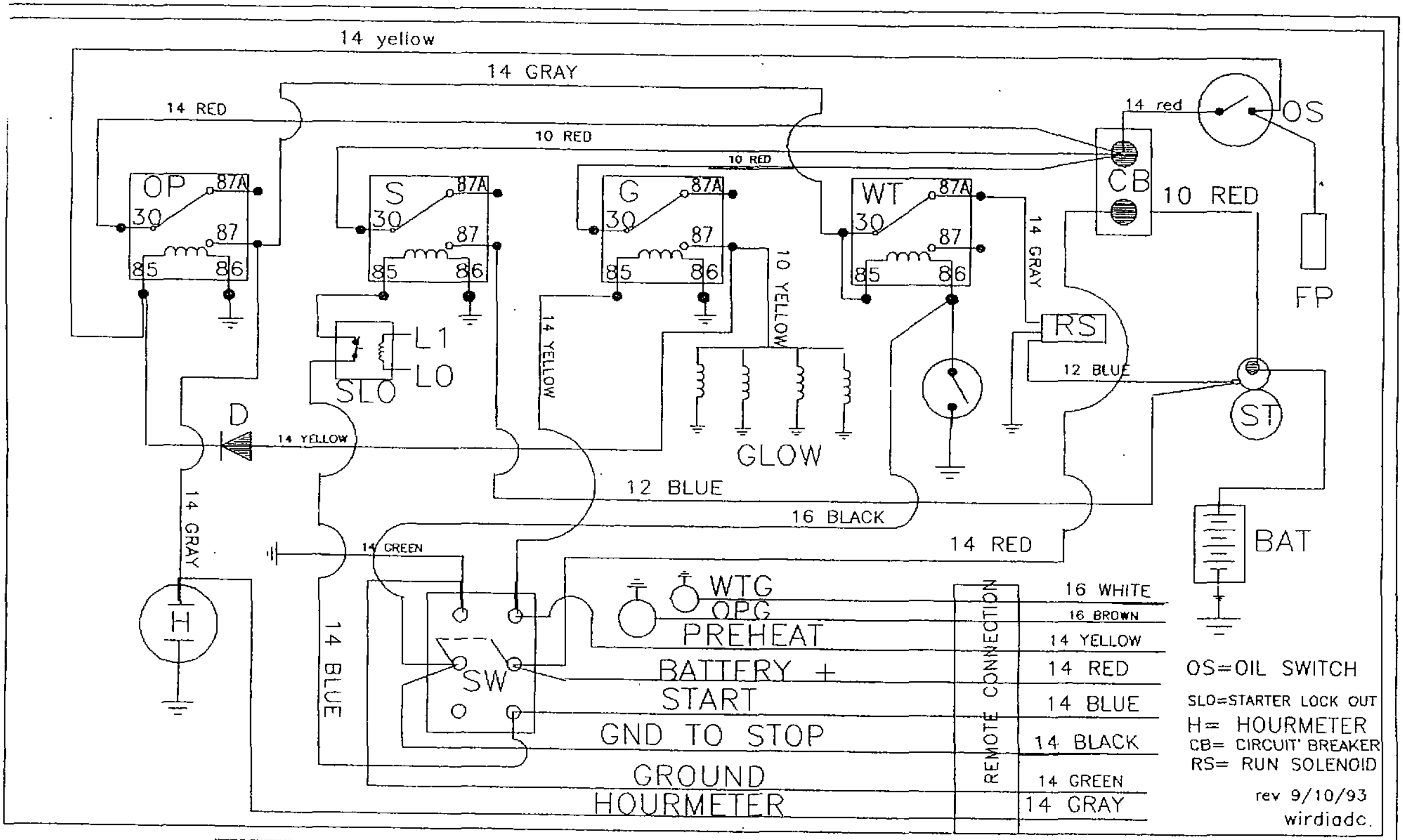
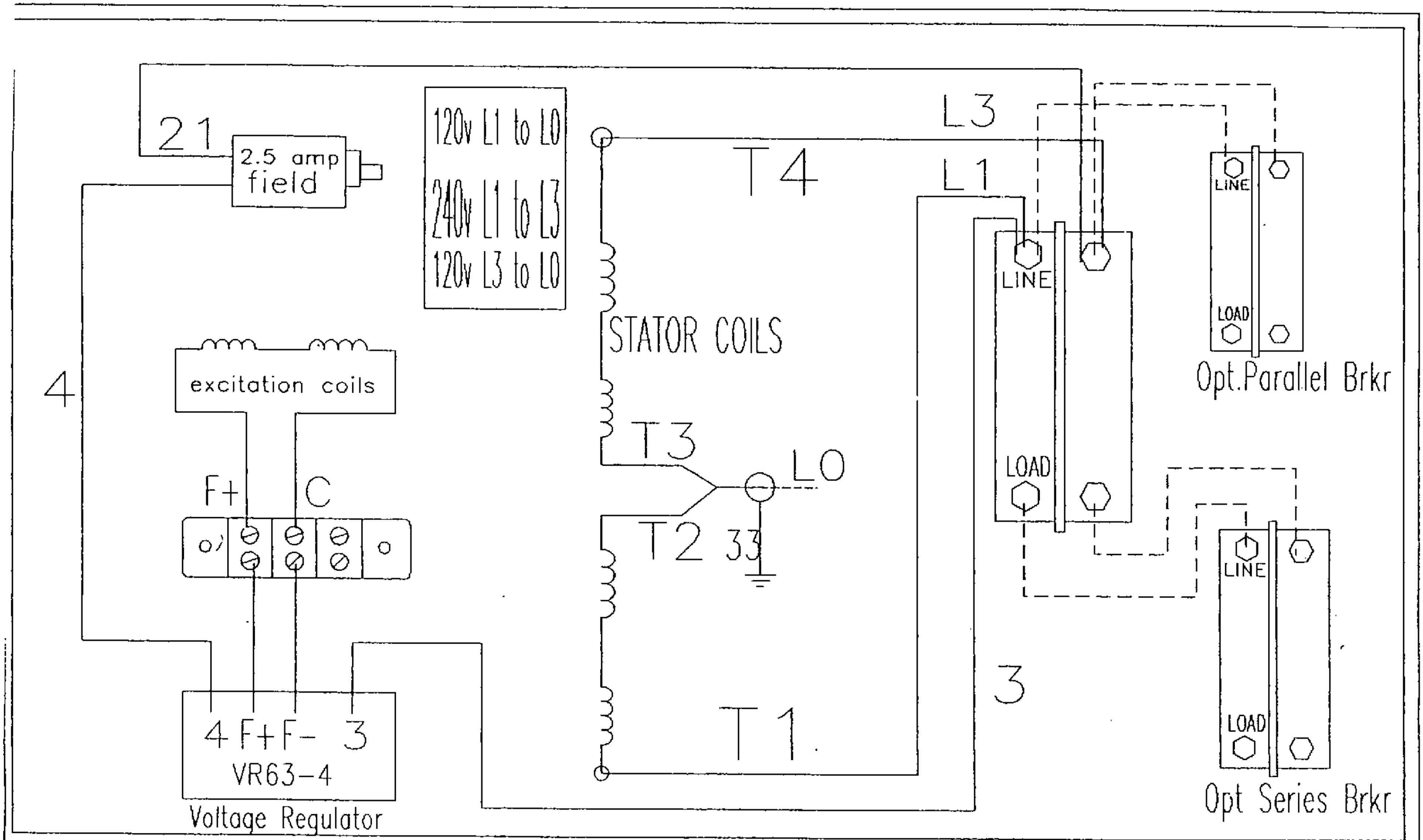


