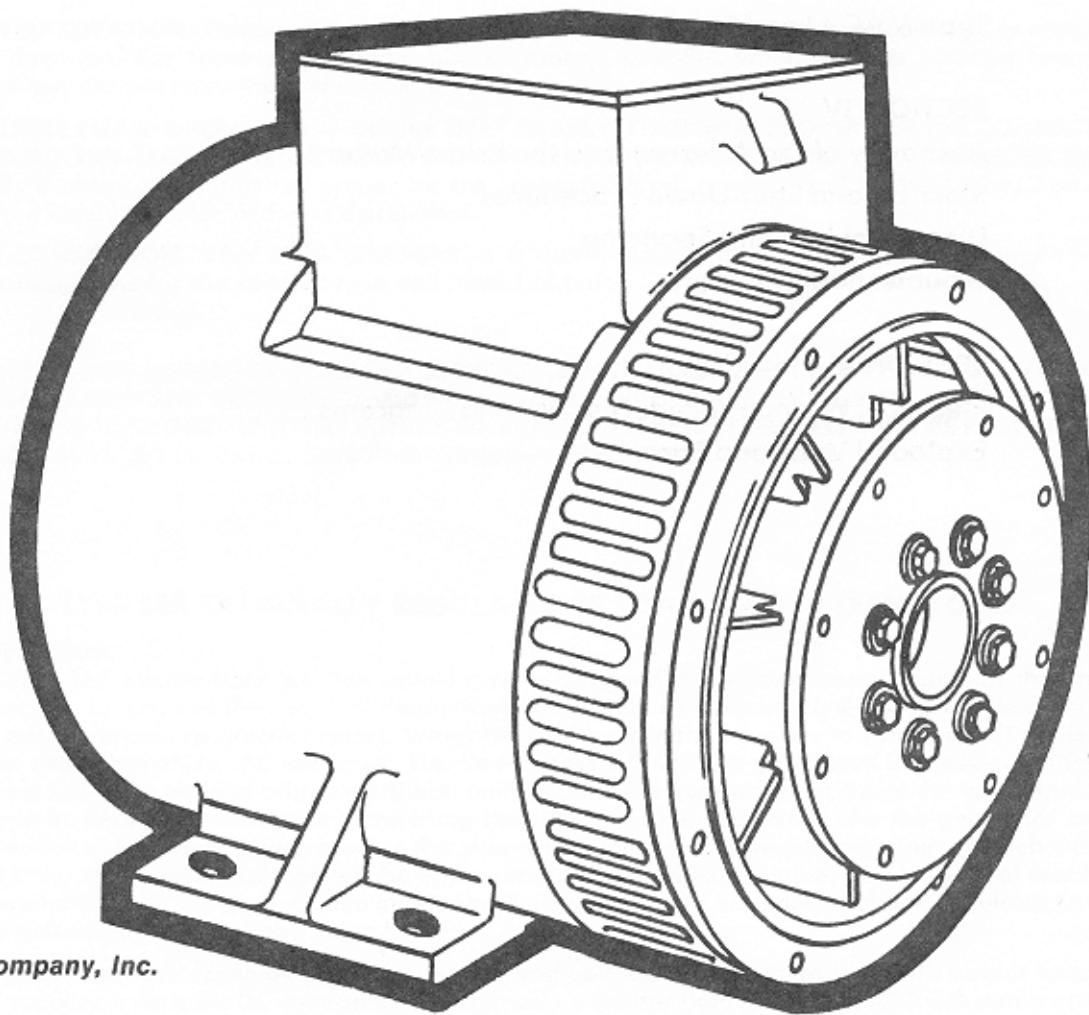


250 FRAME GOLD MEDALLION SERIES BRUSHLESS AC SYNCHRONOUS ALTERNATORS

TYPE SER EXTERNALLY REGULATED ALTERNATOR

TYPE MAC SELF-REGULATED ALTERNATOR, 3 PHASE SERVICE

TYPE MAC SELF-REGULATED ALTERNATOR, 1 PHASE SERVICE



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Making Energy Work for You

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LIMA ELECTRIC CO., INC., FRAME 250 SERVICE MANUAL

GENERAL (ALL TYPES)

NOTICE: The following instructions are essential to assure proper installation, operation, and maintenance of the alternator, and for the safety of operating and service personnel. Installation and maintenance should be performed only by qualified personnel in strict observance of procedures and safety measures set forth in this manual.

All electrical connections should be made in accordance with current government, industry, association codes and standards. Grounding (earthing) of this alternator should be in strict accordance with the National Electrical Code (NFPA 70), or the appropriate electrical code or standard having jurisdiction at the installation site.

Mechanical connections and assembly should be made with grade 5 or better hardware and fasteners.

Observe all cautionary information provided with installation, operation, and maintenance procedures.

Disable or render inoperative any engine cranking devices before attempting to install or service this alternator. For electric start sets, disconnect the cranking battery. For air start, disconnect air supply. Failure to comply with this procedure could result in severe injury to personnel or damage to equipment.

1. **INCOMING INSPECTION.** Immediately upon receipt of your Lima alternator check for damage to housing, windings, and mechanical parts. Shipping damage claims must be instituted through the carrier, and must be made within the time limit specified by ICC regulations.
2. **STORAGE.** Alternators should be stored in a clean, dry place, not subject to rapid and severe changes in temperature and humidity. If humid storage conditions cannot be avoided, the unit should be warmed and dried prior to installation and test.
3. **DIRECTION OF ROTATION.** This unit may be operated with shaft rotation in either a clockwise, or counter-clockwise direction. For three phase units, phase rotation is A-B-C when shaft is rotating counter-clockwise when viewed from the end opposite the drive end.

CAUTION: FOR THREE PHASE OPERATION — INSURE THAT PHASE ROTATION IS PROPER FOR THE CONNECTED LOAD. FAILURE TO DO THIS MAY RESULT IN INJURY TO PERSONNEL, OR DAMAGE TO THE CONNECTED ELECTRICAL EQUIPMENT. If phase rotation is not proper for the connected load, reverse load leads L1 and L2 on the generator side of the circuit breaker or fused disconnect.

4. **EXTERNAL CONNECTION.** Your LIMA alternator is a reconnectable unit. See pages 6, 14 and 15 for available connections for the specific type and model of unit.

CAUTION

WIRING OF THE ALTERNATOR SHOULD BE DONE IN ACCORDANCE WITH GOOD ELECTRICAL PRACTICES. FOLLOW GOVERNMENT, ASSOCIATION AND INDUSTRY STANDARDS. IN SOME WIRING ARRANGEMENTS, GROUPS OF TERMINALS ARE CONNECTED TOGETHER WITH NO FURTHER TERMINATION. THESE TERMINALS MUST BE PROPERLY INSULATED TO AVOID A HAZARD TO PERSONNEL AND POTENTIAL EQUIPMENT DAMAGE.

SECTION I. TYPE SER EXTERNALLY REGULATED 12 LOAD LEAD ALTERNATORS.

PRINCIPLES OF OPERATION

Initial Voltage Buildup. The exciter field (exciter stator) core is designed to be the primary source of the unit's residual magnetism. The function of this residual magnetism is to establish magnetic lines of force (flux) across the air gap to the exciter armature (exciter rotor). When the exciter armature begins to rotate a voltage is induced in the exciter rotor (armature) AC windings. The three phase AC voltage generated in these windings is rectified to DC by two full wave molded bridge rectifiers, and supplies the necessary excitation for initial buildup of the magnetic field in the main rotor, thus eliminating the need for "field flashing". As the generator shaft rotates a "residual voltage" is induced (generated) in the alternator's main armature (stator) windings such that at rated speed, rated RPM, this residual voltage will be approximately 25% of rated value. This amount of residual voltage at the alternator's terminals is more than adequate to allow the unit's automatic voltage regulator (AVR) to "boot strap" the unit up to rated voltage value.

