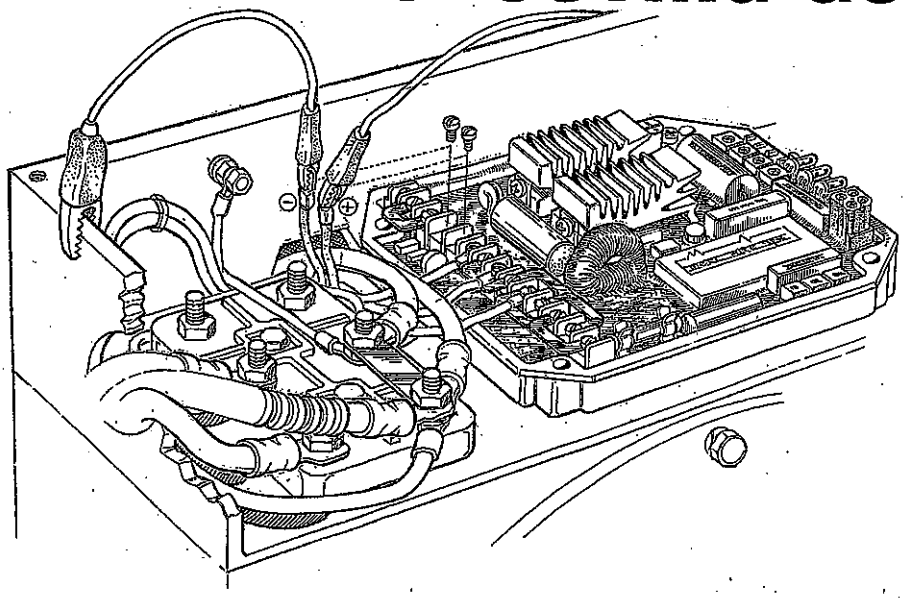
BE GENERATORS

ELECTRICAL TESTING AND TROUBLESHOOTING GUIDE



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WESTERBEKE

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INTRODUCTION

The technical data in this manual is provided for the testing and troubleshooting of WESTERBEKE BE model generators. Only qualified technicians with the proper test equipment and a thorough knowledge of electricity should under take these procedures.

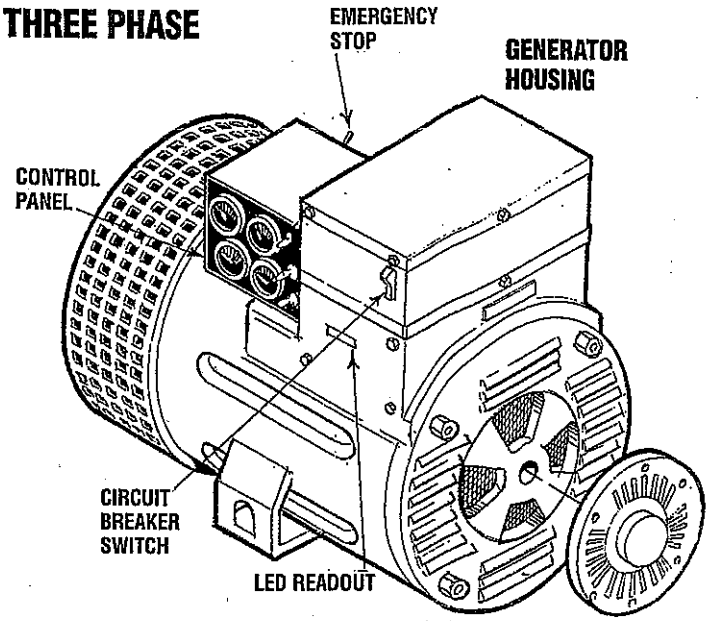
A separate troubleshooting manual is available from your WESTERBEKE dealer for BE "Coliseum" model generators.

TABLE OF CONTENTS

THE BE GENERATOR
SINGLE AND THREE PHASE

DESCRIPTION

This generator is a four-pole, brushless, self-excited generator which requires only the driving force of the engine to produce AC output. The copper and laminated iron in the exciter stator are responsible for the self-exciting feature of this generator. The magnetic field produced causes an AC voltage to be induced into the related exciter rotor windings during rotation. Diodes located in the exciter rotor rectify this voltage to DC and supply it to the windings of the rotating field. This creates an electromagnetic field which rotates through the windings of the main stator, inducing an AC voltage which is supplied to a load. An AC voltage is produced in the auxiliary windings of the main stator and is, in turn, supplied to a voltage regulator. The regulator produces a DC voltage to further excite the exciter stator windings, enabling the generator to produce a rated AC output. The voltage regulator senses AC voltage output and adjusts DC excitation to the exciter stator winding according to amperage load the generator is furnishing to maintain a constant voltage output.



45KW, 55KW, 65KW AND 95KW BE GENERATORS

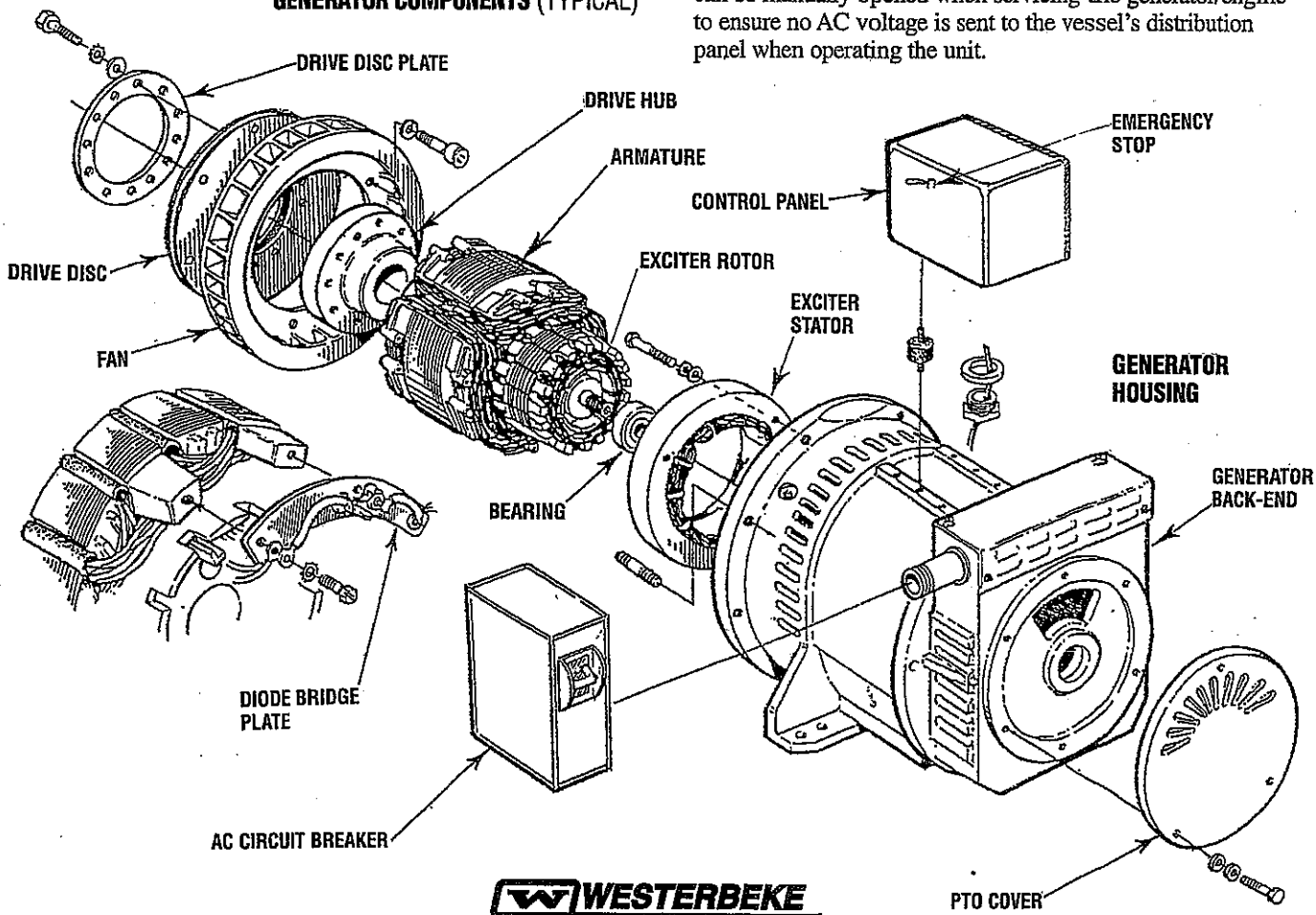
PARALLEL OPERATION

Two or more of these generators may be run in parallel by simply adding a parallel device. The parallel device is added to the electrical terminal box to ensure equal output of generator voltage. Contact your WESTERBEKE dealer or the WESTERBEKE factory for information on parallel operation,

