

SECTION 1.3 - INSULATION RESISTANCE TESTS

IMPORTANT: Dirt, moisture and salt have a detrimental effect on generator windings. The insulation resistance of Rotor and Stator windings should be tested periodically with a "Hi-Pot" tester. When using the Hi-Pot Tester, follow the instructions in this manual carefully.

⚠ 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.**

⚠ CAUTION

Follow the instructions carefully. Wire terminal ends must **NOT** be touching any part of the generator when voltage is applied.

1.3.1- Insulation Resistance Tester (Hi-Pot)

A Hi-Pot Tester:- The "Hi-Pot" tester shown in the illustration is only one of many brands that are commercially available. The tester shown has a "Breakdown" lamp, which will glow to indicate an insulation breakdown during the test.

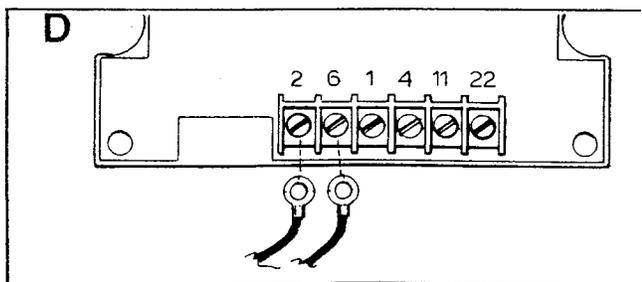
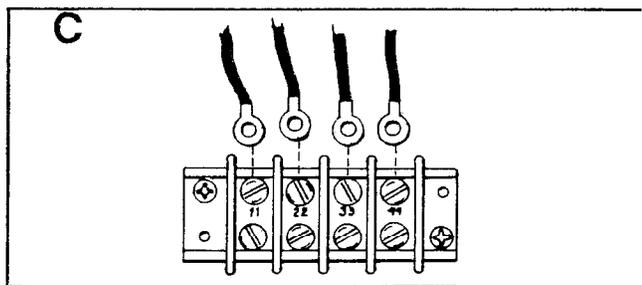
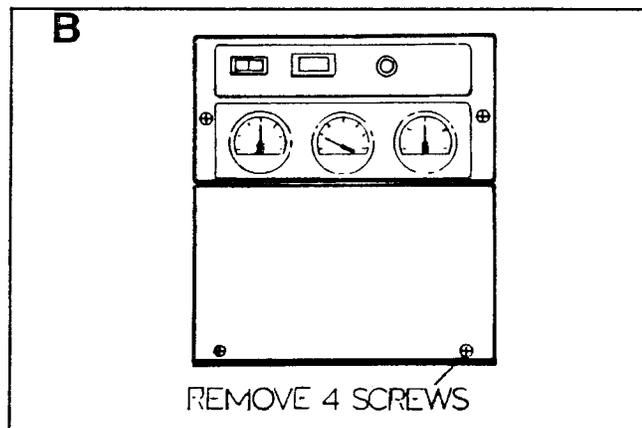
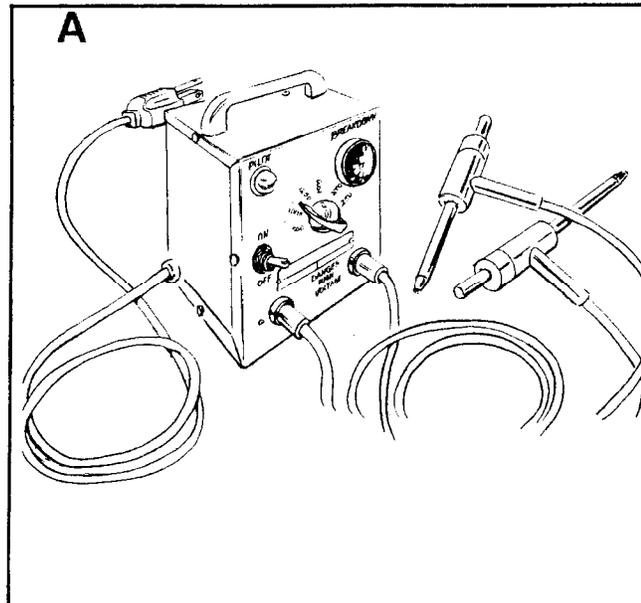
1.3.2- Testing Stator Insulation

Use the Hi-Pot tester to test stator insulation for breakdown as follows:

B Remove a-c Connection Box Cover:- Remove four (4) screws, then remove connection box cover. Also remove six (6) screws and pull the meter and control panel cover away from the control panel housing.

C Disconnect Stator a-c Power Leads:- Inside the connection box, locate the Customer Connection Terminal Strip. Disconnect Stator a-c output leads 11, 22, 33 and 44 from the terminal strip.

D Disconnect Stator Excitation Winding Leads:- In the meter and control panel housing, locate the a-c Voltage Regulator. Disconnect Stator excitation winding leads 2 and 6 from the Voltage Regulator.



E Test all Stator Windings to Ground:- Connect Stator leads 11, 22, 33, 44, 2 and 6 terminal ends together. Make sure none of the terminal ends are touching any terminal or any part of the generator frame. Then, proceed as follows:

1. Connect the red lead of the Hi-Pot tester to terminal ends of Stator leads 11, 22, 33, 44, 2 and 6.
2. Connect tester black lead to a clean, paint-free area on the generator Stator can.
3. Turn the Hi-Pot tester switch OFF.
4. Plug the Hi-Pot tester into a 120 volts wall socket and turn its voltage switch to 500 volts.

CAUTION

DO NOT APPLY VOLTAGE LONGER THAN 1 SECOND. Turn tester switch to ON, check that pilot light is ON, wait 1 second, then turn tester switch OFF.