12V DC ENGINE CONTROLS 200/300/400 SERIES

by J. FUDGE

DATE 1/21/93



120/240 connection exciter generator

by J Fudge

DATE 1\12\93

PRINCIPLE OF OPERATION

The exciter pole pieces contain residual magnetism, setting up lines of force across the air gap to the exciter armature. When the exciter armature begins to rotate a voltage is induced and current flow is initiated in the exciter armature AC windings. This voltage is fed to the rotating rectifier assembly, rectified and fed to the alternator field coils. This DC voltage is sufficient to magnetize the laminated alternator field which will set up lines of force across the air gap to the alternator stator. As the generator rotor rotates a voltage will be induced and current will flow in the alternator stator windings and to the output circuit.

A static type voltage regulator is connected to the generator output. The regulator will rectify part of the output voltage to provide a DC voltage to the exciter field coils. This will increase the density of the lines of force in the exciter increasing the voltage induced into the exciter armature windings, and therefor, to the rotating rectifiers.

The rotating rectifier output will be increased which will increase the alternator field strength and the generator output will build up to its rated voltage.

Adjustment of the generator output to the rated voltage level is accomplished by controlling the current fed to the exciter field coils.

Regulation is automatic with the static type voltage regulator. An additional voltage adjustment range is provided if desired by operating the voltage adjust rheostat.

ROTATING FIELD ASSEMBLY (ROTOR)

The rotating field assembly consists basically of four members; the shaft assembly, the core assembly, field coil damper windings and balance lugs to provide a high degree of static and dynamic balance. The exciter rotor and rotting rectifier-hub assembly are separate units which are head shrunk onto the generator shaft.

CORE ASSEMBLY

The core assembly consists of once piece electrical steel laminations which are stacked on the shaft assembly.

FIELD COIL

Field coils of heavily insulated wire are "wet" wound directly onto the poles. Field coil leads are brought out to the rectifier assembly for connection to the source of DC excitation voltage.

SHAFT

Shaft is made of forged high strength steel, which is turned to close tolerance and then ground to a close tolerance.

FOR OPERATION AT AMBIENT TEMPERATURES ABOVE 40° C DERATE KW RATING 1 PERCENT FOR EACH DEGREE C. ABOVE 40° C. FOR OPERATION AT HIGH ALTITUDES ABOVE SEA LEVEL, RATINGS MUST BE DERATED 2 PERCENT FOR EACH 1000 FEET ABOVE SEA LEVEL

GENERAL DESCRIPTION

The revolving field type generators have a DC field revolving within a stationary AC winding called the stator. AC power is distributed from the generator through leads connected to the stator windings. There are no sliding contacts between the AC winding and the load, therefore, great amounts of power by be drawn from this generator.

