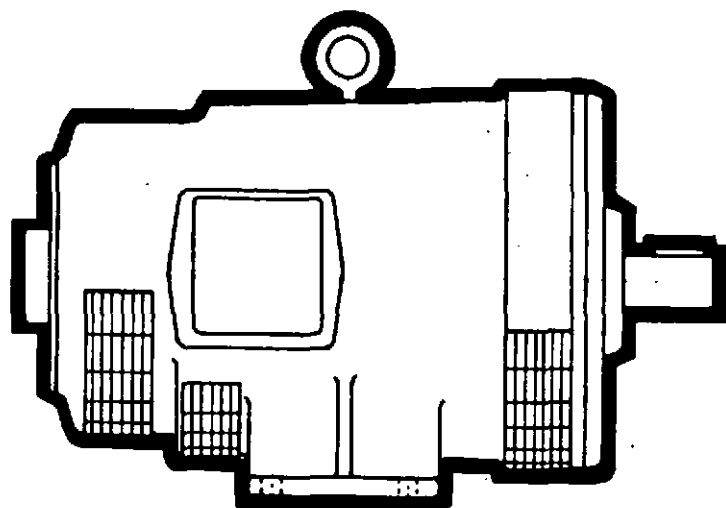




A Subsidiary of Regal-Beloit Corporation

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

LIMA® MAC Brushless AC Synchronous, Internally Regulated Alternator Frame 280



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Making Energy Work For You

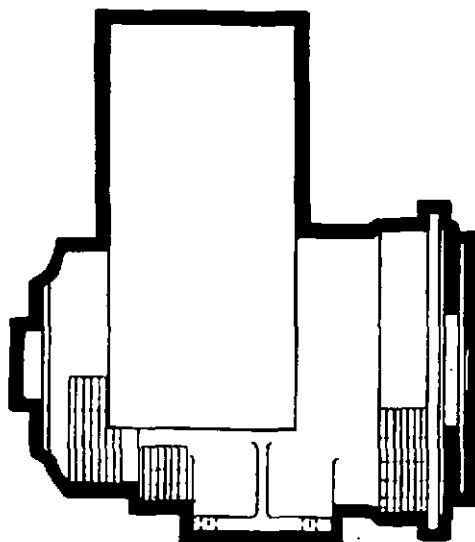


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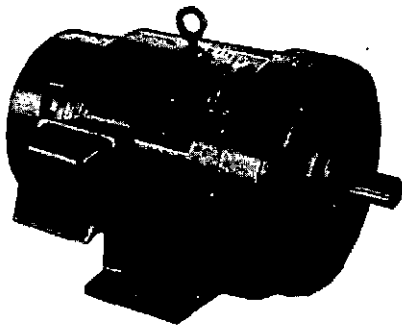
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PRINCIPLE OF OPERATION

The LIMA® MAC generator is a self-regulated, rotating field synchronous unit with the rotor having a salient pole construction with amortisseur windings. 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.

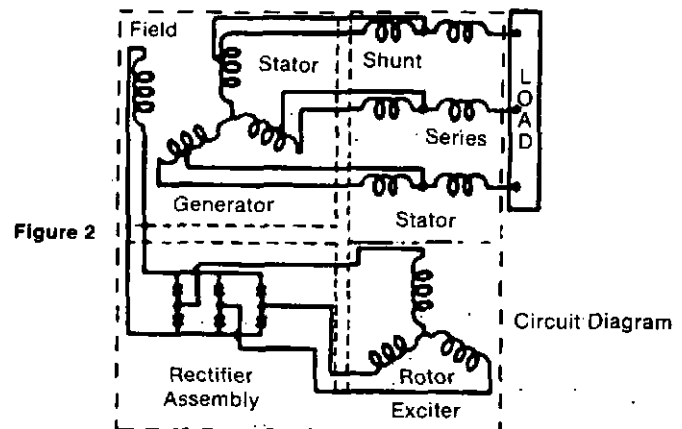
The exciter pole pieces contain residual magnetism, setting up lines of force across the air gap to the exciter armature. When the exciter armature begins to rotate a voltage is induced and current flow is initiated in the exciter armature AC windings. This voltage is fed to the rotating rectifier assembly, 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.

