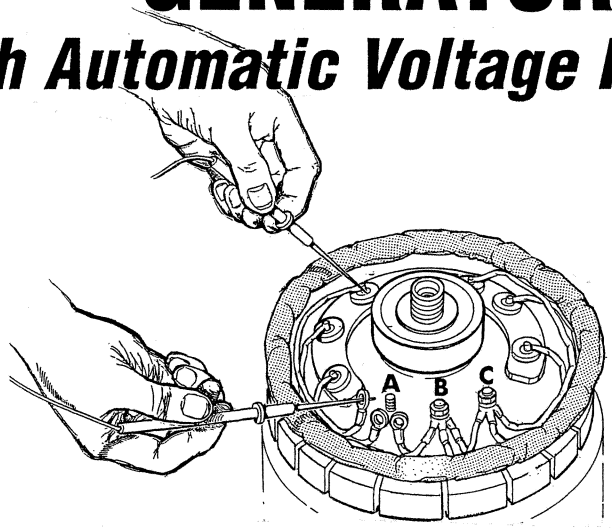
# BE/COLISEUM

# SYNCHRONOUS BRUSHLESS GENERATORS

## *with Automatic Voltage Regulators*




# TROUBLESHOOTING and MAINTENANCE GUIDE

WESTERBEKE

*WESTERBEKE CORPORATION • 150 JOHN HANCOCK ROAD*
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**REVISION 2**
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# BE/COLISEUM GENERATOR

## DESCRIPTION

The Coliseum (4-pole) generators are self-exciting, synchronous, brushless models. Brushless excitation is obtained by electromagnetic transmission of the excitation power through the air gap of the synchronous exciter. The generators are single-phase 4 leads at 60Hz and are manufactured and tested according to NEMA standards, ISO standards and IEC recommendations.

**Generator:** The generator design is based on a multilaminated magnetic circuit with salient poles on the rotor. The rotor is of a special compact construction with an integral damper cage and a field winding section conductor wound directly on the rotor. A special interpole fixation combined to the mechanical compactness of the winding ensures a highly efficient generator..

**Exciter:** The exciter is a six-pole synchronous generator with salient poles on the stator and a cylindrical armature on the rotor. The exciter rotor and the rotating rectifier are mounted on the shaft with the main generator rotor.

**Excitation System:** The system is excited automatically by means of residual magnetism of the magnetic circuits of the generator and exciter and stabilized by the permanent magnet in one of the exciter poles.

**Winding Connections:** The single-phase synchronous generator has 4 stator leads and can be configured to 120 or 240 volt output.

**Bearings:** The bearings are sealed type and permanently greased.

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## Generator Maintenance

- Maintaining reasonable cleanliness is important. Connections of terminal boards and rectifiers may become corroded, and insulation surfaces may start conducting if salts, dust, engine exhaust, carbon, etc. are allowed to build up. Clogged ventilation openings may cause excessive heating and reduced life of windings.
- For unusually severe conditions, thin rust-inhibiting petroleum-base coatings, should be sprayed or brushed over all surfaces to reduce rusting and corrosion.
- In addition to periodic cleaning, the generator should be inspected for tightness of all connections, evidence of overheated terminals and loose or damaged wires.
- The drive discs on single bearing generators should be checked periodically if possible for tightness of screws and for any evidence of incipient cracking failure. Discs should not be allowed to become rusty because rust may accelerate cracking. The bolts which fasten the drive disc to the generator shaft must be hardened steel SAE grade 8, identified by 6 radial marks, one at each of the 6 corners of the head.
- The rear armature bearing is lubricated and sealed; no maintenance is required. However, if the bearing becomes noisy or rough-sounding, have it replaced.
- Examine bearing at periodic intervals. No side movement of shaft should be detected when force is applied. if side motion is detectable, bearings are wearing or wear on shaft of bearing socket outside bearing has occurred. Repair must be made quickly or major components will rub and cause major damage to generator.

### Carbon Monoxide Detector

WESTERBEKE recommends mounting a carbon monoxide detector in the vessels living quarters. **Carbon monoxide, even in small amounts is deadly.**

The presence of carbon monoxide indicates an exhaust leak from the engine or generator, from the exhaust elbow/exhaust hose, or that fumes from the vessels exhaust or a nearby vessel are entering your boat.

If carbon monoxide is present, ventilate the area with clean air and correct the problem immediately!

# BE/COLISEUM GENERATOR

## TROUBLESHOOTING

In some cases, it is difficult to find out on the basis of the existing indications on which part of the generator the fault has occurred. For this reason, it is recommended to follow the step by step procedure below:

1. Inspect visually the condition of all connections, terminal boards, terminals and the excitation system components.
2. Inspect visually for indications of damage to the windings on the generator.
3. Check the operation of the voltage regulator. Check if the voltage regulator is connected correctly and properly adjusted.
4. In case of a faulty regulator operation, the trouble may lie also in the generator. This can be easily verified by checking the generator operation with separate excitation. For this check it is necessary to follow the *EXCITATION MAGNETIZATION PROCEDURE* outlined on page 5 in this manual.
5. A burning smell or signs of smoke would indicate a short in the windings or a mechanical failure.

| FAULT | PROBABLE CAUSE | |
|---|---|---|
| **NO AC VOLTAGE OUTPUT AT NO LOAD.** | **1.** Short or open in the main stator winding.<br>**2.** Four or more shorted or open diodes on exciter rotor. | **3.** Open in exciter stator winding.<br>**4.** Open in rotating field winding.<br>**5.** Shorted supressor. |
| **RESIDUAL VOLTAGE PRODUCED AT NO LOAD 15 - 20 VOLTS AC.** | **1.** Faulty voltage regulator.<br>**2.** Short or open in the AC wiring to the voltage regulator. | |
| **LOW AC VOLTAGE OUTPUT AT NO LOAD 60 - 100 VAC.** | **1.** Reset voltage potentiometer.<br>**2.** Shorted diodes in exciter rotor 1 to 3 diodes.<br>**3.** Shorted exciter rotor winding. | **4.** Faulty voltage regulator.<br>**5.** Short in exciter stator windings.<br>**6.** Short in rotating field winding. |
| **HIGH AC OUTPUT VOLTAGE 150 VAC OR HIGHER.** | **1.** Reset voltage potentiometer.<br>**2.** Faulty voltage regulator. | |
| **UNSTABLE VOLTAGE OUTPUT. (ENGINE SPEED STEADY)** | **1.** The potentiometer on the voltage regulator needs adjusting. | **2.** Faulty voltage regulator. |
| **AC VOLTAGE DROP UNDER LOAD 60 - 100 VOLTS AC.** | **1.** Diode(s) on exciter rotor breaking down when load is applied (inductive) 1-3 diodes. | |
| **VERY LOW AC OUTPUT VOLTAGE 4 - 10 VAC** | **1.** Loss of residual magnetism. | |

