4-2 PowerTech Generator

4-2 PowerTech PTSMH17.5 Generator

A PowerTech PTSMH17.5 Generator is supplied with the 450 LXi Coach. This is located in the front of the coach under the windshield area. The area can be extended out by pushing the "out" button located under the driver's panel inside the coach. See Instruments and Controls section for more details. This allows for easy access for repairs and maintenance procedures. Pushing the "in" button will push the generator back in the coach.

4-2.1 Safety Precautions

Careful operation is your best insurance against an accident. Read and understand this entire section carefully before operating the generator engine. All operators, no matter how much experience they may have had, should read this and other related manuals before operating the engine or any equipment attached to it. It is the owner's obligation to instruct all operators in safe operation.

4-2.1.1 Observe Safety Instructions

- Read and understand carefully this "Operator's Manual" and "Labels on the Engine" before attempting to start and operate the engine.
- Learn how to operate and work safely. Know your equipment and its limitations. Always keep the engine in good running condition.
- Before allowing other people to use engine, explain how to operate and have them read this manual before operation.
- Do not modify the engine by yourself. Unauthorized modifications to the engine may impair the function and/or safety and affect engine life.

4-2.1.2 Wear Safety Clothing

- Do not wear loose, torn or bulky clothing around the machine that may catch on working controls and projections causing personal injury.
- Use additional safety items, e.g. hard hat, safety protection, gloves, etc., as appropriate or required.
- Do not operate machine or any equipment attached to it while under the influence of alcohol, medication, or other drugs, or while fatigued.
- Do not wear radio or music headphones while operating engine.

4-2.1.3 Check Before Operating and Starting the Engine

- Be sure to check the engine before operation. If something is wrong with the engine, do not fail to repair it quickly.
- Keep all guards and shields in place before operating the engine. Replace any that are damaged or missing.
- Check to see if there is a safe distance from the engine before starting.
- Always keep the engine at least 3 feet (1 meter) away from buildings and other facilities.
- DO NOT allow children or livestock to approach the machine while the engine is running.
- DO NOT start the engine by shorting across starter terminals. The machine may start in gear and move.

4-2.1.4 Keep Area Around the Engine Clean

- Be sure to stop the engine before cleaning.
- Keep the engine clean and free of accumulated dirt, grease and trash to avoid a fire. Store flammable fluids away from sparks and fire.
- DO NOT stop the engine without idling; Temperatures around the engine rise suddenly. Keep the engine idling for about 5 minutes or over before stopping.

4-2.1.5 Safe Handling of Fuel and Lubricants

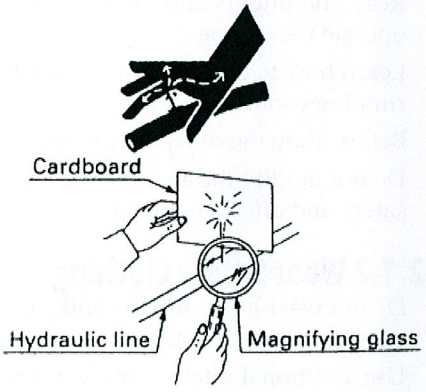
- Always stop the engine before refueling or/and lubricating.
- DO NOT smoke or allow flames or sparks in your working area. Fuel is extremely flammable and explosive under certain conditions.
- Refuel at a well ventilated and open place. When fuel and lubricants are spilled, refuel after letting engine cool off.
- DO NOT mix gasoline or alcohol with diesel fuel. The mixture can cause a fire.

4-2.1.6 Exhaust Gases & Fire Prevention

- Engine exhaust fumes can be very harmful if allowed to accumulate. Be sure to run the engine in a well ventilated place and where there are no people or livestock near the engine.
- The exhaust gas from the muffler is very hot. To prevent a fire, do not expose dry grass, mowed grass, oil and any other combustible materials to exhaust gas. Also, keep the engine and muffler clean all the time.
- To avoid a fire, be alert for leaks of flammables from hoses and lines. Be sure to check for leaks from hoses or pipes, such as fuel and hydraulic by following the maintenance check list.
- To avoid a fire, do not short across power cables and wires. Check to see that all power cables and wirings are in good condition. Keep all power connections clean. Bare wire or frayed insulation can cause a dangerous electrical shock and personal injury.