VOLTAGE CONNECTIONS:

Generator may be connected at the terminal board to deliver 120/240 volts to a 3-wire grounded neutral system, or 120 volts only to a 2-wire distribution system. if any equipment requires 240 volts, then the 120/240 volt connection must be used. If all equipment requires 120 volts, then the 120 volt connection is preferred, even if two lines leave the switch box. The two lines at the input to the switch box are both connected to the ungrounded 120 volt lines from generator. The 120 volt connection enables the EVR to hold the voltage very close the 115 or 120 volts (as initially adjusted) regardless of the power distribution among the different distribution lines. The 120 volt connection is recommended if all the electrical load requires only 115 or 120 volts.

Although the 120/240 volt connection may also be used when all load requires only 110 volts, it should be pointed out that with this connection the 240 volts is regulated and the lightly loaded phase (or line) will deliver a high line-to-neutral voltage and the heavily loaded phase will delivery a low line-to-neutral voltage. The heavily loaded line may have such a low voltage that air conditioning will have more difficulty in starting, and long starting time may over-load generator and trip circuit breakers.

ELECTRONIC VOLTAGE REGULATION

Electronic Voltage Regulation (sometimes called automatic voltage regulation by many users) regulates the voltage by using a solid-state electronic circuit of transistors, integrated circuits, SCR's, resistors, capacitors, etc., to sense the generator voltage and feed a DC current into the exciter field of the proper average value to hold the generator voltage constant from no-load to full rated load and above. These electronic voltage regulators are very reliable devices which regulate the voltage to 2% or less.

BRUSHLESS EXCITER

The brushless exciter consists of an armature with a three phase AC winding and rotating rectifier assembly within a stationary field.

The stationary exciter field assembly is contained in the main generator frame. The exciter armature is bolted fit and keyed onto the shaft assembly. The rotating rectifier assembly slides over the bearing end of the generator rotor shaft.

DC OUTPUT POWER FOR EXCITER FIELD

The EVR rectifies the AC power input with a full wave rectifier to provide DC current (a series of half sine waves) with a high ripple content at a frequency of 120 Hz. This DC current is fed to the exciter field through one (or two) SCR's to provide a pulsed output in one direction only. The resistance and impedance within the regulator is very low and the peak value of the current into the exciter field is limited only by the impedance and resistance of the exciter field. For this reason exciter fields must have minimum specified resistance or the peak current delivered by the regulator will be so high that regulator components will be damaged. The regulators are commonly designed for a minimum exciter field resistance of 25 OHMs, although sometimes a slightly lower resistance can be tolerated. Connections to the exciter field are made of two DC output terminals, F + and C.

ROTATING RECTIFIER BRIDGE

The rotating rectifier bridge consists basically of rectifying diodes mounted on a heat sink which is in turn mounted on a insulating ring. The entire assembly bolt to the adaptor on the generator shaft. Therefore, the rotating rectifier assembly will rotate with the exciter armature eliminating the need for any slidingcontacts between the exciter outpu and the alternator field (see figure 1).

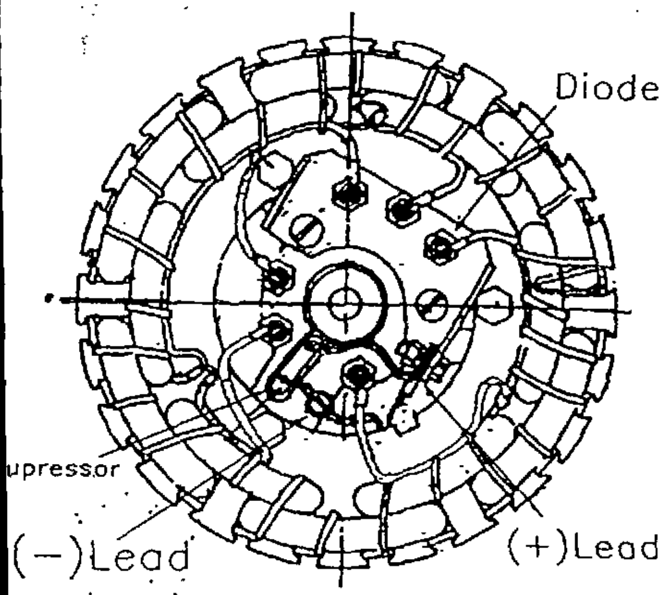


Figure 1

EXCITER FIELD
The exciter field on the high frequency exciter consists of laminated segments of high carbon steel which are fitted together to make up the field poles. the field coils are placed into the slots of the filed poles.

EXCITER FIELD COIL VOLTAGE SOURCE
Field coil DC voltage is obtained by rectifying the voltage from phase to neutral line of the generator output, or other appropriate terminal to provide the needed voltage reference.

The rectifier bridge is an integral part of he static regulator. The static regulator senses a change in the generator output and automatically regulates current flow in he exciter field coil circuit to increase or decrease the exciter field strength. An adjust rheostat sized to be compatible with he regulator is used to provide adjustment o the regulator sensing circuit.

BALANCE
The rotor assembly is precision balanced o a high degree of static and dynamic balance. Balance is achieved with the balance lugs on the field pole tips. Although the balance will remain dynamically stable at speed in excess of the design frequencies, the prime mover should be adequately governed to prevent excessive overspeed. High centrifugal forces at excessive overspeed can damage the damper windings and field coils.