All connections between the exciter stator windings and the generator stator windings are internally connected within the stator housing. Only the output power leads of the generator unit are brought out to the generator terminal box.



CIRCUIT DIAGRAM

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 provides a compounding excitation characteristic.



The 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 a three phase full wave rotating silicon rectifier unit. The response time of the excitation system is very 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.

PERFORMANCE DATA

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® MAC generator.

The performance of a 10 kW LIMA® MAC synchronous generator is indicated in Figure 3.

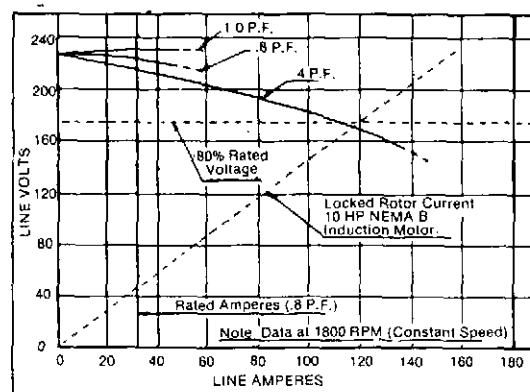


Figure 3

SECTION I INSTALLATION AND OPERATION

UNPACKING:

When unpacking, check for damage in shipping. Report any damage at once to delivering carrier. Read instruction tags shipped with generator.

INSTALLATION:

The generator must be properly aligned and located in a well-ventilated place where the air temperature will not exceed 40°C or 104°F, and should be accessible for cleaning. An open type generator should not be located where there are abrasive or conductive dusts, corrosive gases or fumes, or where excessive moisture may be encountered. A totally fan-cooled generator should be used where these conditions exist. Air openings of the generator should be cleaned frequently to remove accumulated dust and dirt, which may cause overheating and burn out.

WIRING CONNECTIONS:

Electrical characteristics are shown on the nameplate. Refer to connection diagrams on pages 9 and 10 for proper electrical connections.

OPERATION:

After the generator has been properly connected to the driving unit and the load lines connected to the generator's leads according to the wiring diagram, the unit is ready for operation. To connect the coupling discs of a single bearing generator to the driving engine's flywheel it may be necessary to slide the rotor forward a few inches out of the stator, taking care not to slide it so far as to cause the rotor to come out of the bearing entirely and down upon the stator windings, causing damage to the windings.

Ordinarily, a chain hoist is needed to jockey the generator rotor into position.

STANDBY UNITS:

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

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

PARALLEL OPERATION:

For parallel operation, both units must be of the same voltage, frequency, and phase. Phase voltages of paralleled units must be synchronized. This generator set utilizes the "dark lamp" method of paralleling.

ROTATION:

The generator can be operated in either direction of rotation.

OVERLOAD:

The load on the generator should be checked with an AC ammeter to see that the ampere rating stamped on the nameplate is not exceeded. Prolonged overload on the generator may cause it to overheat and possibly burn out.

LUBRICATION:

Ball bearings on Lima generators are pre-lubricated and require no further lubrication for the life of the bearing.

SECTION II SERVICE AND MAINTENANCE

PREVENTATIVE MAINTENANCE AND OPERATING PRECAUTIONS:

Costly repairs and down time can usually be prevented by operating electrical equipment under conditions which are compatible with those at which the equipment was designed to operate. Follow the instructions as outlined to insure maximum efficient utilization of the electrical equipment.

COOLING:

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

BEARING REPLACEMENT:

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

ROTATING DIODE BRIDGE:

The rotating diode bridge can be removed and replaced. Excessive overcurrent, overvoltage, overspeed, or reverse currents can cause damage to the assembly or any of the component parts.

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 overspeed.

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.

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 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.

RESTORING RESIDUAL MAGNETISM:

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 to 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.