4-2.1.7 Escaping Fluid

- Relieve all pressure in the air, the oil and the cooling systems before any lines, fittings or related items are removed or disconnected.
- Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. DO NOT check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- Escaping hydraulic fluid under pressure has sufficient force to penetrate skin causing serious personal injury.
- Fluid escaping from pinholes may be invisible. Use a piece of cardboard or wood to search for suspected leaks: do not use hands and body. Use safety goggles or other eye protection, when checking for leaks.
- If injured by escaping fluid, see a medical doctor immediately. This fluid can produce gangrene or severe allergic reactions



4-2.1.8 Cautions Against Burns and Battery Explosion

- To avoid burns, be alert for hot components, e.g. muffler, muffler cover, radiator, pipes, engine body, coolants, engine oil, etc. during operation and just after the engine has been shut off.
- DO NOT remove the radiator cap while the engine is running or immediately after stopping. Otherwise hot water will spout out from radiator. Wait for more than ten minutes to cool the radiator, before removing the cap.
- Make sure to shut the drain valve off coolant and close oil pressure cap, and to hand fasten pipe before operating. If those parts are taken off, or loosened, it will result in serious personal injury.
- The battery presents an explosive hazard. When the battery is being activated, hydrogen and oxygen gases are extremely explosive.
- Keep sparks and open flames away from the battery, especially when charging the battery. DO NOT strike a match near the battery.
- DO NOT check battery charge by placing a metal object across the terminals. Use a voltmeter or hydrometer.
- DO NOT charge battery if frozen. It can be explosive. When frozen, warm the battery up more than 16°C (61°F).

4-2-1.9 Keep Hands and Body Away From the Rotating Parts

- Be sure to stop the engine before checking or adjusting belt tension and cooling fan.
- Keep your hands and body away from any rotating parts, such as cooling fan, V-belt, fan drive V-belt pulley or flywheel to avoid causing personal injury.
- DO NOT run the engine with installed safety guards detached. Install safety guards securely during operation.

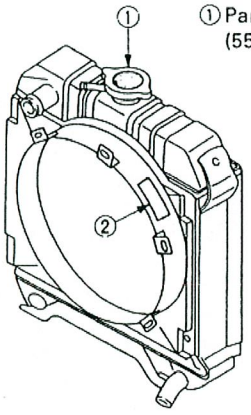
4-2-1.10 Anti-Freeze and Disposal of Fluids

- Anti-freeze contains poison. Wear rubber gloves to avoid personal injury. In case of contact with skin, wash it off immediately.
- DO NOT mix different types of anti-freeze. The mixture can produce a chemical reaction causing harmful substances. Use approved or genuine KUBOTA anti-freeze.
- Be mindful of the environment and the ecology. Before draining any fluids, find out the correct way of disposing of them. Observe the relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters and batteries.
- When draining fluids from the engine, place a container underneath the engine body.
- DO NOT pour waste onto the ground, down a drain, or into any water source.

4-2-1.11 Conducting Safety Checks and Maintenance

- When checking engine or servicing, place the engine on a wide and level ground. DO NOT work on anything that is supported ONLY by lift jacks or a hoist. Always use blocks or correct stands to support the engine before servicing.
- Detach the battery from the engine before conducting service. Put a "DO NOT OPERATE" tag in the key switch to avoid accidental starting.
- To avoid sparks from an accidental short circuit always disconnect the battery's ground cable first and connect it last.
- Be sure to stop the engine and remove the key when conducting daily and periodic maintenance, servicing and cleaning.
- Check or conduct maintenance after the engine, coolant, muffler, or muffler cover, have been cooled off completely.
- Always use the appropriate tools and jig-figure in good condition when performing any service work. Make sure you understand how to use them before service.
- Use ONLY correct engine barring techniques for manually rotating the engine. DO NOT attempt to rotate the engine by pulling or prying on the cooling fan and V-belt. This practice can cause serious personal injury or premature machine damage to the cooling fan.
- Replace fuel pipes and lubricant pipes with their hose clamps every 2 years or earlier whether they are damaged or not. They are made of rubber and are aged gradually.
- When service is performed together by two or more people, take care to perform all work safely.
- Keep first aid kit and fire extinguisher handy at all times.