5. Turn the Hi-Pot tester switch to ON and check that the tester pilot light is ON. Set tester voltage switch to 2000 volts. With pilot light ON, observe the tester breakdown light. DO NOT APPLY VOLTAGE LONGER THAN 1 SECOND. After 1 second, turn the tester switch OFF and reset voltage switch to 500 volts.

Test Between Isolated Windings:-

6. Connect red test lead of Hi-Pot to terminal end of Wire 2, black test lead to terminal end of Wire 11. Turn tester switch ON and check that tester pilot light is ON. Set tester voltage switch to 1500 volts. Apply voltage for 1 second while observing the tester breakdown light. After 1 second, turn tester switch OFF and voltage switch to 500.

Test Between Parallel Windings:-

7. Check that the tester voltage switch is set to 500 volts. Connect tester red lead to terminal end of Wire 11, black test lead to Wire 33. Turn tester switch ON and check that tester pilot light is ON. Apply voltage for 1 second while observing the tester breakdown light. After 1 second, turn tester switch OFF.

RESULTS:- If the HI-Pot tester BREAKDOWN light came ON during any 1 second test, clean and dry the stator. Then, repeat the HI-Pot test. If tester breakdown light comes ON during the second test, replace the Stator assembly.

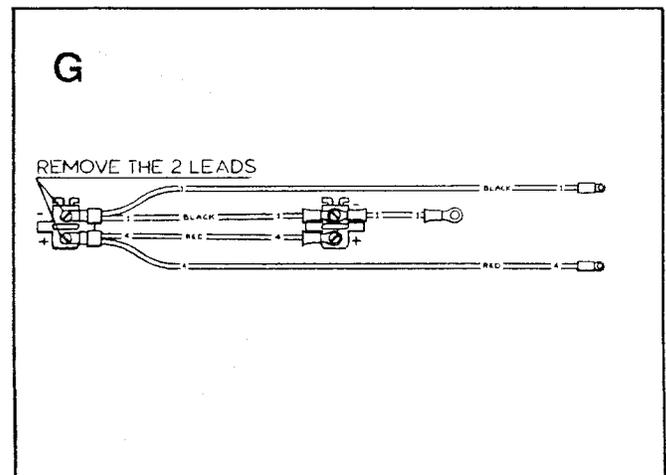
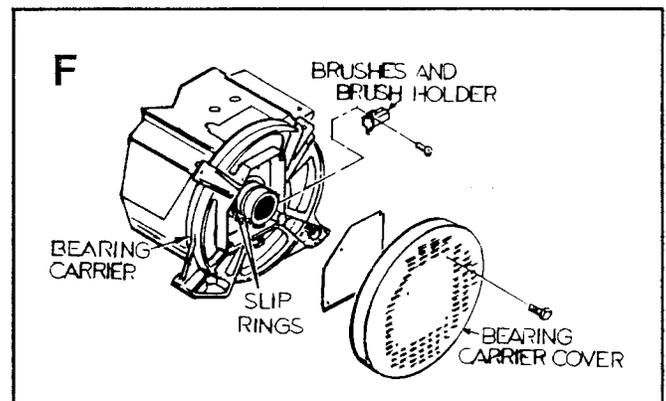
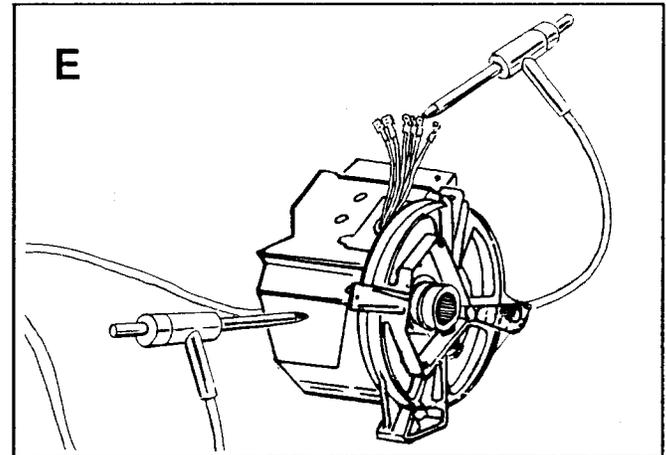
1.3.3- Testing Rotor Insulation

F Remove Bearing Carrier Cover:- Remove SCREWS, then remove BEARING CARRIER COVER and DUST COVER, to expose the BRUSH HOLDER and Rotor SLIP RINGS.

G Disconnect Excitation Leads:- Remove screws that retain excitation leads 1 and 4 to the BRUSHES, then remove leads 1 and 4. Make sure these leads are completely disconnected from brushes and are not touching any part of generator.

CAUTION

Wires 1 and 4 must be completely separated from the brushes and must not be touching any part of the generator frame during the test, or damage to the a-c Voltage Regulator may result.



H Test Rotor Insulation:- After completing Steps "F" and "G", test Rotor insulation for breakdown as follows:-