**NOTE:** *AC GENERATOR TROUBLESHOOTING MUST BE PERFORMED WITH THE ENGINE OPERATING AT 60 HZ.*

# BE/COLISEUM GENERATOR
## WITH EARLY STYLE REGULATOR

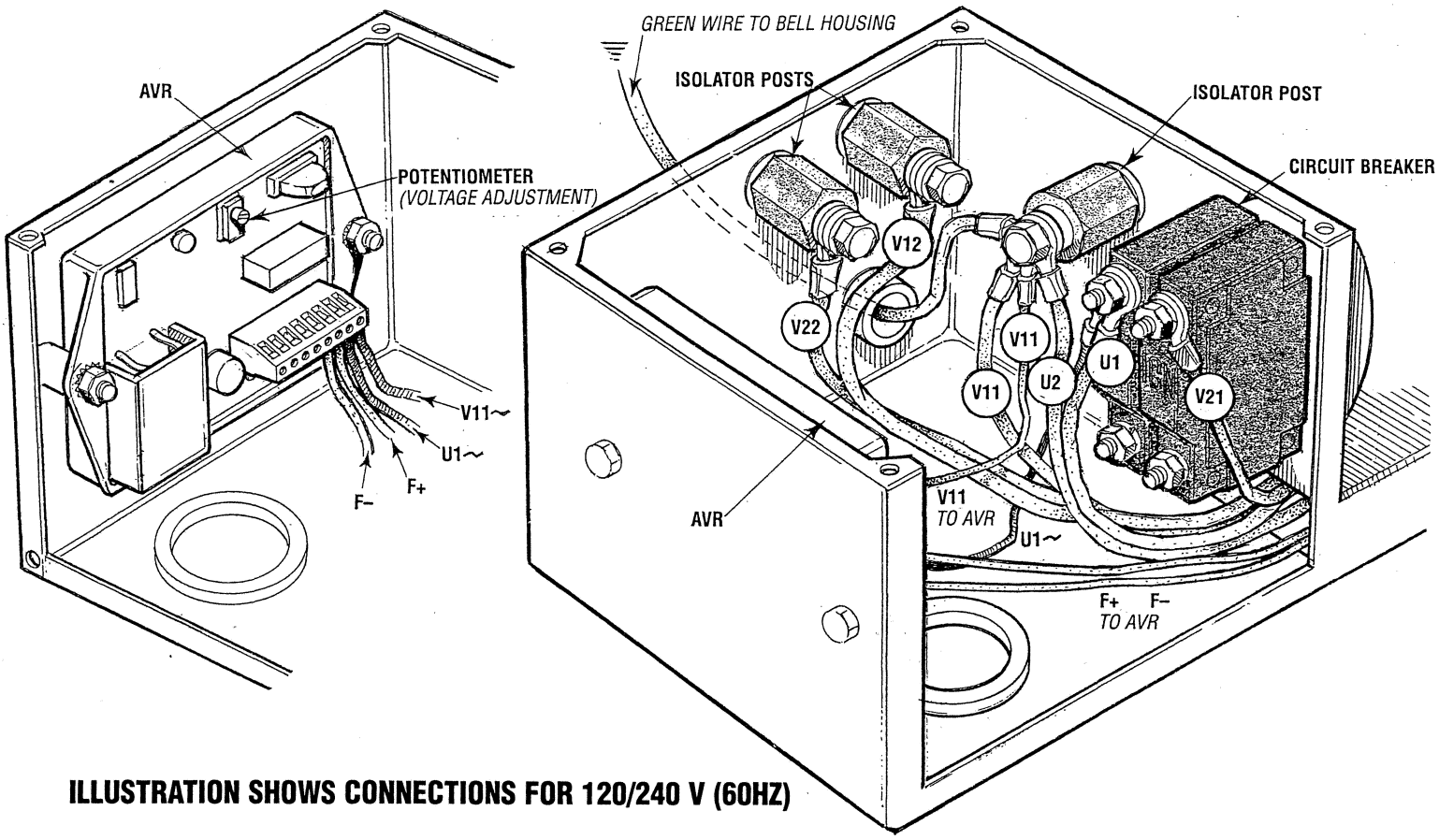



**ILLUSTRATION SHOWS CONNECTIONS FOR 120/240 V (60HZ)**

The illustration above shows the on-engine control panel and illustrates the AC connections and voltage regulator board.

Connections not used (50 Hertz) are shrink wrap ends and are tied off in the control panel.

AC voltage adjustment, troubleshooting the exciter circuit and AC voltage output can be easily accomplished with access to the on-engine control panel.

# BE/COLISEUM GENERATOR

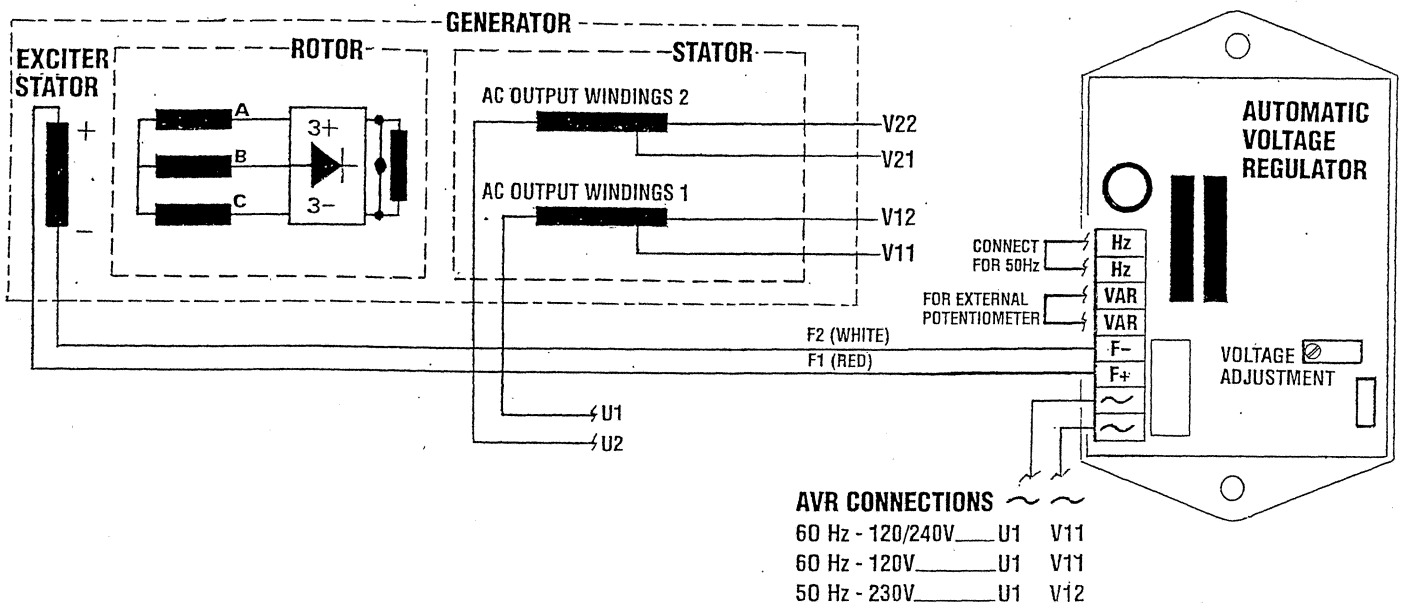
## MAIN STATOR WINDINGS TROUBLESHOOTING

Very low or no AC voltage output is an indication of a shorted or open main stator. To determine if it is a short or open, excite the generator with 12VDC across the **F+** and **F–** leads lifted off the voltage regulator with the unit running.

