GENERAL INFORMATION - ENGINE-ALTERNATOR SETS

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1. GENERAL

1.1 Scope

1.11 This section contains information which must be familiar to the installer of any gasoline or diesel engine alternator set. It supplements the information in the respective engine sections of this handbook.

1.2 CAUTIONS

NOTE: The following cautions are to be observed when testing engine alternators. These are in addition to other cautions listed in Handbook 0 and in handbook sections covering specific equipment.

1.201 The very poisonous carbon monoxide gas, present in the exhaust gases of gasoline engines, is invisible, has no odor or taste and is nonirritant. Its presence may cause a slight headache but even this slight warning is not always present. Exhaust line leaks can sometimes be located by the sound of escaping gas and sometimes, particularly before the engine has warmed up, by the presence of exhaust gases other than carbon monoxide that can be seen or smelled. The absence, however, of sound, odor or visible smoke does not guarantee the absence of a carbon monoxide leak. For method to be used to determine the presence of carbon monoxide gas, refer to Paragraph 6.

1.202 As a general rule, there are not dangerous quantities of carbon monoxide in the exhaust from diesel engines. Leaks in the diesel exhaust system may cause smarting or watering of the eyes and are often detected by observance of a bluish haze in the engine room.

1.203 Persons working in the vicinity of operating diesel engines shall wear ITE-4699, Earmuffs, for protection against excessive levels of noise.

1.204 Gasoline fumes, including those in the crankcase are explosive, Keep engine room well ventilated and avoid the creation of sparks or the use of an open flame in the vicinity of gas fumes.

1.205 The repair of a fuel tank or piping that has held or contains gasoline or fuel oil is a hazardous procedure due to the possibility of an explosion. Such work should be performed by an organization which regularly does that type of work.

1.206 Avoid creation of sparks, including those from static electricity or the use of an open flame near batteries, since the gas given off by the battery is explosive.

1.207 When hoisting equipment always stand to one side; watch what is being raised and be prepared to get out of the way if it falls.

1.208 When handling engine starting batteries, provide a solution of electrolyte neutralizer in case of personal exposure to the skin. Use Boric Acid solution - 1/2 lb. per gallon of water to neutralize nickel cadmium battery electrolyte. Use either Table Soda solution (2 lb./gal.), Washing Soda solution (1 lb./gal.), or Bell System Prophosphate (1/2 lb./gal.) in water to neutralize lead acid battery electrolyte.

1.209 Before using a cranking tool to bar over an engine by hand, make certain that the starting motor is disconnected from the battery, and, in addition, that any automatic starting feature is locked out.

1.210 Determine that adequate guards have been provided over rotating, hot, or live parts, and that coupling bolts, and the like, are secured by locknuts, cotter pins, etc.

1.211 Determine that the fuel system is free of leaks and conforms to local regulations.

1.212 Determine that flammable material is clear of hot parts.

1.213 Wipe up any spilled oils or greases off the floor immediately.

1.214 Do not overload any jack or other equipment used to lift an engine-alternator.

1.215 Use care to prevent dirt or water from entering a fuel storage tank. See that the supplier or attendant cleans all equipment used in filling the tank before placing fuel in the tank. Always allow new fuel to settle for at least six hours before using, if at all practicable.

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1.216 Maintain the cooling water in radiators at the proper level to prevent possible overheating of the engine.

1.217 Engine lubricating oil pressure should not be allowed to fall below the minimum pressure requirement. Most engines have an adjustment provided to raise the oil pressure. Refer to manual furnished with the engine. If unable to raise the oil pressure, discontinue engine operation.

1.218 Check lubricating oil level before each run. If level has fallen more than 1/3 the distance between the "Full" and the "Half" mark, add oil to bring level to "Full".

1.219 An engine-alternator should not be operated above its rated value of voltage, current or kilowatt output.

1.220 Nickel cadmium battery cell containers (metal cans) are electrically alive. Use only insulated tools and be sure that terminals are never shorted to the containers.

1.221 Before starting an engine-alternator, remove any tools likely to fall into the machinery or against any rotating parts.

1.222 An engine-alternator should be routined weekly during the installation period. If, for any reason, it is not possible to make a weekly routine run, the engine should be turned over by hand once-a-week for at least ten revolutions each time.

1.223 An engine-alternator taken out of storage and run for any length of time will have to be reprocessed for storage if it is to be returned to the storage condition.