BEARING
The generator rotor assembly is suspended on shielded, factory lubricated ball bearings. They are greased for life and should not require regreasing.

STATOR ASSEMBLY
The stator assembly consists of laminations of steel mounted in a rolled steel frame. Random wound stator coils are fitted into the insulated slots.

STANDBY UNITS
Generators used as an auxiliary power source in case of commercial power failure must be isolated from the commercial line before being placed in operation.

CAUTION: MAKE SURE UNIT IS COMPLETELY SHUT DOWN AND FREE OF ANY POWER SOURCE BEFORE ATTEMPTING ANY REPAIR OR MAINTENANCE ON THE UNIT.

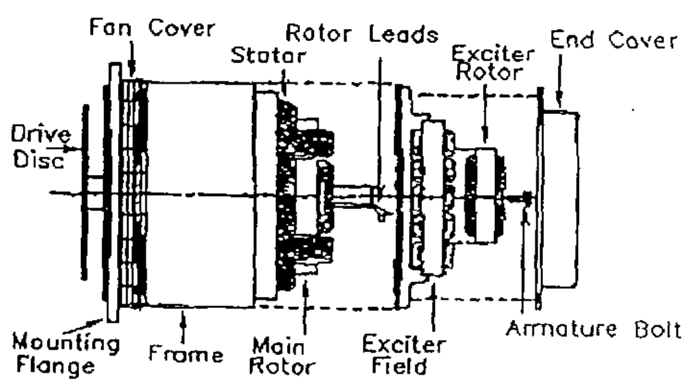


Figure 2

SECTION II
SERVICE AND MAINTENANCE

PREVENTATIVE MAINTENANCE AND OPERATING PRECAUTIONS
Costly repairs and down time can usually be prevented by operating electrical equipment under conditions which are compatible with those at which the equipment was designed to operate. Follow the instructions outlined below to insure maximum efficiency of the electrical equipment.

COOLING
Keep all cooling parts clean and make certain sufficient room is left on all sides for a plentiful supply of fresh coolant air flow. DO NOT EXCEED AIR TEMPERATURE RISE AS SHOWN FOR 50°C ABOVE A 40°C AMBIENT. This ensures that the insulation NEMA Class "F" will not be damaged. DO NOT EXCEED RATED VOLTAGE OR LOAD, except as specified for the equipment. OPERATE GENERATOR AT RATED SPEED. KEEP REGULATING EQUIPMENT IN PROPER ADJUSTMENT. Failure to operate generators at rated voltages, load or speed will cause overheating and possibly damage to windings due to over voltage or current.

REGULATING EQUIPMENT
Regulating equipment should be kept in proper adjustment at all times. READ ALL INSTRUCTIONS CAREFULLY BEFORE ADJUSTING OR REPAIRING REGULATING EQUIPMENT.

BEARING REPLACEMENT
Factory lubricated shielded bearings will normally provide several years of trouble free service when operated under normal conditions. Excessive bearing load and adverse environment conditions will greatly shorten bearing life. should bearing failure occur, bearings can be replaced. ALWAYS REPLACE WITH THE SAME TYPE BEARING AS INSTALLED AT THE FACTORY, CHECK PARTS LIST FOR PART NUMBER. Include generator serial number when ordering bearings.

ROTATING DIODE BRIDGE
The rotating diodes can be removed and replaced. Excessive overcurrent, overvoltage, overspeed, or reverse currents can cause damage to the assembl or any of the component parts.

All rotors are static and dynamically balanced to a high degree on precision machines to assure minimum vibration. They will therefore, remain dynamically stable at speed well beyond the synchronous speed of the generator. The rotors on generators are, however, subjected to extreme centrifugal forces which can increase beyond safe operating limits at excessive overspeed. Therefore, the prime mover should be adequately governed to prevent overspeed.

Damage to the rotor can also occur due t overheating which can be caused by:

1. Excessive field current due to failure of the regulator.
2. Exciter being operatored below the rated speed which can result in excessive field current due to the regulator trying t maintain rated voltage.
3. The air flow is restricted from dust or other foreign objects collecting in the air passage.

If a rotor becomes defective, it should be returned to the factory with full nameplat data, because the rotor coils are enclosed in welded squirrel cage winding. Should failure occur, the factory should be notified immediately and steps will be taken to get the generator back into service with the least expense; and more important, to determine the cause of the failure and take steps to prevent a recurrence.

PRECAUTIONS

GENERATOR WINDINGS (DRYING)

Generators that have been in transit or storage for long periods may be subjected to extreme temperatore and moisture changes. This can cause excessive condensation, and the generator windings should be thoroughly dried out before bringing the generator up to full nameplate voltage. If this precaution is not taken, serious damage to the generator can result. The following steps should be taken to effectively dry the generator windings:

.: Short circuit the generator lead wires. Start the generator and separately excite he exciter with DC battery power of pproximately 50 volts to produce rated C nameplate current. To accomplish this xcitation, the leads (F+ and C-) must be isconnected from the voltage regulator. ameplate current can be measured with a lip-on ammeter at the generator leads. ake sure the AC current does not exceed e nameplate rating. Be sure to econnect the leads F+ and C- to the roper terminals on voltage regulator after ying exercise.

