MODELS COVERED IN THIS MANUAL

MODEL	SERIAL NUMBER
QS-4.0G	OB991000 and Above
QS-6.5G	OB991500 and Above
QS-8.0G	OB992000 and Above

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NOTICE

Throughout this publication, "Dangers", "Warnings" and "Cautions" (accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. —— OBSERVE THEM CAREFULLY!

⚠DANGER

DANGER — Immediate hazards which WILL result in severe personal injury or death.

⚠WARNING

WARNING — Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠CAUTION

CAUTION — Hazards or unsafe practices which could result in minor personal injury or product or property damage.

IMPORTANT: Indicates information or instructions that are necessary for proper operation and/or maintenance.

These "Safety Alerts" alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus "common sense" operation, are major accident prevention measures.

NOTICE TO USERS OF THIS MANUAL

This service manual has been written and published by Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system is capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. (Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possible personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

(OVER)

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PART 1
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SECTION 1.1 - GENERATOR FUNDAMENTALS

1.1.1- Why Generators Produce Electricity

A Magnetism Creates Current Flow:- When a wire or coil of wire is moved through a magnetic field, an electric current is created in the wire. Conversely, when a magnetic field is moved across a wire or coil of wire, an electric current flow is again created in the wire. The direction of current flow in the wire depends on the polarity of the magnetic field and the direction in which the wire (or coil) is moved.

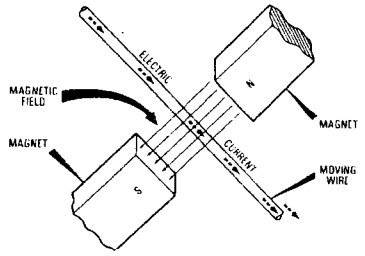
B Current Flow Creates a Magnetic Field:- When an electrical current flows through a wire, a magnetic field is created around that wire. The strength of the magnetic field depends on the amount of current flow and the number of loops or coils in the wire. The direction (polarity) of the magnetic field depends on the direction that current is flowing in the wire.

1.1.2- How the Laws of Magnetism and Current Flow Apply to Generators

C A Simple a-c Generator:- In a simple a-c generator, the Rotor (or revolving field) is a permanent magnet. As the Rotor rotates, its magnetic field cuts across a number of stationary coils of wire called a Stator. When the Stator circuit is completed (as by connecting the wire ends across a load such as a light bulb), an electric current will flow through its wire windings. The illustration shows the Stator circuit completed through a light bulb.

D A More Sophisticated a-c Generator:- In a more sophisticated generator, direct current is delivered to the Rotor windings, to increase the strength of the magnetic field. Current flows through carbon brushes which slide on metallic slip rings, and then through the Rotor windings. As was true of the simple generator, the Rotor's magnetic field induces a voltage into the Stator windings. If the Stator circuit is completed, current will flow through the circuit. The amount of voltage and current flow from the Stator windings depends on (a) Rotor rotational speed, (b) amount of current flow through the Rotor windings, and (c) the number of coils in the Stator windings.

A



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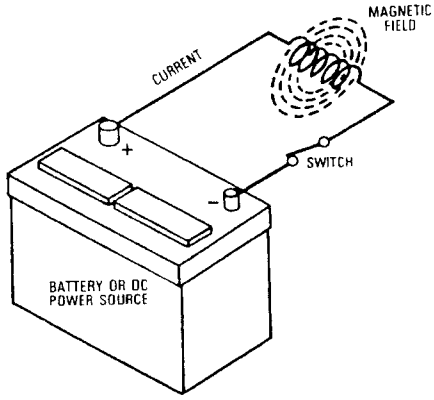

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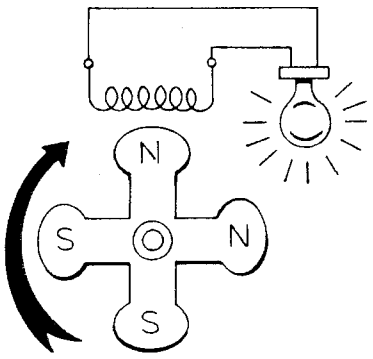