1.224 Before beginning work on any alternator which is in service, consideration should be given to the section in Handbook 0 which covers the following:

(1) Cooperation with the telephone company.

(2) Precautions and safeguards to prevent service interruptions.

(3) General protection of working equipment.

1.225 Obtain telephone company approval before opening switches or removing fuses on working circuits.

1.226 On engine alternators with a manual field rheostat, along with the automatic voltage regulator equipped with a regulator on-off switch, caution must be exercised when the alternator is running, so as not to cut off the voltage regulator without first turning the manual field rheostat to the low voltage position. The normal position of the manual rheostat, with the automatic voltage regulator in operation, is in the full voltage position. If the manual field rheostat is not changed to the low voltage position, voltages of 300 volts or more, along with serious equipment damage will result.

2. DEFINITIONS

2.01 Alternator: An alternator converts rotating mechanical energy into electrical energy composed of alternating currents and voltages. An ac voltage is generated in a coil either by moving a coil past a magnet or moving a magnet past a coil. Most engine-alternators move the magnetic field past stationary coils.

2.02 Back Pressure: This is a pressure opposing the expulsion of the exhaust gases of internal combustion engines. Back pressure is affected by the size and length of the pipe and the sharpness and number of bends in the exhaust pipe. Excessive back pressure causes decreased power and is therefore undesirable.

2.03 Diesel Principle: A diesel engine operates by compressing air in a cylinder. A charge of fuel oil is injected into heated air of this cylinder. The heat ignites the oil, forms gases, raises the temperature, expand and moves the piston.

2.04 Exciter: The direct current for the alternator field is obtained from a small dc generator called an exciter which is either mounted on the alternator or is an integral part of the alternator.

2.05 Four-Cycle Engine: The intake, compression, power, and exhaust strokes are separate and follow in that order. Two revolutions are required to complete the four parts of the cycle.

2.06 Frequency: The frequency of an alternator can be found from the equation:

$$\text{frequency} = \frac{\text{speed (rpm)} \times \text{No. of poles}}{120}$$

For example, for a four-pole alternator operating at 1800 rpm:

$$\text{frequency} = \frac{1800 \times 4}{120} = 60\text{-cycles per second}$$

2.07 Gasoline Principle: A gasoline engine operates by compressing a mixture of fuel and air in a cylinder and igniting the compressed mixture by means of an electric spark.

2.08 Hunting - The condition where the speed of the engine is periodically rising and falling. It occurs because of the lag in action of the governor and voltage regulator.

2.09 Injector - The injector creates the high pressure necessary for fuel injection, meters the proper amount of fuel, atomizes the fuel, and times the injection into the combustion chamber. Other diesel engines use fuel pumps which meter the fuel, time the injection, and furnish the injection pressure to a bank of nozzles.

2.10 In Phase: Two alternating or changing quantities in a circuit, such as current and voltage, are said to be "in phase" if they both reach their positive maximum value at the same instant.

2.11 KVA: The KVA (kilovolt ampere) output of an alternator is a measure of its apparent power. Compute as follows:

Alternator	KVA
Single phase	$\frac{\text{volts} \times \text{amperes}}{1000}$
Three phase	$\frac{(\bigstar)\text{volts} \times (\bigstar)\text{amperes} \times 1.73}{1000}$

★Average of the three phases.

2.12 Neutral Conductor: The neutral conductor (when one is used) is that conductor which is intended to have the same potential difference between it and each of the other conductors. The neutral of a three-phase system carries no current when the loads are balanced on the phases and only the unbalance current if the loads are not balanced. The neutral is often made smaller than the line conductors on three-phase systems for this reason.

2.13 Phase Sequence: In polyphase systems this is the order in which the phase voltages reach their positive maximum values. "Phasing-out" is a term applied to the process of securing the proper phase sequence of polyphase alternators so that motors operated on these systems rotate in the proper direction. For details concerning the methods of "phasing-out" alternators, see Section 130 of this handbook.

2.14 Power Factor: The measurement of the percentage of usable power in the system being the ratio of the active power to the apparent power (volts x amps). To calculate the power factor of a given load, divide the kilowatt (KW) output (as indicated on engine-alternator set meter) by the KVA output. Maximum power factor of unity occurs for a resistance load because the current and voltage in the circuit are in phase.