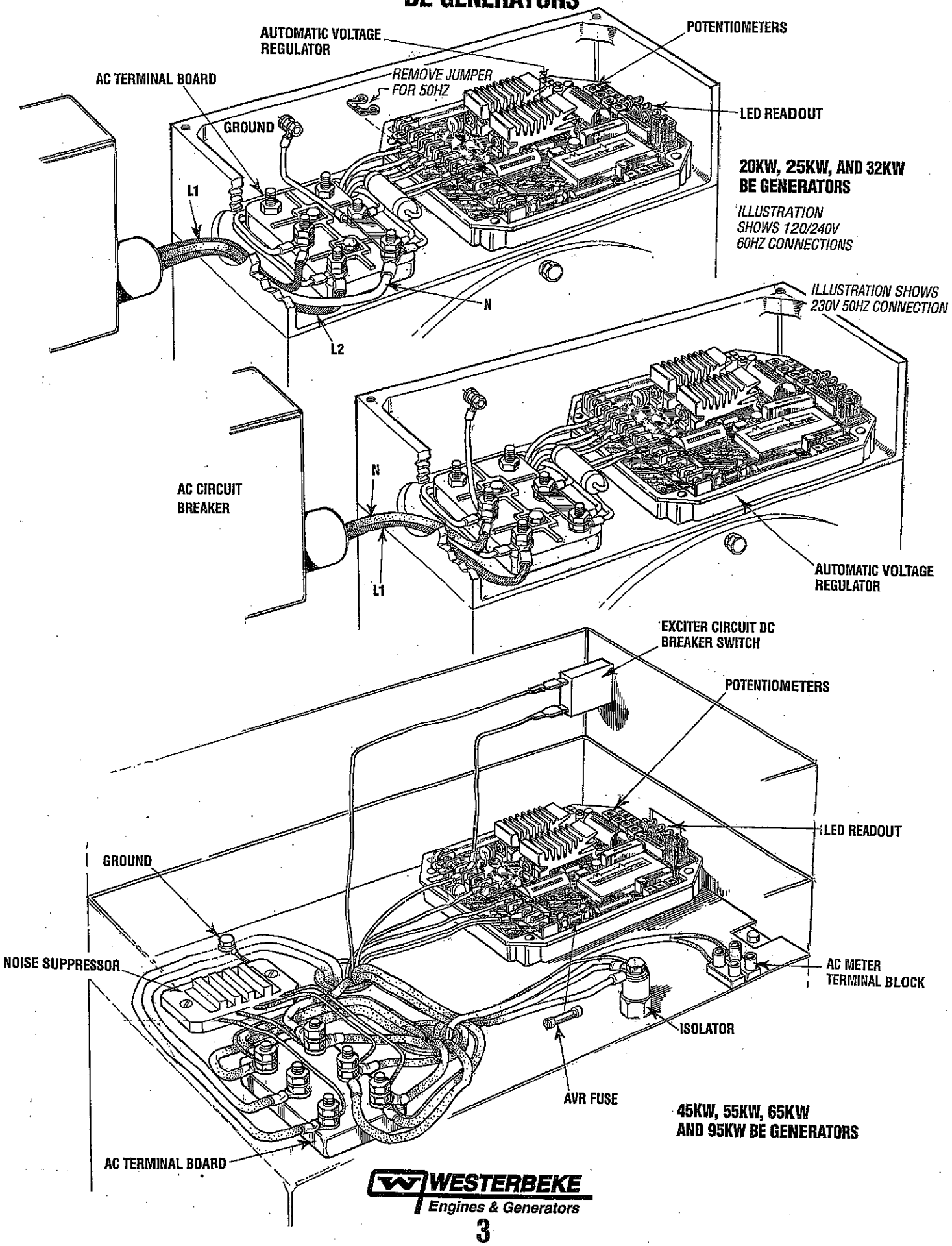
AC CIRCUIT BREAKER

An AC circuit breaker is installed on all single phase generators. This AC circuit breaker will automatically disconnect the generators output from the vessel's AC load in the event of an amperage overload. In the event of an AC breaker tripping, it must be manually reset. The AC breaker can be manually opened when servicing the generator/engine to ensure no AC voltage is sent to the vessel's distribution panel when operating the unit.

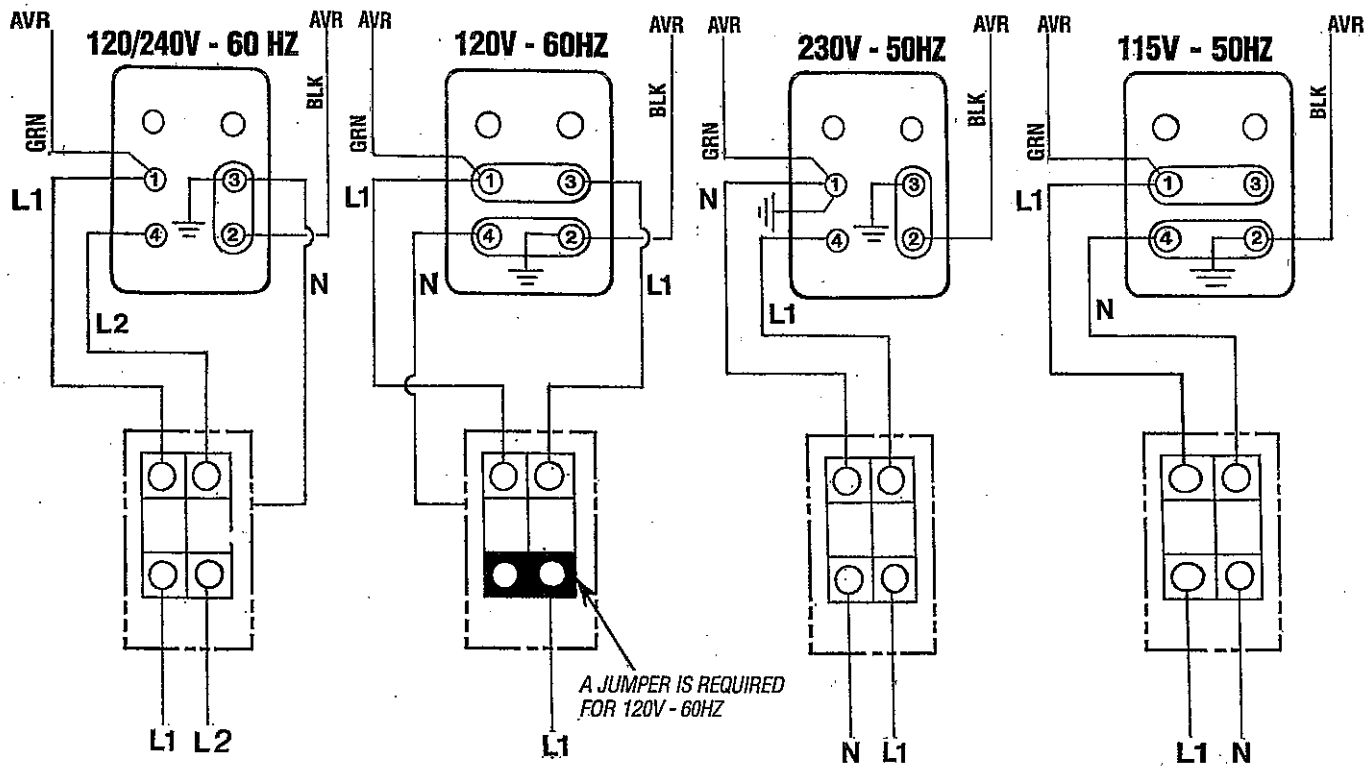
GENERATOR COMPONENTS (TYPICAL)



AVR / AC TERMINAL BOARD CONNECTIONS
BE GENERATORS



GENERATOR AC VOLTAGE CONNECTIONS
BE SINGLE PHASE



AC VOLTAGE CONNECTIONS

The frame ground wire (white/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 wire is white or white with a green strip. It connects between the neutral stud and the generator frame.

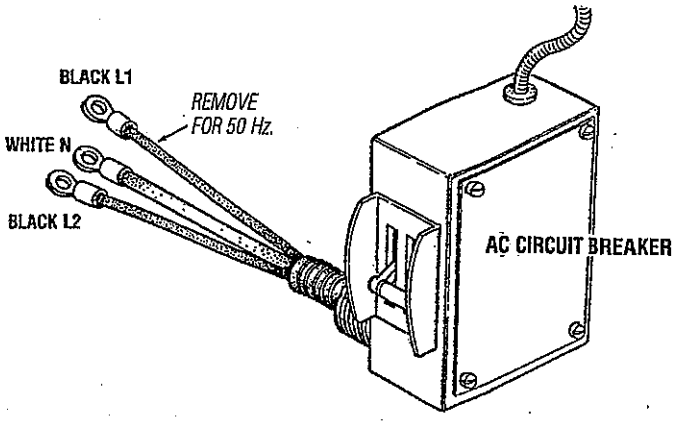
GENERATOR FREQUENCY

Frequency is a direct result of engine/generator speed: 1800 rpm = 60 hertz; 1500 rmp = 50 hertz.

NOTE: *The white/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. The unit must be properly grounded to comply with safety concerns.*

AC CIRCUIT BREAKER

An AC circuit breaker is installed on all single phase generators. This AC circuit breaker will automatically disconnect the generators output from the vessel's AC load in the event of an amperage overload. In the event of an AC breaker tripping, it must be manually reset. The AC breaker can be manually opened when servicing the generator/engine to ensure no AC voltage is sent to the vessel's distribution panel when operating the unit.