Another procedure would be to put the enerator in a hot room or to moderately at with a heat source.

xperience has shown that it is necessary take these precautions in locations such seaboard installations and other highly mid areas. Some installations will be in mospheres that are much more corrosive an others. A little precaution along the es outlined here could eliminate an necessary repair job.

Each generator was subjected to a standard NEMA insulation test, which means 1000 volts plus twice the highest voltage for which the generator is rated was impressed between the windings and frame. All machines are insulated with a high safety factor for the class of insulation used. The latest and newest in insulation and baking techniques are used.

The finest insulation job can be very quickly broken down by carelessly applying high voltage to windings in a moisture saturated condition. Mishandling in this respect can easily cause a break-down, making it necessary to return the generator to the factory for repair, and consequent expense and loss of time.

WARNING: HIGH VOLTAGE (DIELECTRIC) TESTING MUST NOT BE PERFORMED TO THE MACHINE WITHOUT FIRST OBSERVING NEMA RULES. THE INSULATION OF THIS GENERATOR WINDING MAY BE SAFELY CHECKED BY USING A MEGGER. A HIGH MEGGER READING INDICATES LOW INSULATION LEAKAGE.

FIELD FLASHING

The direct current (DC) necessary to magnetize the alternator field is obtained from the exciter. Initially, upon starting the generator, current flow and voltage are induced into the exciter armature by the magnetic lines of force set up by the residual magnetism of the exciter field poles.

Residual magnetism of the exciter field poles may be lost or weakened by a momentary reversal of the field connection, a strong neutralizing magnetic field from any source, or if the generator is not operated for a long period of time.

To restore the small amount of residual

magnetism necessary to begin the voltage build-up, connect a battery from 6 to 32 volts to the exciter field coil circuit. Normally, a battery of 6 or 12 volts is large enough.

PROCEDURE FOR FIELD FLASHING TO RESTORE RESIDUAL MAGNETISM

1. Disconnect exciter field coil wire F+ at terminal F+.
2. Connect battery positive lead to field coil lead F+. Use 12 volt battery.
3. Connect battery negative lead to field coil circuit terminal C-.
4. disconnect battery leads after approximately 3 to 5 seconds. If battery is connected for too long. Overheating and subsequent damage to the exciter can occur.
5. Reconnect field coil lead F+ to terminal F+.
6. Start unit and observe generator build-up.

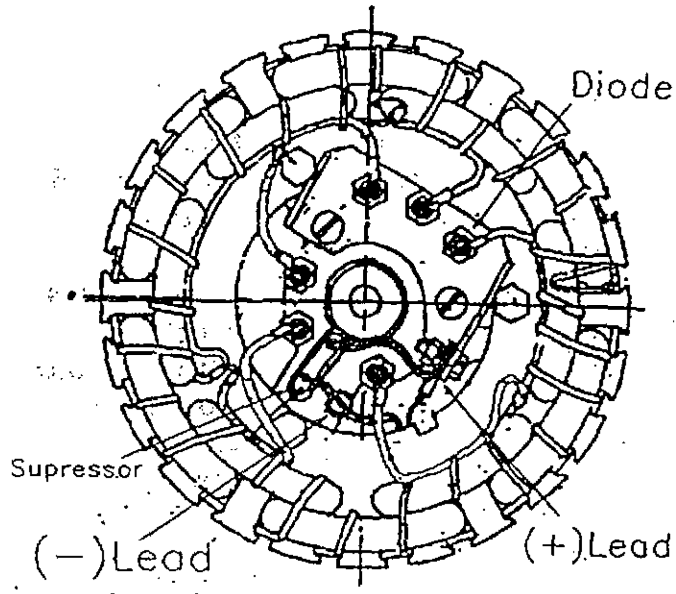
Reflash field (Steps 1 through 5 above) if generator output voltage does not build up.

NOTE: If the polarity of the exciter is reversed by flashing the field, it may be corrected by inter changing the battery leads.

ALTERNATE PROCEDURE FOR FIELD FLASHING

Apply either an alternating current or a direct current voltage of approximately 12 volts to any two generator leads. Do not make a positive connection but rather touch the leads together until the generator voltage begins to rise and then remove. It is suggested that a 30 ampere fuse be inserted in the circuit to prevent any damage in case the build-up voltage is not removed quickly enough.

Start generator and observe generator build-up. Reflash field if generator output voltage does not build up. This procedure should be performed by Trained Service Personnel only.



Exciter Rotor

Figure 3

TESTING DIODES WITH AN OHMMETER

Isolate the rectifier assembly by disconnecting the leads from the main rotor and three leads from the exciter rotor. Test each diode by applying the probes of an ohmmeter to the anode and cathode.

A good diode will produce a meter readi[ng] of only a few OHMs when the probes ar[e] applied in one direction, and a reading o[f] near infinity when the probes are reversed. If both readings are high, or both are low, the diode is defective and must be replaced.

Diode failure after 25 hour "run-in" period is generally traceable to external causes such as overheating or a reverse current fed into the alternator. To save excessive service time and call-backs, it a generally accepted practice to replace diodes where failure can be traced to external causes AFTER THE CAUSE OF THE DIODE FAILURE IS IDENTIFIED AND CORRECTED.

