ATTACH: 1) 60706-3 - PTO operators manual
2) Basler XR2004 operators manual
3) WINCO Troubleshooting - page 9 (form # 1211)
4) Wiring Diagram # 60710-15

The attached operators manual is being revised for inclusion of the voltage regulator information, however, has not been printed. A copy will be sent to you if you fill out and tear out the bottom section of this sheet. We will keep it on file and when copies are received it will be sent to you at no charge. Thank you for your patience. Please contact the Service Department at WINCO, LeCenter if further assistance is needed connecting, operating or maintaining this unit.

Note the changes listed below in your manual.

a) Page 3 - Paragraph 2 - delete reference to brushes and sliprings. This unit is brushless.

b) Page 4 - Paragraph 1 - item 4b. - Octopus plug not supplied. Delete all reference to this load disconnect plug - load wires are directly connected to mainline circuit breaker.

c) Page 5 - delete reference to load connection octopus.

d) Page 8 - 1st column - Starting Procedure - item 3 - delete reference to 260 volts. Set speed for nameplate volts - 208V, 240V or 480V. Readjust speed to keep voltage constant.

e) See procedure below.

f) Delete voltage troubleshooting remarks page 9. Insert new page 9.

g) Page 10 - Delete reference to lube amount. Should be approximately 2 pints.

CUSTOMER NAME: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

MODEL NUMBER: _____ SERIAL NUMBER: _____

This is an interim instruction sheet for the subject models listed above. These new machines are 3600 rpm, brushless, externally regulated PTO generator sets, utilizing a frequency sensitive voltage regulator which will maintain correct voltage when the generator shaft is turning exactly 3600 rpms. The voltage regulator will automatically drop the output voltage whenever speed drops and will automatically increase the voltage whenever the speed is running too high. Setting the tractor speed is done by simply observing the voltmeter on the generator junction box and readjusting the tractor throttle to keep the voltage within the specified range.

The tractor PTO speed output is 1000 rpm. The PTO gearbox is provided on the front end to step up the 1000 rpm speed to 3600 rpm. This is accomplished with a single stage of gearing. See operators manual for maintenance checks on gear case.

Circuit description - The voltage control is accomplished by the model Basler XR2004V voltage regulator with the special frequency controlled voltage regulation circuit. This regulator is described in a separate voltage regulator manual attached. The output of the voltage regulator is a DC voltage varying with the generator frequency. The lower the frequency, the lower the DC voltage. High frequency will yield high voltage.

The DC voltage is applied to the brushless Lundell exciter assembly. Specifically, this voltage goes directly to the exciter field. The Lundell exciter armature, turning inside this strong magnetic field, produces a three phase output which is brought out on three short leads to three of the AC terminals of the rotating rectifier assembly bolted on the end of the shaft.

Upon examination, you will notice that there is a fourth AC terminal that is unused. This unused terminal can be used as a spare if one of the other AC terminals develops fault on the rectifier, particularly important in emergencies such as storms when the failure may occur and replacement parts may not be available. The rotating rectifier converts the three phase AC from the exciter armature to DC. The plus terminals of both rectifiers are tied together and fed to the plus field lead on the main rotor down the shaft. The minus rectifier terminals are also tied together and fed to the minus field terminals. The function of the Lundell exciter assembly and rotating rectifiers is to provide DC for the main rotating field while eliminating the need for brushes or other connections.

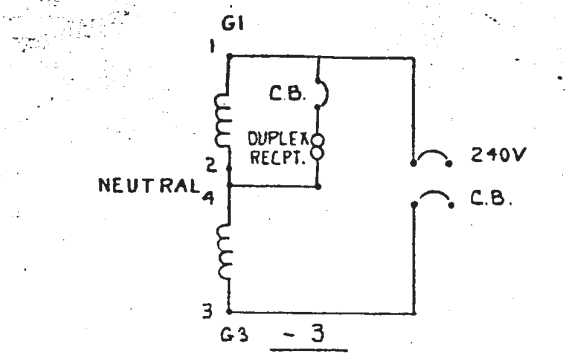
The DC on the main rotating field establishes strong north and south magnets on the two pole rotor. This very strong north and south magnet system rotating inside the main stator windings induces voltage in the stator output. This voltage is connected to the main circuit breaker and fed to the connected customer load. This voltage is also monitored by a voltmeter and a portion is tapped off to supply the input needs of the voltage regulator.

One revolution of the main generator shaft produces one sign wave cycle, so the rotating shaft must spin at 60 revolutions every second to produce 60 cycles per second power. 60 cycles per second (60 revolutions per second) is equivalent to 3600 cycles per minute; 3600 rpm. Whenever the frequency rises above 60 cycles (3600 rpm), the voltage regulator increases the generator voltage. This results in a high output voltage reading on your voltmeter and is an indication that the tractor speed should be reduced to bring the generator shaft speed down to 3600 rpm.

Maintenance - Unit should require no maintenance other than occassionally checking the lube level in the gearbox. The capacity of the gearcase is approximately 2 pints. The lube spec is in the attached PTO operators manual on page 10. The PTO operators manual is provided for general instruction. Please disregard references to 1800 rpm, 4 pole and brush maintenance as these items have been previously covered in this instruction.