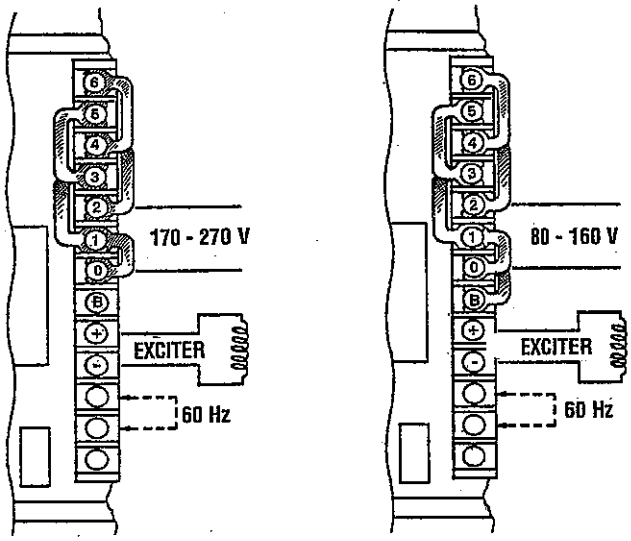
NOTE: *The DC exciter circuit breaker protects the three phase models from amperage overload or from an AC short circuit*

GENERATOR AC VOLTAGE CONNECTIONS
BE THREE PHASE

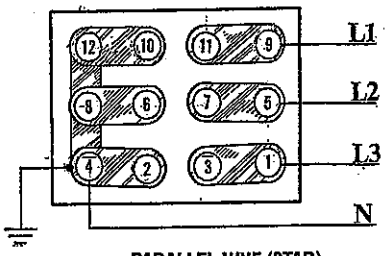
VOLTAGE REGULATORS
THREE PHASE CONNECTIONS

The regulator is equipped with seven numbered terminals (0 to 6) and their related brass jumpers. The illustrations shown connection points and jumpers for the 3 phase configuration of the generator. The sensing leads connect between pin #1 and pin #2 on the AC terminal block and connection #2 and #0 on the voltage regulator board.

NOTE: Either SERIES configuration requires the installation of a jumper between terminals B and O.

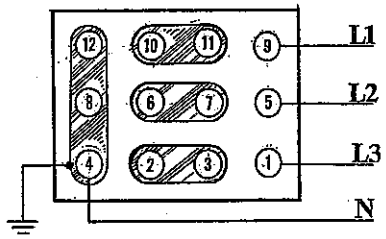


AC TERMINAL CONNECTIONS
THREE PHASE 12 WIRE



PARALLEL WYE (STAR)

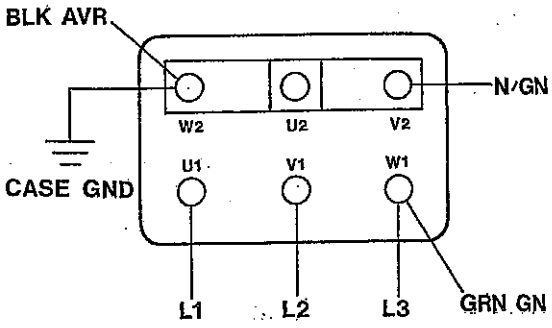
L -N - 120 VAC 1Ø 60 HZ L -L - 208 VAC 3Ø 50 HZ
L -N - 110 VAC 1Ø 60 HZ L -L - 190 VAC 3Ø 50 HZ

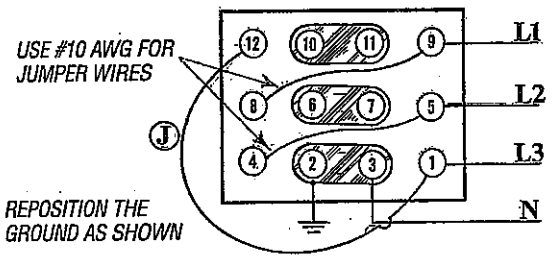


SERIES WYE (STAR)

L -L - 450 VAC 3Ø 60 HZ L -L - 380 VAC 3Ø 50 HZ
L -N - 265 VAC 1Ø 60 HZ L -N - 230 VAC 1Ø 50 HZ

AC TERMINAL CONNECTIONS
THREE PHASE 6 WIRE





SERIES DELTA

L -L - 240 VAC 3Ø 60 HZ L -L - 230 VAC 3Ø 50 HZ
L2, L3 -N - 110 VAC 1Ø 60 HZ L2, L3 -N - 115 VAC 1Ø 50 HZ

GENERATOR AV VOLTAGE CONNECTIONS
BE THREE PHASE 6 STUD / 12 WIRE TERMINAL BOARDS

NOTE: *For output leads from the AC terminal block use terminal ends for 1/4" studs that accept multi-strand copper wire sized for the average rating from the hot lead*

AC VOLTAGE CONNECTIONS

The frame ground wire (white/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 wire is white or white with a green strip. It connects between the neutral stud and the generator frame.

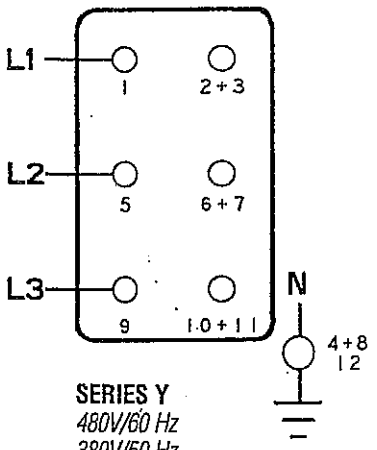
GENERATOR FREQUENCY

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

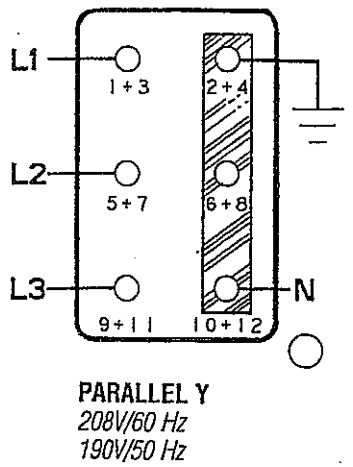
NOTE: *The white/green ground wire may be removed in those installations where the AC circuit has a separate neutral and ground circuit. This will prevent the unit from being a ground source in the vessel. The generator must be properly grounded to meet safety concerns.*

When changing from 50 Hz to 60 Hz the generator power and nominal voltage will increase by 20% but the current does not change from the 50Hz value. Should voltage stay at 50Hz, then the output power may increase by 5% due to improved ventilation. This is accomplished by resetting the AVR potentiometer. Changing from 60Hz to 50Hz, the voltage and power values must decrease by 20% of the 60 Hz value.

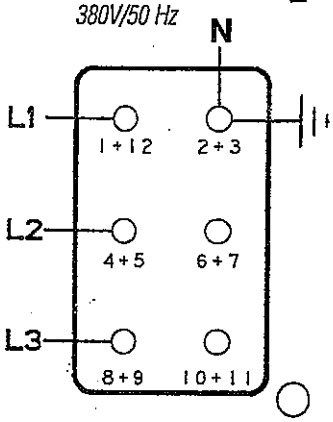
⚠ CAUTION: ***When connecting terminals or performing electrical testing make certain the generator is shut down, switches are off and the unit is at room temperature.***



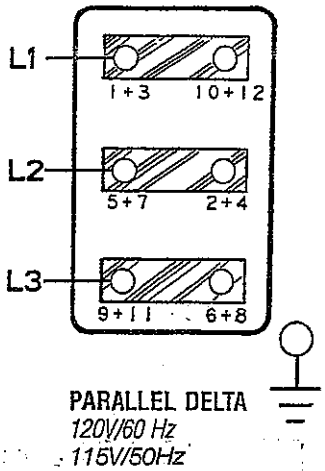
SERIES Y
480V/60 Hz
380V/50 Hz



PARALLEL Y
208V/60 Hz
190V/50 Hz

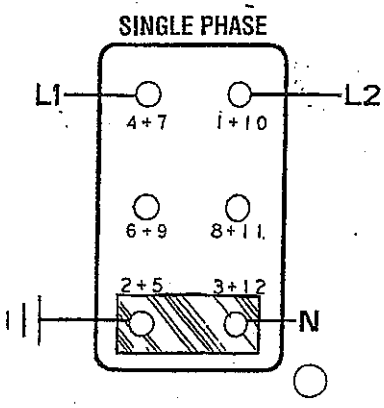


SERIES DELTA
240V/60 Hz
220V/50 Hz



PARALLEL DELTA
120V/60 Hz
115V/50Hz

NOTE: *IF WIRING FOR 50 Hz, THE 60 Hz JUMPER MUST BE REMOVED FROM THE REGULATOR.*

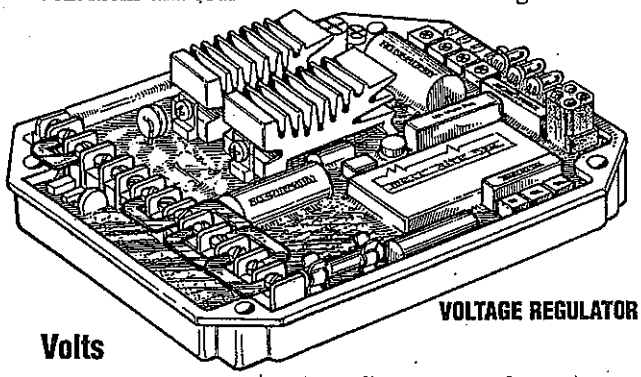


DOUBLE DELTA
120-240V/60 Hz
115-230V/50Hz

VOLTAGE REGULATOR ADJUSTMENTS

Description

The voltage regulator is an advanced design which ensures optimum AC generator performance. It is equipped with complete protection circuitry to guard against operating conditions that could be detrimental to the AC generator.