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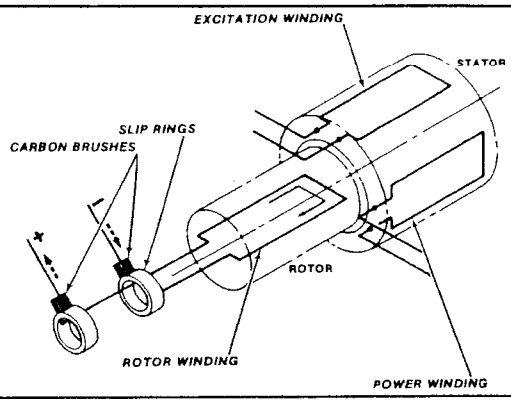


1.1.3- How the Rotor Gets Regulated Direct Current

The amount of voltage and current flow induced into the Stator windings of a generator depends, in part, on the strength of the Rotor's magnetic field. In turn, the strength of the Rotor's magnetic field depends on the amount of direct current flow through the Rotor windings. If the amount of current flow through the Rotor windings can be *regulated*, the strength of the Rotor's magnetic field and the current flow and voltage induced into the Stator windings can be *regulated*.

E **The Electronic Voltage Regulator:-** Receives a-c frequency "sensing" signals from the Stator a-c output leads. Also receives the alternating current (a-c) output from a Stator Excitation winding. The Voltage Regulator changes the a-c output of the Stator Excitation winding to direct current (d-c). In addition, the Regulator "regulates" the rectified Excitation winding current in proportion to the frequency sensing signals from the Stator a-c output leads. The regulated and rectified Excitation winding output is then delivered to the Rotor, via carbon brushes and metallic slip rings.

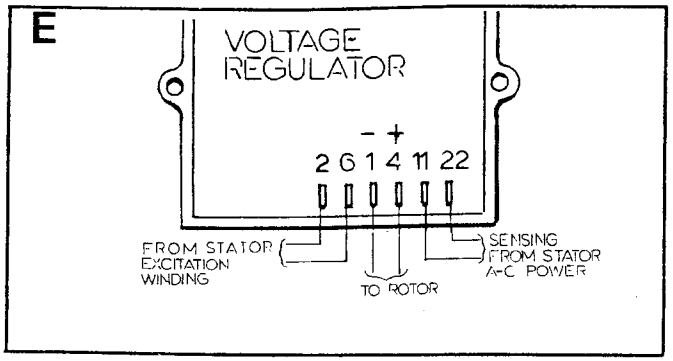
F **Field Boost:-** During engine cranking only (Start/Stop switch at START position), direct current flow from the generator battery is delivered to the Rotor windings. This "field boost" current ensures that the required "pickup" current is induced into the Rotor and Stator windings each time the engine is started. In effect, the field boost system restores the Rotor's residual magnetism (flashes the field) each time the engine is started. As shown in the illustration, battery direct current flows to the Rotor windings, via an engine control circuit board, Wire 16, a CHOKE MODULE, Wire 4, brushes and slip rings.

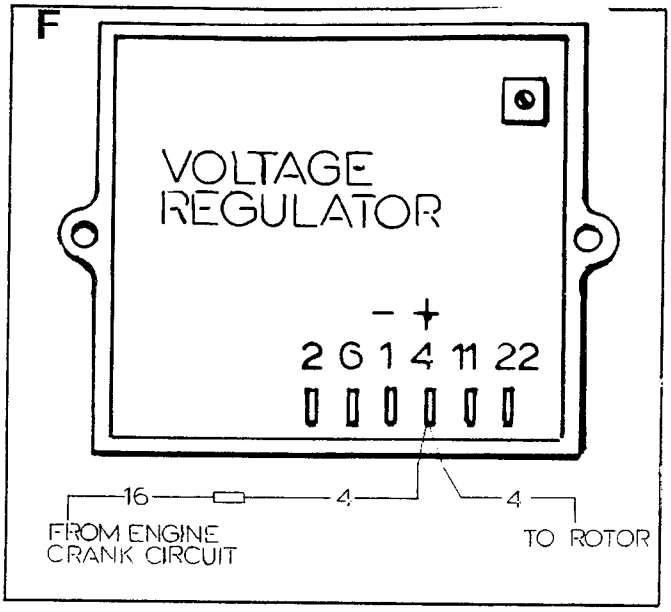
IMPORTANT: Some "residual" magnetism is normally present in the Rotor windings at all times. Loss of Field Boost current flow during startup may not cause a problem, unless the Rotor's residual magnetism is also lost.