4-2-1.11 Warning and Caution Labels



① Part No. 9077-8724-1 or 16667-8724-1
(55mm in diameter) (37mm in diameter)

② Part No. TA040-4957-1
Stay clear of engine fan and fan belt.

4-2.1.12 Care of Warning and Caution Labels

1. Keep warning and caution labels clean and free from obstructing material.
2. Clean warning and caution labels with soap and water, dry with a soft cloth.
3. Replace damaged or missing warning and caution labels with new labels from your local KUBOTA dealer.
4. If a component with warning and caution label(s) affixed is replaced with new part, make sure new label(s) is (are) attached in the same location(s) as the replaced component.
5. Mount new warning and caution labels by applying on a clean dry surface and pressing any bubbles to outside edge.

4-2.2 Pre-Operation Check

4-2.2.1 Break-In

1. During the engine break-in period, by all means, observe the following:
   Change engine oil and oil filter cartridge after the first 50 hours of operation (See "Engine Oil" in Periodic Service Section).
2. When ambient temperature is low, operate the machine after the engine has been completely warmed up.

4-2.2.2 Daily Check

To prevent trouble from occurring, it is important to know the conditions of the engine well. Check it before starting.

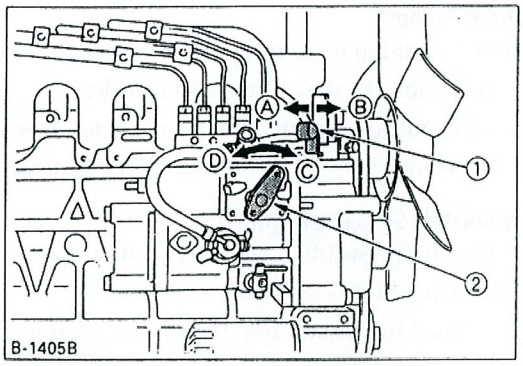
!!CAUTION: To avoid personal injury:

- **Be sure to install shields and safeguards attached to the engine when operating.**
- **Stop the engine at a flat and wide space when checking.**
- **Keep dust or fuel away from the battery, wiring, muffler and engine to prevent a fire. Check and clear them before operating everyday. Pay attention to the heat of the exhaust pipe or exhaust gas so that it cannot ignite trash.**

ITEM	
Parts which had trouble in previous operation.	
1. By walking around the machine	(1) Oil or water leaks
	(2) Engine oil level and contamination
	(3) Amount of fuel
	(4) Amount of coolant
	(5) Dust in air cleaner dust cup
	(6) Damaged parts and loosened bolts and nuts
2. By inserting the key into the starter switch	(1) Proper functions of meters and pilot lamps; no stains on these parts.
	(2) Proper functions of glow lamp timer.
3. By starting the engine	(1) Color of exhaust fumes
	(2) Unusual engine noise

4-2.2.3 Stopping the Engine

1. Return the speed control lever to low idle, and run the engine under idling conditions.
2. Set the engine stop lever to the "STOP" position.
3. With the starter switch placed at the "OFF" position, remove the key. (Be sure to return the engine stop lever to the "START" position to be ready for the next start.)



(1) Speed control lever
(2) Engine stop lever
(A) "IDLING"
(B) "OPERATION"
(C) "START"
(D) "STOP"

4-2.2.4 Checks During Operation

While running, make the following checks to see that all parts are working correctly.

Radiator Cooling Water (Coolant)

▲WARNING: To avoid personal injury:
Do not remove radiator cap until coolant temperature is well below its boiling point. Then loosen cap slightly to the stop position, to relieve any pressure, before removing cap completely.