VOLTAGE REGULATOR

Volts

This potentiometer is used to adjust output voltage. At proper engine operating speed the output voltage should be held at ±1% from a no-load condition to a full rated generator output and from power factor 1.0 - 0.8 with engine drive speed variations up to -6%.

Prior to starting the engine, turn the VOLT and STAB trimmers (using a mini phillips screwdriver) fully in a counter clockwise (Minimum) direction until you feel them hit their stops.

Turn the AMP and HERTZ trimmers completely clockwise (Maximum) in the same manner.

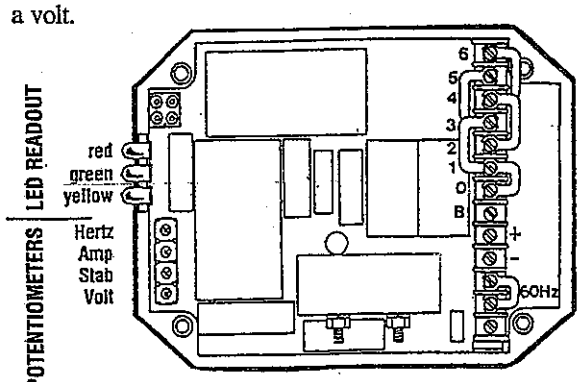
With the generator running at no-load, at normal speed, and with VOLT adjust at minimum, it is possible that output voltage will oscillate. Slowly rotate the VOLT adjust clockwise. The voltage output of the generator will increase and stabilize. Increase the voltage to the desired value. In this situation, only the green LED will stay lit.

Stability

This potentiometer permits variation of the regulator's response to generator load changes so as to limit overcompensation and obtain a minimum recovery time to the normal voltage output.

In order to adjust the regulator stability the generator must be running at no-load and the output must be monitored.

Turn the STAB adjust slowly clockwise until the voltage starts to fluctuate. At this point rotate the STAB adjust counterclockwise until the voltage is stable within 1 or 2 tenths of a volt.



VOLTAGE REGULATOR DIAGRAM

Amp-Hertz

These two adjustments are used in conjunction with the two protection circuits in the voltage regulator that are indicated by the illumination of a colored LED lights.

1. Delayed overload protection (yellow LED).
2. Low speed protection (red LED).

Both systems have an intervention threshold which can be adjusted using the respective potentiometer. Each of the two circuits are able to cause an adequate reduction in excitor voltage to safeguard the excitor windings and prevent their overheating.

The overload protection system has a delay which permits temporary overloading of the generator during times such as motor start-up or other similar load surge demands. The regulator also has a third LED (green), that glows during generator operation to indicate correct operation of the regulator with the generator.

Setting the Overload Protection

In order to set the AMP overload protection, the generator must be loaded to its full output rating.

1. Load the alternator to its rating, then decrease the speed of the engine by 10.10% (54 Hertz on 60 hertz units, 45 hertz on 50 hertz units).
2. Rotate the AMP adjustment counterclockwise until it hits its stop. Wait about 15-20 seconds after which the AC output of the generator should drop and the yellow LED light should come on.
3. Slowly rotate the AMP adjustment clockwise until the output voltage increases to approximately 97% of the voltage output at the start of the adjustment.
4. Return the generator to 50/60 hertz operating speed. The yellow LED light will go off and the normal green LED light will come on. AC output voltage should be normal. If this does not happen, repeat adjustments 1-4.

NOTE: *When changing from 60 hertz to 50 hertz operation, remove the 60 hertz jumper bar from the regulator board.*

Setting the Underspeed Protection

NOTE: *If the unit is operating at 60 Hertz ensure that the jumper strap is in place on the regulator board between the two 60 Hertz terminals. In order to adjust the underspeed setting, the alternator should be running at no-load.*

1. To adjust the underspeed (low frequency) protection circuit, lower the engine speed at 90% of its normal running speed (54 hertz on 60 hertz units, 45 hertz on 50 hertz units.
2. Rotate the Hertz adjustment counterclockwise slowly until the generator's AC output voltage starts to decrease and at the same time the red "LED" light comes on.
3. Increase the engine speed to its normal speed 50/60 Hz. The red LED light will go out and the AC output voltage will return to normal and the green LED light will come on.

With the above adjustments made, the regulator should function normally.

BE TROUBLESHOOTING CHART

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

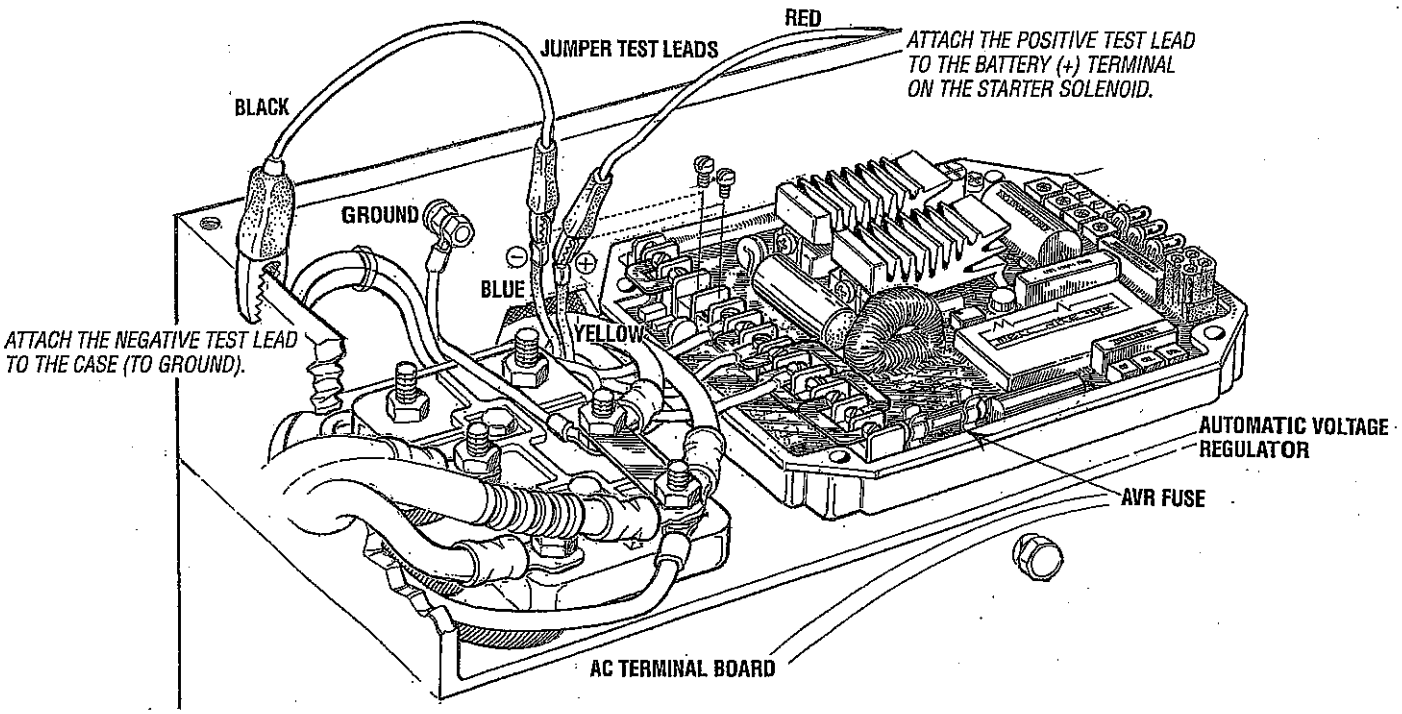
FAULT	PROBABLE CAUSE	
NO AC VOLTAGE OUTPUT AT NO LOAD.	1. Short or open in the main stator winding. 2. Shorted pozi-resistor on exciter rotor. 3. Four or more shorted or *open diodes on exciter rotor.	4. Open in exciter stator winding. 5. Open in rotating field winding.
RESIDUAL VOLTAGE PRODUCED AT NO LOAD 15 - 20 VOLTS AC.	1. Blown 6 AMP fuse auxiliary circuit feed to AVR. 2. Faulty voltage regulator 3. Shorted or open main stator auxiliary winding.	4. AC circuit breaker tripped. 5. DC exciter breaker open. (Century Series)
LOW AC VOLTAGE OUTPUT AT NO LOAD 60 - 100 VAC.	1. Reset voltage potentiometer. 2. Open or shorted diodes in. exciter rotor 1 to 3 diodes. 3. Open or short in one of the three exciter rotor windings.	4. Faulty voltage regulator. 5. Short in rotating field winding. 6. Short in the exciter stator.
HIGH AC OUTPUT VOLTAGE 150 VAC OR HIGHER.	1. Reset voltage potentiometer. 2. Faulty voltage regulator.	
UNSTABLE VOLTAGE OUTPUT. (ENGINE SPEED STEADY)	1. STB pod on regulator needs adjustment.	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.	