TESTING DIODES WITH AN OHMMETER:

Isolate the rectifier assembly by disconnecting the two leads from the main rotor and three leads from the exciter rotor. Do not unsolder diodes. Test each diode by applying the probes of an ohmmeter to the anode and cathode.

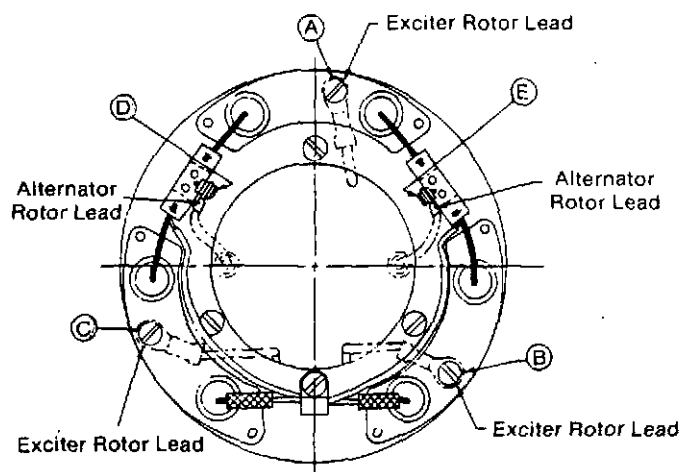
A good diode will produce a meter reading of only a few ohms when the probes are applied in one direction, and a reading of near infinity when the probes are reversed. If both readings are high, or both are low, the diode is defective and must be replaced.

Diode failure after a 25 hour "run-in" period is generally traceable to external causes such as lightning strike, 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 the entire rectifier assembly where failure can be traced to external causes **AFTER THE CAUSE OF DIODE FAILURE IS IDENTIFIED AND CORRECTED.**

RECTIFIER REMOVAL PROCEDURE:

Rectifiers may be removed through the bearing cap on the rear of the generator. (See Figure 6, Item B.) First, remove the bearing cap by removing the four bolts shown in Figure 6 as Item A. You can now see both the bearing (Item C) and rectifier assembly (Item D). Use a bearing puller to remove the bearing from the main shaft being careful to locate the puller on the inner race of the bearing to avoid bearing damage. Once the bearing is free it is then necessary to disconnect leads A, B, C and D as shown in Figure 5 assembly drawing. Then remove the three hold-down cap screws which secure the rectifier assembly to its adaptor. Once this procedure is complete the rectifier assembly is free for removal.

Follow the testing procedures outlined in testing diodes and Figure 5.



**Rectifier Assembly 778600
Figure 5**

After the rectifier assembly has been repaired or replaced, reverse the procedure as stated above, being careful that all lead connections are tight and that set screws are locked with a Loctite compound.

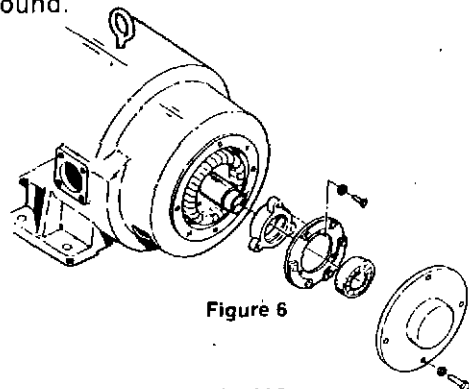


Figure 6

TROUBLESHOOTING PROCEDURES

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.

SPEED DEVIATIONS:

The generator speed should be maintained at rated nameplate speed. The frequency and voltage of the generator output depends on speed. If the generator runs slower than rated speed, the voltage will drop off.

CAUSE

- Loss of residual magnetism in exciter field poles.
- Open in stator windings.
- * Open or short in rotating rectifiers.
- Short circuited.
- * Open in alternator field.
- * Shorted exciter armature.
- * Shorted leads between exciter armature and generator field.