Trouble Shooting Table

Symptom	Possible Cause	Correction
No output voltage	Load circuit breaker open	Reset/Replace
	Field circuit breaker open	Reset/Replace
	Voltage adjust rheostat dirty	Rotate knob back and forth, then reset. Test/Replace
	Loss of initial exciter residual magnetism	Flash the exciter field
	Loose or shorted wires in control box	Check all wiring and repair as needed
	Defective electronic voltage regulator	Carefully follow test procedure. Replace
	Defective rectifier	Carefully follow test procedure. Replace
	Shorted or open exciter field coil	Measure exciter field coil resistance for open or short. Replace
	Shorted or open exciter armature	Measure exciter armature resistance for open or short. Replace
	Shorted or open rotor	Measure rotor resistance for open or short. Replace
	Shorted or open stator	Measure stator resistance for open or short. Replace
Low output voltage	Engine speed too low	Check no load engine speed with a frequency meter and adjust governor to give 61.5 Hertz
	Generator overloaded	Calculate load being run and compare with name plate rating. With 3-phase generators, the load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.
	Defective electronic voltage regulator	Carefully follow test procedure. Replace
	Defective rotating rectifier	Carefully follow test procedure. Replace
	Defective rotor winding	Measure resistance between rotor leads and compare with the unit's Technical Data Sheet. Replace
	Defective stator winding	Measure resistance between stator leads and compare with the unit's Technical Data Sheet. Replace
High output voltage	Engine speed too high	Check no load engine speed with a frequency meter and adjust governor to give 61.5 Hertz
	Defective electronic voltage regulator	Carefully follow test procedure. Replace
Fluctuating voltage	Erratic engine speed	Refer to the engine manufacturer's maintenance manual
	Loose terminal or load connection	Make better mechanical and electrical connection
	Voltage regulation unstable	Carefully follow electronic voltage regulator test procedure. Replace
	Intermittent short in exciter field coil	Measure exciter field coil resistance for short. Replace
Generator overheating	Air vents obstructed	Clear obstruction
	Inadequate ventilation	Provide adequate compartment ventilation. Provide a fresh air inlet duct.
	High intake air temperature	Improve ventilation. Allow at least two feet clearance around generator.
	Generator overloaded or unbalanced	Calculate load being run and compare with name plate rating. With three-phase generators, the load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.
	Shorted turns in either rotor or stator	Measure rotor and stator resistance for short. Replace
Generator noisy and/or vibrates	Loose sheetmetal	Check hold-down fasteners. Tighten
	Rotor or impeller rubbing	Repair or replace defective part
	Bearing defective	Replace bearing
	Rotor unbalanced	The rotor should have small balancing washers or bars attached at one or both ends. If these are missing, contact the distributor.
	Drive engine unbalanced	Refer to the engine manufacturer's maintenance manual



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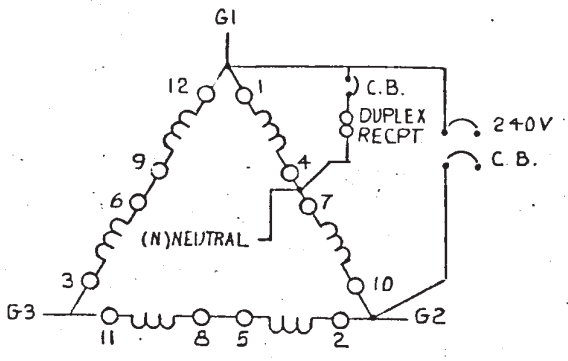

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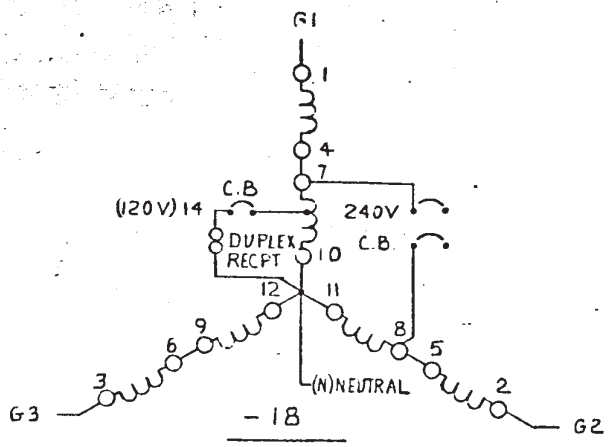

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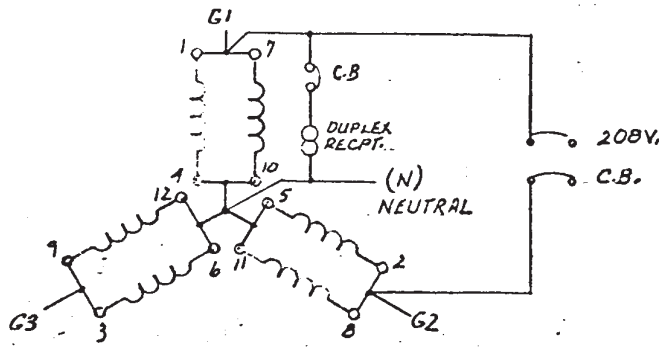

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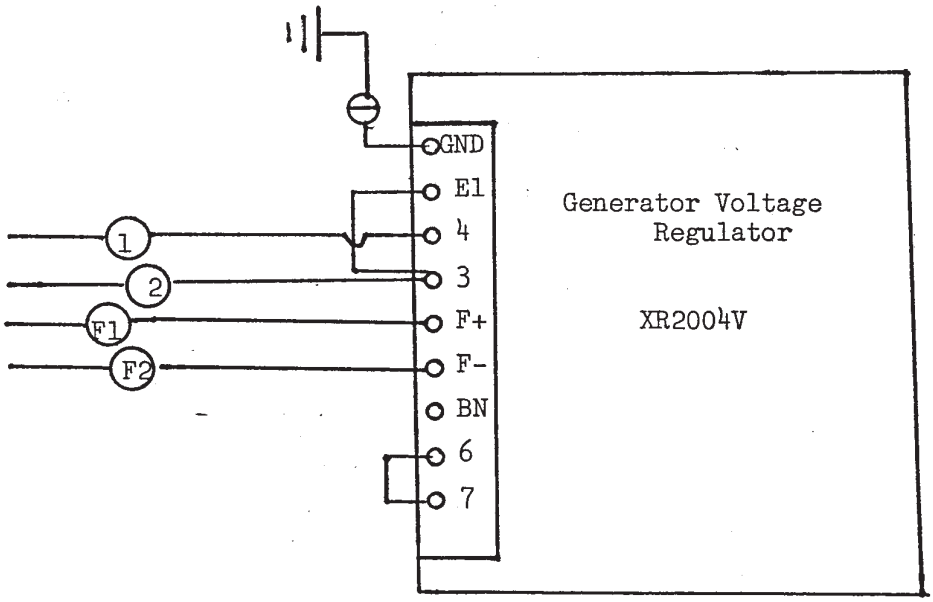


1. Lead wire from field circuit breaker.
2. Lead wire from small 240V/50A circuit breaker.

F1
F2 > To generator exciter stator.

Testing Procedures

Test procedures should be carefully followed when it has been learned from the Trouble Shooting Chart that symptoms point to a particular problem area. It should be noted that most maintenance and testing will require removal of the control box top and/or the louvered front cover.

> High voltage test equipment should not be used. All tests should be conducted using a volt-ohm meter.