WINDING RESISTANCE VALUES *(IN OHMS)*

SINGLE PHASE		20 & 25 KW	32KW
EXCITER STATOR		18.06	18.20
EXCITER ROTOR	A-B	0.68	0.72
	B-C	0.68	0.72
ROTATING FIELD		1.75	2.01
MAIN STATOR	1-2	0.05	0.05
	3-4	0.05	0.05
AUXILLARY WINDING		1.19	0.98

THREE PHASE		20 & 25 KW	32KW	45KW	55KW	65KW	95KW
EXCITER STATOR		18.20	18.20	15.26	15.26	15.26	15.26
EXCITER ROTOR	A-B	0.7	0.7	0.39	0.39	0.39	0.39
	B-C	0.7	0.7	0.39	0.39	0.39	0.39
ROTATING FIELD		2.01	2.01	1.77	1.96	2.22	2.65
MAIN STATOR *(EACH WINDING)*		0.06	0.06	0.09	0.06	0.04	0.03
AUXILLARY WINDING		1.19	0.98	0.98	0.98	0.98	0.98

BE GENERATOR TROUBLESHOOTING
TESTING VOLTAGE

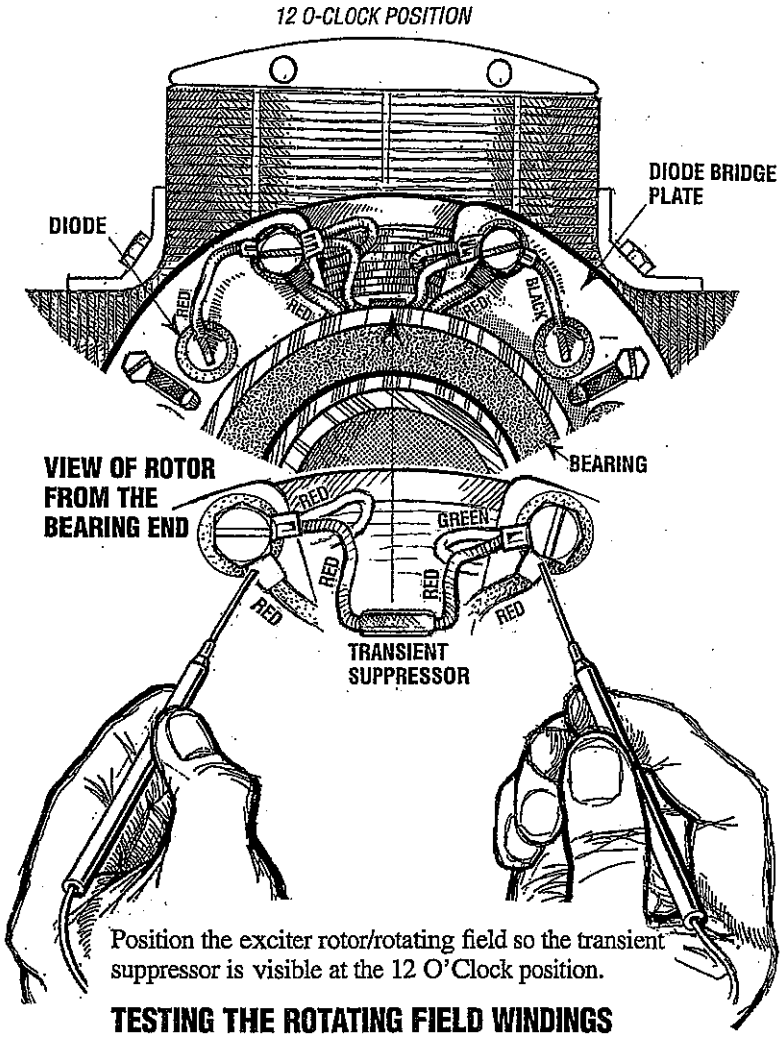


TO EXCITE THE BE GENERATOR

1. Lift the (DC+) yellow wire and the (DC-) blue wire off the regulator. Attach the test leads to these wires as shown: black to the blue wire, red to the yellow wire.
2. Connect the red test lead (+) to the battery voltage (12VDC) at the battery cable connection on the adjacent starter motor solenoid.
3. Open the generator's AC breaker. start the generator and observe the AC output voltage between the line and neutral (residual 15-20VAC).
4. Connect the black test lead (-) to the metal case (ground) of the generator. This will now put a 12VDC circuit through the exciter stator of the generator.
5. Normal output AC voltage should be 140 - 150 volts AC. This indicates that the exciter stator, exciter rotor, main rotor and main stator windings are all ok.
6. Monitor the auxiliary circuit voltage into the regulator, correct voltage should be 220 - 230 VAC indicating this circuit is ok.

BE GENERATOR TROUBLESHOOTING

LOW VOLTAGE - EXCITER ROTOR AND ROTATING FIELD



Position the exciter rotor/rotating field so the transient suppressor is visible at the 12 O'Clock position.

TESTING THE ROTATING FIELD WINDINGS

Place the ohm meter probes on the two large red wires (+) and (-). These are the connecting wires for the rotating field windings.

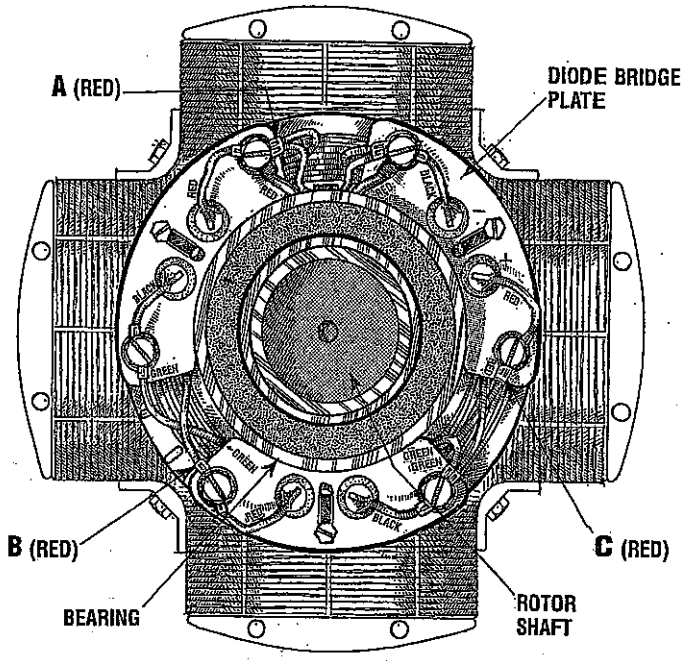
These wires do not need to be lifted off their connections unless, when testing, there is an ohm valve discrepancy or a continuity to ground (the rotor shaft).

If this occurs, lift these two large field wires off the diode plates, isolate them, and repeat the above test.

NOTE: *When removing these wires, be careful not to drop the screws or washers into the rotor.*

TESTING THE EXCITER ROTOR WINDINGS

These windings are tested in pairs: **A** to **B**, **B** to **C**, and **C** to **A** as shown on the drawing.



EXCITER ROTOR WINDINGS

Disconnect these three wires from the diode bridge plates taking care not to drop any screws or washers.

With the wires clear from the bridge plates, test each pair with an ohm meter, **A** to **B**, **B** to **C**, and **C** to **A.**

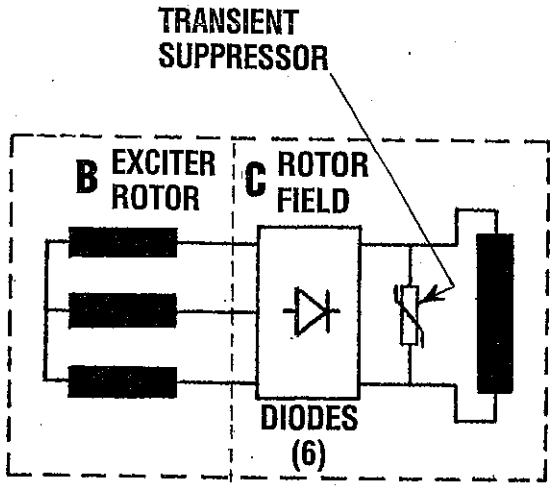
No continuity should be found between the rotor and any of these three winding parts.