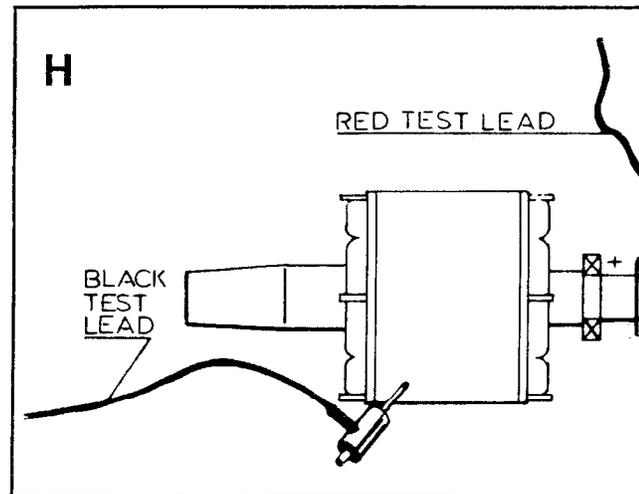
1. Connect the Hi-Pot tester red test lead to the positive (+) slip ring. See illustration. The brush to which Wire 4 connected rides on this slip ring (nearest the Rotor bearing).
2. Connect the black Hi-Pot test lead to a clean frame ground.
3. Turn the Hi-Pot tester switch OFF.
4. Plug the Hi-Pot Tester into a 120 volts wall socket.
5. Set the Hi-Pot voltage switch to "500 VOLTS".
6. Turn the tester switch ON and check that the tester pilot light is ON. Set the Hi-Pot tester voltage switch to 1250. Wait 1 second, then turn the tester switch OFF. DO NOT APPLY VOLTAGE LONGER THAN 1 SECOND.

RESULTS:- If the tester BREAKDOWN light comes on during the 1 second test interval after the tester pilot light has illuminated, drying may be necessary. After drying, repeat the test. If Rotor windings fail the second test (after drying), replace the Rotor.

1.3.4- Drying the Generator

To dry the generator, proceed as follows:

1. Open the main circuit breaker or main line switch. NO ELECTRICAL LOADS MUST BE APPLIED TO THE GENERATOR WHILE DRYING.
2. Disconnect both Wires #4 from the Voltage Regulator (see Illustration "D" on Page 8).
3. Provide an external source to blow warm, dry air through the Rotor and Stator windings. DO NOT EXCEED 185° F. (85° C.).
4. Start the generator engine and let it run for 2 to 3 hours.
5. Shut engine down and retest Stator and Rotor insulation.



1.3.5- Cleaning the Generator

Caked or greasy dirt may be loosened with a soft brush or a clean, damp cloth. A vacuum system may be used to clean up loosened dirt. Loose dust and dirt may also be blown from the unit with clean, dry, low pressure air (25 psi maximum).

⚠ CAUTION

DO NOT use a forceful spray of water to clean the generator. Some of the water will be retained on generator windings and terminals, and will cause serious problems.

SECTION 1.4 - DIAGNOSTIC TESTS

This section is intended to aid the service technician in performing the various test procedures required to locate the cause of a generator problem. Use the instructions on these pages in conjunction with the TROUBLESHOOTING FLOW CHART (Page 7). Perform all tests in exactly the order given. As each test is completed, ask yourself whether test results were "bad" or "good". Then, follow the arrows in the flow chart to the next test.

1.4.1- Check No-Load a-c Voltage and Frequency

▲ DANGER

Extremely high and dangerous voltages are present at terminals and wire terminal ends, inside the generator a-c connection panel. Use extreme care to avoid contact with live wires and terminals during the following tests. DO NOT perform tests while standing in water, while barefoot, or while hands or feet are wet. DO NOT perform tests while physically or mentally fatigued.

To check generator a-c voltage and frequency output, proceed as follows:-

A Remove four (4) SCREWS, then remove the a-c connection panel COVER.

B Locate the A.C. POWER OUT CONNECTION terminal strip, to which Stator a-c output leads 11, 22, 33 and 44 are connected. Disconnect output leads from the terminal strip, bottom side to eliminate load induced problems and obtain a true reading of voltage and frequency output.

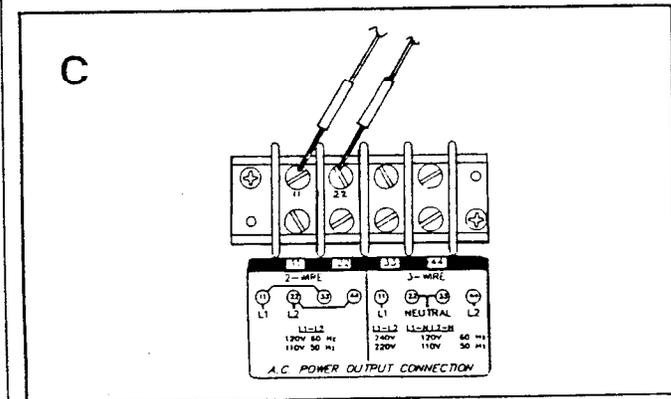
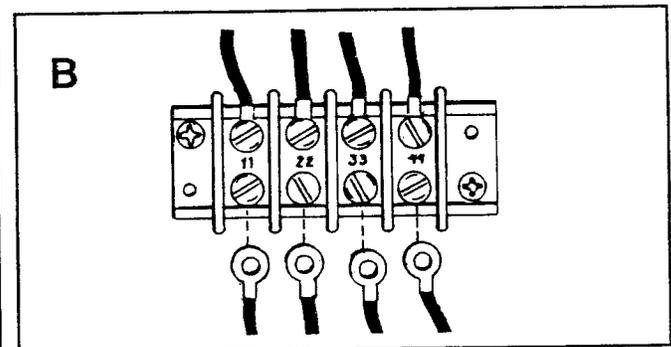
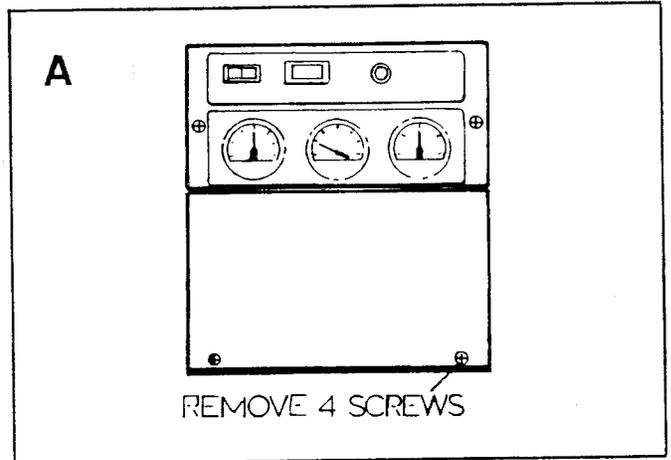
C Connect an accurate a-c VOLTMETER and a-c METER across terminals of Stator a-c power output leads 11 and 22. Make sure leads are not touching any part of generator, then start the generator engine. Let engine stabilize and warm up. Then, read the indicated a-c voltage and frequency. Repeat test with test leads connected across leads 33 and 44. Readings should be as follows:

Units Rated 120/240 Volts, 60 Hz:- 121-126 volts at 61-63 Hz.