If a short exists the excitation will produce a load on the drive engine. A growling noise will be produced by the AC generator. The short will produce heat affecting the windings adjacent to it and smoke may be produced.

If a short is not found but rather an open is indicated, the two main stator windings will have to be electrically isolated and the windings checked with an ohm meter. Test between **V12** and **U1** for an open circuit or check for an open between **V22** and **U2**.

## INTERNAL WIRING DIAGRAM




## RESISTANCE VALUES (IN OHMS)

| WESTERBEKE GENERATORS | 8.0Kw | 10.0Kw | 12.5Kw | 15.0Kw |
|---|---|---|---|---|
| *Exciter Stator* | 23.5 | 25.1 | 25.5 | 26.6 |
| *Main Stator* | | | | |
| V22 to U2 | 0.3 | 0.3 | 0.4 | 0.4 |
| V12 to U1 | 0.3 | 0.3 | 0.4 | 0.4 |
| *Exciter Rotor* | | | | |
| A to B | 1.2 | 0.6 | 0.6 | 0.4 |
| B to C | 1.2 | 0.6 | 0.6 | 0.4 |
| C to A | 1.2 | 0.6 | 0.6 | 0.4 |
| *Rotor Field* | 2.2 | 2.4 | 2.8 | 3.0 |
| *Supressor* | *NO RESISTANCE* | | | |

# BE/COLISEUM GENERATOR
## WITH EARLY STYLE REGULATOR

### RESTORING RESIDUAL MAGNETISM TO THE GENERATOR

The initial excitation of the generator is assured by the permanent magnet built in one of the exciter stator poles. Trouble with the initial excitation can occur after prolonged storage or after a service repair that dismantles the exciter. In some rare instances, it may be the result of rough transport or handling. To restore the residual magnetism necessary to begin the voltage build-up, excite the generator with 40 - 60VDC by following the procedure below:

1. Disconnect the **F+** lead from the voltage regulator.
2. Disconnect the **F–** lead from the voltage regulator.

**NOTE:** *Be sure to maintain DC polarity.*

3. Connect the 40 - 60VDC+ to the **F+** lead
4. Connect the 40 - 60VDC– to the **F–** lead.
5. Leave connected for 2 -3 seconds. Disconnect and reconnect **F+** and **F–** leads to the regulator.
6. Start the generator and observe the voltage build-up. If the voltage build-up does not occur, repeat steps **1** thru **5**.

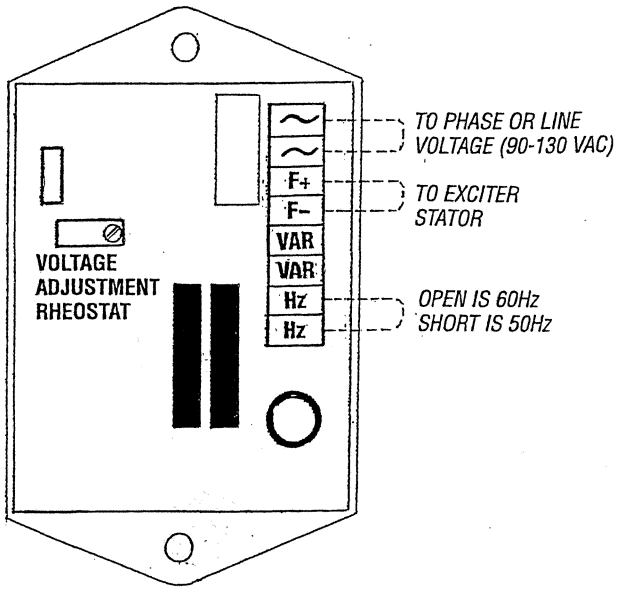
> ⚠ **CAUTION:** ***Damage to the voltage regulator will occur if he regulator is not disconnected from the exciter field during flashing.***

### VOLTAGE REGULATOR

Normal DC voltage to exciter stator winding generator at no load.

**F+ F– → 8 - 9 VDC**

Normal AC input voltage to regulator. **120 VAC – 60Hz**
~ → ~ **230 VAC – 50Hz**




### EXCITATION OF THE GENERATOR TO DETERMINE FAULT

1. Disconnect the **F+** lead from the voltage regulator.
2. Disconnect the **F–** lead from the voltage regulator.

**NOTE:** *Be sure to maintain DC polarity.*

3. Connect the 12 DC+ to the **F+** lead
4. Connect the 12 DC– to the **F–** lead.
5. Leave the 12VDC connected for 5 minutes. Disconnect and reconnect **F+** and **F–** leads to the regulator.
6. Start the generator and observe the voltage build-up. If the voltage build-up does not occur, repeat steps **1** thru **5**.

**NOTE:** *Steps **1** thru **4** are performed when flashing the exciter field (stator) to determine the cause of a fault in the generator.*

***Step 5:*** *Start the generator and observe/note the reaction of the generator while applying 12VDC to the exciter stator. Record the AC voltage output/generator.*

***Step 6:*** *Stop the generator. and remove the 12VDC lead from **F+** and **F–** and reconnect it to the regulator board.*

# BE/COLISEUM GENERATOR

## AC VOLTAGE CONNECTIONS

The frame ground wire (green) must be properly positioned when changing the AC output configuration of the AC terminal block. For making connections to the AC breaker, use terminal ends for 1/4 inch studs that will accept multi-strand copper wire sized for the amperage rating from the hot lead connection. The frame ground green wire connects between the neutral stud and the generator frame.

### Generator Frequency

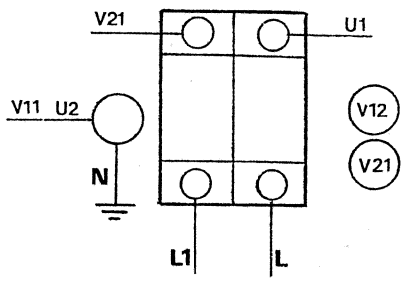
1. Frequency is a direct result of engine/generator speed: 1800 rpm = 60 hertz; 1500 rpm = 50 hertz.
2. To change generator frequency, follow the steps below:

   Connect the AC leads to the AC breaker and isolation posts as the illustrations show for the hertz/voltage desired. Ensure that the case ground wire is connected to the correct isolation post neutral ground stud.
3. Remove or install the jumper on the automatic regulator (depending on the frequency).

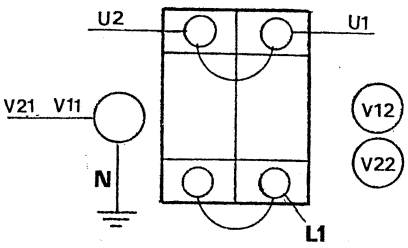
**NOTE:** *The green ground wire may be removed in those installations where the AC circuit has a separate neutral and ground circuit. This will prevent the unit from being a ground source in the vessel.*

4. Open the AC circuit breaker.
5. Start the generator and adjust the engine speed to the correct no-load hertz, then adjust the voltage rheostat on the regulator to the corresponding AC output.