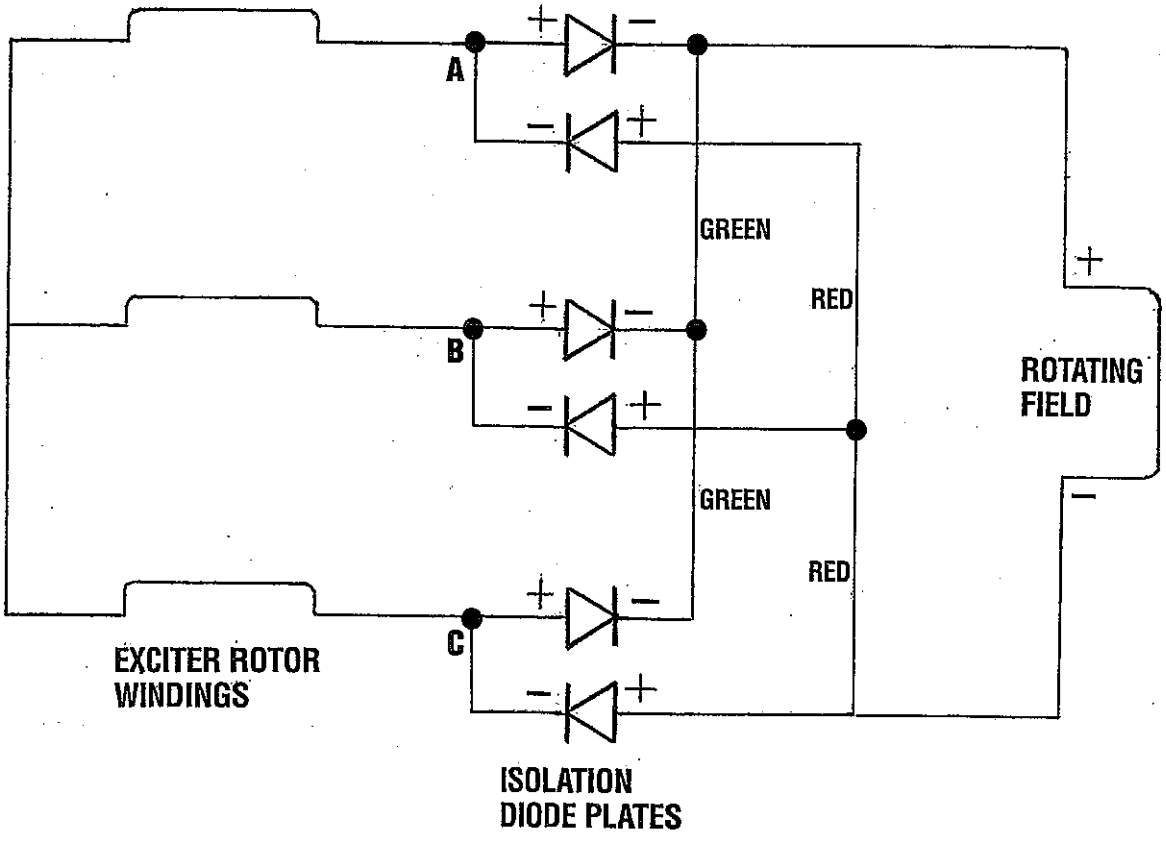
TESTING THE DIODES

Diodes can be checked with an ohmmeter. Disconnect the wire of the particular diode and test its resistance in both directions. A perfectly functioning diode will show a very high resistance in one direction and a very low resistance in the opposite direction. A faulty diode will show either a very low resistance, or an infinite resistance in both directions.

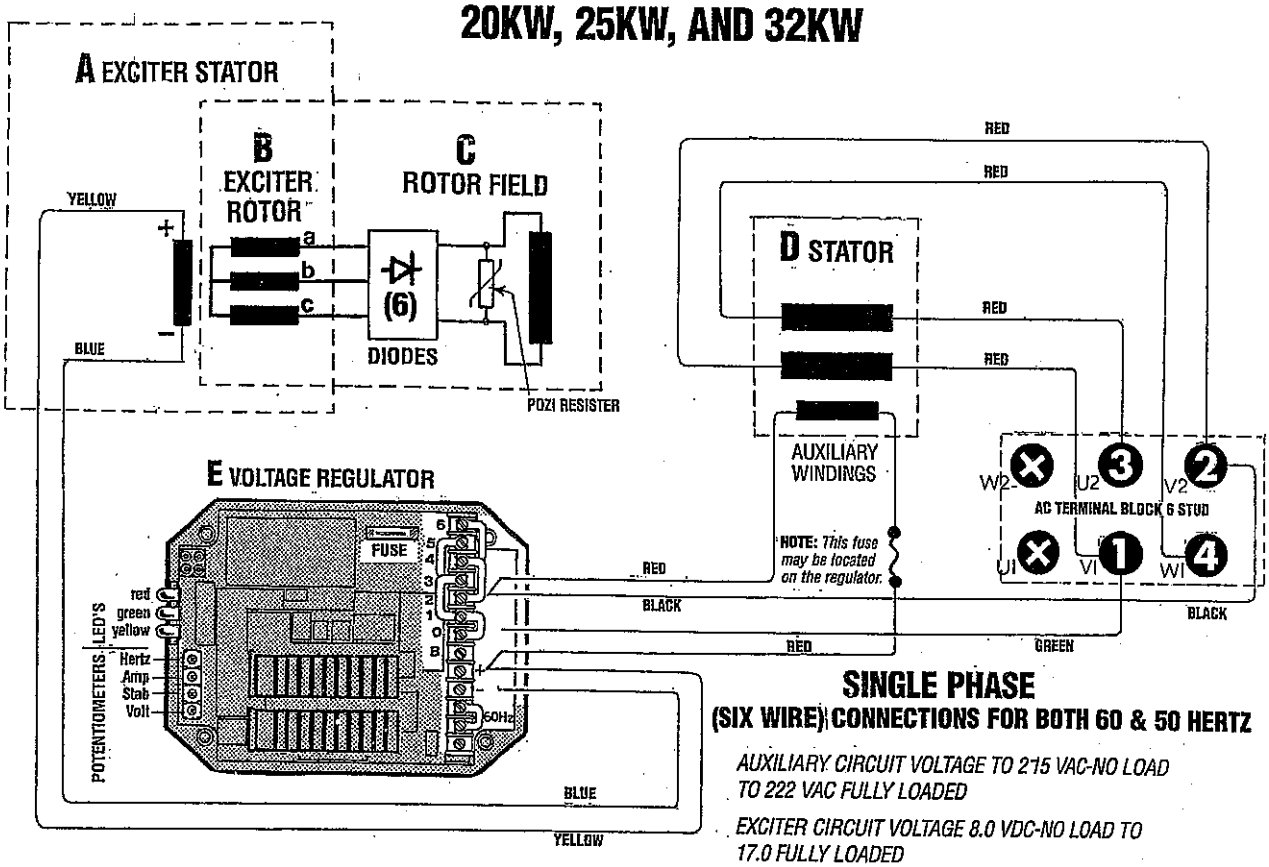
Should the whole bridge be replaced, remember to tighten the screws with a suitable wrench and strictly comply with the polarities and internal wiring diagrams in this manual.

INTERNAL WIRING SCHEMATICS BE GENERATORS
EXCITER ROTOR / ROTATING FIELD





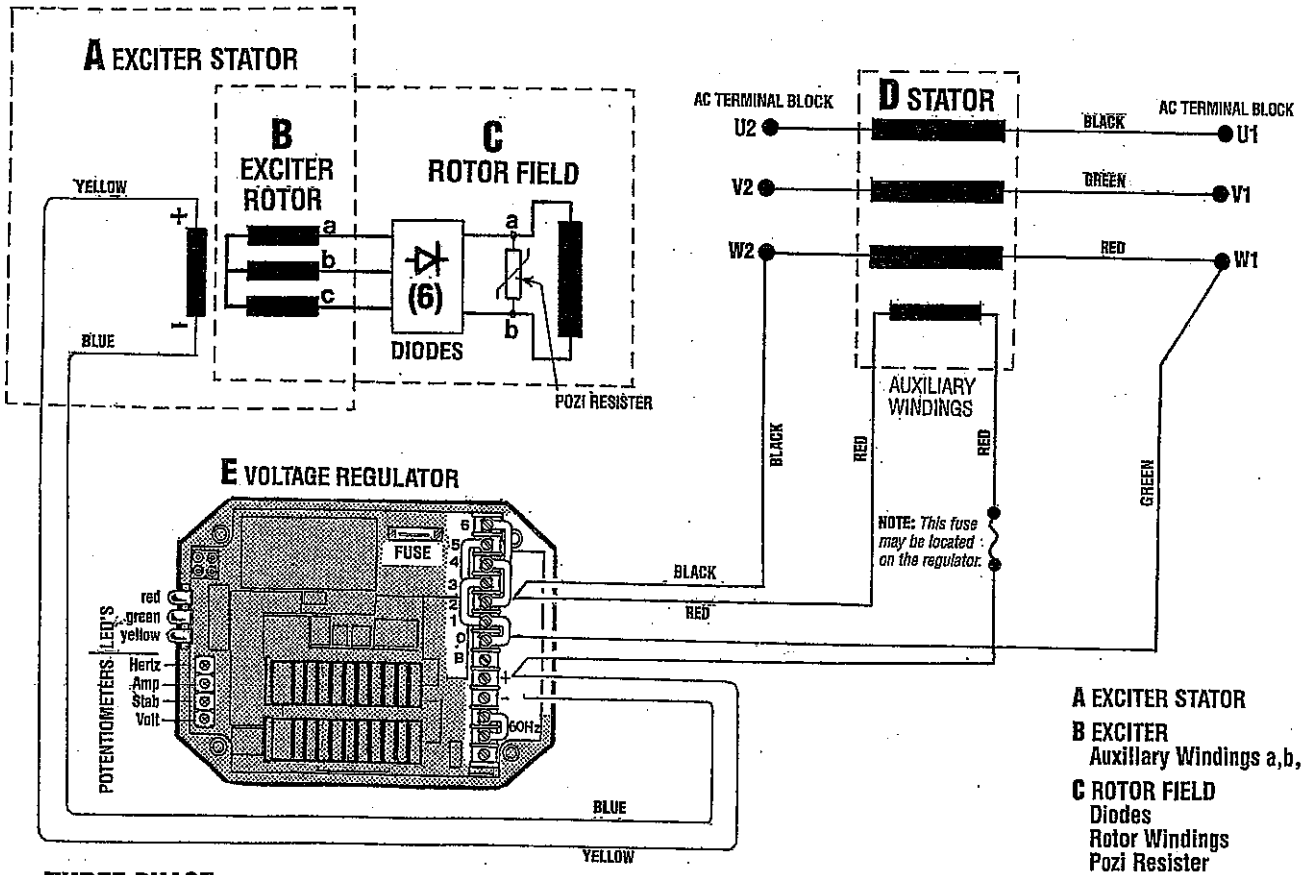
INTERNAL WIRING SCHEMATICS BE GENERATORS
20KW, 25KW, AND 32KW