When the engine overheats and hot coolant overflows through the overflow pipe and cannot be stopped, stop the engine immediately and make the following checks to determine the cause of trouble:

Check Item

1. Check to see if there is any coolant leak;
2. Check to see if there if any obstacle around the cooling air inlet or outlet;
3. Check to see if there is any dirt or dust between radiator fins and tube;
4. Check to see if the fan belt is too loose;
5. Check to see if radiator water pipe is clogged; and
6. Check to see if anti-freeze is mixed into coolant in warm seasons.

Oil Pressure Lamp

The lamp lights up to warn the operator that the engine oil pressure has dropped below the prescribed level. If this should happen during operation or should not go off even after the engine is accelerated more than 1000 rpm, immediately stop the engine and check the following:

1. Engine oil level (See "Engine Oil" in Maintenance Section).
2. Lubricant system (See "Engine Oil" in Maintenance Section).

Fuel

!!CAUTION: To avoid personal injury:

- **Fluid escaping from pinholes may be invisible. Do not use hands to search for suspected leaks; Use a piece of cardboard or wood, instead. If injured by escaping fluid, see a medical doctor at once. This fluid can produce gangrene or a severe allergic reaction.**
- **Check any leaks from fuel pipes or fuel injection pipes. Use eye protection when checking for leaks.**

Be careful not to empty the fuel tank. Otherwise air may enter the fuel system, required fuel system bleeding. (See *"FUEL" in Maintenance Section*).

Color of Exhaust

While the engine is running within the rated output range:

- The color of exhaust remains colorless.
- If the output slightly exceeds the rated level, exhaust may become a little colored with the output level kept constant.
- If the engine is run continuously with dark exhaust emission, it may lead to trouble with the engine.

Immediately Stop the Engine If:

- The engine suddenly slows down or accelerates.
- Unusual noises suddenly sound.
- Exhaust fumes suddenly become very dark.
- The oil pressure lamp or the water temperature alarm lamp lights up.

4-2.2.5 Reversed Engine Revolution and Remedies

!!CAUTION: To avoid personal injury:
Reversed engine operation can make the machine reverse and run it backwards. It may lead to serious trouble.
Reversed engine operation may make exhaust gas gush out into the intake side and ignite the air cleaner; it could catch fire.

Reversed engine revolution must be stopped immediately since engine oil circulation is cut quickly, leading to serious trouble.

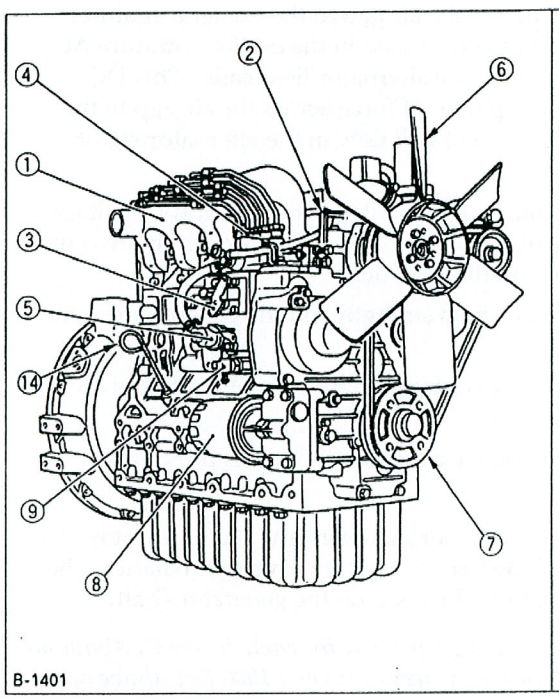
How to Tell When the Engine Starts Running Backwards