Exciter Assembly

1. **Testing the Exciter Field:** The exciter field is checked for shorts and opens. Disconnect exciter field leads F1 and F2 from the voltage regulator. The resistance between F1 and F2 should be about 25 ohms. Resistance between either F1 or F2 and ground should be infinite. Replace the exciter field coil and ring assembly if resistance readings are incorrect.
2. **Separate Excitation of the Exciter Field:** Disconnect the F1 (positive) and F2 (negative) leads from the voltage regulator. Connect a 12 volt DC power source with Off/On switch in series with the F2 exciter field lead. Maintain polarity of positive to F1 and negative to F2.

> **CAUTION** Insulate connections so they cannot short against other components or against the control box itself.

Restart the unit and close the switch to the 12 volt DC power source. Voltage should build up with near normal voltage being measured at output terminals. If voltage builds to the correct level, continue to "tests of the electronic voltage regulator." If voltage does not build, continue to the next test.

3. **Testing the Exciter Armature:** The exciter armature is checked for shorts and opens. Disconnect the three exciter armature leads from the rotating rectifiers. Connect an ohmmeter lead to one lead of the armature and the other ohmmeter lead to each of the remaining armature leads in turn. The resistance measured should be too small to read on most test equipment. Resistance between each exciter armature lead and the rotor shaft should be infinite.
4. **Testing Rotating Rectifiers and Surge Suppressors:** *See Figure 4.* Disconnect the positive lead and one AC lead from the rectifier to be tested. Mark if necessary for identification. Place one ohmmeter lead on the positive terminal and the other lead on each AC terminal in turn. These readings should be the same whether high or low. Reverse the ohmmeter leads and repeat the test. These readings should be opposite. Repeat these tests between the negative terminal and each AC terminal in turn. If resistance readings are incorrect, replace the rectifier.

The surge suppressor is tested in like manner. Set volt-ohmmeter to RX 10,000. Disconnect the two field leads, marking if necessary to identify which is positive and which negative. Disconnect the negative (-) leads from the two rotating rectifiers. Place an ohmmeter lead on each end of the surge suppressor and then reverse the leads. Readings should be infinite one direction, and a high resistance the other direction. If resistance readings are incorrect, replace the surge suppressor.

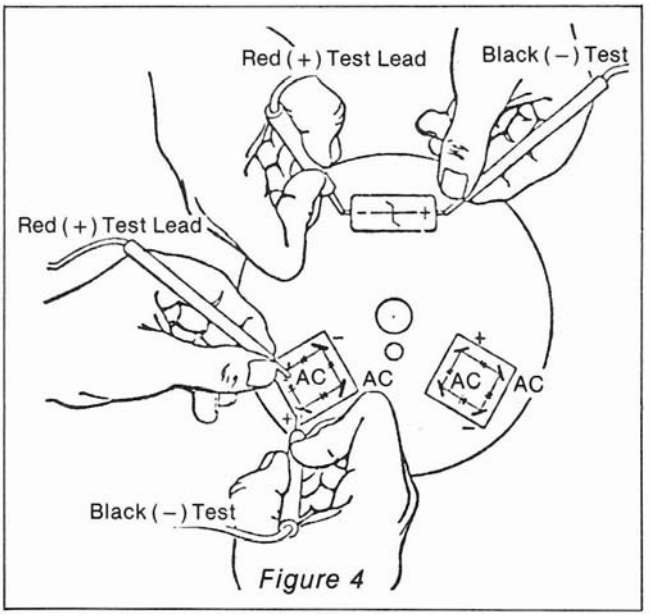


Figure 4

Testing the Rotor

1. Disconnect both rotor leads. These are connected to the surge suppressor on the rotating rectifier assembly. Measure the resistance between leads. The resistance should measure approximately 2.5 to 5 ohms. If the reading is correct, connect one ohmmeter lead to the rotor shaft and the other ohmmeter lead to one of the rotor leads. The reading should show infinite resistance. If the rotor proves to be defective, it must be returned to the factory for repair or replacement. Do not rewind.

Voltage Regulator (Optional KR4F/KR4FF)

1. Testing for Sensing Voltage: Measure the voltage between output leads 7 and 10. The voltage should be approximately 125 volts AC.
2. Regulator Voltage Output to Exciter: Using a voltmeter set to read at least 25 volts DC, connect the positive lead to F1 and the negative lead to F2. The reading should be between 10 and 20 volts DC at no load.
3. Consult voltage regulator instruction manual for testing, trouble shooting and adjustment procedures.

Testing the Stator

1. To test the stator for opens and shorts, the windings must be isolated.

> **CAUTION** Mark all leads for correct reconnection.

Disconnect the load leads from G1, G2, and G3. Disconnect the neutral leads. Disconnect the voltage regulator voltage sensing leads. Using a volt/ohmmeter, test the coil groups for continuity, and shorts to ground. If the stator proves defective it must be returned to the factory for repair or replacement.

Flashing the Field

1. Disconnect the F1 (positive) and F2 (negative) leads from the electronic voltage regulator. Connect a 12 volt DC power source across the exciter field leads for 1-3 seconds. Battery positive must go to F1 (positive) lead and negative to F2 (negative) lead. Touch F1 lead to F2 lead to neutralize any stored charge. Reconnect F1 and F2 exciter field leads to the electronic voltage regulator. Be careful to maintain F1 to positive and F2 to negative.

Testing Policy

Before any generator is shipped from the factory, it is fully checked for performance. The generator is loaded to its full capacity, and the voltage, current, and frequency are carefully checked. A test card with this data is filed by unit serial number for permanent record of performance.

Rated output of generators is based on factory tests of typical units, and is subject to, and limited by, the temperature, altitude, fuel, and other conditions specified by the manufacturer of the applicable engines.