Operation. In operation, the AVR receives both input power and voltage sensing from the unit's output voltage (see Figure 1), and supplies a variable DC voltage to the alternator's exciter field leads. The AVR will automatically control and coordinate this DC voltage supplied to the exciter with the sensed alternator output voltage to keep the unit's main revolving field at the appropriate level of flux density necessary to maintain output voltage at the preset level under any condition of loading from no load to rated load.

Adjustment of the alternator's output voltage is accomplished by a voltage adjust rheostat provided with the automatic voltage regulator. Since a variety of AVRs are offered for use with Lima Type SER alternators, consult the manual supplied with your particular voltage regulator for specific adjustment and operating instructions.

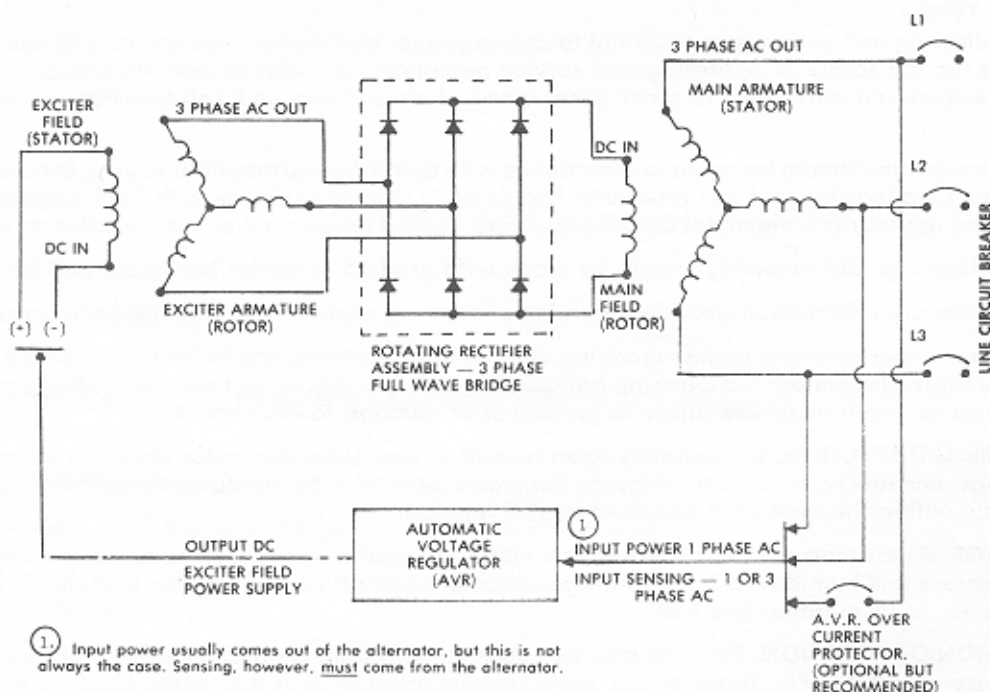


FIGURE 1

Brushless Exciter. The brushless, rotating exciter consists of a 6 pole stationary field housed in the main alternator frame, a three phase rotating armature winding with the core keyed and pressed on the shaft, and a rotating rectifier assembly consisting of two full wave molded bridge rectifiers securely bolted to the exciter rotor (armature) core.

External Connections. Your 12 load lead Type SER alternator may be connected in a variety of either three phase or single phase connection methods. See pages 14 and 15 for the specific connection method desired.

SECTION II. SELF REGULATED TYPE MAC 10 AND 12 LOAD LEAD ALTERNATORS.

PRINCIPLES OF OPERATION.

The MAC alternator is a self-regulated, revolving field synchronous generator with a four salient pole "wet wound" main field. The generator stator and exciter stator are combined in a common housing. The generator field, exciter rotor and rotating rectifier assembly are mounted on a common shaft. The output of the exciter rotor is applied to the generator field winding through a rotating, full wave bridge, silicon rectifier unit. Each of the four main field poles have a small permanent magnet imbedded in it to provide the residual magnetism necessary for initial voltage buildup.

Figure 2 shows the internal schematic diagram of the generator, exciter and rectifier unit. The generator is a three phase unit and the exciter stator and exciter rotor also have three phase windings. A portion of the exciter stator windings is connected across a tap on the generator stator winding. This exciter shunt winding provides the generator field excitation power required for the generator no load voltage. Another portion of the exciter stator windings, is connected in series with the output of the generator and the exciter rotor is, in effect, the secondary of a rotating current transformer induction frequency converter. The exciter rotor output voltage is applied to the generator field windings by two molded full wave rectifiers secured to the exciter rotor. The response time of this type of excitation system is extremely fast since the exciter stator carries an alternating current corresponding to the load current which appears immediately on the exciter primary. An increase in load current will cause an immediate increase in the exciter secondary output voltage which is rectified and applied to the generator field windings. The inherent compounding characteristics of the excitation system provide excellent voltage regulation even under heavy overload conditions. The excitation characteristics of fast exciter response with maximum exciter output makes this generator ideal for motor starting loads that require a very high current at low power factor during the motor starting and acceleration periods. At the same time it offers the rugged, reliable, maintenance-free operation inherent in the brushless type generator. No external controls are needed with a Lima generator.

All inter-connections between the main stator and the exciter stator windings are made internally with the connected leads insulated and brought up in the conduit box for easy inspection. For normal operation these leads

CIRCUIT DIAGRAM OF LIMA TYPE MAC BRUSHLESS, SYNCHRONOUS, SELF-EXCITED, SELF-REGULATED ALTERNATOR

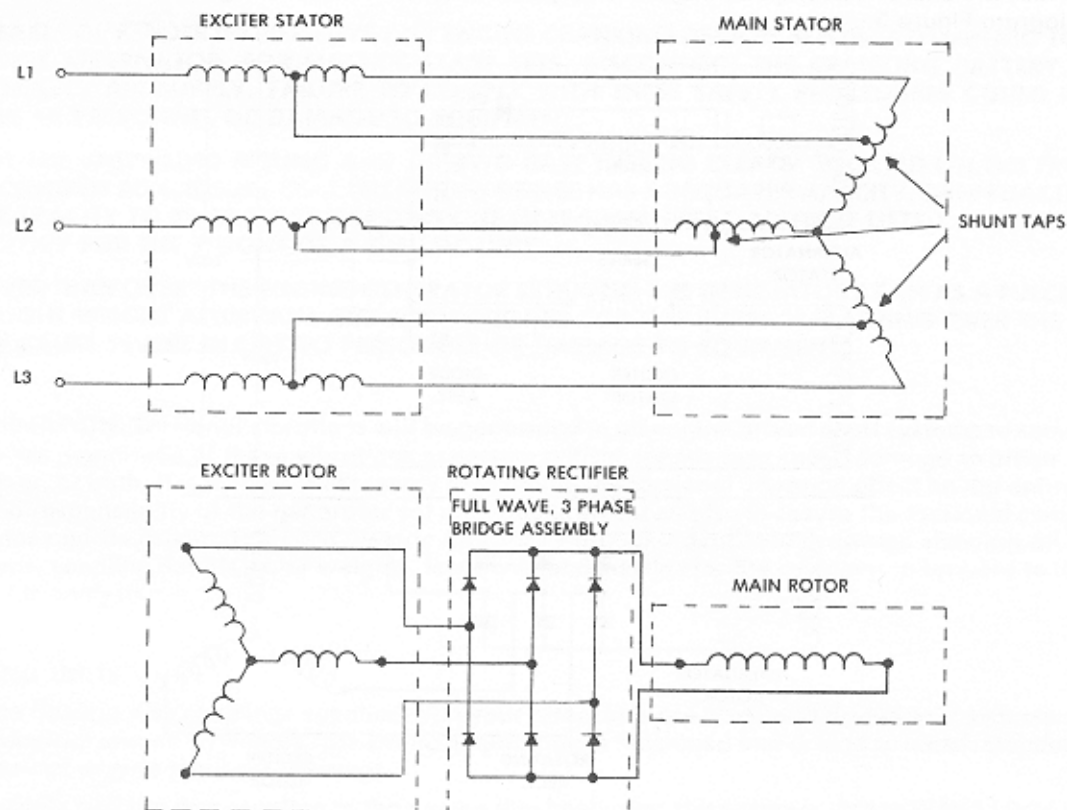


FIGURE 2

should be left in the bundle undisturbed. The **INTERCONNECTING LOAD LEADS ARE NOT USED IN RECONNECTION OF THE UNIT**. Depending upon the specific unit, 10 or 12 additional **OUTPUT LOAD LEADS** are brought out to the connection box for external connections.