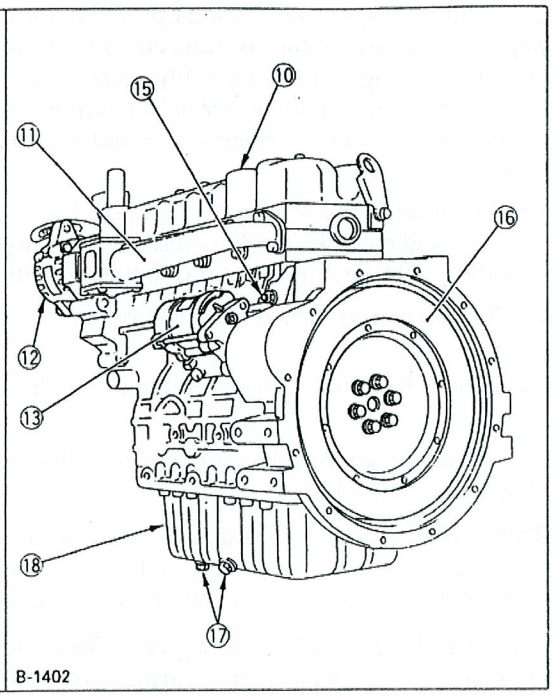
1. Lubricating oil pressure drops sharply. Oil pressure warning light, if used, will light.
2. Since the intake and exhaust sides are reversed, the sound of the engine changes, and exhaust gas will come out of the air cleaner.
3. A louder knocking sound will be heard when the engine starts running backwards.

Remedies

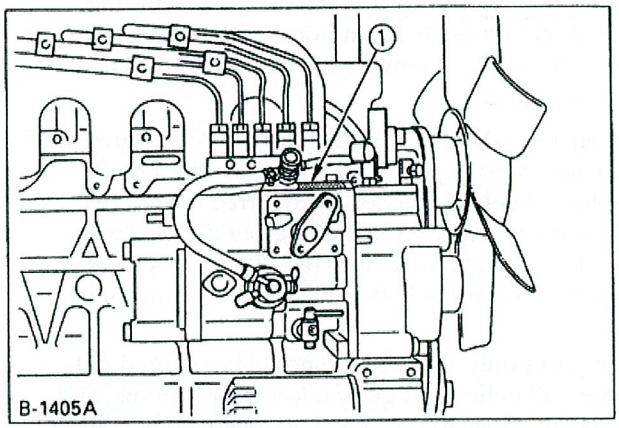
1. Immediately set the engine stop lever to the "STOP" position to stop the engine.
2. After stopping the engine, check the air cleaner, intake rubber tube and other parts and replace parts as needed.

4-2.3 Names of Parts





(1) Intake manifold
(2) Speed control lever
(3) Engine stop lever
(4) Injection pump
(5) Fuel feed pump
(6) Cooling fan
(7) Fan drive pulley
(8) Oil filter cartridge
(9) Water drain cock
(10) Oil filler plug
(11) Exhaust manifold
(12) Alternator
(13) Starter
(14) Oil level gauge
(15) Oil pressure switch
(16) Flywheel
(17) Oil drain plug
(18) Oil pan



(1) Engine serial number

4-2.4 Principles 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 therefore 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 rotating rectifier-hub assembly are separate units which are heat shrunk onto the generator shaft.

NOTE: For operation at ambient temperatures above 40 degrees C derate KW rating 1 percent for each degree C. Above 40 degrees C. For operation at high altitudes above sea level, rating must be derated 2 percent for each 1000 feet above sea level.

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

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 may be drawn from this generator.

VOLTAGE CONNECTIONS - The 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 the 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 120 volts, it should be pointed out that this connection the 240 volt is regulated and the lightly loaded phase will deliver a high line-to-neutral voltage and the heavily loaded phase will deliver 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.