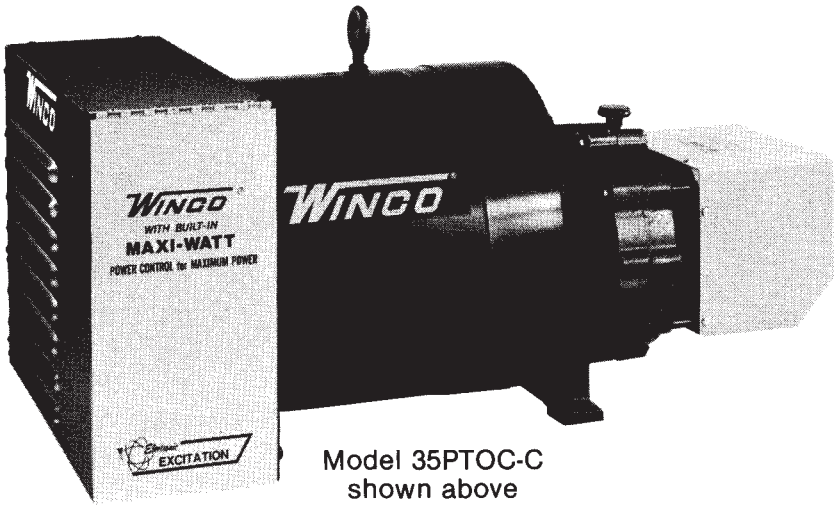
> NOTE: This instruction book covers only the generator, **not** the engine. See the engine manufacturer's operator's manual regarding any problems pertaining to the engine.

WINCO®

GENERATORS

POWER TAKE-OFF ROTATING FIELD GENERATORS

INSTALLATION, OPERATION, and MAINTENANCE INSTRUCTIONS



Model 35PTOC-C
shown above

Model 75FPTOC-4
shown above

Attention: Read all instructions in this manual before attempting to install, operate, or service your WINCO generator. This manual covers all WINCO Rotating Field PTO Generators.

Index

Limited Warranty

Winco Division of Dyna Technology, Inc., warrants that for thirty-six months from date of shipment it will repair or replace for the original user the whole or any part of the product found upon examination by Winco at its factory at 225 South Cordova Street, LeCenter, Minnesota, or by any Factory-Authorized Service Station to be defective in material or workmanship under normal standby use (average less than 50 hours per month) and service.

For warranty service, please return the product within thirty-six months from date of shipment, transportation charges prepaid, to the Winco factory or to your nearest Factory-Authorized Service Station as listed in the 'Yellow Pages' under Generator-Electric.

THERE IS NO OTHER EXPRESS WARRANTY. TO THE EXTENT PERMITTED BY LAW, ANY AND ALL IMPLIED WARRANTIES, INCLUDING THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED TO THIRTY-SIX MONTHS FROM DATE OF SHIPMENT, AND LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OR EXPENSES IS EXCLUDED. Some states do not allow limitations on the duration of an implied warranty, and some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights; you may have other rights which vary from state to state.

Winco does not warrant trailer tires, tumbling bars, or certain other component parts of the product, since such items are warranted by their manufacturers.

Winco does not warrant alterations or repairs which were made by someone other than the Winco factory or a Factory-Authorized Service Station and which affect the stability or reliability of the product.

Winco does not warrant products which have been exposed to misuse and/or negligence or have been involved in an accident.

Winco reserves the right to change or improve its products without incurring any obligations to make such changes or improvements on products purchased previously.

General Information

Description

WINCO Direct Drive Power Take-Off rotating field type generators are designed primarily for farm use, as a stand-by electrical power supply, utilizing the power take-off of a tractor or truck as the prime mover. The generator can be permanently installed on a foundation, or mounted on a trailer. The portable trailer mounted unit can be used to provide electrical power to machinery and out buildings where commercial power is not accessible.

Before any generator is shipped from the factory it is thoroughly checked for peak performance. The generator has been run a minimum of 20 minutes to seat the excitation brushes, so that good electrical contact is made between them and the slip rings. The generator has been fully loaded to its full rated capacity, and the voltage, frequency and current checked. No generator is shipped unless it produces its full rated capacity and passes other rigid inspection tests.

NOTE: The prime mover which drives the generator must be capable of delivering approximately 2.2 H.P. per 1000 watts output from the generator.

Safety Information

CAUTION: Possible damage to equipment

CAUTION

Caution notes indicate any condition or practice, which if not strictly observed or remedied, could result in damage or destruction of the equipment.

WARNING: Personal danger

Warning notes indicate any condition or practice, which if not strictly observed, could result in personal injury or possible loss of life.

Despite the safe design of this generator, operating it imprudently, neglecting its maintenance, or being careless with it can cause serious injury or death. This generator is powerful enough to deliver a fatal electric shock. Allow only a responsible and capable person to operate this generator.

1. Do not allow anyone to operate the generator without proper instruction.
2. Guard against electric shock.
3. Avoid touching live terminals or receptacles.
4. Be extremely careful if operating this generator in rain or snow.
5. Do not make or break electrical receptacle connections under load.
6. Use only grounded receptacles and extension cords.
7. This generator must be properly grounded.
8. Hot engine parts, moving parts, and generator output all can seriously injure the generator operator. The operator must use caution and remain alert when using this generator.
9. Provide safety guards for all drive systems.
10. Keep all safety guards and power shields in position and tightly secured.
11. When operating this generator, do not wear neckties, loose articles of clothing, or anything else that can be caught in moving parts.
12. Engine exhaust fumes are poisonous. Do not inhale them. Provide adequate ventilation if prime mover for generator is gas or diesel engine. Be sure generator itself is well ventilated.
13. The generator manufacturer recommends that only qualified electrical technicians be allowed to service (install, maintain, repair, or replace parts) this generator, and that only factory approved repair parts be used in it.
14. Do not work on this generator when fatigued.
15. Use extreme caution when working on electrical components. High generator output can cause injury or death.
16. Installing and wiring a home-standby generator installation is not a "do it yourself" project. Consult a qualified, licensed electrician or contractor. The installation must comply with all national, state, and local codes.
17. Excessive noise is tiring, and continual exposure to it can cause some degree of temporary and permanent hearing loss. Muffle engine noise with the best available noise suppression equipment; wear noise protection devices when necessary.
18. Keep the generator and the area around it clean. Remove all material that can create slippery conditions, such as grease, water, ice, and snow. Also remove oily rags and other flammable material from the area.
19. Keep a fire extinguisher near the generator. Extinguishers rated ABC by the NFPA are appropriate for this use. Consult the local fire department if you have questions regarding fire extinguisher ratings. Keep the extinguisher properly maintained and be familiar with its proper use.

Unpacking

NOTE: DO NOT invert generator during unpacking. Gearcase contains oil.