SECTION III. TYPE MAC 4 LOAD LEAD SINGLE PHASE ALTERNATOR.

The Lima Electric Co., Inc. Type MAC 4 load lead, single phase alternator is self excited, self voltage regulated alternator with a compound wound DC exciter in lieu of the standard MAC rotating current transformer-frequency converter type exciter. This unique alternator has a two circuit concentric wound single phase stationary armature (stator), and a patented stationary 6 pole exciter field comprised of shunt and series DC windings. The entire rotating assembly is identical to that of the standard Type MAC three phase 10 and 12 load lead units. Mounted in the unit's conduit box is a stationary diode and terminal strip assembly consisting of a four double terminal "barrier type" terminal board, three stud type diodes mounted on a common grounded heat sink, a slide wire "No Load" voltage adjust rheostat, a surge suppressor and a small "Pig Tail" diode. (See Figures 3 and 4).

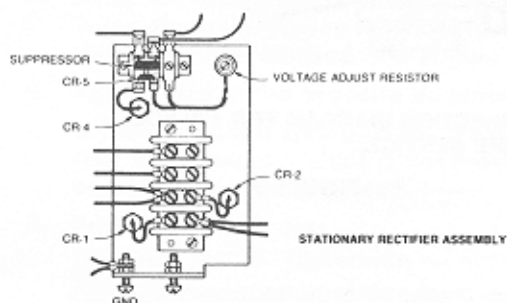


FIGURE 3

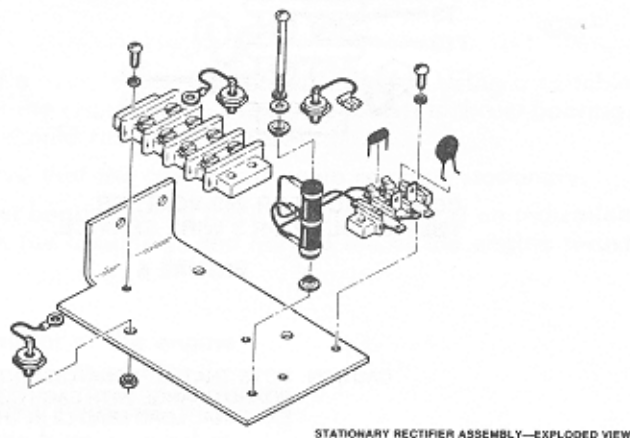


FIGURE 4

The exciter field consists of six poles alternately wound with shunt and series windings. The shunt portion of the circuit provides no load excitation, and the series portion, being in series with the load via the stationary rectifiers, provides the excitation compounding necessary to maintain terminal voltage constant under load as shown in circuit diagram Figure 5.

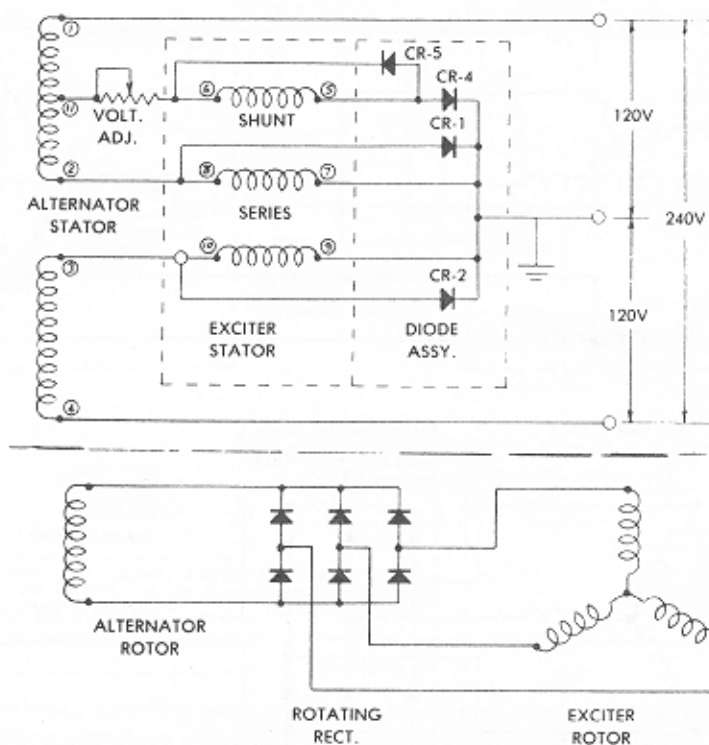
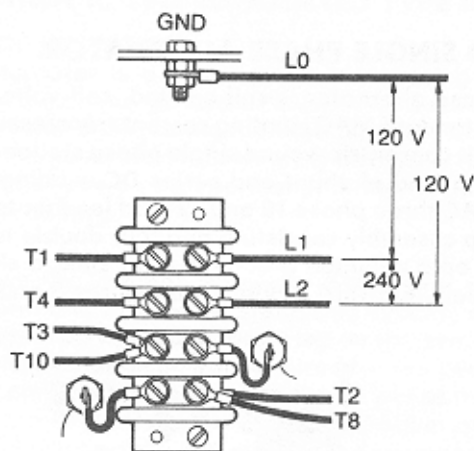


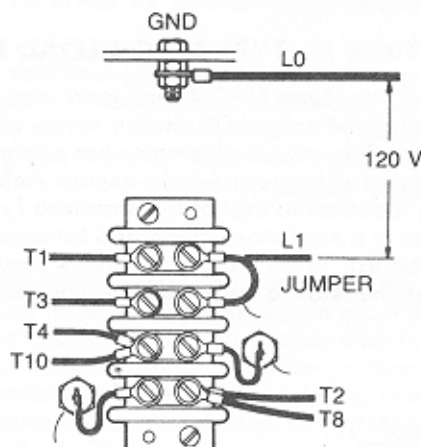
FIGURE 5

External connections are made on the terminal board in accordance with connection diagrams Figures 6 and 7.



CONNECTION FOR 240 VOLT, OR
120/240 VOLT 2 OR 3 WIRE SERVICE.

FIGURE 6



CONNECTION DIAGRAM FOR 120 VOLT
2 WIRE SERVICE.

FIGURE 7

CAUTION: NOTE THAT ALTERNATOR LOAD LEADS T3 AND T4 LOCATIONS ON THE TERMINAL BOARD CHANGE WITH EACH CONNECTION, AND JUMPER WIRE INSERTED IN LIEU OF EXTERNAL LOAD LEAD L2 IN THE 120 VOLT, 2 WIRE CONNECTION.

SECTION IV

ASSEMBLY OF THE ALTERNATOR TO THE PRIME MOVER

CAUTION: DISABLE OR RENDER INOPERATIVE ANY ENGINE CRANKING DEVICES BEFORE ATTEMPTING TO INSTALL OR SERVICE THIS ALTERNATOR. FOR ELECTRIC START SETS, DISCONNECT THE CRANKING BATTERY. FOR AIR START, DISCONNECT AIR SUPPLY. FAILURE TO COMPLY WITH THESE SAFETY PROCEDURES COULD RESULT IN SEVERE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT.