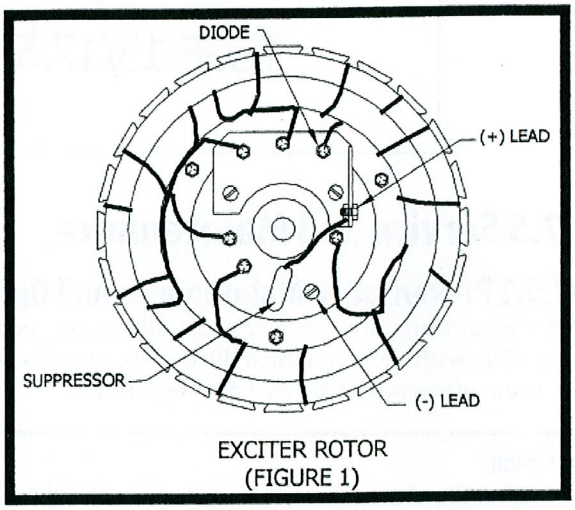
ELECTRONIC VOLTAGE REGULATION - Electronic Voltage Regulation (sometimes called automatic voltage regulation by many users) regulates the voltage by using a solid state electronic circuit of transistors, integrated circuits, SCR's, resistors, capacitors, etc., to sense the generator voltage and feed 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 rectifiers 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 impedence and resistance of the exciter field. For this reason 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 regulators are commonly designed for a minimum exciter field resistance of 25 OHM's, 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 an insulating ring. The entire assembly bolts to the adaptor on the generator shaft. Therefore, the rotating rectifier assembly will rotate with the exciter armature eliminating the need for any sliding contacts between the exciter output and the alternator field. (See Figure 1).



EXCITER ROTOR
(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 field 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 the static regulator. The static regulator senses a change in the generator output and automatically regulates current flow in the exciter field coil current to increase or adjustable rheostat sized to be compatible with the regulator is used to provide adjustment to the regulator sensing circuit.

BALANCE - The rotor assembly is precision balanced to 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 over speed. High centrifugal forces at excessive over speed can damage the damper winding 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 the unit is completely shut down and free of any power source before attempting any repair or maintenance on the unit.

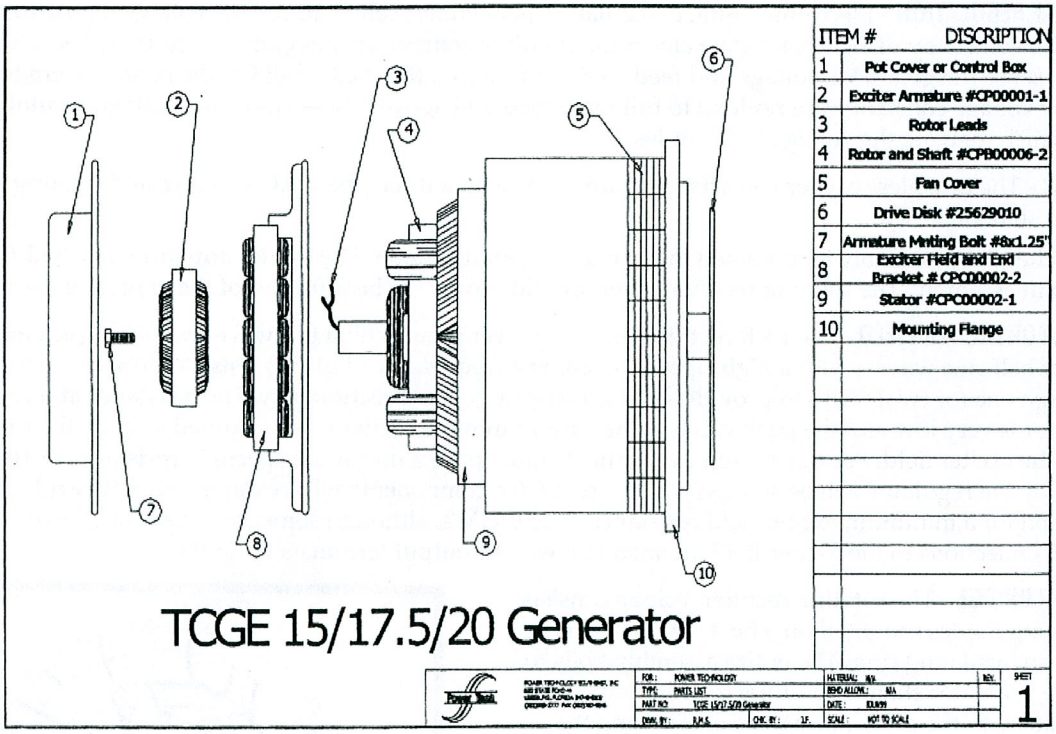


FIGURE 2

4-2.5 Service and Maintenance

4-2.5.1 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 ensure maximum efficiency of the electrical equipment.