Unpack the generator as follows:

1. Remove strapping from carton.
2. Lift off carton.
3. Remove the small subpack carton.
4. Open the subpack carton and make sure it contains:
   a. one generator instruction manual
   b. one load disconnect plug (disassembled, in bag)
   c. one quality control inspection tag.
5. Remove the four bolts which hold down the generator feet to the pallet. (A six inch crescent wrench is suitable for this job.)
6. Lift the generator from the pallet by means of the lifting eye on the top of the generator.
7. Inspect the generator carefully for freight loss or damage. If loss or damage is noted at time of delivery, require that the person making the delivery make note of the loss or damage on the freight bill, or sign the consigner's memo of the loss or damage. Contact the carrier for claim procedures.

   When loss or damage is noted after delivery, segregate the damaged material, and contact the carrier for claim procedures.

   "Concealed damage" means damage to the contents of a package which is not evident when the package is delivered by the carrier, but which is discovered later. The carrier or carriers are responsible for merchandise lost or damaged in transit. The title to the goods rests with the consignee when the goods are shipped FOB factory, and only the consignee can legally file claims. Two years are allowed in which to file suit after a claim is disallowed in writing by the carrier.

Octopus Plug Assembly

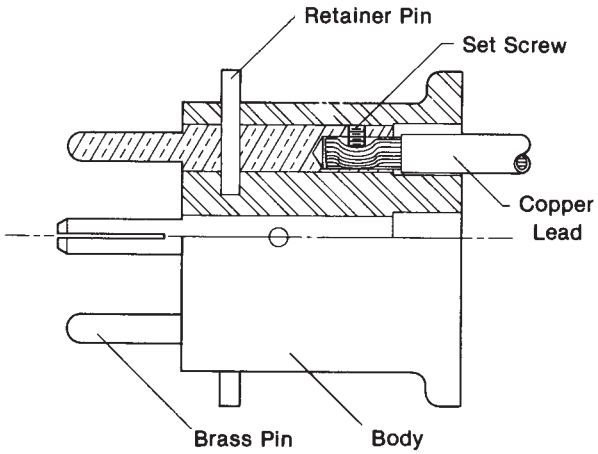


Figure 1

Assembly

The only assembly required after unpacking the generator is to assemble and wire the octopus plug, which is contained in a bag in the subpack carton packed in the generator carton.

The bag contains an instruction sheet, a plug body, three brass pins (large pin for neutral) for the single phase models, four brass pins (large pin for neutral) for the three phase models, and a manila envelope. The envelope contains an allen wrench, three or four retainer pins, and three or four set screws. The number and size of retainer pins and set screws included are designated by generator model and plug type.

To assemble and wire the octopus plug, proceed as follows. *See Figure 1.*

1. Cut lead cables to the required length.
2. Strip off insulation 7/8" back from one end of each cut-to-length cable.
3. Start a set screw into each pin.
4. Insert the stripped end of one cable fully into one of the brass pins, and tighten the set screw firmly to secure the cable end in the pin.

CAUTION If cable-to-pin connection is loose, arcing and heat damage to equipment can result.

5. Insert the brass pin (with cable) into the plug body, and line up the retainer pin holes in the brass pin with those in the plug body.
6. Insert the retainer pin, and tap it firmly into place. The retainer pin will protrude approximately 3/8" when fully seated. *See Figure 1.*
7. Repeat steps 4 through 6 for each brass pin. Make sure to connect the neutral lead (cable), identified and color coded in conformance with the applicable local electrical codes, to the large diameter pin ("N") on the plug.

During the next step, the octopus plug should not be plugged into its receptacle. Also, make sure that the equipment to which the plug leads are being connected is not energized (live).

8. Strip the insulation off the free end of each of the plug leads and connect them to the load transfer switch (or directly to the load).

Installation

Foundation Mounting

Mount the generator on a foundation if it is to be used as a leave-in standby power source.

See Figure 2. When planning a new foundation, consider the following points:

1. The foundation location should enable aligning the tumbling bar (coupling shaft) in a straight (or nearly straight) line with the power take-off and the generator input shaft. (Misalignment must be less than 15 degrees even though the mechanical design of the tumbling bar would allow greater misalignment.)
2. The foundation must be solid enough to absorb generator starting and reflected load torque during operation.
3. The foundation surface should be flat.
4. Space is required around the generator for mounting switching devices, making connections, and for servicing.

All four generator mounting pads must rest firmly on the foundation. Install shims if necessary to even out the foundation under the mounting pads, then bolt the generator firmly in place.

Foundation, for Permanent Installation

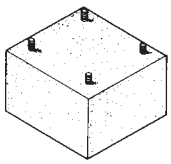


Figure 2

Trailer Mounting

Mount the generator on a trailer if you plan to use it as a portable power source.

See Figure 3. When selecting or building a trailer to mount the generator, consider the following points:

1. The trailer construction must be strong enough to support the generator.
2. The design of the trailer must enable the trailer to remain stable during operation, and to resist tipping caused by generator starting and reflected load torque.
3. The trailer height and mounting position of the generator on the trailer should enable aligning the tumbling bar (coupling shaft) in a straight (or nearly straight) line with the power take-off and generator input shafts. (Misalignment must be less than 15 degrees even though the mechanical design of the tumbling bar would allow greater misalignment.)
4. The generator mounting area of the trailer bed should be flat.

All four generator mounting pads must rest firmly on the trailer bed. Install shims if necessary to even out the bed under the mounting pads, then bolt the generator firmly in place.

Trailer may tip over and cause injuries if wheels are not spaced far enough apart.

Trailer, for Portable Installation

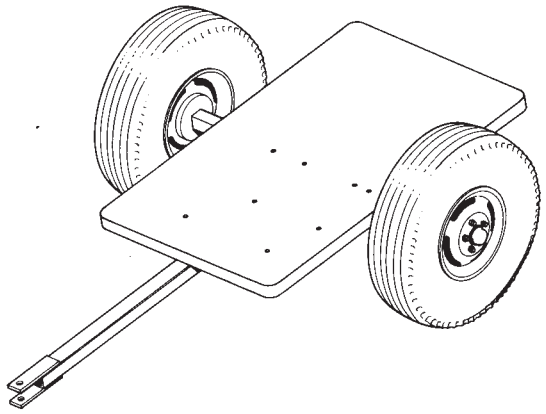


Figure 3

Output Power and Load Determination

The maximum load which should ever be applied to the generator is the KW (kilowatt) or wattage rating of the generator. This rating is stamped on the generator identification nameplate, and is only available at the octopus plug. The 120 volt receptacle protected by a 15 amp. push to reset circuit breaker is limited to a 15 amp. load. The 240 volt, 50 amp. receptacle protected by a switch type circuit breaker rated at 50 amps is limited to a 50 amp. load. *Example:* If the generator is rated at 125 amps. and a load of 15 amps. was plugged into the 120 volt 15 amp. receptacle, that would leave 110 amps. available at the octopus plug. If a 15 amp. load was plugged into the 120 volt receptacle, and a 50 amp. load at the 240 volt receptacle, that would leave 60 amps. available at the octopus plug. Use the following formulas to find the load current of different appliances.