CAUTION: LIFT THE UNIT USING A SLING AND THE TWO CAST "LIFTING CLEATS" LOCATED ON THE FRONT AND REAR OF THE CONDUIT BOX. INSURE THAT THE LIFTING DEVICE HAS ADEQUATE CAPACITY. SAFE PRACTICE CALLS FOR LIFTING CAPACITY TO BE AT LEAST ONE AND ONE HALF TIMES THE LOAD TO BE LIFTED. IF IN DOUBT CONSULT THE FACTORY FOR THE WEIGHT OF A SPECIFIC UNIT.

CAUTION: NEVER "BAR OVER" THE ENGINE-GENERATOR SET USING THE GENERATOR'S FAN AS A FULCRUM. FAN MATERIAL IS LIGHT WEIGHT ALUMINUM AND NOT DESIGNED FOR THIS PURPOSE. BARRING OVER THE SET WITH THE FAN MAY CAUSE SEVERE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT.

TORSIONAL VIBRATION. Torsional vibrations will be generated in all engine driven shaft systems to some degree. In some cases the magnitude of these vibrations at certain critical speeds may cause damage to either the alternator or its driver, or both. It is therefore necessary to examine the torsional vibration effect on the entire rotating system. It is the responsibility of the generator set manufacturer/assembler to assure the torsional compatibility of the alternator and its driver. The Lima Electric Co., Inc. will make available drawings showing all pertinent shaft dimensions, coupling details, rotor weights, locations, and inertias for the customer to forward to the engine manufacturer for analysis.

SINGLE BEARING UNITS

- A. The flexible disc couplings supplied with your alternator are sized and drilled to match standard SAE industrial engine flywheels. The frame engine ring is machined and drilled to match standard SAE industrial engine flywheel housings.
- B. Loosely bolt the disc coupling to the engine flywheel using flat washers. **DO NOT USE LOCK WASHERS** for this purpose.
- C. Loosely bolt the alternator frame engine ring to the engine flywheel housing. Insure that the alternator's engine ring register (lip) is properly seated inside the engine flywheel housing.
- D. Insure that the flex discs are properly seated in the flywheel pilot bore. Tighten all bolts in rotation, making sure that the bolts are of the proper length so that they will not "bottom out" and prevent a secure coupling. Torque bolts to tension proper for the size, type and grade being used.
- E. Shim under the alternator feet as necessary to assure proper alignment of the alternator frame with the engine so that tightening the alternator foot bolts will not result in placing a prestress on either the alternator engine ring, or the engine flywheel housing.

TWO BEARING UNITS

- A. The shaft extension and keyway on two bearing units can be used with either a direct coupling adaptor, or belt driven with sheaves. For the latter, it is important that both the drive and driven sheave diameters are matched to assure proper running speed of the alternator.

ENDPLAY TEST PROCEDURE (ALL UNITS)

- A. After the alternator is installed with the prime mover, check for proper endplay. Using a suitable lever, force the engine flywheel forward so that the crankshaft is pressed against its thrust bearing. When force is released, the engine crankshaft should remain in this position.
- B. Apply force in the opposite direction and observe that the crankshaft again remains stationary.
- C. If the crankshaft springs away from either thrust bearing when force is removed, it is an indication that the alternator shaft is not moving freely in the assembly, and normal life of the engine thrust bearings could be impaired.
- D. Probable causes are:
 - (1) Improper "G" dimension on either the alternator or the engine;
 - (2) Improper seating of the drive discs in the engine flywheel;
 - (3) Improper mating of the alternator and flywheel housings, or;
 - (4) The alternator bearing is bottoming out in the bearing bracket.
- E. Refer to the engine manual for recommended end play. Frequently, it will be in the range of 0.007" to 0.015".

START-UP AND SHUT-DOWN PROCEDURES

IMPORTANT: Review alternator wiring diagrams for proper connection. **NEVER START AN ALTERNATOR WITH THE LOAD LEADS NOT PROPERLY CONNECTED OR INSULATED. VOLTAGE WILL BE PRESENT AT THE LEAD TERMINALS AND SEVERE INJURY TO PERSONNEL OR EQUIPMENT COULD BE CAUSED BY IMPROPER CONTACT WITH THESE LEADS.**

TYPE SER UNITS: Review voltage regulator and accessory manuals to insure that these devices are properly installed and connected. Make sure exciter field leads (F+ and F-) are connected in proper polarity at the voltage regulator.

- A. Insure that the main line circuit protector is **OPEN** and that no external load is on the machine. If the voltage regulator is equipped with an ON/OFF switch or a FIELD CIRCUIT BREAKER, set the device to its OFF or OPEN position.
- B. Reconnect and energize starting power to the prime mover. Adjust running speed and governor so the alternator is running at nameplate RPM.
- C. With the regulator "off" output voltage will be approximately $\frac{1}{4}$ normal. This "residual voltage" is provided by the residual magnetism of the exciter stator. Read all voltages-line to line and line to neutral to check for equal and balanced values. If the unit has been improperly connected unbalanced voltages will result. In this case, shut the unit down and correct any improper connections. **Energizing the regulator with the unit improperly connected could result in damage to the unit.**
- D. Once checks listed in sub-paragraph C above are satisfactorily completed indicating proper connections, turn the regulator switch to "ON" position and adjust the alternator's output voltage to the desired level according to the regulator manufacturer's operating manual.

NOTE: It is quite possible to observe a "no voltage" condition upon start-up due to loss of residual magnetism in the exciter field during transit, storage or under certain electro-mechanical conditions. If no output is observed, shutdown the system and refer to the **PROCEDURE FOR FLASHING FIELD** (Sec VI 1) of the Disassembling and Servicing section of this manual.

SHUT-DOWN

There are no specific instructions for alternator shut-down, but several practices should be observed to prolong equipment life.

- A. It is advisable to disconnect all loads prior to shut-down. This is especially important if loads can be damaged by low voltage and frequency conditions during alternator "wind down."
- B. If at all possible, shut off the voltage regulator before shut-down.
- C. Isolate any conditions that would cause the alternator to see an input voltage at its terminals. Failure to do this could result in rectifier damage.

MAINTENANCE. Lima alternators require no specific periodic maintenance except for occasional observation to assure ventilating louvers and slots are clear, all mounting bolts are secure, and electrical connections are tight and not corroded. The bearings are permanently lubricated and shielded for long life. Bearings should be checked periodically and when performing routine maintenance on the engine to insure extreme environmental or severe operating conditions are not causing premature bearing failure.

DISASSEMBLING AND SERVICING.

CAUTION: Before servicing, make certain that the alternator is isolated from any other voltage source, and that the engine or other prime mover cannot be started, either locally or remotely. It is urged that the battery or starting source be removed from the prime mover, or at least rendered inoperable.

1. **DIODE TESTING.** Diode testing can be conducted with either an ohmmeter or battery/light continuity checker. A good diode will produce a low ohmmeter reading (continuity checker will be lighted) when the probes are applied in one direction, and a reading of, or near infinity (no light on a continuity checker) when the probes are reversed. If the results are the same regardless of which direction the probes are applied, the diode is defective and must be replaced.

Diode failure after an initial post assembly checkout and load test is generally traceable to outside causes such as a lightning strike, overheating, or a reverse current fed into the unit. To save excess service time and callbacks, it is generally accepted practice to replace all diodes in a circuit where failure can be traced to external causes. The cause of diode failure must be determined and corrected prior to returning the unit to service.