!!CAUTION:

- **Do not exceed air temperature rise as shown for 50 deg. C above 40 deg. C ambient.**
- **Do not exceed the rated voltage or load.**
- **Operate Genset at rated speed.**
- **Keep regulating equipment at proper adjustment.**

4-2.5.2 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 40°C ambient. This ensures that the insulation NEMA class "F" will not be damaged. Do not exceed the rated voltage or load. 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 the windings due to over voltage or current.

4-2.5.3 Regulating Equipment

Regulating equipment should be kept in proper adjustment at all times. Read all instructions carefully before adjusting or repairing the regulating equipment.

!!CAUTION: Read all instructions carefully before adjusting or repairing the regulating equipment.

4-2.5.4 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 PART LIST FOR PART NUMBER. Include generator serial number when ordering bearings.

4-2.5.5 Rotating Diode Bridge

The rotating diode bridge can be removed and replaced. Excessive over current, over voltage, overspend, or reverse currents can cause damage to the assembly 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 speeds 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 over speed. Therefore, the prime mover should be adequately governed to prevent over speed. Damage to the rotor can also occur due to overheating which can be caused by one of the following:

1. Excessive field current due to failure of the regulator.
2. The exciter being operated below the rated speed which can result in excessive field current due to the regulator trying to 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 nameplate data, because the rotor coils are enclosed in welded squirrel cage winding. Should a 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 recurrence.

4-2.6 Precautions

4-2.6.1 Generator Winding (Drying)

Generators that have been in transit or storage for long periods may be subjected to extreme temperature 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 generator can result. The following steps should be taken to effectively dry the generator windings:

1. Short circuit the generator lead wires. Start the generator and separately excite the exciter with DC battery power of approximately 50 volts to produce rated AC nameplate current. To accomplish this excitation, the leads (F+ and C-) must be disconnected from the voltage regulator. Nameplate current can be measured with a clip-on ammeter at the generator leads. Make sure the AC current does not exceed the nameplate rating. Be sure to reconnect the leads to the proper terminals on the voltage regulator after the drying exercise.
2. Another procedure would be to put the generator in a heated room or to moderately heat with a heat source.

Experience has shown that it is necessary to take these precautions in locations such as seaboard installations and other highly humid areas. Some installations will be in atmospheres that are much more corrosive than others. A little precaution along the lines outlined here could eliminate an unnecessary repair job.

▲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.

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 the 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.

4-2.6.2 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 being 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 the exciter field coil wire F+ at terminal F+.
2. Connect a batteries positive lead to the field coil lead F+. Use 12 volt battery.
3. Connect the batteries negative lead to the field coil circuit terminal C.
4. Disconnect the battery leads after approximately 3 to 5 seconds. If the battery is connected for too long, over heating and subsequent damage to the exciter can occur.
5. Reconnect the field coil lead F+ to terminal F+.
6. Start the unit and observe the generator build up.

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

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

4-2.6.3 Alternate Procedure for Field Flashing

Apply either an alternating current or a direct current voltage of approximately 12 volts to any tow generator leads. Do not make a positive connection but rather touch the leads together until the generator voltage begins to rise and then separate the leads. It is suggested than 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 the 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. (See Figure 1)

4-2.6.4 Testing Diodes with an Ohmmeter

Isolate the rectifier assembly by disconnecting the lead from the main rotor and tree 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 reading of only a few OHM's when the probes are applied in one direction, and a reading of 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 hours "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 is a generally accepted practice to replace all diodes where failure can be traced to external causes after the cause of the diode failure is identified and corrected.

4-2.6.5 Troubleshooting Procedure for AC Brushless Generator

As with any machine, trouble may develop in electrical generators. It may be due to long service or neglect of regular 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.