1.1.4- How the Generator Operates

G **Review of Generator Operation:-** Operation may be briefly described as follows:-

1. During engine cranking, battery current is applied to the positive (+) brush and slip ring, through the Rotor windings and to ground via the negative (-) slip ring and brush. This current flow increases the strength of the Rotor magnetic field. As soon as the engine has started and the engine Start/Stop switch is released, the "field boost" current flow through the Rotor is terminated.





2. The Rotor's magnetic field induces a voltage and current flow into the Stator Excitation and a-c power windings.

3. Stator a-c power winding output is delivered to the connected electrical load, via Wires 11, 22, 33 and 44.

4. Stator excitation winding a-c output is delivered to the Voltage Regulator, via Wires 2 and 6.

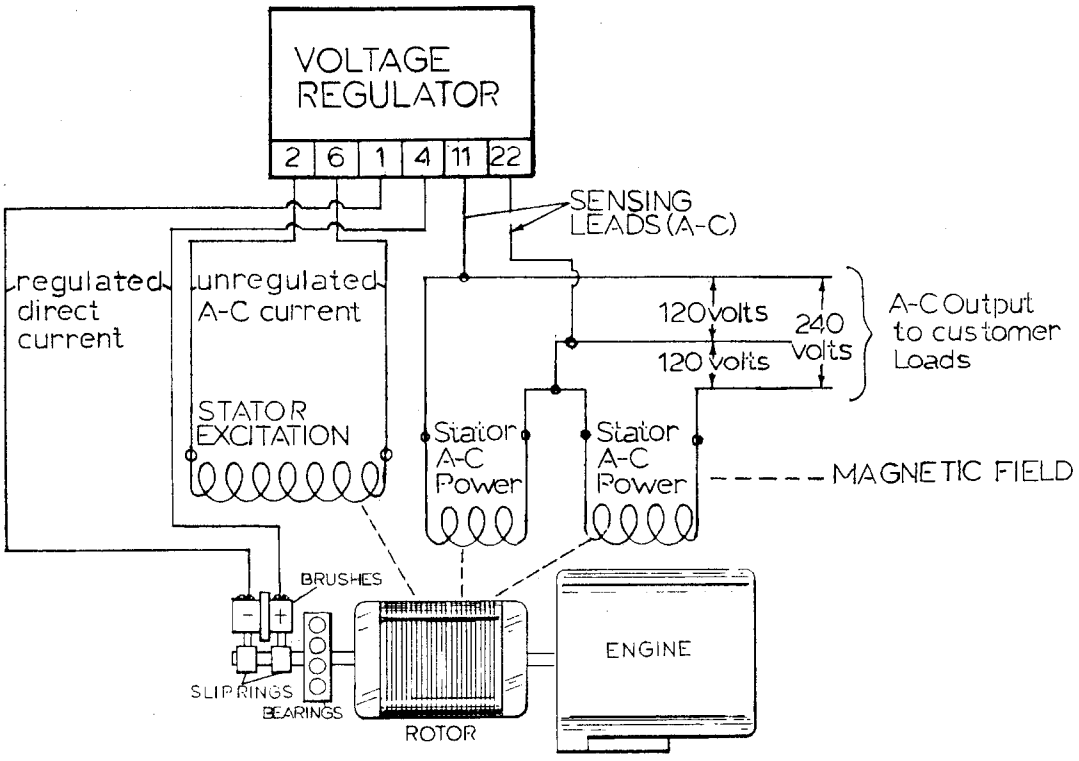
5. The Voltage Regulator "senses" a-c frequency and voltage in the Stator a-c power leads, via Wires 11 and 22.

6. The Voltage Regulator rectifies Stator excitation winding current (changes it to direct current or d-c).

7. Based on the "sensing" signals from the Stator a-c output leads, the Voltage Regulator delivers a regulated direct current flow to the Rotor, via Wires 1 (-) and 4 (+).

8. Based on the regulated direct current from the Voltage Regulator, the strength of the Rotor magnetic field and the resultant voltage induced into the Stator a-c power windings is regulated.