CAUTION: NEVER TEST DIODES IN A "LIVE" OR ENERGIZED CIRCUIT.

- A. **ROTATING RECTIFIER ASSEMBLY (ALL UNITS).** The rotating rectifier assembly consists of two "full wave molded bridge rectifiers" mounted on the exciter rotor core with cap screws. See Figures 8 and 9. Each bridge consists of a positive (+) terminal and a negative (-) terminal, and two AC terminals marked with an AC sine wave symbol.

To test the molded bridge rectifiers: Remove all external leads from the bridge terminal posts. Apply one probe of the tester to the (+) terminal and the other tester probe to each of the AC terminals in succession, the readings should be identical, either deflection of the ohmmeter needle, or no deflection of the needle when each AC terminal is touched. (The checker light must either be lighted, or dark for each terminal.) Then reverse the probes and repeat the test, again the readings should be identical, but opposite in effect from the first test, i.e. If you observed ohmmeter needle deflection or the checker light was lighted, reversing the test probes should result in no deflection of the ohmmeter needle, or the checker light should not light. Repeat the complete test procedure using the negative (-) terminal as a reference. If test shows a good bridge, reconnect the external leads taking care to assure each lead is on its proper post. Repeat these tests on the second bridge. If either bridge tests defective replace both bridges. Since both bridges are in the same circuit, they have both been subjected to the same stresses and, therefore, if one bridge tests bad, the other bridge should be considered "suspect."

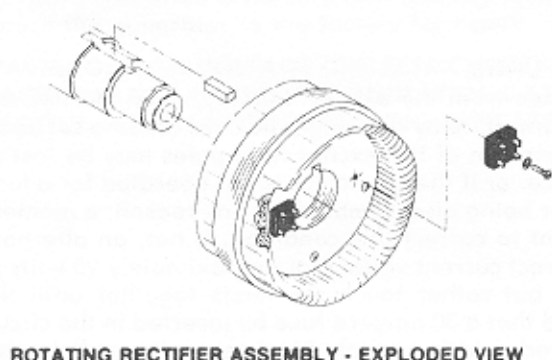


FIGURE 8

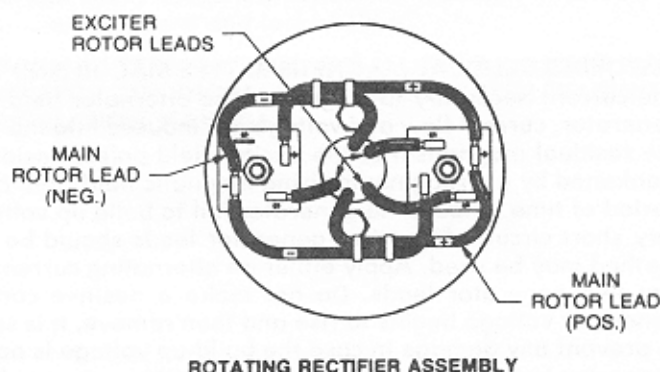


FIGURE 9

B. Stationary diode assembly. Single phase MAC 4 lead only.

Four diodes are located on the stationary rectifier plate located in the connection box. (See Fig. 3 and Fig. 4) Remove connection box cover and disconnect diode CR-1, CR-2 and CR-4 leads from the terminal board. These diodes can be tested in place by applying the tester probes to the terminal lug of the diode lead and the body of the diode. To test the small diode (CR-5), remove the diode from the terminal board by unscrewing the two flat terminals from the terminal board. Apply the test probes to either the terminal plates or the diode lead wires.

2. **BEARING REMOVAL.** Remove the rear cover plate. Remove rear bearing bracket. For two bearing units, remove both bearing brackets. Suggested practice is to remove one bearing bracket at a time, and replace one bearing at a time.
3. **BEARING REPLACEMENT.** NOTE: Always install the same type and size of bearing that was supplied as original equipment. Recommended procedure is to warm the bearing to 200 to 250 degrees F. with a bearing heater or in an oven. Replacement may be done with a conventional bearing tool when heating is not available. To avoid damage to the outer race and bearing shields, apply pressing force to the inner race only. Bearing must seat against the machined shoulder on the shaft.
4. **WOUND COMPONENT (MAIN AND EXCITER STATORS, MAIN AND EXCITER ROTORS).** These repairs are normally made by an authorized service station. Contact your distributor or the factory for the service station in your area.
5. **FACTORY SERVICE.** The Lima Electric Co., Inc. operates a service station at its factory. Trouble shooting personnel are available to answer questions not covered in this manual. You must note serial number and part number when contacting the factory for assistance.

RESTORING RESIDUAL MAGNETISM TYPE SER

The direct current (DC) necessary to magnetize the alternator field is obtained from the exciter. Initially, upon starting the generator, current flow and voltage are induced into the exciter armature by the magnetic lines of force set up by the residual magnetism of the exciter field poles. Residual magnetism of the exciter field poles may be lost or weakened by a momentary reversal of the field connection, a strong neutralizing magnetic field from any source, or if the generator is not operated for a long period of time. To restore the small amount of residual magnetism necessary to begin the voltage build-up, connect a battery from 6 to 32 volts to the exciter field coil circuit. Normally, a battery of 6 or 12 volts is large enough.

PROCEDURE FOR FLASHING FIELD TO RESTORE RESIDUAL MAGNETISM

- (1) Disconnect exciter field coil wire F+ at terminal F+.
- (2) Connect battery positive lead to field coil lead F+. Use 12 volt battery.
- (3) Connect battery negative lead to field coil circuit terminal F-.
- (4) Disconnect battery leads after approximately 3 to 5 seconds. If battery is connected for too long, overheating and subsequent damage to the exciter can occur.
- (5) Reconnect field coil lead F+ to terminal F+.
- (6) Start unit and observe generator build-up. Reflash field (steps 1 through 5 above) if generator output voltage does not build up.

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

RESTORING RESIDUAL MAGNETISM: TYPE MAC 10 AND 12 LEAD UNITS

The current 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 strong neutralizing magnetic field from any source, or if the generator is not operated for a long period of time. Should the generator fail to build up voltage after being disassembled for any reason, a momentary short circuit of any two generator leads should be sufficient to correct this condition. If not, an alternate method may be used. Apply either an alternating current or a direct current voltage of approximately 20 volts to any two generator leads. Do not make a positive connection but rather touch the leads together until the generator voltage begins to rise and then remove. It is suggested that a 30 ampere fuse be inserted in the circuit to prevent any damage in case the build-up voltage is not removed quickly enough. Start generator and observe generator build-up. Reflash field if generator output voltage does not build up.

RESTORING RESIDUAL MAGNETISM — SINGLE PHASE 4 LOAD LEAD TYPE MAC.

Direct Current necessary to restore residual magnetism for these machines should be applied to leads 5 and 6 secured to the small terminal strip on the stationary rectifier assembly that contains the surge suppressor and the small "pig-tail" diode (CR-5) along with leads from CR-4 and the Voltage Adjust Rheostat. (See Figure 3 Stationary Rectifier Assy.) Lead #6 is positive (+), and lead #5 is negative (-). **When flashing the field with leads 5 and 6 secured to the terminal strip, USE a 12 VOLT UNGROUNDED SOURCE.** If the only source of 12 volts DC is a **grounded source**, lift leads #5 and #6 from the terminal strip and apply the 12 volts DC directly to lead #5 (-) and #6 (+). Flashing the field on these units may be done with the unit at rest or running.

ROTOR DAMAGE: The damper bars of the generator prevent excessive hunting when AC generators are operated in parallel. Damper bars, because they must have a low electrical resistance and are subjected to extreme centrifugal forces, must be mechanically secure and permanent. Consequently, they are welded to end plates completely covering the field.