Units Rated 110/220 volts, 50 Hz:- 110-112 volts at 51-53 Hz.

RESULTS:

1. Voltage/Frequency Both GOOD..... Go to 1.4.2
 2. Both HIGH or LOW..... Go to 1.4.3
 3. Low or No a-c Voltage..... Go to 1.4.4
 4. Frequency GOOD, Volts HIGH..... Go to 1.4.9
- Reconnect LOAD LEADS to terminal strip before proceeding.



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1.4.2- Check Load Voltage and Frequency

If the no-load voltage and frequency were within limits, but operational problems occur with electrical loads applied, check a-c voltage and frequency under load. Proceed as follows:

1. Check that Stator a-c output leads 11, 22, 33 and 44 are properly connected to the A.C. POWER OUTPUT CONNECTION terminal strip.
2. Check that all LOAD leads are properly connected.
3. Connect an accurate a-c voltmeter and frequency meter across Terminals 11 and 22.
4. Start the generator engine, let it stabilize and warm up. Then, turn ON electrical loads by whatever means provided (such as turning ON main circuit breaker, using a load bank, etc.). Apply electrical loads as close as possible to the specific unit's rated maximum continuous wattage capacity.
5. Check a-c voltage and frequency readings under load. Readings should be as follows:

Units Rated 120/240 volts, 60 Hz:- Readings should be at least 116 volts and 58 Hz (or greater).

Units Rated 110/220 volts, 50 Hz:- Readings should be at least 107 volts and 48 Hz (or greater).

Excessive voltage/frequency drop under load may be caused by one or more of the following:

A. Generator is Overloaded:- Add up wattage ratings of all electrical loads applied to the generator at one time. This total should not be greater than the specific generator's rated maximum continuous a-c wattage capacity. Reduce electrical loading as necessary, to bring loads within the unit's rated capacity.

B. A Ground Fault Condition:- A shorted condition in the generator or in one or more connected electrical loads may increase current flow dramatically. A badly shorted condition may cause main circuit breakers to trip open or may even open the Stator thermal protector. Increased current flow caused by a shorted condition can show the same indications as an overloaded generator.

C. Loss of Engine Power:- If the engine has lost power for any reason, excessive voltage and frequency drop will occur when electrical loads are applied. Check the engine for adequate air flow, clogged air cleaner, incorrect timing, mechanical failure, etc. Complete necessary repairs to the engine.

1.4.3- Check/Adjust Engine Governor

If the no-load voltage and frequency are both correspondingly low or high, adjustment of the engine governor may be required. Instructions and information pertaining to the engine governor may be found in Section 1.5 (ADJUSTMENTS).

Following engine governor adjustment to the correct frequency at no-load, a-c voltage must be re-checked. If frequency (engine speed) is correct, but voltage is not, adjustment of the a-c Voltage Regulator may be required.

IMPORTANT: The marine generator was shipped from the factory pre-set for a rated voltage and frequency of 120/240 volts at 60 Hz. The generator may have been re-set by the Installer to a rated output 110/220 volts at 50 Hz. To reset the generator 110/220 volts at 50 Hz, (a) the engine governor must be adjusted, (b) the a-c Voltage Regulator must be adjusted, and (c) the engine control circuit board OVERSPEED setting must be adjusted.

Adjust the engine governor to the correct a-c frequency output as outlined in Section 1.5. When a-c frequency correct, check voltage and (if necessary) adjust the Voltage Regulator to obtain correct voltage output.

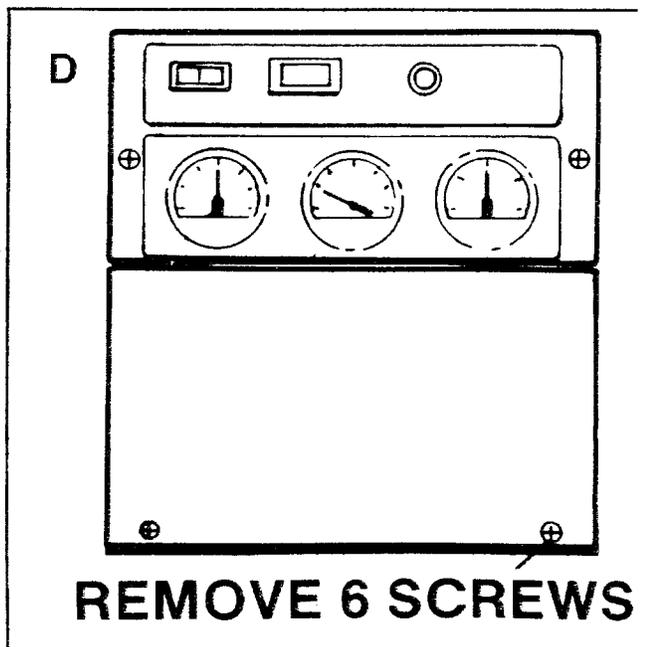
RESULTS:

1. Voltage/Frequency both GOOD..... End Test
2. Frequency GOOD, Voltage NO-GOOD.. Go to 1.4

1.4.4- Check Field Boost Circuit

See Paragraph 1.1.3. Check the Field Boost circuit as follows:-

D Remove six (6) SCREWS, then remove the generator meter and control panel cover. In side the meter and control panel housing, locate the CHOKE MODULE at the VOLTAGE REGULATOR.