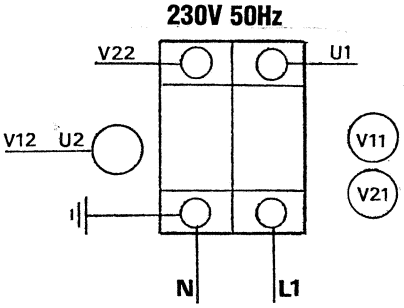
**120/240V 60Hz**

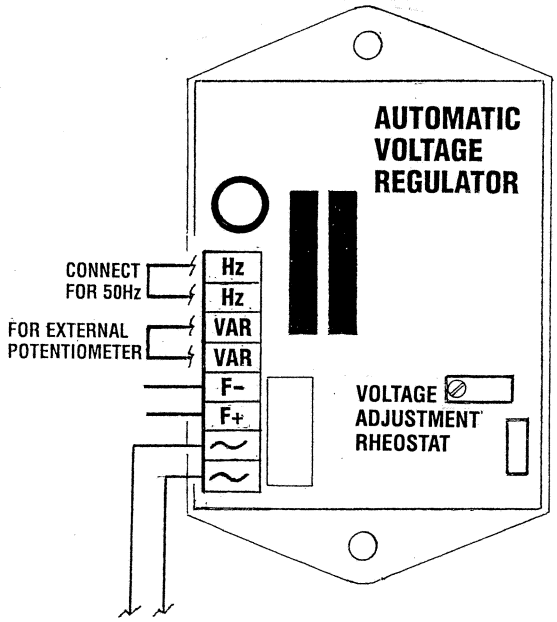



**120V 60Hz**




**230V 50Hz**




**AVR CONNECTIONS** ~ ~

| | | |
|---|---|---|
| 60 Hz - 120/240V | U1 | V11 |
| 60 Hz - 120V | U1 | V11 |
| 50 Hz - 230V | U1 | V12 |

**AVR CONNECTIONS** (September 2004 Production on)

| | | | ~ ~ |
|---|---|---|---|
| 60 Hz | - | 120/240V | T2 : T4 |
| 60 Hz | - | 120V | T3 : T5 |
| 50 Hz | - | 230V | T2 : T4 |

**WIRE COLOR CODE**

**T2** YELLOW

**T3** ORANGE

**T4** LT. GREEN

**T5** LT. RED

# BE/COLISEUM GENERATOR
## WITH VOLTAGEE REGULATOR #046446 (CURRENT STYLE)

### DESCRIPTION

This is a four pole brushless generator. The exciter provides residual magnetism which guarantees the self excitation of the generator on start-up. (The residual voltage is about 10% of nonimal AC voltage). the Automatic Voltage Regulator (AVR) converts this AC voltage to DC voltage and supplies this DC voltage to the exciter windings. This DC voltage indirectly controls the main rotating field by means of the sequence exciter rotor-diode bridges-main rotating field. The AVR has a plus or minus voltage precision of 1% in the generators working range with distortion free loads. The AVR controls and keeps the voltage constant on one phase. The AVR monitors generator frequency, if the frequency should drop below a factory set point, excitation from the AVR can be modulated to remove any voltage output instability that may arise.

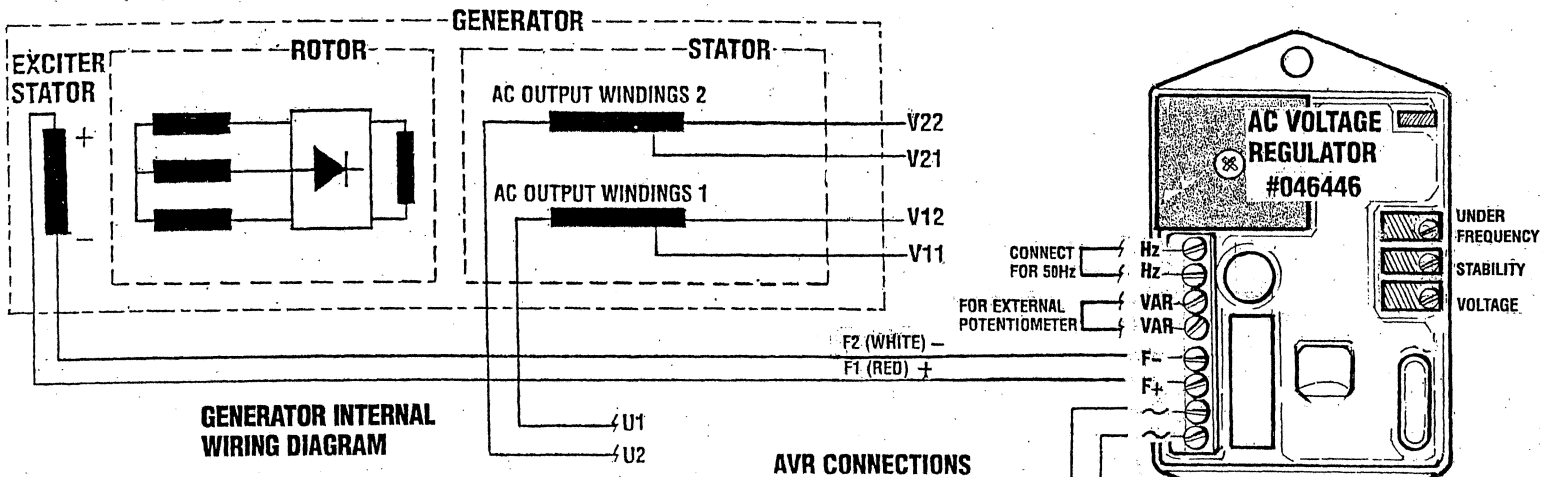
### Voltage Adjustments

This potentiometer is used to adjust output voltage. At proper engine operating speed the output voltage should be held at ±2% from a no-load condition to a full rated generator output and from power factot 1.0 with engine drive speed variations up to .5Hz (1%).

With the alternator running at no-load, at normal speed, and with VOLT adjust at minimum, it is possible that output voltage will oscillate. Slowly rotate the VOLT adjustment clockwise. The voltage output of the alternator will increase and stabilize. Increase the voltage to the desired value.

### CIRCUIT BREAKER

A circuit breaker is installed on all WESTERBEKE generators. This circuit breaker will automatically disconnect generator power in case of an electrical overload. The circuit breaker can be manually shut off when servicing the generator to ensure that no power is coming into the boat.