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

Damage to the rotor can also occur due to overheating which can be caused by the air flow being 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 field coils are "wet wound" and formed on the pole body under tension, with special tooling to provide the proper forming of the end turns. To repair a rotor the special tooling and technique of the factory is necessary and essential. THE LIMA ELECTRIC COMPANY, INCORPORATED, facilities can perform a complete rebuild, or rewind with the skill and craftsmanship that went into the unit during its original construction. 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 a recurrence.

PRECAUTIONS:

GENERATOR WINDINGS (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 the generator can result. The following steps should be taken to effectively dry the generator windings:

- A. (1) Place generator in drying oven or hot room.
(2) Dry with warm air blower directed through windings.
- B. (1) If the generator has been operated and then put into storage for any period of time, a P.D. George #11127 type air-dry fungus resistant varnish should be reapplied.

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. 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 winding and frame. All machines are insulated with a high safety factor for the class of insulation used. The latest and newest in insulation and baking techniques are used. The finest insulation job can be very quickly broken down by carelessly applying high voltage to windings in a moisture saturated condition. Mishandling in this respect can easily cause a breakdown, making it necessary to return the generator to the factory for repair, and consequent expense and loss of time.

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

TROUBLE SHOOTING PROCEDURES FOR LIMA BRUSHLESS ALTERNATORS.

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

SPEED DEVIATIONS. Voltage and frequency in any AC generator is a function of speed, therefore for proper operation, the units rotative speed should be maintained at rated nameplate RPM. All MAC units, and SER units equipped with voltage regulators with "built in" underfrequency protection will exhibit low voltage when the unit is running underspeed.

Notes on the Trouble Shooting Chart:

Since this manual covers three basic types of alternators; Type SER, Type MAC, and the new type MAC 4 load lead single phase unit, many of the checks and remedies will apply to all types, while others will be unique to one specific type. For this reason, a suffix letter will be shown for each check:

- A — All types in this frame size.
- B — Type SER.
- C — Type MAC, 10 and 12 load lead units.
- D — Type MAC 4 load lead, single phase.

TROUBLESHOOTING CHART

CAUSE	TYPE	CHECK AND REMEDY
NO VOLTAGE OUTPUT		
Loss of residual magnetism in the exciter.	A	Flash the exciter field. See next section.
Open circuit in exciter field.	A	Check continuity. If open, return to factory for repair.
Open stator windings.	A	Check continuity. If open, return to factory for repair.
Faulty rectifiers.	A	Check per instructions that follow. Replace if faulty.
Malfunction of automatic voltage regulator.	B	See AVR manual. Replace if faulty.
Short circuit.	A	Check all leads and clear fault.
Open in main field coil.	A	Check continuity. If open, return to factory for repair.
Shorted exciter rotor.	A	Check for short with bridge-type resistance meter.
Grounded exciter rotor.	A	Check insulation to ground with megohmmeter after disconnecting AVR and rectifier assy.
Shorted leads between exciter rotor and main field.	A	Test and repair.
Open voltage adjust resistor.	D	Test (Resistor is located on stationary rectifier assembly.)
LOW VOLTAGE OUTPUT		
Low rheostat setting.	B,D	Adjust to rated output.
Excessive load.	A	Reduce load. Balance all loads to as near equal as possible. Do not exceed rated current on any leg.
Low RPM.	A	Check engine and governor. Check system for overload.
Automatic Voltage Regulator.	B	See AVR manual. Replace if faulty.
Insufficient excitation.	B	Check regulator. Replace if faulty.
Line losses.	A	Use larger line wiring.
High resistance connections.	A	Check for warm or hot connections. Restore good connections.
Shorted main or exciter field.	A	Check main field with a bridge-type meter. Check exciter field with ohmmeter for approximately 17 ohms for parallel field and 35 ohms for series field. Return to factory for repair.

Low power factor (lagging).	A	Reduce inductive (motor) load. Some AC motors draw approximately the same current regardless of load. Do not use motors of larger horsepower rating than is necessary to carry the mechanical load. Reduce inductive loads or install capacitors to improve power factor.
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HIGH VOLTAGE OUTPUT

High rheostat setting.	B,D	Adjust to rated output.
High RPM.	A	Check engine and governor.
Automatic Voltage Regulator.	B	See AVR manual. Replace if faulty.
Low Leading Power Factor.	A	Check load — low leading power factor will be indicated by proper voltage no load, and a rise in voltage as load is added. Adjustments can only be made to this load.

FLUCTUATING VOLTAGE

Irregular engine speed.	A	Check engine and governor.
Fluctuating load.	A	Stabilize load.
Loose connections.	A	Check alternator and load connections. Restore good connections.
Unstable voltage regulator.	B	See AVR manual. Replace if faulty.
Intermittent short in exciter field.	B	Check with ohmmeter for approximately 17 ohms for parallel field and 35 ohms for series fields. Return to factory for repair.
Uneven air gap.	A	Measure stator/rotor clearance at several points. Suspect bearing(s) drive discs, flywheel, flywheel housing or alternator frame if clearances are uneven.

OVERHEATING

Excessive load.	A	Check with ammeter and compare with nameplate. Reduce load.
Clogged vent openings.	A	Clear air passages.
Environmental conditions.	A	Improve ventilation and air circulation.
Low power factor.	A	Reduce inductive loads or install capacitors to improve power factor.
Unbalanced load.	A	Strive for balanced load on each leg. Do not exceed rated current on any leg.
Dry bearing.	A	Replace bearing.

MECHANICAL NOISE

Defective bearing(s).	A	Replace.
Rotor rubbing on stator.	A	Bad bearing(s); replace. Bent shaft; return to factory. Loose endbell; tighten. Loose drive discs; tighten.
Loose or misaligned coupling.	A	Align and tighten.

ALTERNATOR PRODUCES SHOCK WHEN TOUCHED

Static charge.	A	Ground alternator frame.
Grounded stator of field coil.	A	Check with megohmmeter AFTER DISCONNECTING AVR. Return to factory for repair.

SECTION V ELECTRICAL WIRING PROCEDURES — WIRING DIAGRAMS

CAUTION

Wiring of the alternator should be done in accordance with good electrical practices. Follow government, association and industry standards. In some wiring arrangements, groups of terminals are connected together with no further termination. These terminals must be properly insulated to avoid a hazard to personnel and potential equipment damage.

Lima Alternators built in the 250 Frame are supplied in a 4, 10, or 12 output load configuration depending upon the Type, number of phases, and required output voltage. From the nameplate information and system voltage requirements, select the appropriate wiring diagram from the table below.

Notes:

C-1: Some models intended for 4-Wire WYE connection may be equipped with bus bar termination. Diagram "A" applies to these units.

C-2: Certain 480 Volt, 4-lead units are supplied with two winding legs centertapped (T-14, T-16) to provide 240 Volt, 1 phase input power to the automatic voltage regulator. All other 4-lead, WYE connected units will require the addition of power isolation transformer to obtain 240 Volt, 1 phase power for AVR operation.

C-3: Wiring diagram for single phase, 4 lead MAC units are per Figures 6 and 7 Page 6.

C-4: For Type SER units consult Automatic Voltage Regulator manual for recommended regulator connections.