TROUBLESHOOTING PROCEDURE AC BRUSHLESS GENERATOR

As with any machine, trouble may develop in electrical generators. It may be due to long service or neglect of regulator maintenance, servicing, and checking. Should trouble develop, the following instructions will be helpful in tracing the cause and making repairs.

Brushless generators are not complete units without added control equipment; therefore, reference will be made to control components.

VOLTAGE DEVIATIONS

The generator output voltage should be kept as close as possible to the rated voltage shown on the generator nameplate. High voltage, low voltage and fluctuating voltage (hunting) may cause serious damage to the generator and its control equipment. A high voltage could damage sensitive equipment and low voltage could cause motors to burn out.

SPEED DEVIATION

The generator speed should be maintained at rated nameplate speed. The frequency of the generator output depends on speed. If the generator runs slower than rated speed, the voltage may drop off. Automatic control equipment may burn out trying to maintain voltage by forcing the field.

VISUAL EXAMINATION

The first step in investigating any generator failure or trouble should be to look for obvious evidence: burned areas, loose or open connections, wrong speed, incorrect reassembly and reconnection, etc.

OBSERVE VOLTAGE OF DEFECTIVE GENERATOR

The next step is to carefully measure line-to-line voltage. A voltage about 10 percent of rated voltage (at rated RPM) is probably the residual voltage (determined by residual magnetism in exciter field). A normal residual voltage indicates exciter armature, rotor and stator are all good and that the trouble is probably in the excitation circuit. A very low voltage, or no voltage, indicates either that residual magnetism in the exciter field was lost (generallly by disassembly or by sudden interruption of the exciter field current), or that a generator defect exists in the exciter armature, rotor or stator.

BATTERY EXCITATION

The behaviour of the generator, when the exciter field is connected to a 12 volt battery for excitation current, is a useful guide for locating the generator fault. Disconnect F+ and C- from EVR and open CBI circuit breaker/switch in lead 3 or 4 to EVR (lead for power input to EVR). Connect F(+) to (+) of battery. Connect (-) of battery to C(-). Spin generator 1800 RPM.

A. If residual voltage is normal, 12 volts across lead F+ and C- should cause the generator to deliver a voltage near rated voltage with no load. If 12 volt excitation produces near normal voltage, failure of voltage regulator to provide voltage could mean a defective voltage regulator, or an open circuit in leads to terminals 3 or 4 of electronic regulator. Check switch or circuit breaker in these leads. With 12 volt excitation, connect voltmeter across terminals 3 and 4. Voltage should be 200 to 240 volts with CBI closed.

B. If 12 volt excitation produces no voltage, check exicter field resistance. It should normally be 25-28 OHMs at 77°F. If field is open or shorted, then the exciter field is defective. An open or short in the main rotor behaves similarly, but is also accompanied by a very low line-to-line voltage (residual voltage) without 12 volt battery excitation. If open or shorted rotors suspected, remove "R" lead from #10 base terminal on armature and measure resistance since "Q" lead is normally connected to ground. See "Resistance of Rotors".

c. If 12 volt excitation causes the engine to growl and load the engine with no or very low generator output voltage, the stator could be grounded or shorted. Or, a short or ground in the wiring of the generator power circuit could be the main fault. In either case, the stator will develop hot spots or could even smoke after running a few minutes. Run generator until a hot smell is detected, or stop in 5 minutes (whichever occurs first). Feel the stator winding. If it is hot, the stator or power wiring contains a short circuit. Examine the stator for burned (black) insulation which indicates a defective or damaged stator. Measure stator resistance T1 to T2 and T3 to T4 if possible. With 12 volt excitation measure voltage T1 to T2 and T3 to T4. If one of these voltages is very low while the other is close to normal, the low voltage winding has shorted turns.

d. If 12 volt excitation causes an increase in voltage but the output voltage is less than 60 percent of rated voltage, the rectifier (see 4) in the exciter armature could be defective or the exciter armature could have an open circuit. Also, one pole of the main field (rotor) could be shorted or grounded. If any of these defects exist, failure of the electronic regulator will occur. Replacement of regulator alone will be followed by failure of the new regulator. If electronic regulator has failed, it is wise to check exciter current by placing a DC ammeter in the F(+) lead to exciter field. Normal exciter current at no-load rated voltage is 0.65 to 0.95 ampere. A higher current is another indication of a generator defect (described above), which could cause a new voltage regulator to fail.

4. <u>RECTIFIER CHECKING</u>

a. Each armature full-wave bridge rectifier has 5 terminals and 6 rectifying junctions. Rectifiers may be readily checked on the low range of an ohmmeter. From the "+" tab to "AC" tab, the ohmmeter should show a high resistance when polarity of the ohmmeter leads is reversed. The same conditions should be found from the "+" tab to any other "AC" tab and from "-" to "AC" tabs. If a ZERO resistance reading is found, this junction of the rectifier is shorted and the rectifier must be replaced. If a HIGH resistance is found with both polarities of the ohmmeter, this junction of the rectifier is "OPEN" and the rectifier must be replaced.

b. Armatures with 3-phase FULL-WAVE bridge rectifier.
The three-phase full-wave rectifier is now standard on most armatures used in generators. This 3-phase (full-wave rectifier) is a single unit with 6 diodes in a special case. The (+) terminal is identified by a red dot on the case and is connected by a short lead to the (+) terminal of armature to which the (+) rotor lead and suppressor lead are connected.