SINGLE PHASE
(SIX WIRE) CONNECTIONS FOR BOTH 60 & 50 HERTZ

AUXILIARY CIRCUIT VOLTAGE TO 215 VAC-NO LOAD TO 222 VAC FULLY LOADED

EXCITER CIRCUIT VOLTAGE 8.0 VDC-NO LOAD TO 17.0 FULLY LOADED



THREE PHASE

BE THREE PHASE (SIX WIRE) CONNECTIONS FOR 60Hz AND 50 Hz

A EXCITER STATOR

B EXCITER
Auxillary Windings a,b,c

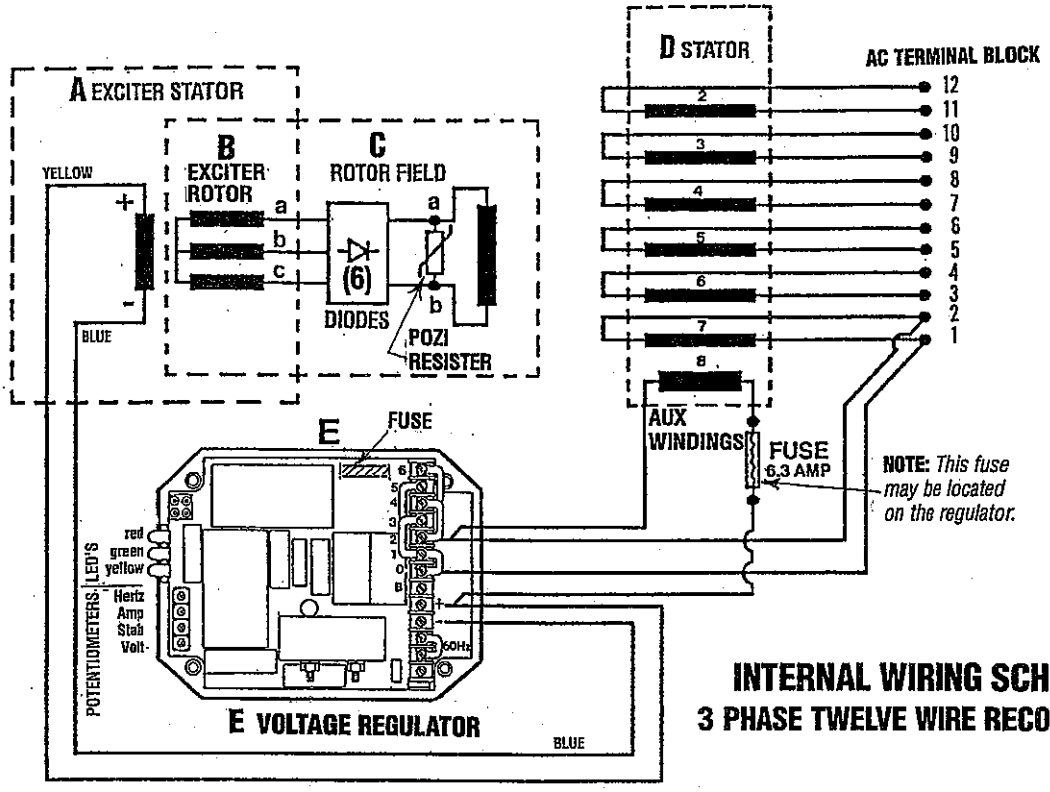
C ROTOR FIELD
Diodes
Rotor Windings
Pozi Resister

D MAIN STATOR
Stator Windings
Auxillary Windings-AC to Regulator
AC Terminal Board

E VOLTAGE REGULATOR

WESTERBEKE
Engines & Generators

INTERNAL WIRING SCHEMATIC
20KW, 25KW, AND 32KW



INTERNAL WIRING SCHEMATIC
3 PHASE TWELVE WIRE RECONNECTABLE

A EXCITER STATOR

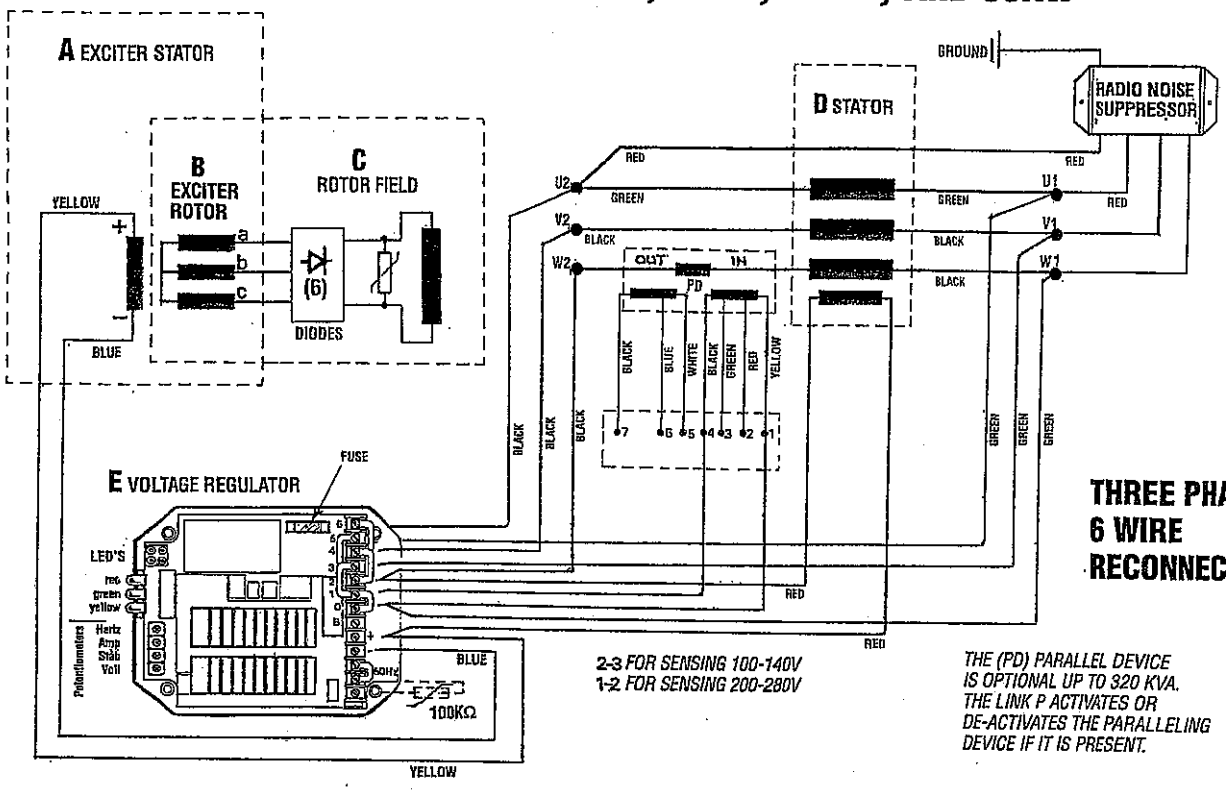
B EXCITER ROTOR
Windings a,b,c

C ROTOR FIELD
Diodes
Rotor Windings
Pozi Resister

D MAIN STATOR
Stator Windings
Auxillary Windings-AC to Regulator
AC Terminal Board

E VOLTAGE REGULATOR

INTERNAL WIRING SCHEMATICS BE GENERATORS
CENTURY MODELS - 45KW, 55KW, 65KW, AND 95KW



THREE PHASE
6 WIRE
RECONNECTABLE

2-3 FOR SENSING 100-140V
1-2 FOR SENSING 200-280V

THE (PD) PARALLEL DEVICE IS OPTIONAL UP TO 320 KVA. THE LINK P ACTIVATES OR DE-ACTIVATES THE PARALLELING DEVICE IF IT IS PRESENT.