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Test the Field Boost circuit as follows:-

Test Wire 16:- Locate Wire 16, between the Starter contactor and the Choke Module. Disconnect the wire from the Starter Contactor and at the Choke Module, to prevent interaction. Use an accurate ohmmeter to test a wire for an open or shorted condition.

IMPORTANT: Wire 16 has a double connection at the choke module. To obtain a correct reading, wire 16 must be disconnected from the double connector.

RESULTS:

- Wire Tests GOOD..... Go to Step (2)
- Wire tests BAD..... Repair or Replace

Test Choke Module:- During engine cranking, +d-c battery voltage is delivered to Pin 3 of the Choke Module, a Wire 16. The Choke Module houses a 1 amp, 600 volts DIODE and a 47 ohm, 2 watt RESISTOR. Battery voltage is delivered through those components and to the motor assembly, via Choke Module Pin 2, Wire #4 and the brushes and slip rings. Disconnect Wires 16 and 4 from the Choke Module. Then, connect the test leads of an ohmmeter across Choke Module Pins 2 and 3. Note the resistance reading. Now, reverse the meter test leads (reverse polarity) and again note the resistance reading. The meter should swing upscale and indicate the resistance of the resistor plus the forward resistance of the diode at one polarity only (meter will read infinity at the opposite polarity).

RESULTS:

- Choke Module Tests GOOD..... Go to Step (3)
- Choke Module Tests BAD..... Replace Module

Test Wire 4:- To prevent interaction, disconnect Wire 4 from Pin 2 of the Choke Module and from Terminal 4 of the a-c Voltage Regulator. Use an accurate ohmmeter to test the wire for open or shorted condition.

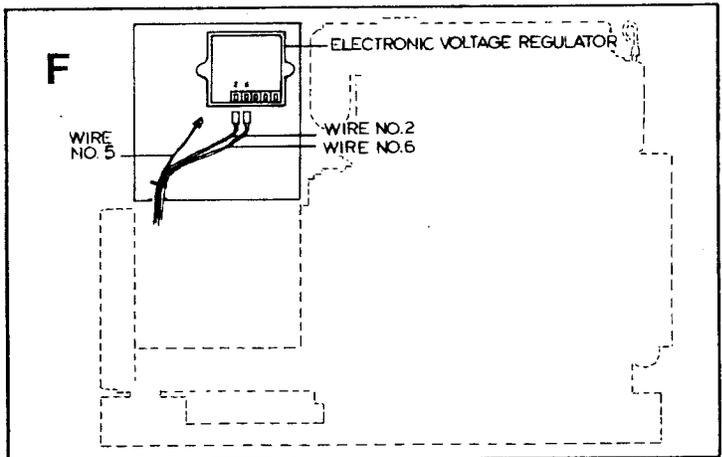
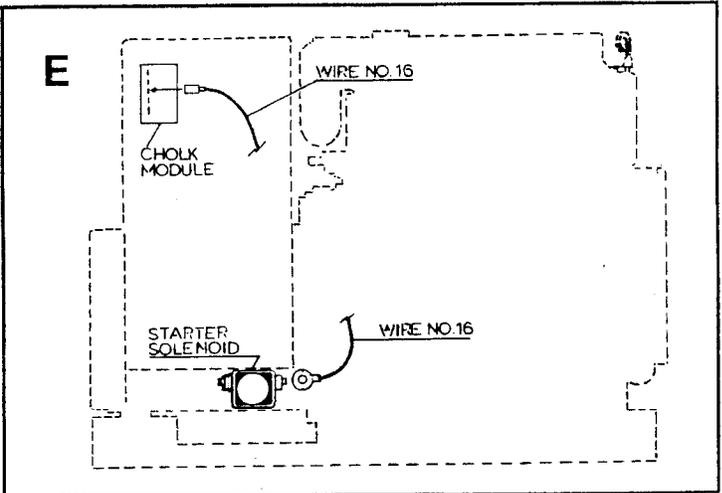
RESULTS:-

- Wire 4 tests GOOD..... Go to 1.4.5
- Wire 4 Tests BAD..... Repair or Replace

1.4.5- Check Stator Excitation Windings

Locate Excitation winding output leads 2 and 6, which connect to the Voltage Regulator. Also locate Wire 5. These wires are all located in the meter and control panel housing. The end of Wire 5 is capped by a wire nut, or crimp connector.

Test Excitation Windings:- Disconnect Wires 2 and 6 from the Voltage Regulator. Remove wire nut from end of Wire 5. Connect the test leads of an accurate



ohmmeter across terminal ends of Wires 2 and 5. Meter needle should indicate Stator Excitation winding resistance, as follows (plus or minus 10%):-

- Model QS-4.0G..... 1.65 ohms
- Model QS-6.5G..... 1.30 ohms
- Model QS-8.0G..... 0.88 ohms

RESULTS:

1. Windings Test GOOD..... Go to Step (2)
2. Windings Test BAD..... Replace Stator

2. Test Thermal Protector:- Connect an accurate ohmmeter across terminal ends of Wires 2 and 6. Meter needle should indicate Excitation winding resistance as stated in Step (1) of this test. If windings checked good in Step (1), but checked BAD in this step, bypass the thermal protector as follows:-

- a. Cut Excitation winding output lead 2, using the wire with the spad connector attached, strip the end back about 1/4 inch.
- b. Use the wire nut or crimp connector and connect stripped end of Wire 2 to stripped end of Wire 5.