The other 3 terminals at the top of the rectifier are AC connections to each of the armature phase leads. The case is the (grounded) (-) lead to the rotor. To test the diodes disconnect the rectifier positive lead at the armature (+) terminal. Test between rectifier (+) lead and any AC terminal. Make the test also between rectifier (-) lead (ground or case_) to any AC lead. The test determine that all diodes are good or that one or more is defective. Since a grounded armature winding gives the same test results as a bad diode, it is necessary to disconnect all AC rectifier connections and test armature windings for a short to ground before a fault can be positively identified. Also test each diode separately (-) to each AC terminal, and case to each AC terminal to positively identify which diode is bad. (See Figure 4).

c. Armature with two FULL-WAVE bridge rectifiers.

On some generator models an armature will be supplied with two full-wave bridge rectifiers very similar to the rectifiers used on armatures with one 3-phase FW rectifier.

To test these rectifiers, remove the two rectifier (-) leads at the R (rotor) + terminal and test each rectifier separately, first from + lead (rectifier #10 to any AC terminal, then case to any AC terminal. Then go to rectifier # 2 and test + to any AC terminal, then case to any AC terminal. A failure in the test "case to any AC terminal" could be as bad diode in either FW bridge rectifier. To determine which diode is bad, all AC terminals must be disconnected and each AC terminal of the rectifier tested to both + and to - (case) of that bridge rectifier.

VOLTAGE SUPPRESSOR

Voltage suppressor are similar to rectifiers in that they contain in effect a single semiconductor one-way junction. A suppressor should have a high resistance with one polarity of test leads and low but not zero resistance in the opposite direction. Resistance measurements sometimes fail to identify a defective suppressor. The best test is to remove suppressor from circuit. If an obvious improvement in generator is observed, suppressor is bad. Some suppressor have a high resistance ineither polarity of applied voltage (if applied voltage is low), but have a low resistance of voltages of 300 to 450 volts.

RESISTANCE OF WINDINGS

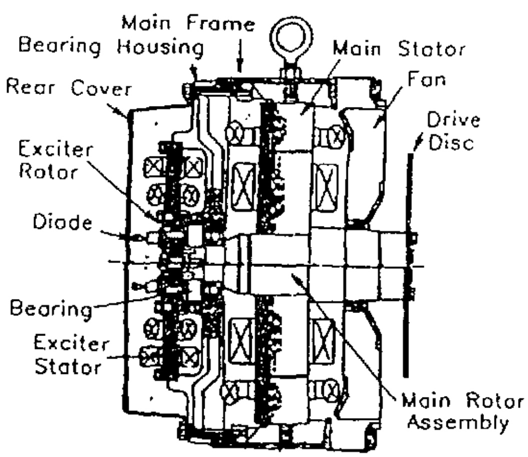
Frequently in troubleshooting a generator, a defective component can be identified by measuring the resistance of a winding.

Exciter field, armature, rotor and stator should withstand 1500 volts between winding and ground with less than 0.002 ampere of current between winding and ground. All electronic components such as rectifiers, suppressor and resistors must be disconnected.

GENERATOR RESISTANCE VALUES

Armature: .470-.520 OHMs per phase, 5 -10KW
.650-.720 OHMs per phase, 12.5 - 50KW
Field: 18 - 22 OHMs 5 - 10KW
23 - 28 OHMs 12.5 - 50KW
Stator: OHMs vary with KW rating, but less than 1.0 OHM per phase.
ROTOR:

KWs	8	10	12.5	15	17.5	20	25	30 to 50
OHMs	1.47	1.58	1.73	1.84	2.00	2.1	2.2	2.5 to 3.8



Exciter Type Generator

Figure 4

ELECTRONIC REGULATION

An electronically regulated generator has superior voltage regulation than other types. (+/- 2%) within rated loads.

Power Technology SE, uses voltage regulators made by Basler Electric Co., Highland, Illinois.

The electronic voltage regulator, regulates the voltage using a solid-state electronic circuit of transistors, integrated circuits, SCR's, resistors etc. to sense the generator voltage and feed a DC current into the exciter field of the proper average value to hold the generator voltage constant from no-load to full rated load and above.

Characteristics of the Regulator

Overload Protection

To prevent damage to devices receiving electrical power from the generator. The regulator provides both under load frequency and over load protection. the voltage regulator operates at 50 HZ or 60 HZ, or both. if frequency and engine speed, falls below the rated value, the generator voltage decreases to provide underfrequency protection, but if the engine is over the speed required to give 50 HZ or 60 HZ, the voltage does not rise above that value set at the proper frequency (proper engine speed).

AC Power Input

All EVR's must supply up to 4 amperes of DC output current into the exciter field at a voltage up to 70 volts DC. This voltage and current constitutes a power output of about 280 watts. This output power must come from the generator. The exciter field input power must be supplied at 190 to 240 volts AC at a volt-ampere burden of 500 VA maximum.