**GENERATOR INTERNAL WIRING DIAGRAM**

**AVR CONNECTIONS**

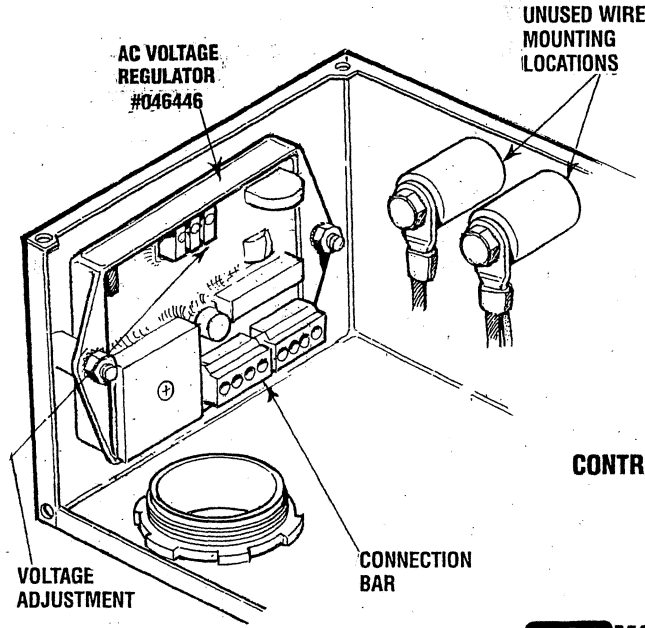
| | |
|---|---|
| 60 HZ - 120 VOLTS | U1 ; V11 |
| 60HZ - 120/240 VOLTS | U1 ; V11 |
| 50HZ - 230 VOLTS | U1 ; V12 |

**AVR CONNECTIONS**

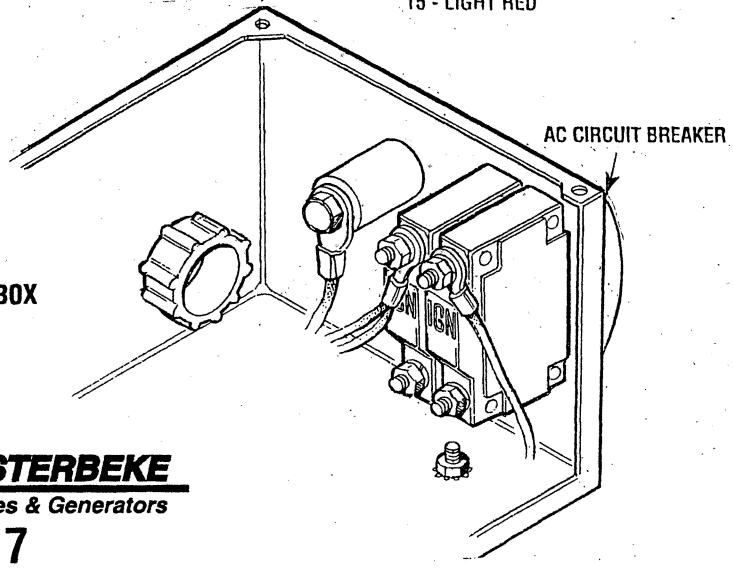
| | |
|---|---|
| 60 HZ - 120 VOLTS | T3 ; T5 |
| 60HZ - 120/240 VOLTS | T2 ; T4 |
| 50HZ - 230 VOLTS | T2 ; T4 |

**WIRE COLOR CODE**

T2 - YELLOW
T3 - ORANGE
T4 - LIGHT GREEN
T5 - LIGHT RED




**CONTROL BOX**



# BE GENERATOR VOLTAGE CONNECTIONS

## AC VOLTAGE CONNECTIONS

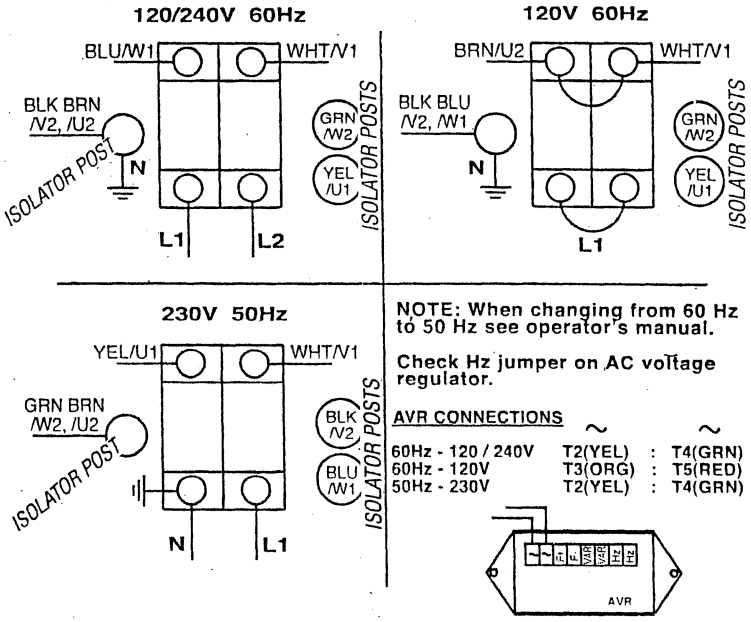
The frame ground wire (green) must be properly positioned when changing the AC output configuration of the AC terminal block. For making connections to the AC terminal block, use terminal ends for 1/4 inch studs that will accept multi strand copper wire sized for the amperage rating from the hot lead connection. The frame ground green wire connects between the neutral stud and the generator frame.

### Generator Frequency

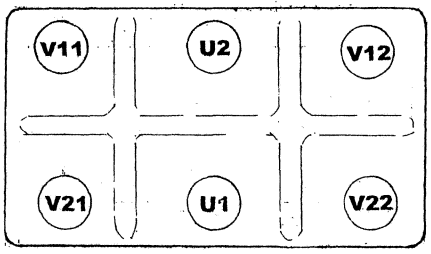
1. Frequency is a direct result of engine/generator speed: 1800 rpm = 60 hertz; 1500 rmp = 50 hertz.
2. To change generator frequency, follow the steps below:

   Configure the AC terminal block for the desired voltage frequency as shown. Ensure that the case ground wire is connected to the correct terminal block neutral ground stud.
3. Remove or install the jumper on the automatic regulator (depending on frequency). Refer to *BE GENERATOR.*

**NOTE:** *The green ground wire may be removed in those installations where the AC circuit has a separate neutral and ground circuit. This will prevent the unit from being a ground source in the vessel.*