Electrical Connections

NOTE: Only qualified electricians should install electrical wiring. Wiring must conform to all applicable national, state, and local codes. (Reference: National Fire Protection Association Manual No. 70, National Electrical Code.)

If the generator is to be used as a standby power plant wired into the existing commercial system, a disconnect switch must be installed which will isolate the generator from the commercial power whenever the generator is not operated, and will isolate the commercial power from the generator when the generator is operating. *See Figure 4.*

IMPORTANT: When making standby service hook up, make sure load to be transferred to standby generator will not exceed generator rating.

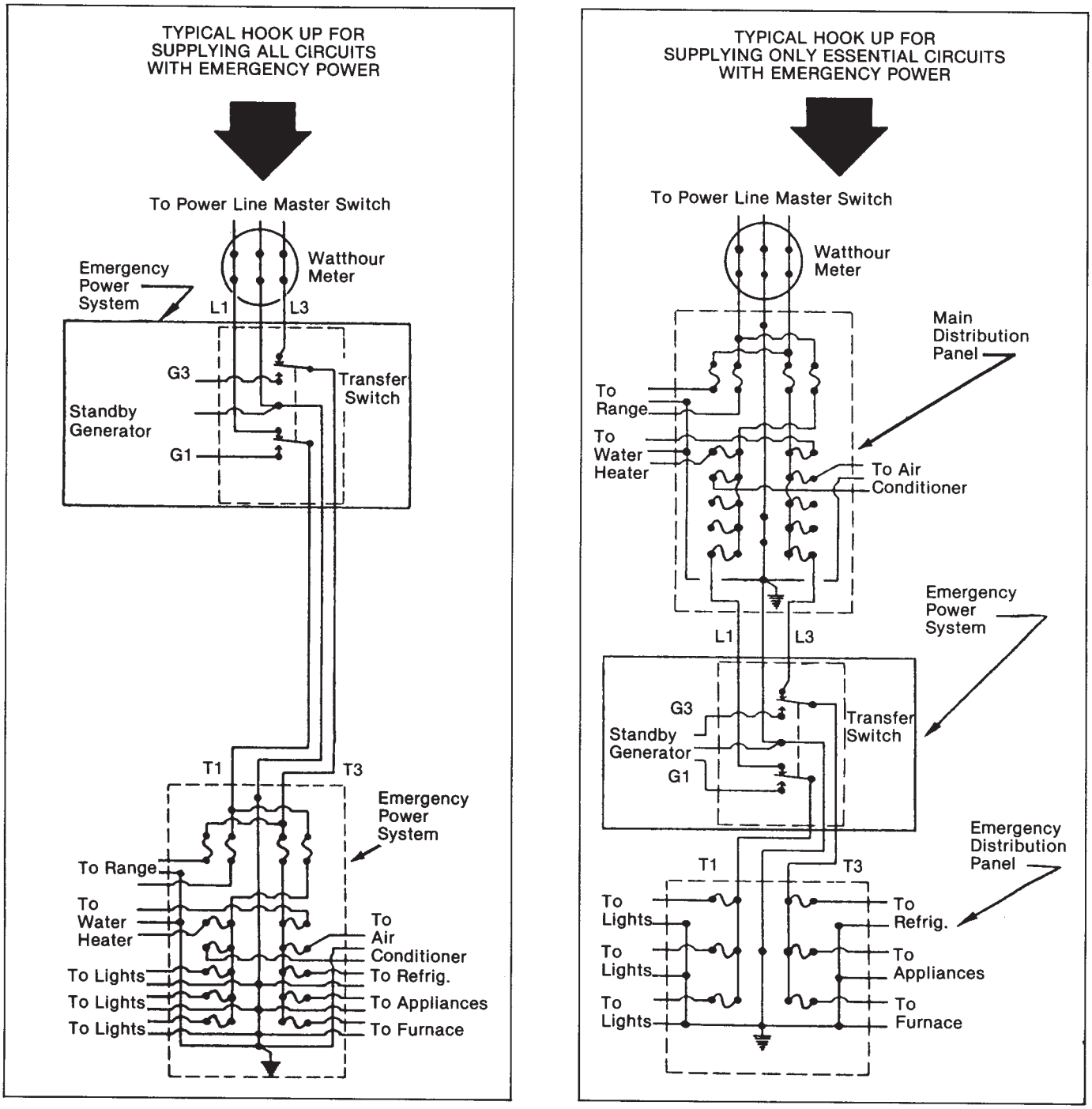


Figure 4 **Typical Connection Methods for Generator Standby Power Service**

$$\frac{\text{Load Wattage Rating}}{120 \text{ volts}} = \text{Load current in amperes}$$

Example:
Food freezer requires 300 watts

$$\frac{300 \text{ watts}}{120 \text{ volts}} = 2.5 \text{ amps.}$$

Refrigerator requires 325 watts

$$\frac{325 \text{ watts}}{120 \text{ volts}} = 2.7 \text{ amps.}$$

Ten 100 watt light bulbs require 1000 watts

$$\frac{1000 \text{ watts}}{120 \text{ volts}} = 8.3 \text{ amps.}$$

Freezer	=	2.5 amps.
Refrigerator	=	2.7 amps.
Lights	=	8.3 amps.
Total Load	=	13.5 amps.

Use the same method to figure the load current for the 240 volt electrical loads.

NOTE: Check appliance/motor nameplate for voltage, current, and wattage specifications when figuring load current.