G



SECTION 1.2 - INTRODUCTION TO TROUBLESHOOTING

⚠DANGER

The marine generator produces extremely high and dangerous voltages. Contact with live wires and terminals may result in hazardous and possibly fatal electrical shock. ONLY PERSONNEL WHO HAVE BEEN THOROUGHLY TRAINED IN THE SERVICING OF MARINE GENERATORS SHOULD ATTEMPT TO TROUBLESHOOT, TEST, REPAIR OR SERVICE A MARINE GENERATOR.

1.2.1- Troubleshooting Tools and Equipment

The marine generator service technician should have a well stocked tool box having a good selection of common hand tools. Such a tool box should contain wrenches in both metric and english sizes. Also recommended is a good nut driver set. In addition to standard hand tools, the following test equipment should be available:

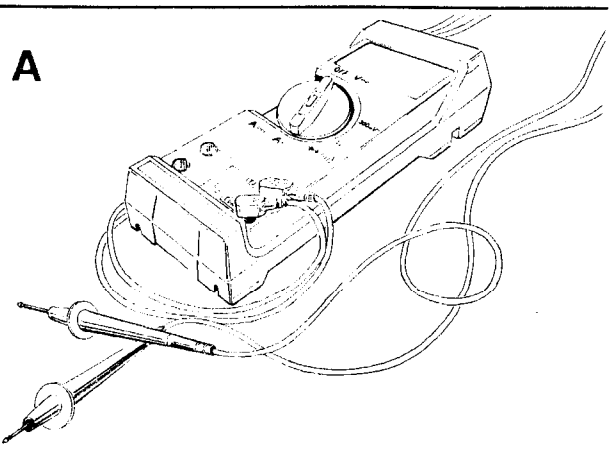
A **Volt-Ohm-Milliammeter:-** Never attempt to test, adjust or troubleshoot a generator set without a volt-ohm-milliammeter (VOM). Simply having a VOM available is not enough. The technician must understand electricity, must be familiar with electrical circuits, must be able to read wiring diagrams and electrical schematics, and finally must know how to use the VOM.

B **Frequency Meter:-** This test device will permit its user to read alternating current (a-c) frequency in HERTZ (cycles per second). Unless the generator frequency is known, precise adjustment of engine and generator speed cannot be accomplished. See Paragraph 1.2.3, ROTOR ROTATIONAL SPEED.

C **Insulation Resistance Tester:-** Also called a "HI-POT", this device will permit its user to test generator Stator and Rotor winding insulation for breakdown. See Paragraph 1.2.4, EFFECTS OF DIRT AND MOISTURE ON GENERATORS. Use the Hi-Pot to test resistance between parallel stator windings, between isolated windings, and the resistance of all windings to ground.

IMPORTANT: An electrical LOAD BANK is also recommended, for generator testing and adjustment. The load bank will permit a known electrical load to be applied to the generator, for the purpose of testing generator operation under load.

A



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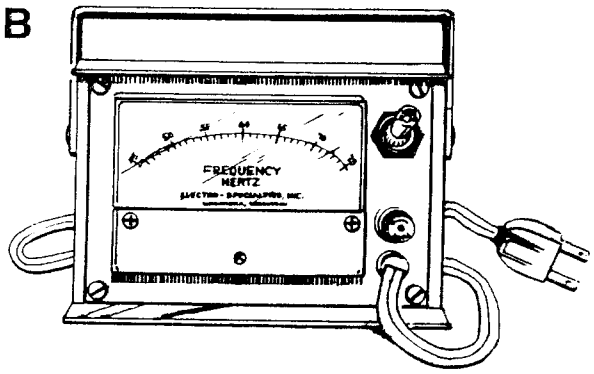

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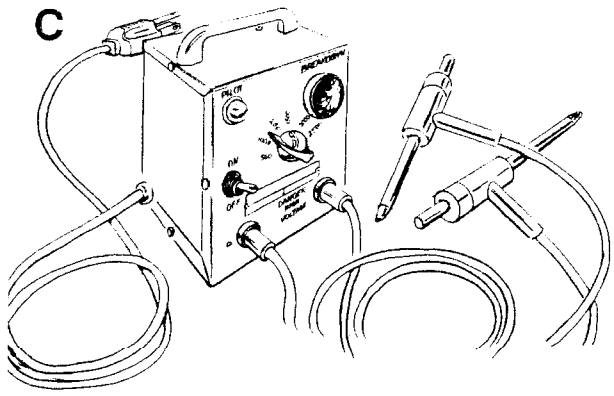