2.15 Single Phase: This is a system energized by a single alternating voltage. The system may use either two or three wires. In three-wire systems, the third or center wire is a neutral which is usually required to be grounded.

2.16 Speed Droop: This is the characteristic of an engine governor which causes the engine to slow down when a load is applied. In order that governor operation may be stable with fluctuating loads (that is, without hunting), most governors are designed to cause a drop in speed with an increase in load. The amount of this droop is usually adjustable from 0 to 7% of full-load speed.

2.17 Three Phase: This is a system energized by three substantially equal voltages which differ in phase by one third of a cycle (120 electrical degrees) and which are at the same frequency. The system may use three or four wires. One of the four wires is a neutral which is usually required to be grounded. In some three-phase three-wire systems, one of the three lines may be grounded.

2.18 Two-Cycle Engine: Is one in which the four events of the cycle, namely, intake, compression, power and exhaust are performed during one revolution of the crankshaft. There is one power stroke in every revolution.

2.19 Two Phase: This is a system energized by two substantially equal voltages which differ in phase by one fourth of a cycle (90 electrical degrees) and which are at the same frequency. The system may use either three, four, or five wires. With three wires, an end of each phase is common and this common lead may require grounding. With four wires, the phases may be separate or tied together at a neutral point which is the center of the phases. This point requires grounding. With a five-wire system, the grounded neutral point is brought out.

3. FUEL SUPPLY

3.1 Fuel is furnished by the telephone company. The full-load fuel consumption for diesel engines is frequently stated in terms of pounds per hour. This may be converted to gallons by considering that one gallon of fuel oil weighs approximately 7.1 pounds.

4. COOLING WATER

4.1 Only soft water should be used in the cooling system. In this connection, if the water used by a particular telephone company has been determined to be satisfactory for use where the heating of it is involved, as for example in their heating boilers, hot water systems, etc., it should be satisfactory.

5. AIR SUPPLY

5.1 Internal combustion engines require an adequate supply of fresh clean air for fuel combustion and proper cooling. It is essential that a sufficient supply of fresh air be made available to the engine room. A closed room with inadequate air intake during engine operation may cause the engine water temperature to rise high enough to shut the set down by tripping the switch provided in the cooling system.

6. CARBON MONOXIDE DETECTOR

6.1 Equipment

6.11 Tests for gasoline exhaust piping leaks are made with a R-2722 carbon monoxide detector. Packages of carbon monoxide detectors are dated and should not be used after the date specified.

6.12 The detector includes a color chart and a glass ampoule containing a chemical solution surrounded with absorbent cotton.