IMPORTANT: Tape end of unused Wire 2 from Stator; excitation winding, or install a crimp connector onto wire, to prevent it from shorting against any part of the frame.

RESULTS:

1. Generator Checks GOOD..... End of Tests
2. Generator Still checks BAD..... Go to 1.4.6

1.4.6- Check Stator Power Windings

G Locate the A.C. POWER OUTPUT CONNECTION terminal strip in a-c connection box (below meter and control panel). To prevent interaction, disconnect Stator output Wires 11, 22, 33 and 44 from the terminal strip. Connect an accurate ohmmeter across terminal ends of Wires 11 and 22, and note the meter reading. Then, connect test leads across Wires 33 and 44 and again note the meter readings. Both readings should be as stated below (plus or minus 10%):

Model QS-4.0G	0.43 ohms
Model QS-6.5G	0.26 ohms
Model QS-8.0G	0.16 ohms

RESULTS:

1. Checks GOOD..... Go to 1.4.7
2. Checks BAD..... Replace Stator Assembly

1.4.7- Check Field (Rotor) Circuit

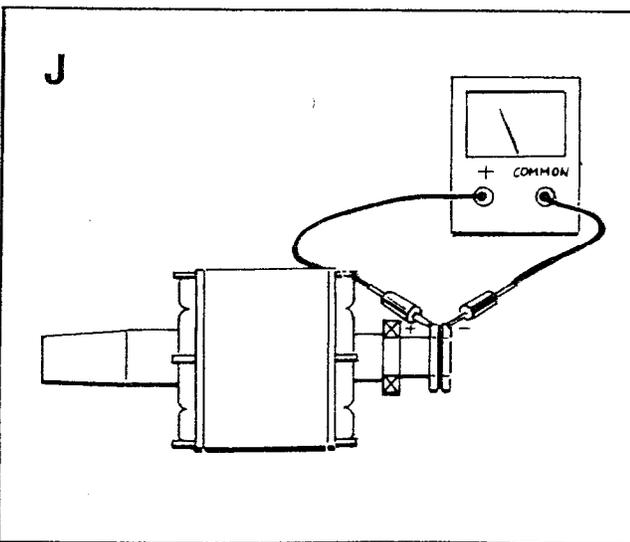
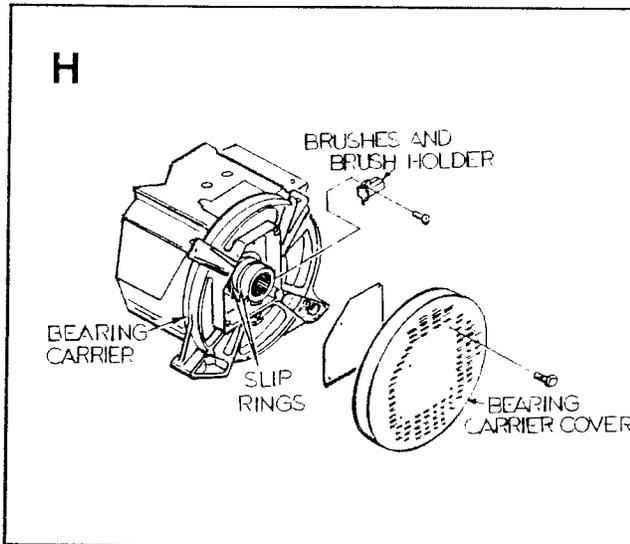
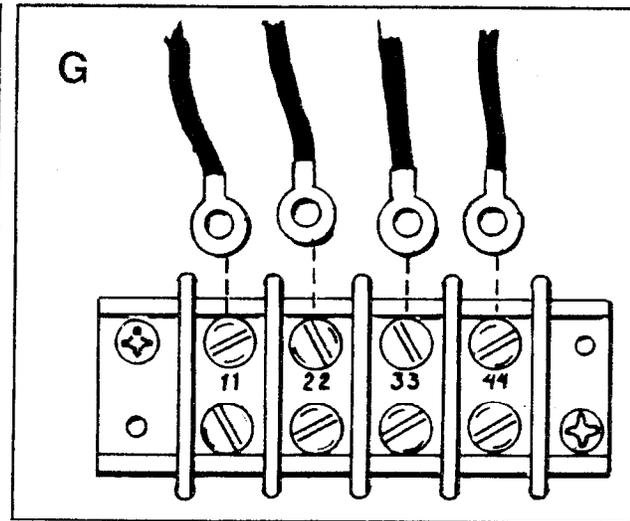
H Remove Bearing Carrier Cover:- Remove SCREWS, then remove BEARING CARRIER COVER and DUST COVER, to expose the BRUSH HOLDER and SLIP RINGS.

J Test Rotor Resistance:- To prevent interaction, disconnect Wires 1 and 4 at brushes. Connect positive (+) lead of an ohmmeter to the positive (+) slip ring, common test lead to the negative (-) slip ring. Meter should indicate the following:

Model QS-4.0G	6.6 ohms
Other Models	7.4 ohms
All readings plus or minus 10%	

RESULTS:

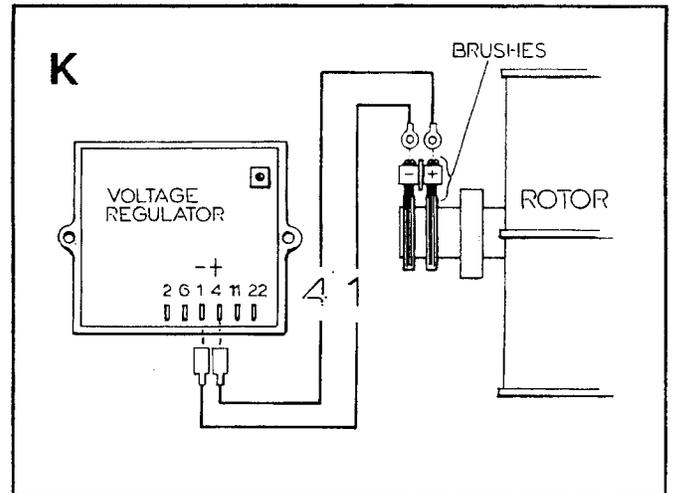
1. Tests GOOD..... Go to Step K
2. Checks BAD..... Replace Rotor & Test



K Check Wires 1 and 4:- Inspect Wires 1 and 4 connections at Voltage Regulator and at brushes carefully. Use an ohmmeter to test both wires for an open or shorted condition.

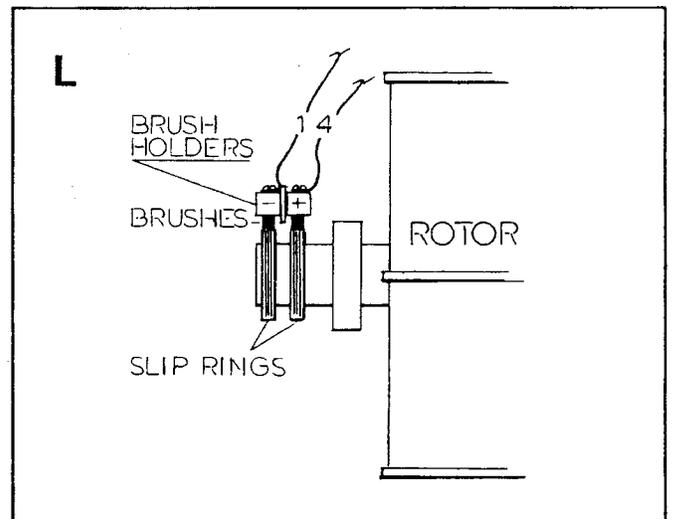
RESULTS:

- 1. Checks GOOD..... Go to Step L
- 2. Checks BAD..... Repair or replace wires



L Inspect Brushes and Slip Rings:- Carefully inspect brushes and slip rings as follows:-

- 1. Remove wires 1 and 4 from brushes.
- 2. Remove Brush Holder from Rear Bearing Carrier.
- 3. Inspect Brushes and Brush Holder. Replace, if damaged, cracked, worn excessively, etc.
- 4. Inspect Slip Rings. If they are dull or tarnished, polish with fine sandpaper. DO NOT USE ANY METALLIC GRIT TO CLEAN SLIP RINGS. Use low pressure air (25 psi or less) to blow away cleaning residue.
- 5. Reassemble Brushes and Brush Holders to Rear Bearing Carrier. Make sure Brushes are properly seated in Brush Holder and are contacting the Slip Rings properly. Reconnect Wires 1 and 4 to Brushes. Rotate the Rotor several times, to seat Brushes against the Slip Rings.



RESULTS:

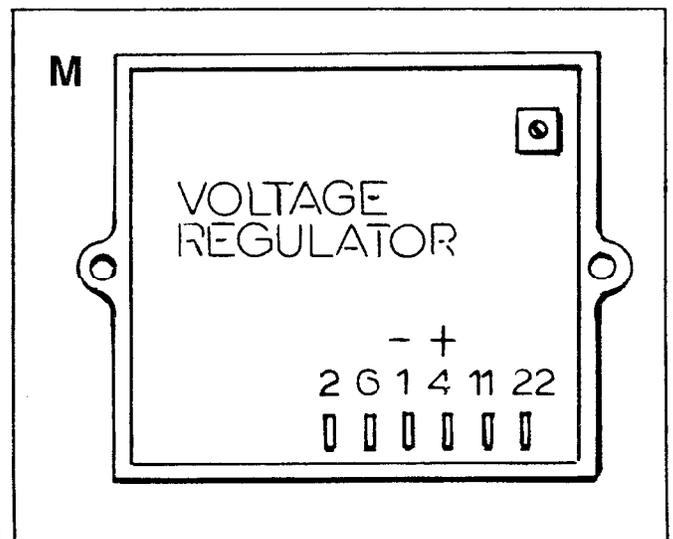
- 1. Generator Tests GOOD..... End of Tests
- 2. Generator Tests BAD..... Go to 1.4. 8

1.4.8- Check Voltage Regulator

M Try adjusting the Voltage Regulator (see ADJUSTMENTS section).

RESULTS:-

- 1. Adjusts GOOD, checks GOOD..... End of Tests
- 2. Will not adjust, checks BAD..... Go to 1.4.9



1.4.9- Check Voltage Regulator Sensing

▲ CAUTION

Make sure all wires previously disconnected have been properly reconnected to the correct terminals.

N Start the generator, let it stabilize and warm up. Then, connect an accurate a-c voltmeter across Voltage Regulator SENSING TERMINALS (11 and 22). The voltmeter should indicate Stator a-c output voltage.

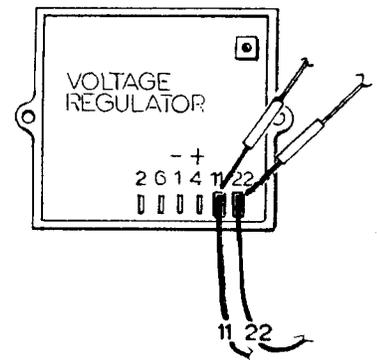
O Now connect the a-c voltmeter across Terminals 11 and 22 of the A.C POWER OUTPUT CONNECTION terminal strip. Voltmeter should again indicate Stator a-c output voltage.