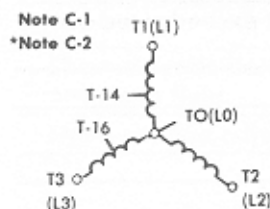
WIRING REFERENCE CHART

OUTPUT LOAD LEAD CONNECTION CONFIGURATION	TYPE SER ADJUSTABLE VOLTAGE RANGE (60 HZ) (LINE TO LINE)	TYPE MAC VOLTAGE (L TO L)	REF. DIAG. NO.
4 Lead Unit, Delta Connection, Special Voltage	Per Specification		B
4 Lead Unit, Wye Connection, Special Voltage	Per Specification	600 Volts	A
12 Lead Unit, High Voltage, Delta Connection	220 to 240 Volts	240 Volts	C
12 Lead Unit, High Voltage, Wye Connection	416 to 480 Volts	416 Volts	D
12 Lead Unit, Low Voltage, Wye Connection	208 to 240 Volts	208 Volts	E
10 Lead Unit, High Voltage, Wye Connection		480 Volts	F
10 Lead Unit, Low Voltage, Wye Connection		240 Volts	G
12 Lead Unit, 120 Volt Delta Connection	110 to 120 Volts	120 Volts	H
12 Lead Unit, 120/240 Volt Zig-Zag Connection	220 to 240 Volts	240 Volts	I
12 Lead Unit, 240/480 Volt Zig-Zag Connection	440 to 480 Volts	240 Volts	J
4 Lead Unit, 120/240 Volt Connection		240 Volts	C-3
4 Lead Unit, 120 Volt Connection		120 Volts	C-3

DIAGRAM A

4-Lead Unit, 480 or 600 Volt, Wye Connected, 3 Phase

Note C-1
*Note C-2

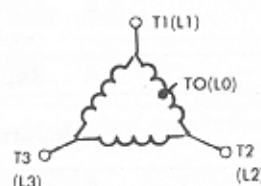


OUTPUTS:	480 V	600 V
L1 to L2	480 V, 3Ø	600 V, 3Ø
L2 to L3	480 V, 3Ø	600 V, 3Ø
L1 to L3	480 V, 3Ø	600 V, 3Ø
L1 to L0	277 V, 1Ø	346 V, 1Ø
L2 to L0	277 V, 1Ø	346 V, 1Ø
L3 to L0	277 V, 1Ø	346 V, 1Ø

CAUTION: Properly insulate all unused terminations

DIAGRAM B

4-Lead Unit, 480 Volt, Delta Connected, 3 Phase



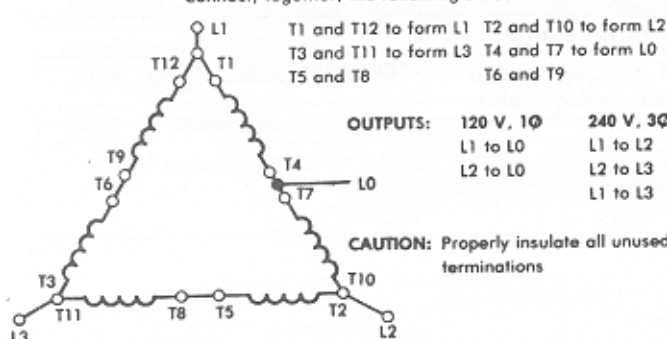
OUTPUTS:	240 V, 1Ø	480 V, 3Ø
L1 to L0	240 V, 1Ø	480 V, 3Ø
L2 to L0	240 V, 1Ø	480 V, 3Ø
L3 to L0	240 V, 1Ø	480 V, 3Ø

CAUTION: Properly insulate all unused terminations

DIAGRAM C

12-Lead Unit, 240 Volt, Delta Connected, 3 Phase

Connect, together, the following six sets of terminations:



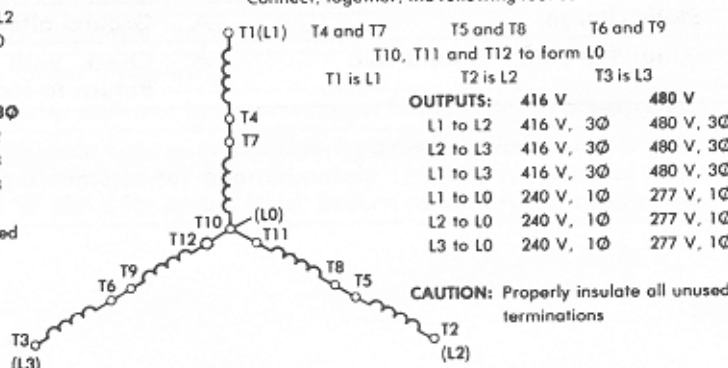
OUTPUTS:	120 V, 1Ø	240 V, 3Ø
L1 to L0	120 V, 1Ø	240 V, 3Ø
L2 to L0	120 V, 1Ø	240 V, 3Ø
L3 to L0	120 V, 1Ø	240 V, 3Ø

CAUTION: Properly insulate all unused terminations

DIAGRAM D

12-Lead Unit, High Voltage, Wye Connected, 3 Phase

Connect, together, the following four sets of terminations:



OUTPUTS:	416 V	480 V
L1 to L2	416 V, 3Ø	480 V, 3Ø
L2 to L3	416 V, 3Ø	480 V, 3Ø
L1 to L3	416 V, 3Ø	480 V, 3Ø
L1 to L0	240 V, 1Ø	277 V, 1Ø
L2 to L0	240 V, 1Ø	277 V, 1Ø
L3 to L0	240 V, 1Ø	277 V, 1Ø

CAUTION: Properly insulate all unused terminations

DIAGRAM E

12-Lead Unit, Low Voltage, Wye Connected, 3 Phase

Connect, together, the following four sets of terminations:

T1 and T7 to form L1 T2 and T8 to form L2
T3 and T9 to form L3
T4, T5, T6, T10, T11 and T12 to form L0

OUTPUTS: 120 V, 1 ϕ 208 V, 3 ϕ
L1 to L0 L1 to L2
L2 to L0 L2 to L3
L3 to L0 L1 to L3

CAUTION: Properly insulate all unused terminations

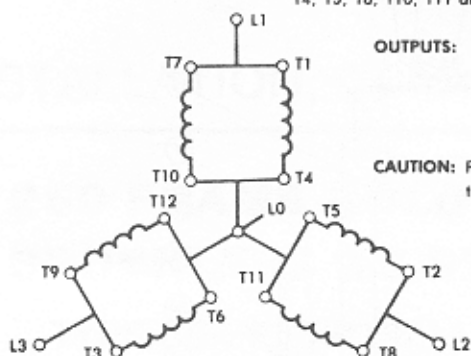


DIAGRAM F

10-Lead Unit, High Voltage, Wye Connected, 3 Phase

Connect, together, the following four sets of terminations:

T4 and T7 T5 and T8 T6 and T9
T1 is L1 T2 is L2 T3 is L3

OUTPUTS: 277 V, 1 ϕ 480 V, 3 ϕ
L1 to L0 L1 to L2
L2 to L0 L2 to L3
L3 to L0 L1 to L3

CAUTION: Properly insulate all unused terminations

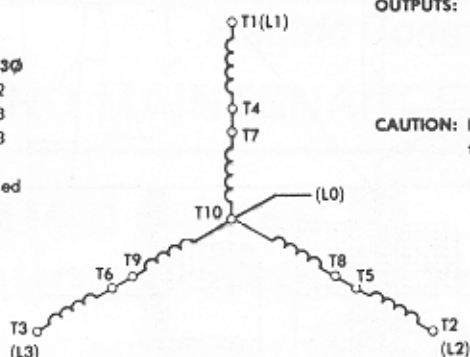


DIAGRAM H

12-Lead Unit, Low Voltage, Delta Connected, 1 Phase

Connect, together, the following three sets of terminations:

T2, T8, T6, T12 and Insulate
T1, T5, T7, T11 to form L1
T3, T4, T9, T10 to form L2