Use of Electric Motors

Electric motors require much more current to start than to run. Most fractional horsepower motors take about the same amount of current to run them whether they are of the Repulsion-Induction, Capacitor, or Split-Phase type. Starting current, however, varies greatly. Repulsion-Induction motors are the easiest to start and usually require 1½ to 2½ times as much current to start as to run them. Capacitor start motors usually require 2 to 4 times as much current to start them as to run them. Split-phase motors are hardest to start, with starting currents about 5 to 7 times the running current.

NOTE: In applications where several motors are to be started, excessive overload may be avoided by starting them one at a time, starting the motor that requires highest running and starting current first.

Pre-Start Checks

When working on or around this generator, do not wear loose fitting clothing or any articles that may get caught in moving parts.

1. Visually inspect the generator. Check for:
   a. correct mounting
   b. physical damage
   c. debris in cooling vents and screens (could cause generator to overheat).

CAUTION If the generator has been stored for any length of time it is recommended that the control box cover, and the cooling fan screen be removed, and the generator inspected for rodent nests or other foreign objects that could cause binding or overheating of the generator. *See "Cleaning" generator maintenance for procedures.*

2. Check gear case oil level. *See Figure 5.* Case should be filled with oil to plug marked "OIL LEVEL." Fill or remove oil as required.

CAUTION Either too little or too much oil can harm the equipment. *See* "Lubrication" portion of Maintenance for oil specifications.

Gear Case Oil Plug Locations

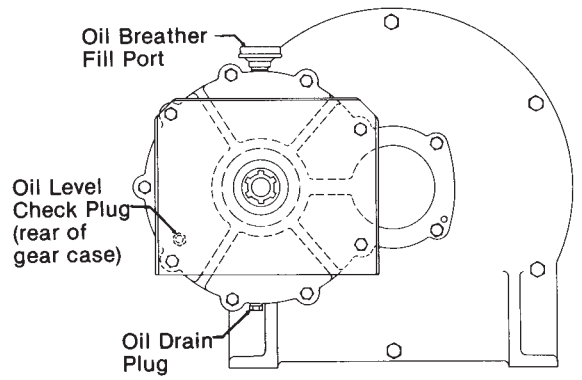


Figure 5

3. Make sure tumbling bar (coupling shaft) is assembled with its universal joint knuckles "synchronized," as illustrated in *Figure 6.* If knuckles are not synchronized, the bar will chatter when rotating, which will cause the generator output voltage to fluctuate.

Power take-off must be disengaged at this time.

4. Couple the generator drive (power take-off) to the generator with the tumbling bar. Couple the tumbling bar to the generator input shaft first, then to the power take-off shaft. Check alignment: power take-off shaft, tumbling bar, and generator input shaft should form a straight (or nearly straight) line, with less than 15° misalignment between the shafts. Misalignment will cause generator output voltage to fluctuate.

Make sure that all tumbling bar lock pins are engaged and that all safety shields are in place.

5. Make sure no binding exists in generator or gear box by rotating tumbling bar by hand. If binding is found, locate the cause and correct it before proceeding.
6. Make sure that the electrical loads connected will not draw more current than the rating of the generator or receptacle being used.
7. Check all electrical connections in the system to be energized by the generator. Make sure the connections are correct and are tight.
8. Make sure all loads are turned off.

CAUTION Do not start the generator under load.

Tumbling Bar (Coupling Shaft) Universal Joints: Synchronized vs. Unsynchronized

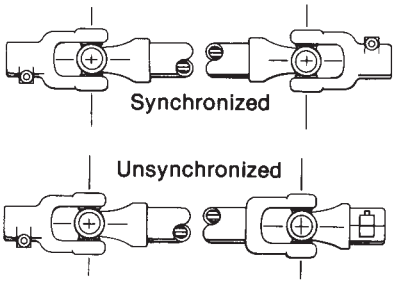


Figure 6

Generator Starting Procedure

1. With the power take-off drive disengaged, start the engine which will drive the generator. Run the engine long enough to warm it up before proceeding, so that it will run smoothly and achieve full power under generator load.
2. With engine idling, engage the power take-off drive.
3. Watch the voltmeter on the generator and slowly increase engine speed until the output reaches approximately 260 volts (in green portion of voltmeter scale).
4. With engine and generator running smoothly, switch on the electrical load while watching the voltmeter.

CAUTION If load includes motors, turn them on one at a time, highest starting current motor first, next highest second, etc.

Readjust engine throttle to keep generator output under load at 240V (in green portion of voltmeter scale). If engine is equipped with a speed governor, it may automatically readjust the throttle as the load changes and keep the generator output at 240V. However, some governors are not sensitive enough to maintain 240V output under changing load, and in such cases the throttle will have to be manually readjusted.

Generator Shutdown Procedure

1. Switch off electrical load.
2. Reduce speed of engine driving generator to idle.
3. Disengage power take-off drive, and allow generator to coast to a stop.

Never try to manually stop the generator—let it coast until it stops!

4. Disconnect tumbling bar (coupling shaft) power take-off end first, then generator end.

Trouble Shooting

The following chart lists various symptoms of poor generator operation with possible causes for them and the appropriate corrective action. You will need a volt-ohm meter or test light to check some of the causes. For some of the other causes you will need to check generator speed. To check generator speed you can use a frequency meter, a tachometer, or a 120V-60Hz electric clock and a correctly operating wrist watch. (Run the electric clock on generator power and compare the clock's second hand movement with that of the wrist watch. They should run at the same speed. If clock runs faster, generator speed is too high, and vice versa.)

CAUTION Most electrical equipment in North America operates satisfactorily at frequencies between 59 and 61 Hz (cycles per second). Operating the generator at frequencies outside that range may cause damage to the generator and/or to electrical equipment driven by the generator.