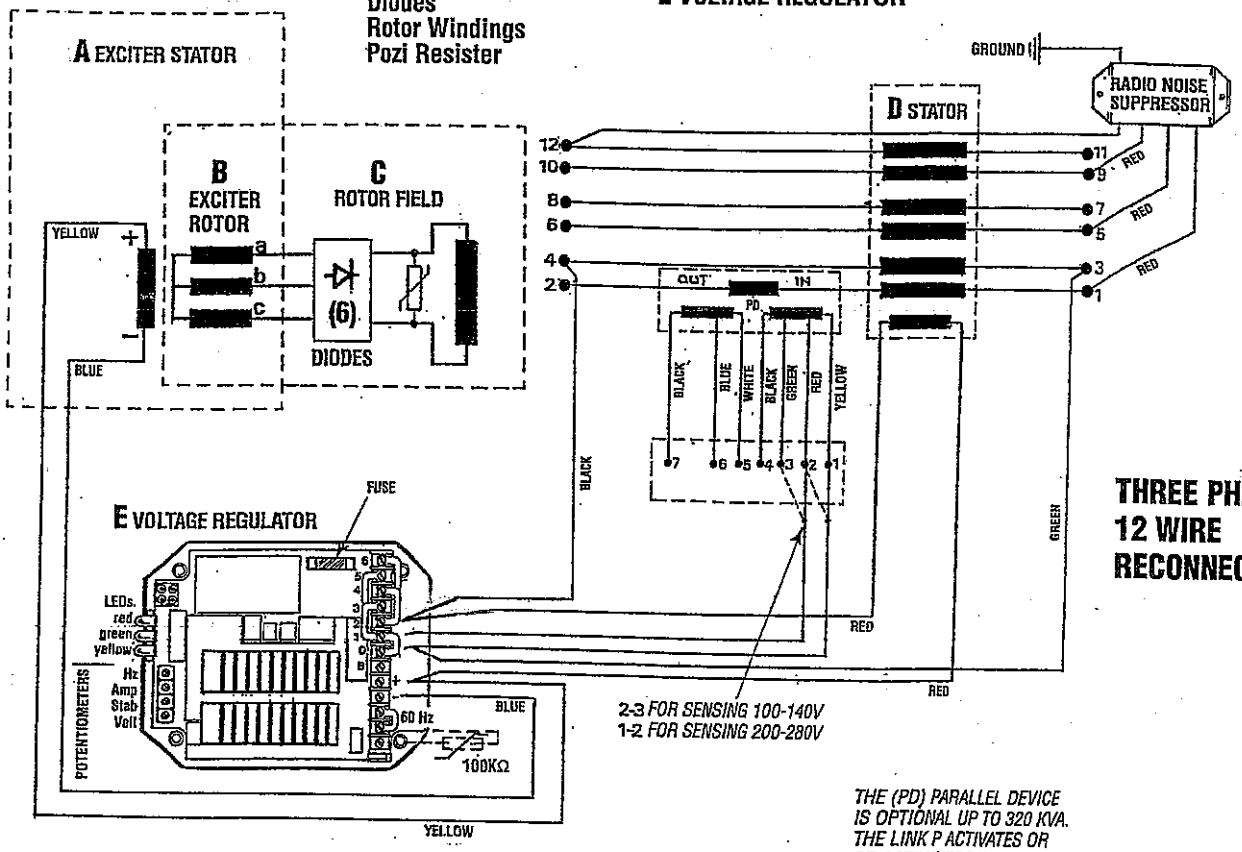
A EXCITER STATOR

B EXCITER ROTOR
Windings a,b,c

C ROTOR FIELD
Diodes
Rotor Windings
Pozi Resister

D MAIN STATOR
Stator Windings
Auxillary Windings-AC to Regulator
AC Terminal Board

E VOLTAGE REGULATOR



THREE PHASE
12 WIRE
RECONNECTABLE

2-3 FOR SENSING 100-140V
1-2 FOR SENSING 200-280V

THE (PD) PARALLEL DEVICE IS OPTIONAL UP TO 320 KVA. THE LINK P ACTIVATES OR DE-ACTIVATES THE PARALLELING DEVICE IF IT IS PRESENT.

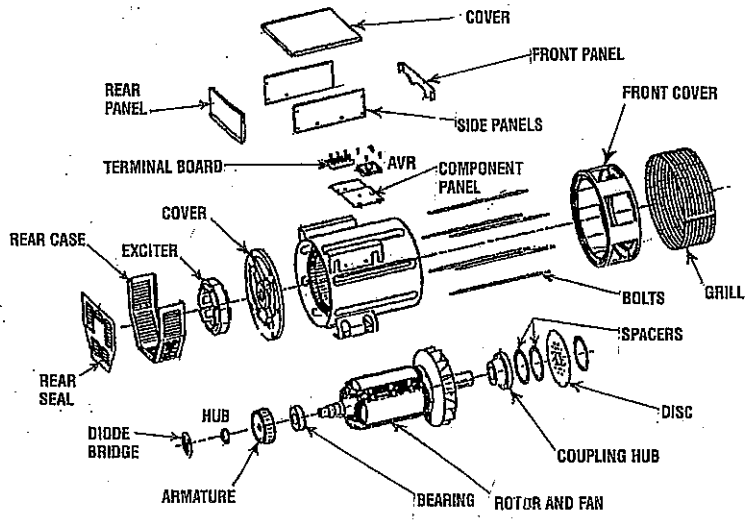
GENERATOR MAINTENANCE
45KW, 55KW, 65KW, 95KW BE

> **⚠ WARNING:** ***Prior to performing any maintenance, make certain that the generator is shutdown, switches are off and the unit is at room temperature.***

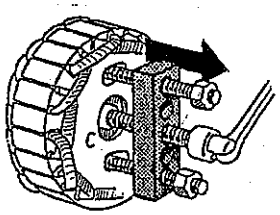
DISASSEMBLY

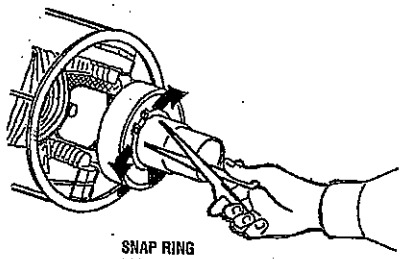
If it becomes necessary to disassemble the stator/rotor assembly, use the following text as a guide.

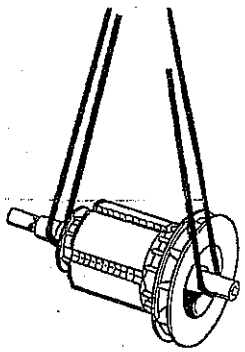
1. Insert a suitable puller (which can be easily made) and remove the exciter.
2. Extract the rotor using a hoist with soft ropes of sufficient strength. carefully remove the rotor and place it on a prepared work area. It may be necessary to remove the front cover to extract the rotor due to the diameter of the fan.

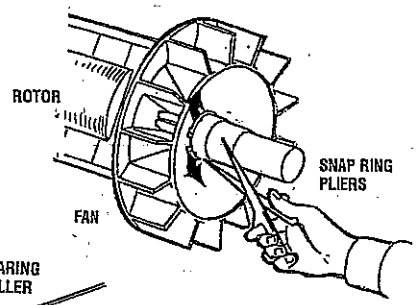


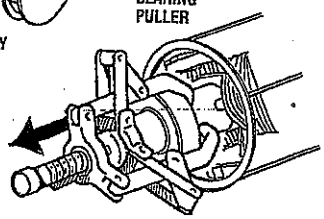
3. Remove the seager rings with snap ring pliers.
4. Remove the bearings with a proper bearing puller.





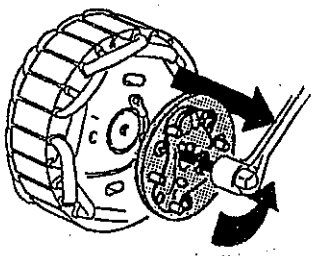


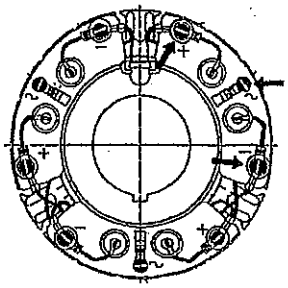




Rotation Diode Bridge

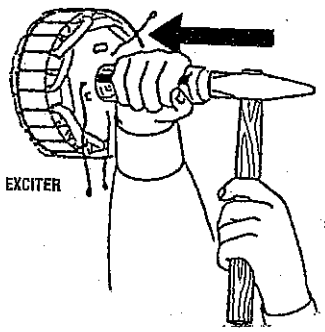
1. Disconnect the five wires of the rotating diode bridge.
2. Remove the blocking bolt and pulling gently, remove the diode bridge.

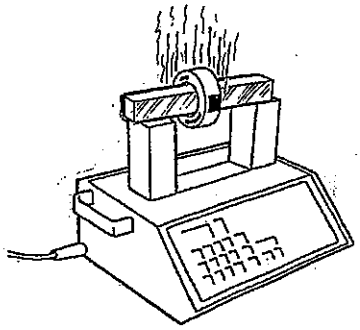




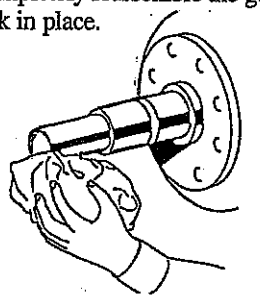
REASSEMBLY

1. Heat the bearing with a special magnetic device and using insulated gloves, assemble the bearings to the shaft.
2. Put the seager rings back into place. Thoroughly clean the shaft and spread a thin layer of Permabond or similar product over the shaft seat.





3. Reassemble the exciter carefully, making sure the diode connecting cables are turned toward the outside.
4. Install the rotor and completely reassemble the generator with all the covers back in place.



CLEANING

Use compressed air to clean the exterior of the generator. Do not use liquids or water. Do not use compressed air on interior components as this could cause shirt circuits.

MAINTENANCE

To clean the windings, use solvents like oil of turpentine or "Solvesso" solvent. Cleaning with such substances, which contain a high evaporation level, will not damage the isolation level of the windings. When cleaning is over, please look out for any overheating or carbonization signs.

We also recommend drying the windings at 60 - 80°C and if you notice that the varnish of the windings is not in good shape, then have them varnished again.

REVISED 2/2013