OUTPUTS: 120 V, 1 ϕ
L1 to L2

CAUTION: Properly insulate all unused terminations

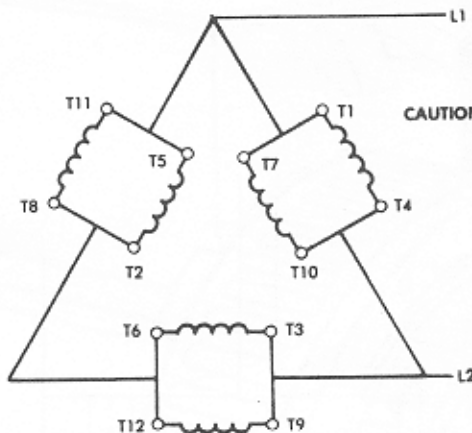


DIAGRAM G

10-Lead Unit, Low Voltage, Wye Connected, 3 Phase

Connect, together, the following four sets of terminations:

T1 and T7 to form L1 T2 and T8 to form L2
T3 and T9 to form L3
T4, T5, T6 and T10 to form L0

OUTPUTS: 139 V, 1 ϕ 240 V, 3 ϕ
L1 to L0 L1 to L2
L2 to L0 L2 to L3
L3 to L0 L1 to L3

CAUTION: Properly insulate all unused terminations

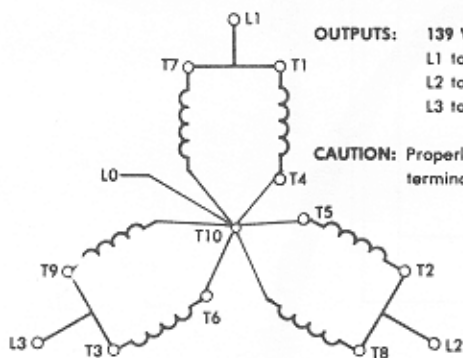


DIAGRAM I

12-Lead Unit, 240 Volt, Zig Zag, 1 Phase

Connect, together, the following four sets of terminations:

T2, T8, T6, T12 and Insulate
T1, T7, to form L1
T3, T9, to form L2
T4, T10, T5, T11 to form L0

OUTPUTS: 120 V, 1 ϕ 240 V, 1 ϕ
L1 to L0 L1 to L2
L2 to L0

CAUTION: Properly insulate all unused terminations

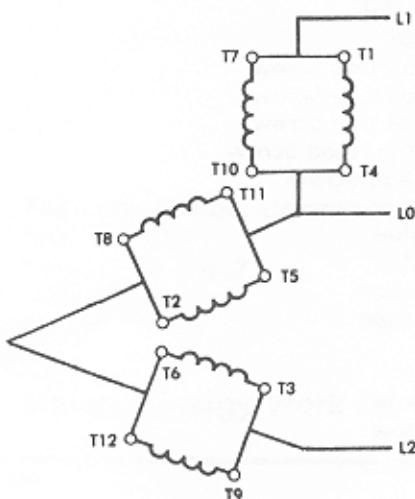


DIAGRAM J

12-Lead Unit, 480 Volt, Zig Zag, 1 Phase

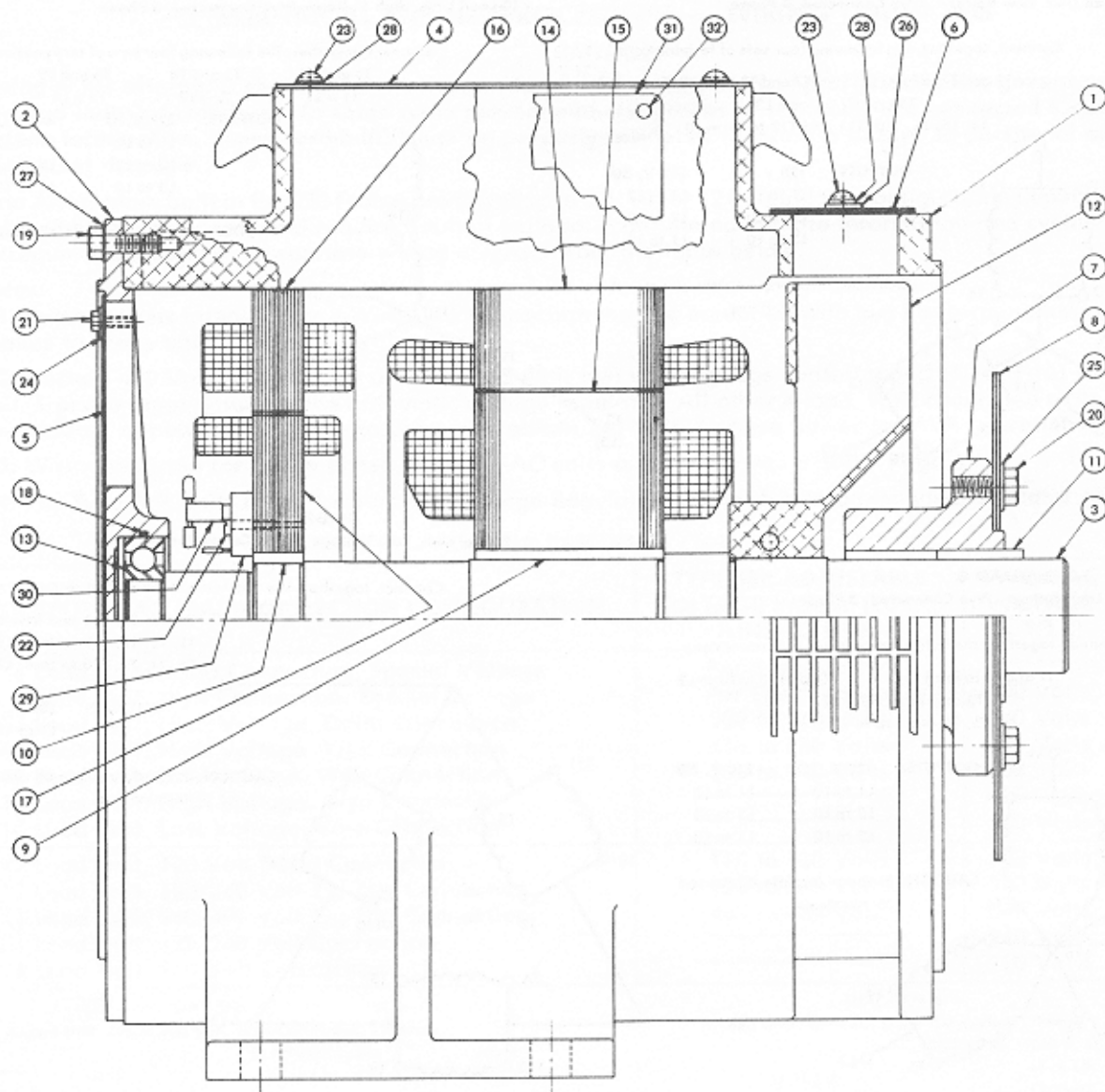
Connect, together, the following five sets of terminations:

T4 and T7 T2 and T12 T6 and T9 T5 and T8
T10, T11 to form L0
T1 is L1 T3 is L2

OUTPUTS: 240 V, 1 ϕ 480 V, 1 ϕ
L1 to L0 L1 to L2
L2 to L0

CAUTION: Properly insulate all unused terminations





PARTS LIST SINGLE BEARING UNITS

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Frame	17	Exciter Rotor
2	Endbell	18	O Ring
3	Shaft	19	Hex. Head Cap Screw
4	Connection Box Lid	20	Hex. Head Cap Screw
5	Screen For Endbell	21	Hex. Head Cap Screw
6	Screen Band	22	Slotted Pan Head Screw
7	Driving Hub	23	Round Head Screw
8	Disc Coupling	24	Flat Washer
9	Key — For Main Rotor	25	Flat Washer
10	Key — For Exciter Rotor	26	Flat Washer
11	Key — For Driving Hub	27	Lock Washer
12	Fan Assembly	28	Lock Washer
13	Bearing	29	Diode
14	Main Stator	30	Terminal
15	Main Rotor	31	Name Plate
16	Exciter Stator	32	Drive Screw