4-2.6.6 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.

4-2.6.7 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 the rated speed, the voltage may drop off. Automatic control equipment may burn out trying to maintain voltage by forcing the field.

4-2.6.8 Visual Examination

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

4-2.6.9 Observe Voltage of Defective Generator

The next step is to carefully measure line to line voltage. A voltage about 10% of the rated voltage (at rated RPM) is probably the residual voltage (determined by residual magnetism in the 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 the residual magnetism in the exciter field was lost (generally by disassembly or by sudden interruption of the exciter field current), or that a generator defect exists in the exciter armature, rotor or stator.

4-2.6.10 Battery Excitation

The behavior of the generator, when the exciter field is connected to a 12 volt battery for excitation current, is a useful guide for location the generator fault. Disconnect F+ from C- from EVR and open CBI circuit breaker/switch in lead 3 or 4 to EVR (lead for power input to the EVR). Connect F+ to the positive side of the battery. Connect the negative side of the battery to C-. Spin the generator at 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 the voltage regulator to provide the voltage could mean a defective voltage regulator, or an open circuit in leads to terminals 3 or 4 of the electronic regulator. Check the 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 the exciter field resistance. It should normally be 25 to 28 OHM's at 77 deg. F. If the 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 an open or shorted rotors suspected, remove "R" lead from #10 base terminal on the armature and measure the 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 the generator until a hot smell is detected, or stop in 5 minutes (whichever occurs first). Feel the stator winding. If it is not, the stator or power wiring contains a short circuit. Examine the stator for burned (black) insulation which indicates a defective or damaged stator. Measure the stator resistance T1 to T2 and T3 to T4 if possible. With 12 volt excitation measure the voltage of 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% of the 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 effects exist, failure of the electronic regulator will occur. Replacement of the regulator alone will be followed by failure of the new regulator. If the electronic regulator has failed, it is wise to check the exciter current by placing a DC Ammeter in the F+ lead to the 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.

4-2.6.11 Rectifier Checking

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 the "AC" tab the ohmmeter should show a high resistance when polarity of the ohmmeter leads are reversed. The same conditions should be found from the "+" tab to any other "AC" tab and from "-" tab 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. Armature 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 the armature to which the (+) rotor lead and suppressor leads 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 the rectifier (+) and any AC terminal. Make the test also between the rectifier (-) lead (ground to case) to any AC lead. The test determines that all diodes are good or that one or more is defective. Since a ground armature winding gives the same test results as a bad diode, it is necessary to disconnect all AC rectifier connections and test the 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.

C. The 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 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 a 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.

4-2.6.12 Voltage Suppressor

Voltage suppressors 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 the suppressor from the circuit. If an obvious improvement in the generator is observed, the suppressor is bad. Some suppressors have a high resistance in either polarity of applied voltage (if applied voltage is low), but have a low resistance of voltages of 300 to 450 volts.

4-2.6.13 Resistance of Windings

Frequently in troubleshooting a generator, a defective component can be identified by measuring the resistance of a winding. The 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, suppressors, and resistors must be disconnected.

GENERATOR RESISTANCE VALUES								
ARMATURE			470-520 OHMS PER PHASE			5 TO 10 KW		
			650-720 OHMS PER PHASE			12.5 TO 50 KW		
FIELD			18-22 OHMS			5 TO 10 KW		
			23-28 OHMS			12.5 TO 50 KW		
Stator OHM's vary with KW rating, but less than 1 OHM per phase.								
ROTOR:								
8	10	12.5	15	17.5	20	25	30	50
1.47	1.58	1.73	1.84	2	2.1	2.2	2.5	3.8

4-2.6.14 Electronic Regulation

An electronically regulated generator has superior voltage regulation than other types (+/- 2 deg. within rated loads). Power Technology Southeast, Inc. 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: 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, 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 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 HA. 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 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 OHM's 8-10 KW and 25 OHM's 12-50 KW, although sometimes a slightly lower resistance can be tolerated. Connections to the exciter field are made at two DC output terminals, F+ and F-.

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