especially in one man operations.

3.3 Since operation of this unit must be done with the unit approx. 50' away from the radio equipt. A combination of paragraphs 3.1 and 3.2 is strongly recommended. If the operation is a two man affair then the present arrangement is adequate.

OUTLINE FOR REPORTS ON GASOLINE MOTOR DRIVEN ALTERNATORS

1. INTRODUCTION

2. [illegible]

[illegible] EVALUATION

[illegible] CAL

[illegible] SPECIFICATIONS

3.1.1 ENGINE

[illegible] RATIO

[illegible] START [illegible]

[illegible]

3. [illegible]

[illegible] precision EXHAUST INTAKE OTHER MECHANICAL V[illegible]

3.1.1.5 COOLING

3.1.1.5.1 Type
3.1.1.5.2 Etc.

3.1.1.6 LUBRICATION

3.1.1.6.1 Type
3.1.1.6.2 Etc.

3.1.1.7 ACCESSORIES AND SPARES

3.1.1.7.1 [illegible]
3.1.1.7.2 Etc.

3.1.1.8 [illegible]

3.1.2 CO[illegible]

3.1.3 O[illegible]

[illegible] ary of the [illegible] including [illegible] [illegible] etc.

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3.1.4 MAINTENANCE

This section shall include minor repair description
including changing and setting the breaker points
spark plug, removing and cleaning the carburetor,
other pertinent points.

. Running Time
. Etc.

3.2.2 CON

3 IGNI

3.2.4.
3.2.4.6

4. CONCLUSIONS

4.1 MECHANICAL
4.2 ELECTRICAL

5. RECOMMENDATIONS

5.1 MECHANICAL
5.2 ELECTRICAL