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1.2.2- Rotor Rotational Speed

The generator's Rotor (revolving field) is directly coupled to the engine crankshaft and will rotate at the same speed as the engine. Marine generators covered in this manual have a 4-pole Rotor, i.e., one having two SOUTH magnetic poles and two NORTH magnetic poles. The 4-pole Rotor must be operated at 1800 rpm to supply a 60 Hz a-c output; at 1500 rpm to supply a 50 Hz a-c output. The following formulas apply when determining frequency, rpm and number of Rotor poles:

$$\text{FREQUENCY} = \frac{\text{RPM} \times \text{NO. OF ROTOR POLES}}{2 \times 60}$$

$$\text{RPM} = \frac{2 \times 60 \times \text{FREQUENCY}}{\text{NO. OF ROTOR POLES}}$$

$$\text{NO. OF ROTOR POLES} = \frac{2 \times 60 \times \text{FREQUENCY}}{\text{RPM}}$$

1.2.3- Relationship of Voltage and Frequency

The generator's a-c output voltage is set at a fixed ratio to a-c frequency, by means of an adjustment potentiometer on the Voltage Regulator. Engine governed speed and a-c voltage are both adjusted with no electrical loads connected to the generator (no-load). No-load a-c frequency and voltage settings should be as follows:

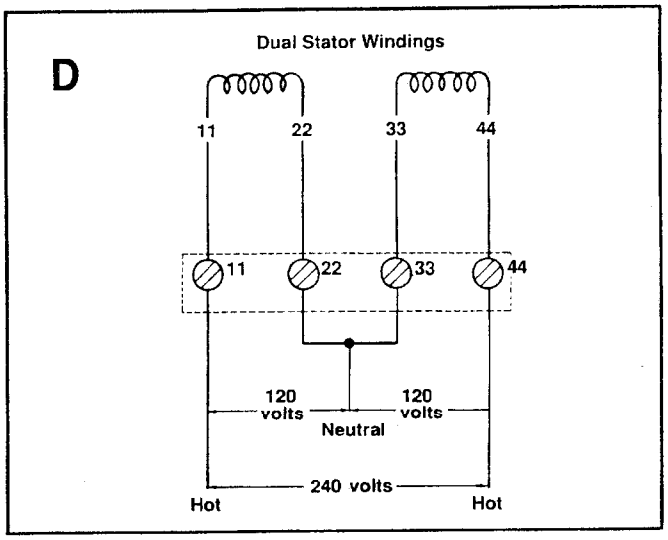
Units Rated 120/240 Volts at 60 Hz:- Set a-c frequency to about 60.5-63.5 Hz and to 121-126 volts a-c (line to neutral voltage).

Units Rated 110/220 Volts at 50 Hz:- Set a-c frequency to about 49-52 Hz and to a-c voltage to about 110-112 volts (line to neutral voltage).

1.2.4- Generator a-c Connection System

D All marine generators covered in this manual are equipped with dual stator a-c power windings. When these windings are connected in parallel to form a 3-wire connection system, stator output leads 11 and 44 form the two "hot" terminals while the junction of leads 22 and 33 form the NEUTRAL terminal. Connect 120 volts, 60 Hz a-c loads across lead 11 (hot) and neutral; or across leads 44 (hot) and neutral. When the dual stator windings are connected in series, a 240 volts a-c output results. Connect 240 volts, 60 Hz a-c loads across the two hot leads (11 and 44).