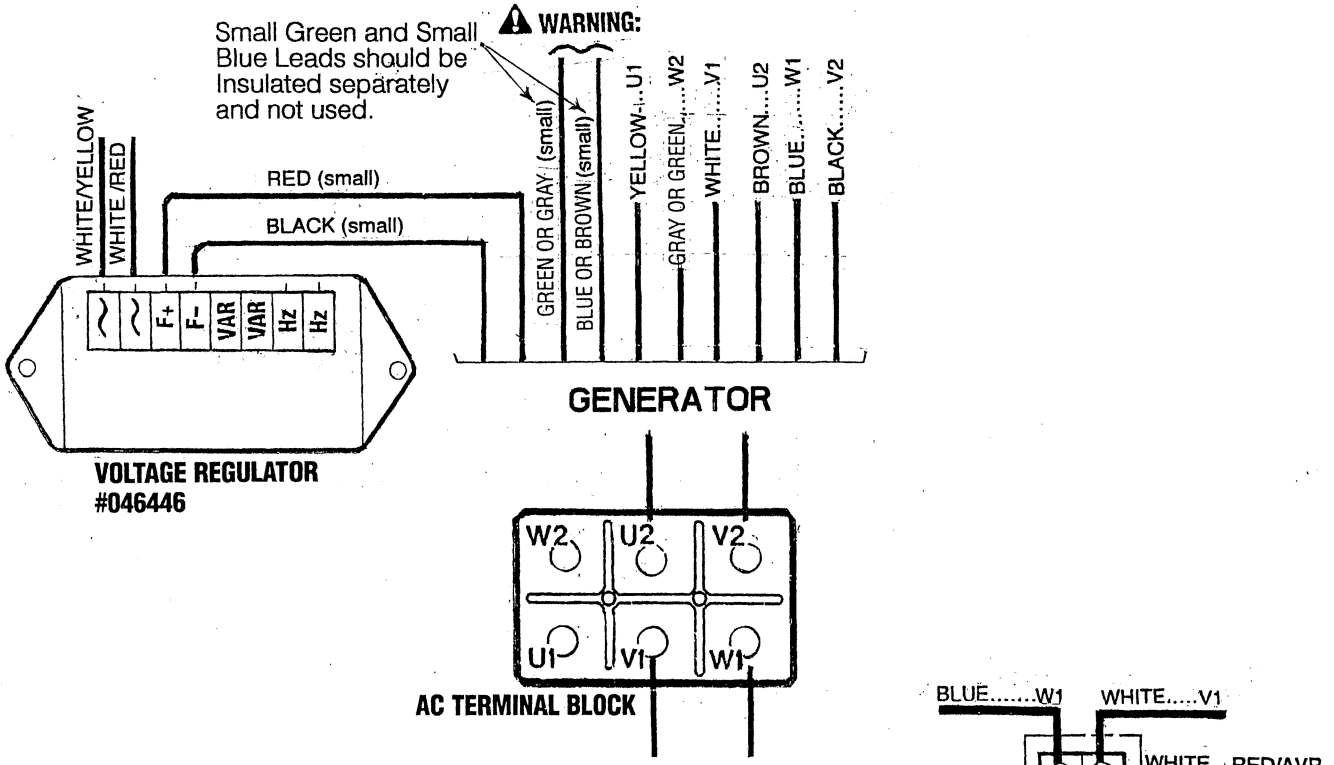


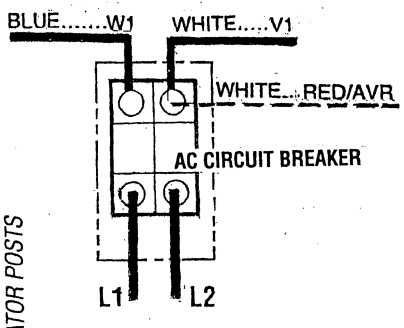

**VOLTAGE REGULATOR #046446**

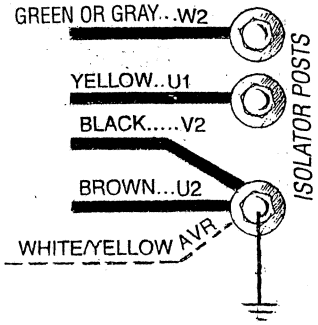



**AC TERMINAL BLOCK**

# **BE GENERATOR** (EARLIER MODELS)
## WITH VOLTAGE REGULATOR #046446

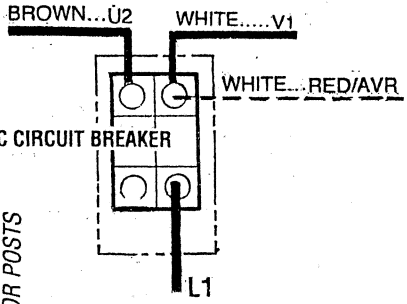


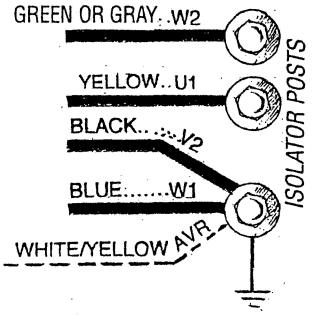



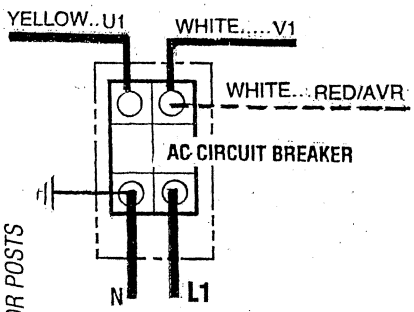

**120/240V 60Hz**

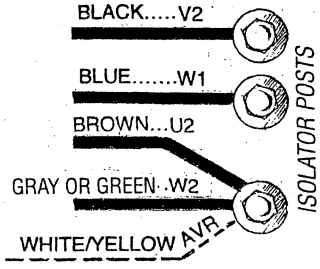
**120V 60Hz**




**230V 50Hz**



# BE/COLISEUM GENERATOR
## WITH VOLTAGEE REGULATOR #046446 (CURRENT STYLE)

### VOLTAGE POTENTIOMETER

The output voltage of the generator can be adjusted using the potentiometer with the generator running at its selected speed (frequency) by turning the adjustment until the desired voltage is obtained. **NOTE:** *If the voltage is set higher than selected rated voltage, the generator may be damaged.*

### FREQUENCY

A **jumper** on the regulator is connected to two of the three pins for either 60 hertz or 50 hertz operation. **NOTE:** *This does not automatically change the engine speed. Engine speed change is performed using the adjustment on the belt driven mechanical governor.*

### STABILITY

If at no-load or while under load with steady engine speed, AC output voltage fluctuation is experienced. Adjust the **stability** potentiometer. This modulates the reaction time of the regulator to external inputs, thereby eliminating any instability in the AC generator load system.

### UNDER FREQUENCY

With the generator running at rated speed and producing desired voltage, reduce the engine speed using the mechanical governor by 4 hertz. Adjust the under frequency potentiometer until the AC output voltage of the generator starts to drop. Then restore the engine speed to the original rated speed.

### VOLTAGE SENSING

The voltage sensing connections are *0* and *115* when selected output voltage is between *100V* and *140V*. Connect between *0* and *230* when selected output voltage is between *200V* and *280V*.

### EXCITER WINDING

Proper polarity in this circuit **must** be maintained. **White** to **F-** and **red** to **F+**. Failure to do so may damage the regulator.

### AUXILIARY WINDING

Connect the correct color wires to the terminals. Green or gray to **Aux L** and blue and brown to **Aux N**.