When the generator is operated at 208 volts to 240 volts this power comes from the generator load lines. when the generator is connected to deliver 120 volts, a separate winding in the stator provides 208 to 240 volts for the voltage regulator power input.

DC Output Power for the Exciter Field

The EVR rectifies the AC power input with a full wave rectifier to provide DC current (a series of half sine waves) with a high ripple content at a frequency of 120 HZ. This DC current is fed to the exciter field through one or two SCR's to provide a pulsed output in one direction only. Th resistance and impedance within the regulator is very low and the peak value of the current into th exciter field is limited only by the impedance and the resistance of the exciter field. For this reason the exciter fields must have a minimum specified resistance or the peak current delivered by the regulator will be so high that the regulator components will be damaged. The regulator is commonly designed for a minimum exciter field resistance of 20 OHMs 8-10KW & 25 OHMs 12-50KW, although sometimes a slightly lower resistance can be tolerated. Connections to the exciter field are made at two DC output terminals F+ and F-.

NO VOLTAGE

CAUSE	CHECK AND REMEDY
Open circuit in exciter field.	Check out continuity of field coils. If open in field coils, remove field assembly and return assembly to factory for repair.
Loss of residual magnetism in exciter field poles.	Flash field by making a flash connection of DC across terminals C- to F+ to positive lead of DC source. (See previous instructions).
Open in stator windings.	Check for continuity in windings. Return to factory for repair of open.
*Open in rotating rectifiers.	Check rectifiers per previous instructions, replace if faulty.
Malfunction of automatic voltage regulator.	See troubleshooting of voltage regulator, replace if faulty.
Short circuited.	Clear lead to restore build-up.
*Open in generator field.	Check for continuity and return rotor to factory for repair if field coils are open.
*Shorted rotating rectifiers.	Check for shorts and replace if faulty.
*Shorted exciter armature.	Check for short and replace if faulty. Measure resistance.
*Shorted leads between exciter armature and generator field.	Test and Repair

NOTE: *Designates rotating parts. Generator must be open to test.

LOW VOLTAGE

CAUSE	CHECK AND REMEDY
Excessive load.	Reduce load. the load on each leg should be as evenly blanced as possible and should not exceed the reated current on any leg.
Low speed.	Check engine for malfunction or system for overload.
Automatic voltgage regulator defective.	See troubleshooting for automatic regulator. Replace if faulty.
Insuffiecient excitation.	Check regulator. Replace if faulty.
Line loss.	Increase size of line lead wire.
High resistance connection -- connection will be warm or hot.	Make better connection electronically and mechanically.
Shorted filed.	Test field coils for possible short by checking resistance with an ohmmeter. Return rotor assembly to factory for repa if alternator field coils are shorted.
Low power factor.	Reduce inductive (motor) load. Some AC motors draw approximately the same current regardless of load. Do not use motors of larger horsepower rating than i necessary to carry the mechanical load.

FLUCTUATING VOLTAGE

(May be indicated by flickering lights)

CAUSE	CHECK AND REMEDY
Irregular speed of engine.	Check engine for malfunction or load for fluctuation.
Fluctuating speed.	Stabilize load. The addition of a lamp load (resistance load) may conpensate partially for laoad changes caused by intermittent motor operation. Do not overload.
Loose terminal or load connections.	Make better connection mechanically and electronically.
Voltage reulator unstable.	Check regulator. Replace if faulty.
Intermittent short in generator exciter field.	Test field coils for possible short by cheking resistance with an ohmmeter. Return assembly to factory for repair if field coil is shorted.

HIGH VOLTAGE

Excessive speed.	Check engine for malfunction.
Voltage regulator defective.	See troubleshooting for voltage regulator. Replace if necessary.

OVERHEATING

CAUSE	CHECK AND REMEDY
Generator overloaded.	Reduce load (Check with ammeter and compare with nameplate rating.)
Clogging ventilating screens.	Clean air passages.
High room temperature.	Improve ventilation.
Insufficient circulation.	Provide cross-ventilation.
Operating with excessive voltage.	Check voltage drop in distribution lines and connections and adjust as described i voltage deviation instruction.
Low power factor.	Reduce inductive loads or install power factor improvement capacitors.
Unbalanced load.	The load on each leg should be as evenly balanced as possible and shold not exceed the rated current on any leg.
Dry bearing.	Replace bearing.

MECHANICAL NOISE

Defective bearing.	Replace bearing.
Rotor scrubbing onstator.	Bad bearing, replace. Bent shaft, return to factory. Loose endbell, tighten; losse drive discs, tighten.
Loose laminations.	Return to factory for repair.
Loose or misaligned coupling.	Tighten or align.

GENERATOR FRAME PRODUCES SHOCK WHEN TOUCHED

CAUSE	CHECK AND REMEDY
ic charge.	Ground generator frame.
unded armature or field coil.	Return to factory for repair.

OPERATING HOUR SERVICE LOG

The following is provided to help you keep an accumulative record of operation hours on your generator set and the dates required services were performed. Enter hours to the nearest hour.

Date Run	Operating Hours		Service Record	
	Hours Run	Cumulative	Date	Service

Date Run	Operating Hours		Service Record	
	Hours Run	Cumulative	Date	Service

Exhibit B

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.