D

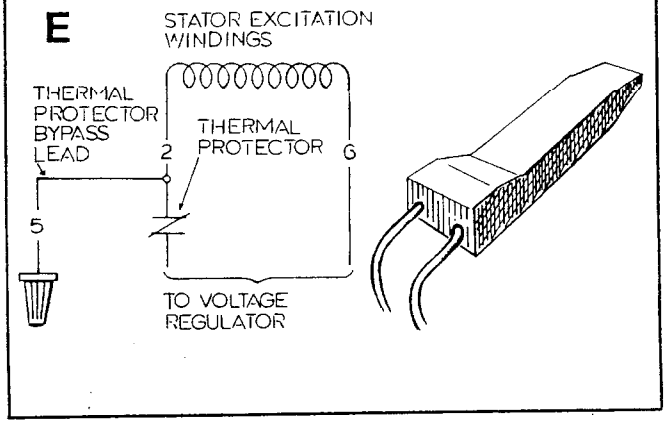


1.2.5- The Generator Thermal Protector

E A thermal protector is imbedded in the wire windings of the stator assembly and electrically connected in series with the stator excitation winding output leads to the voltage regulator. This device is essentially a normally-closed (N.C.) thermal switch, which is both temperature and current sensitive. Should internal stator temperatures increase above approximately 144°-156° F. (62°-69° C.), the switch contacts will open and loss of excitation current flow to the Rotor will result. In addition, should stator excitation winding output current exceed a safe value, the switch will open with the same results. The thermal protector is "self-resetting", i.e., when temperature and current decrease to a normal safe value the switch will close and normal excitation current flow to the Rotor will resume.

IMPORTANT: Opening of the thermal protector contacts and resultant loss of excitation current to the Rotor will result in a loss of Stator a-c power winding output to nearly zero. The voltage output from the a-c power windings will depend on the amount of "residual" magnetism in the Rotor (approximately 5-12 volts).

E



IMPORTANT: Note the thermal protector is connected in series with stator excitation winding output wire #2. In case of thermal protector failure, a BYPASS LEAD (Wire #5) is provided. To bypass a defective thermal protector, simply connect Wire #2 from the voltage regulator to Wire #5 using the supplied wire nut. When the thermal protector is bypassed, no generator overtemperature protection is available.

1.2.6- Effects of Engine Power

The generator engine must be able to develop sufficient power to operate the generator under load. The greater the wattage (or amperage) demands of connected loads, the greater the engine power needs. As a general rule, approximately 2 engine horsepower is required for each 1000 watts (1.0 kW) of generator power output.

If the generator wattage capacity is exceeded, engine power output may not be sufficient to handle the load. The result will be a decrease in engine speed (rpm) and a corresponding reduction in generator a-c output frequency and voltage.

A badly worn engine, one that has lost compression, or one with a mechanical problem may not be able to handle even an electrical load within the generator's rated capacity. Problems with generator output are often a direct result of an engine problem, rather than a generator problem.

IMPORTANT: A shorted condition in generator windings or in one or more connected electrical loads can dramatically increase the power demands placed on the driving engine. Such a shorted condition may cause the same symptoms as an underpowered engine. If such shorted condition is severe enough, internal stator temperatures will increase and the thermal protector contacts will open. Exceeding the generator's rated maximum continuous wattage/amperage capacity for any length of time can also cause the thermal protector to open.

1.2.7- Effects of Dirt and Moisture on Marine Generators

If moisture is permitted to remain in contact with generator windings, some of the moisture will be retained in cracks and voids of the winding insulation. This will result in a reduced insulation resistance and, eventually, generator a-c output will be affected. The insulation in Quicksilver marine generators is moisture resistant. However prolonged exposure to moisture will gradually decrease the resistance of stator and rotor winding insulation. Dirt can make the problem worse, since it tends to hold the moisture into contact with the windings. Salt (from sea air) also makes the problem worse, since salt will absorb moisture from the air. When salt and moisture combine they make a good electrical conductor.

Because of the detrimental effects of dirt and moisture, the generator should be kept as clean and dry as possible. Stator and rotor windings should be tested periodically, using an insulation resistance tester (megohmmeter). If insulation resistance is excessively low, drying may be required to remove moisture. After drying, a second test of the insulation resistance should be performed. If resistance is still low after drying, replacement of defective windings may be necessary. See Section 1.3 for testing, cleaning and drying procedures.

1.2.8- Troubleshooting Chart

A TROUBLESHOOTING CHART for the applicable marine generators is provided on the following page. Use the CHART as a guide in diagnosing generator problems. The sequence in the CHART has been carefully planned to avoid the labor and expense of replacing parts unnecessarily.

Start at the top of the CHART and follow the arrows down, performing each operation in the exact order given. A more detailed diagnostic test procedure, which matches the sequence in the CHART, can be found in Section 1.4 (DIAGNOSTIC TESTS).

TROUBLESHOOTING FLOW CHART