Troubleshooting Table

Symptom	Cause(s)	Corrective Action
No output voltage.	Circuit breaker open.	Reset circuit breakers; replace if defective.
	Defective voltmeter.	Check output with another meter, replace meter if defective.
	Short circuit in the load.	Disconnect the load. Check voltage at receptacle cord set. Check motors, appliances and load leads for short circuit. Repair short.
	Defective receptacles.	Remove panel cover and check for voltage to the receptacles. Replace defective receptacles.
	Loose (or broken wires or connections in control box.	Remove panel cover and check all wiring and connections. Tighten and/or repair where necessary.
	Defective rectifier.	Test rectifier. Replace if defective.
	Dirty slip rings.	Clean and polish. Use 00 sandpaper and crocus cloth, **never** emery paper.
	Brushes binding in holders.	Check brushes for swelling; replace defective brushes; clean brush holders.
	Shorted or open rotor.	Measure rotor resistance. Replace rotor if open or shorted.
	Shorted or open stator.	Measure between leads for open or short. Replace stator if defective.
	Open transformer.	Connect or tighten primary and secondary leads. Check secondary for open circuit. Replace transformer if defective.
	Rotating field polarity incorrect.	Check by interchanging F (−) and F (+) leads at brushes. Inner slip ring is positive F (+) and must be connected to the (+) terminal of the rectifier. Flash the field with 12 volts DC.
Low voltage.	Engine speed too slow.	Check engine speed. Increase RPM if necessary.
	Generator overloaded.	Reduce load if it is higher than the rated capacity of the generator. (See generator nameplate.)
	Inadequate engine horsepower.	Generator requires 2.2 H.P./1000 watts output. Obtain larger engine if necessary.
	Incorrect field excitation. (No load output low.)	Check for worn brushes and weak or broken brush springs; replace as required. Check input AC voltage to rectifier. Check rectifier output DC voltage to positive DC brush. If no DC voltage is present at the brush, replace the rectifier. Check for dirty slip rings. Clean them if they are dirty.
	Connection of current transformer secondary leads not correct.	Have qualified service technician recheck and correct the connections.
High voltage.	Engine speed too fast.	Check engine speed for correct input RPM.
	Connection of current transformer secondary leads not correct.	Have qualified service technician recheck the connections.
Output voltage flickering or fluctuation.	Tumbling bar (coupling shaft) misalignment.	Reduce tumbling bar misalignment to less than 15 degrees.
	Engine speed not constant.	Engine governor may be worn or improperly adjusted. Set or repair defective governor.
	Loose connection in field circuit.	Check and tighten connections.
	Tumbling bar U-joints not synchronized.	Reassemble tumbling bar; see Figure 6.
Excessive vibration.	Power take-off misalignment excessive.	Correct misalignment. It should be less than 15 degrees.
	Loose mounting nuts and bolts or hold-down studs.	Tighten mounting nuts and bolts; repair hold-down stud mountings.
	Universal joints in coupling shaft worn or dry.	Repair or replace defective parts.
	Defective bearings.	Check for possible causes. Replace defective bearings.
Generator overheating.	Poor ventilation.	Clean ventilation and cooling fan screens.
	Generator overloaded.	Reduce load, then check voltage and current.
	Shorted turns in field or stator.	Replace defective components.
Oil leak.	Loose plug in gear case.	Tighten plug.
	Defective seal, gasket, or plug in gear case.	Replace seal(s), gaskets or plugs. Maintain correct oil level.

Preventive Maintenance

General

Routine preventive maintenance minimizes costly repairs and generator down-time. Before each use, inspect the generator: gear case oil level should be correct, cooling vents and screens should be clear, and generator mounting hardware should be tight. Clean and inspect the generator after storing it for long periods, and after using it in extremely dusty conditions or in severe weather, such as rain or blowing snow.

CAUTION The manufacturer strongly recommends running the generator under load at least once a month in order to evaporate any accumulated moisture condensation.

Lubrication

The generator bearings are factory lubricated and sealed, and require no further lubrication.

The splined generator input shaft should be cleaned and lubricated with a thin film of grease before and after each use of the generator.

The coupling shaft (tumbling bar) requires greasing. Keep the universal joints in the coupling shaft free from grease and dirt buildup.

CAUTION Do not overlubricate the universal joints.

See Figure 7 for recommended lubrication schedule for tumbling bar.

Check the generator gear case oil level before each use of the generator. Maintain the oil level at oil level plug height. *Figure 5* illustrates oil level plug location. The generator is shipped with lubricant in the gear case. Specifications for gear case lubricant are:

API Service: GL-5
Grade: SAE 85W-90-140
Amount: 1 pint

The following kinds of oil are recommended for use in the generator gear case: Mobil SAE 85W-90-140 API Service GL-5, Sunoco/DX XL80-90-140, Kendal Three Star 85W-140, Amoco 85W-140, or equivalent.

CAUTION Do not overfill generator gear case. Overfilling causes overheating and oil seal failure.

Change the oil at least once every six months. Change it more often if you use the generator in bad weather.

Use the following procedure to change generator gear case oil. *See Figure 5.*

1. Remove gear case breather. Soak breather in cleaning solvent, then allow it to dry.
2. Remove oil level check plug.
3. Remove the oil drain plug. Drain the oil into a clean oil resistant container, one quart or more capacity. Check the oil for metal. Fine metal dust in the oil does not indicate trouble, but metal chips do. Dismantle the gear case and look for damaged gears if you find metal chips in the oil.
4. Replace the oil drain plug. Refill the gear case through the breather port with new oil of the recommended type. Fill the case up to oil level check plug height. (It will take about one pint.)
5. Replace the oil level check plug.
6. Replace the breather.

Cleaning and Inspecting the Generator

Use a vacuum cleaner or dry low pressure compressed air (regulated at 25-35 PSI) to clean the generator periodically.

Do not clean the generator while it is running.

Proceed as follows:

1. Remove ventilated control box cover. Vacuum or blow vents and screen clear of dust or debris. Wash them down with cleaning solvent if necessary.
2. Remove cooling fan shroud. Vacuum or blow dust from screen and fan blades. Wipe them off with cleaning solvent if necessary.
3. Vacuum or blow dust and other debris from inside generator and control box.
4. With panel cover removed, inspect the brushes for wear, and inspect the wiring for correct routing, fraying insulation, and secure connections.
5. Replace panel cover and cooling fan shroud.

Generator Storage

Before storing the generator, apply a heavy coat of grease to the splined input shaft. Store the generator in sheltered area, where it is protected against snow, rain, and excessive dust.

Lubrication for Typical Tumbling Bar (Coupling Shaft)

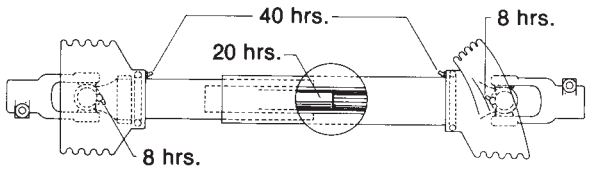


Figure 7

Maintenance Record

Date	Maintenance Performed	Replacement Components Required

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