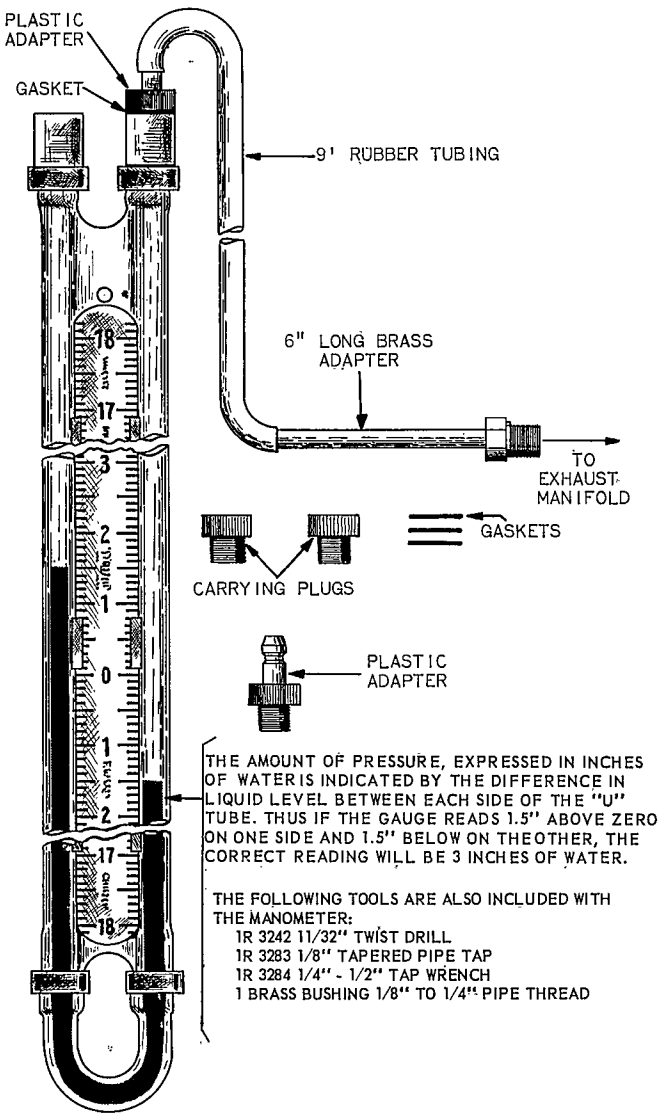

FIG. 1 THE R-3076 MANOMETER CONNECTED FOR USE

6.2 Test Procedure

6.21 Without removing the ampoule from the glassine envelope, hold the detector in a vertical position between the thumb and forefingers. Crush and press the ampoule flat to obtain a uniform saturation of the cotton. Use a gripping pressure and avoid a sliding motion which might cause the solution to accumulate at the ends of the ampoule.

6.22 After the ampoule has been crushed remove the glassine envelope and hang the ampoules for ten minutes slightly above and in close proximity to the flexible section of exhaust pipe, exhaust space drains, connections of exhaust silencer or exhaust piping with the engine operating. This check should be made at the start of a test and repeated during the test.

6.23 Presence of leaks will be indicated by the absorbent cotton changing color corresponding with different shades shown on the color chart found in each box of ampoules.

6.3 Recommendations

6.31 It is recommended that tests be made at time of installation with the engine operating, windows and doors of the engine room closed and without the use of artificial ventilation other than that required for operation of the engine. As soon as a leak is discovered or indicated, the engine should be stopped and the rooms should immediately be ventilated as conditions permit and the source of leaks investigated and corrected at once. Recommended closure of doors, windows, etc., should not be interpreted to apply to ventilation necessary to maintain engine room temperature below the locally accepted maximum allowable nor is it to apply to arrangements for air intake to an engine room to replace air exhausted from the room either by a ventilating fan or a radiator cooling fan. The intent is to have the ventilation slightly poorer than it would be under normal operating conditions.

7. Manometers

7.1 Equipment

7.11 Manometers are gauges for measuring back pressure in engine exhaust systems.

7.12 Mercury manometers may often be obtained from the telephone company. These usually read 4 inches of mercury and require not over 1/2 pound of mercury.

7.13 The R-3076 flexible manometer is made of plastic and uses water. It reads back pressure up to 36" of water corresponding to 2.65 inches of mercury. (13.6" water = 1" mercury).

7.2 Procedure for Use

NOTE: Connection to the engine exhaust manifold will have to be made before mounting the exhaust manifold guard.

7.21 Remove the two knurled carrying plugs. Add water, if necessary, to bring the columns to approximately the 0-0 mark. Shake the manometer to remove any air pockets in the water columns.

7.22 Insert a rubber tubing adapter (plastic with rubber gasket) into the top of one column of the manometer and connect the rubber tubing to this adapter. Hang the manometer some distance away from the heat of the engine exhaust. Shift the scale on the manometer so that the 0-0 mark is in line with the top of the columns.

7.23 Remove the 1/8" pipe plug that has been provided either in the engine exhaust manifold or the exhaust line and thread the 6" long brass adapter into this hole. If a tapped hole has not been

provided, tools are included with the manometer for drilling and tapping a 1/8" hole. Connect the rubber tubing from the manometer to this adapter.

7.24 The amount of back pressure, expressed in inches of water or inches of mercury depending on the manometer used, will be indicated by the difference in levels of the two columns of liquid. Add the amount that one column is above zero to the amount that the other column is below zero to obtain the total difference in levels.

Arrows not shown due to extensive changes.

7.25 After use, remove the plastic adapter from the manometer, and replace the carrying plugs in the tops of the columns. Remove the adapter from the exhaust line and replace the pipe plug. Roll up the manometer and the rubber tubing and put them in the carrying case along with the fittings and tools. The manometer may be shipped with water in it.

Manager, Product Engineering

Reason for Reissue:
(1) To remove reference to 267 Kit for R-2722 Carbon Monoxide Detector.
(2) To remove RM-580554 Mercury.

Replaces Section 131 dated 12-19-63.