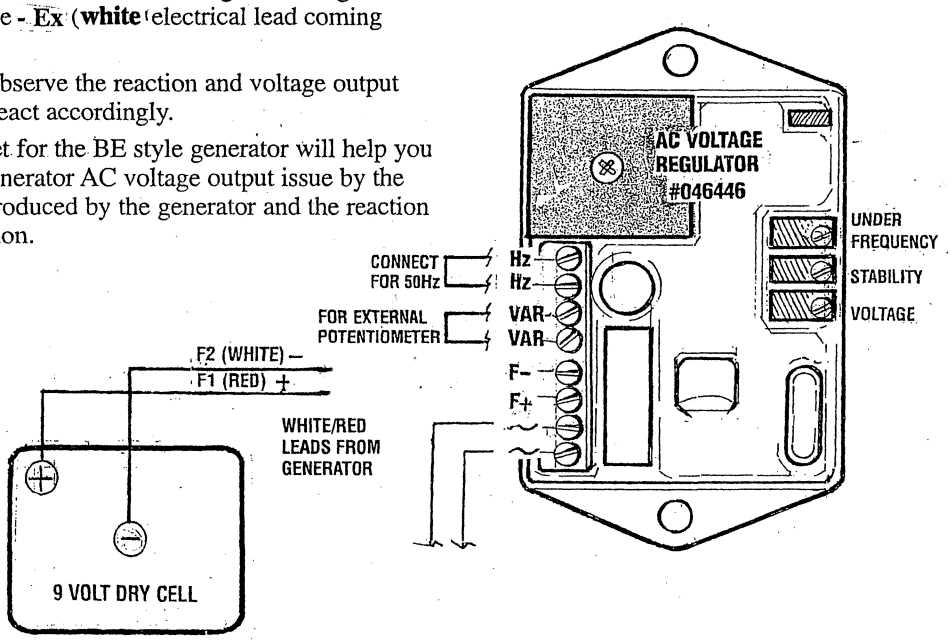
## EXCITING THE GENERATOR

Exciting the generator using an external DC source can be performed when troubleshooting a generator/AC voltage output issue.

The following procedure should be followed:

1. The generator should not be operating. Remove the **- Ex** and **+ Ex** electrical connections off the regulator.
2. Maintaining polarity. Connect the + (plus) from a 9 volt dry cell battery to the **+ Ex** (**red**) electrical lead coming from the generator and the - (negative) to the **- Ex** (**white**) electrical lead coming from the generator.
3. Start the generator and observe the reaction and voltage output from the generator and react accordingly.

The troubleshooting booklet for the BE style generator will help you determine the cause of a generator AC voltage output issue by the AC voltage found being produced by the generator and the reaction of the generation to excitation.



# BE/COLISEUM GENERATOR

## TO ACCESS THE ROTOR ASSEMBLY FOR TROUBLESHOOTING

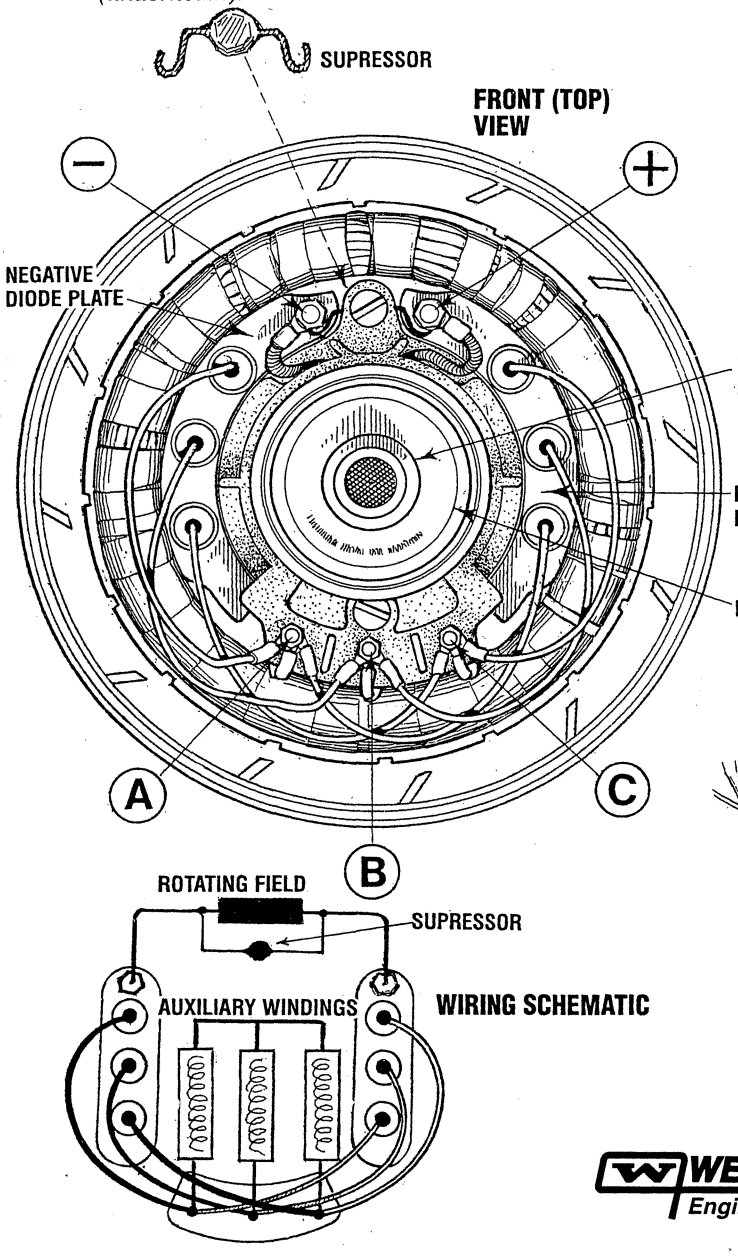
1. Remove the six (5mm) allen head screws that hold the end cover to the generator housing.
2. At the 9:00 and 3:00 O'clock position are threaded bosses. Thread a bolt (8mm - 1.5 x 50mm) into these two bosses. This will push the end cover off the housing exposing the rotor assembly.

   **When re-installing:** Place a small amount of petroleum jelly on the rotor bearing "O"-ring located in the cover boss.

   Position the cover onto the bearing and thread the six (5mm) allen head screws back in place (finger tight).

   Tighten the screws in a cris-cross manner drawing the end cover onto the bearing. When fully on, tighten the screws securely.

**NOTE:** *A transient voltage supressor is connected between the (+) and (-) terminals of the rotating field windings (underneath).*




## ROTOR TROUBLESHOOTING (Low voltage Output)

### Rotating Field Winding

1. Position the rotor as shown above with the (+) and (-) connections at 12 O'Clock.
2. Place the ohm meter leads across the (+) and (-) connections and record the ohm valve. Also check that there is no continuity between either the (+) or the (-) connections and the rotor shaft.