If voltage is indicated in "O" but not in "N", Sensing leads 11 and 22 to the Voltage Regulator are open. Repair or replace defective sensing leads, as required.

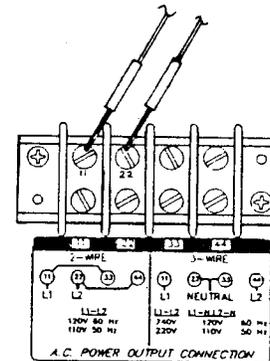
IMPORTANT: When the sensing leads are open, Stator a-c output voltage will be higher than normal (voltage regulator establishes the Rotor in a "full field" condition).

If voltage is high or low in both "N" and "O", try adjusting the Voltage Regulator. If voltage is still high or low, replace the Voltage Regulator.

N



O



All diagnostic tests are now completed. Retest the generator, starting with a-c output voltage and frequency. If problems are still encountered, try a visual inspection of all generator wiring using the applicable WIRING DIAGRAM as a guide. Make sure all wiring properly routed and properly connected as shown in the wiring diagram. You may wish to repeat the diagnostic tests, to make sure nothing has been overlooked.

SECTION 1.5 - ADJUSTMENTS

IMPORTANT: The marine generator was factory set for a rated a-c output voltage and frequency of 120/240 volts, 60 Hz. However, if required, units may be reset to a rated a-c output of 110/220 volts at 50 Hz.

1.5.1- Engine Governor Adjustment

Generator a-c output frequency is directly proportional to engine speed. Rated a-c frequency of 60 Hz is obtained at 1800 rpm; or 50 Hz at 1500 rpm. To help prevent excessive rpm, voltage and frequency droop under heavy electrical loading, the engine governor is generally adjusted to maintain a 62 Hz output at no-load for units rated at 60 Hz; or a 51 Hz output at no-load for units rated at 50 Hz. To adjust the engine governor, proceed as follows:-

A Remove four (4) screws, then remove the a-c connection panel cover.

▲ DANGER

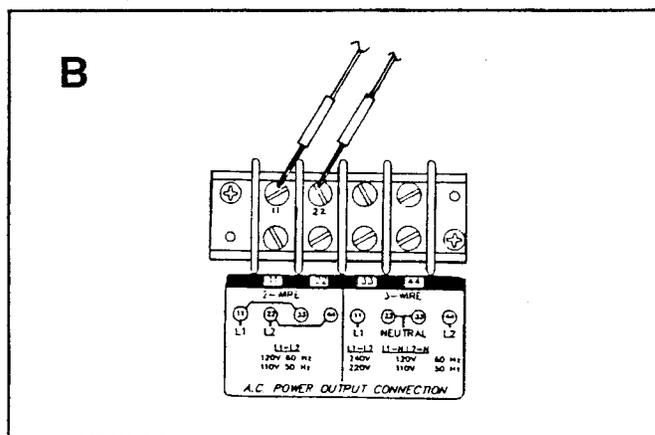
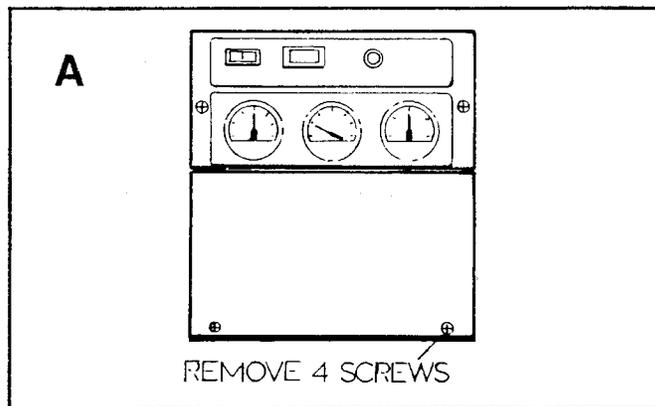
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B Connect an accurate a-c frequency meter and voltmeter across Terminals 11 and 22 of the a-c connection terminal strip. Turn OFF all electrical loads, using whatever means provided (such as a main line circuit breaker). Initial adjustments must be done at no-load. Start the generator, let it stabilize and warm up. Then, check no-load frequency and voltage. These readings should be as follows:-

Units Rated 120/240 Volts, 60 Hz;- 121-126 volts at 61-63 Hz.

Units Rated 110/220 Volts, 50 Hz;- 110-112 volts, 51-52 Hz.

IMPORTANT: If a-c frequency is not within limits, go to Step "C". If a-c frequency is good but voltage is not, adjustment of the Voltage Regulator is required.



C If necessary, adjust the engine governor as follows:

1. Adjust the NO-LOAD SPEED ADJUST SCREW to obtain a frequency reading as close as possible to 61.5 Hz (60 Hz units); or to 50.0 Hz (50 Hz units).
2. Adjust the NO-LOAD BUMPER SCREW to obtain a frequency of 62 Hz (60 Hz units); or 51 Hz (50 Hz units).
3. Apply an electrical load to the generator as close as possible to the full rated wattage capacity of the unit. Check the a-c frequency under load. If frequency drops below about 58 Hz (60 Hz units) or 49 Hz (50 Hz units), adjust the DROOP ADJUSTMENT downward. Adjust the DROOP ADJUSTMENT until application of the load results in the smallest possible a-c frequency drop when maximum load is applied.

IMPORTANT: If surging occurs when electrical loads are removed, adjust the NO-LOAD BUMPER SCREW inward. If BUMPER SCREW adjustment changes the a-c frequency, back the SCREW out until no-load frequency returns to 62 Hz (60 Hz units) or 51 Hz (50 Hz units).