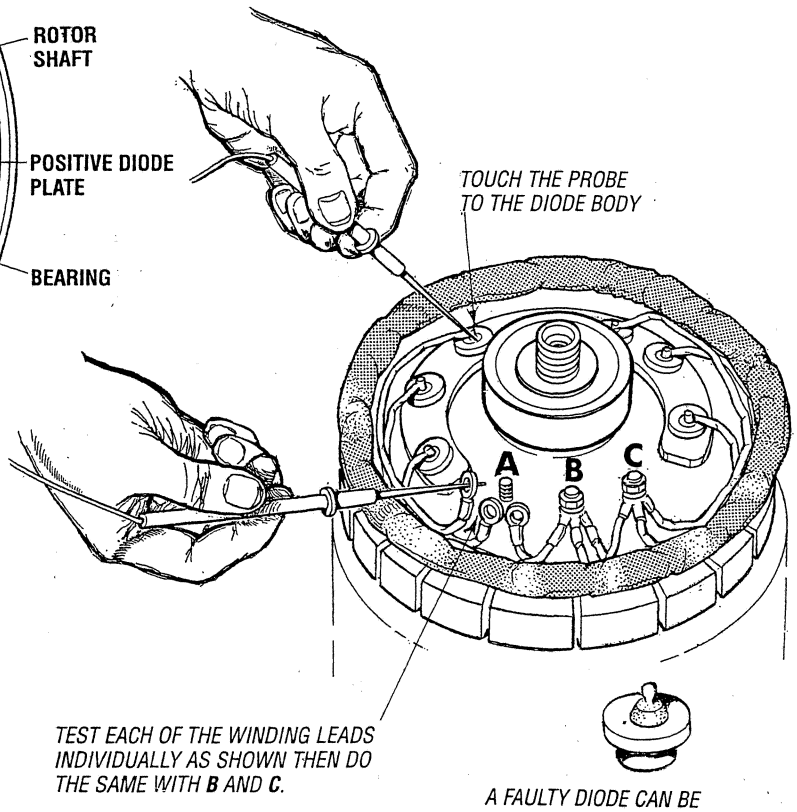
### Diodes and Auxiliary Windings

1. Test the diodes on the (+) and (-) sides by lifting the leads from the auxiliary winding studs **A**, **B**, and **C** as illustrated. Test each diode for an open or short.

   **NOTE:** *The three pairs of windings should have the same ohm values.*

2. Test the auxiliary windings in pairs. Check the ohm values between **A** and **B**, **B** and **C**, **A** and **C** and record. Check that there is no continuity between the rotor shaft and windings **A**, **B**, and **C**.

3. Test each diode individually. A resistance value should be found through the diode in one direction and, with the meter probes reversed, show no ohm value. The ohm value found for each diode should be approximately the same.



# BE/COLISEUM GENERATOR

## GENERATOR DISASSEMBLY

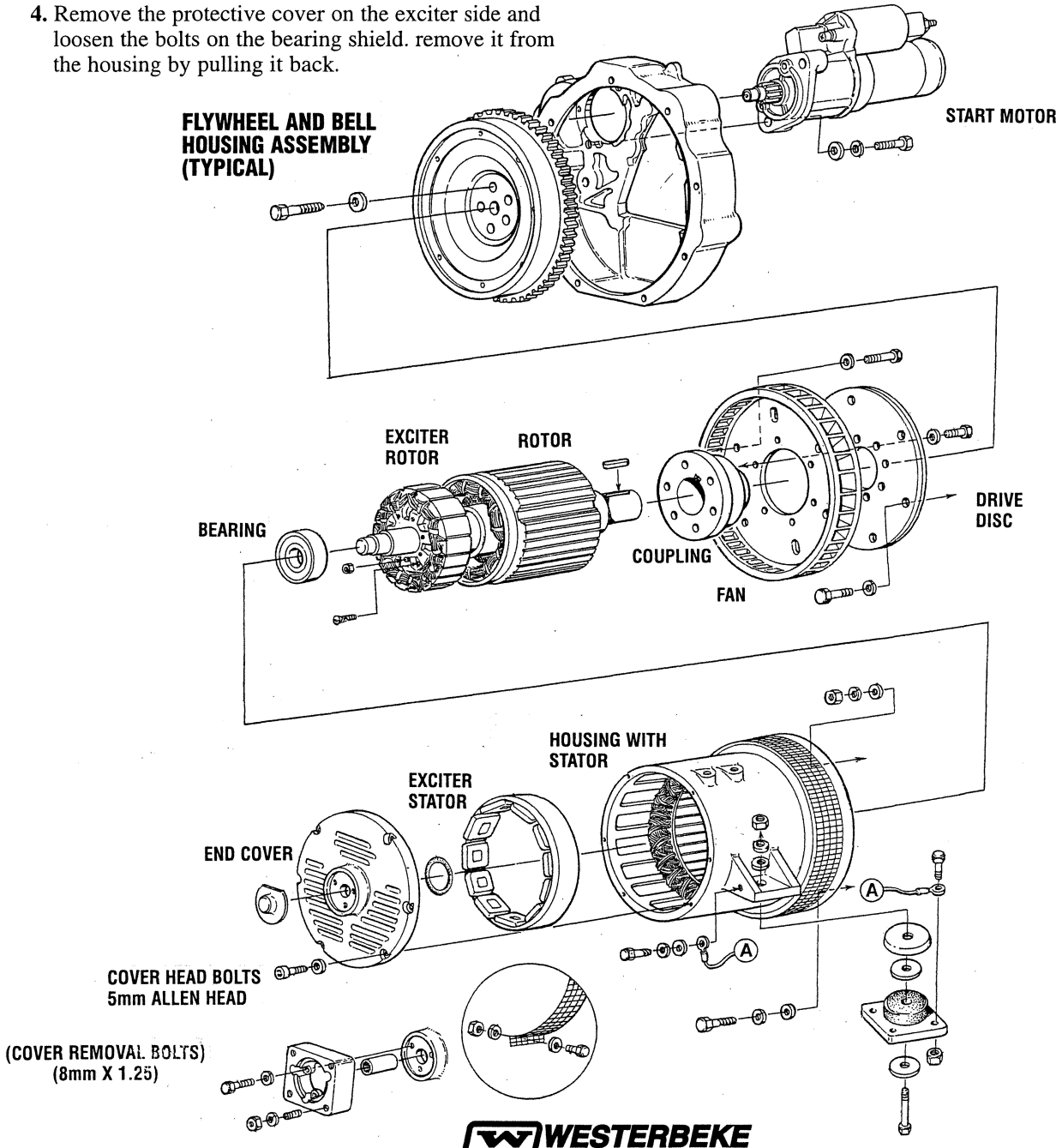
The generator layout should be studied carefully before disassembly.

1. Remove terminal box cover. Disconnect the wire leads from the generator. If necessary, disassemble the voltage regulator support (if the Automatic Voltage Regulator is mounted in the terminal box) and the box complete.
2. Disconnect the voltage regulator leads and the leads from the exciter stator **F+** and **F–** to the voltage regulator.
3. Remove the fastening bolts to the generator and disassemble the generator from the prime mover by disconnecting the adapter housing and the coupling disc from the flywheel.
4. Remove the protective cover on the exciter side and loosen the bolts on the bearing shield. remove it from the housing by pulling it back.
5. Remove the rotor horizontally through the flange end of the generator.
6. When the rotating rectifier is to be removed, the bearing should be pulled out first.

**NOTES:** *During the transport of the single bearing generator, the rotor of the generator should be fixed to the housing with the coupling disc on the flange.*

*Closed type bearings are used on this series of generators. During the dismantling, be careful not to damage the protective cover rings.*

*To prevent damage to the rotor and stator windings while removing the rotor, place cardboard between the packages and remove the rotor by pulling it out gently.*

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