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

NO VOLTAGE:

CHECK AND REMEDY

- Flash field, see page 6 "Restoring Residual Magnetism."
- Check for continuity in windings. Return to factory for repair if open.
- Check rectifiers per previous instructions, replace if faulty.
- Clear lead to restore voltage build-up.
- Check for continuity and return rotor to factory for repair if field coils are open.
- Check for short and replace if faulty. Use a "Kelvin" type bridge to measure this resistance.
- Test and repair.

CAUSE

- Excessive load.
- Low speed.
- Line loss.
- High resistance connections — connection will be warm or hot.
- Shorted field.
- Low power factor.

LOW VOLTAGE:

CHECK AND REMEDY

- Reduce load. 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.
- Check engine for malfunction or system for overload.
- Increase size of line lead wire.
- Make better connection electrically and mechanically.
- Test field coils for possible short by checking resistance with an ohmmeter or resistance bridge. Return rotor assembly to factory for repair if alternator field coils are shorted.
- 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.

FLUCTUATING VOLTAGE:

(May be indicated by flickering lights)

CAUSE

Irregular speed of engine.
Fluctuating speed.

Loose terminal or load connections.

Defective bearing causing uneven air gap.

CHECK AND REMEDY

Check engine for malfunction or load for fluctuation.
Stabilize load. The addition of a lamp load (resistance load) may compensate partially for load changes caused by intermittent motor operation. Do not overload.

Make better connection mechanically and electrically.

Replace worn bearing.

HIGH VOLTAGE:

CAUSE

Excessive speed.

CHECK AND REMEDY

Check engine for malfunction.

OVERHEATING:

CAUSE

Generator overloaded.

Clogging ventilating screens.
High room temperature
Insufficient circulation.
Low power factor.

Unbalanced load.

Dry bearing.

CHECK AND REMEDY

Reduce load. (Check with ammeter and compare with nameplate rating.)

Clean air passages.
Improve ventilation.
Provide cross-ventilation.

Reduce inductive loads or install power factor improvement capacitors.

The load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.

Replace bearing.

MECHANICAL NOISE:

CAUSE

Defective bearing.

Rotor scrubbing on stator.

Loose laminations.
Loose or misaligned coupling.

CHECK AND REMEDY

Replace bearing.

Bad bearing, replace. Bent shaft, return to factory. Loose endbell, tighten; loose drive discs, tighten.

Return to factory for repair.

Tighten or align.

GENERATOR FRAME PRODUCES SHOCK WHEN TOUCHED:

CAUSE

Static charge.
Grounded armature or field coil.

CHECK AND REMEDY

Ground generator frame.
Return to factory for repair.

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® MAC alternators are supplied in 10-lead or 12-lead configurations. From the nameplate information and system voltage requirements, select the appropriate wiring diagram from the information that follows.

WIRING REFERENCE CHART

Configuration		MAC Type Specific Voltage (60 HZ)	Ref. Diag.
3 Phase	12-Lead Unit, 4-Wire 240 Volt Delta Connected	240V	A
	12-Lead Unit, High Voltage Wye Connected	416V	B
	12-Lead Unit, Low Voltage Wye Connected	208V	C
	10-Lead Unit, High Voltage Wye Connected	480V	D
	10-Lead Unit, Low Voltage Wye Connected	240V	E
1 Phase	12-Lead Unit, Low Voltage Delta	120V	F
	12-Lead Unit, 240 Volt Zigzag	240V	G

DIAGRAM A

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

Connect together the following six sets of terminations:

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

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

CAUTION: Properly insulate all unused terminations.

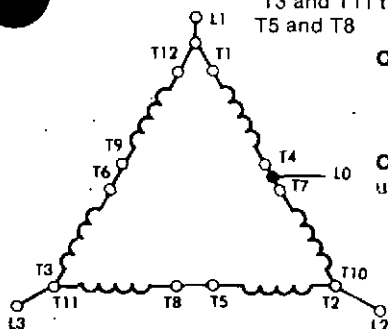


DIAGRAM B

12-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
T10, T11 and T12 to form L0
T1 is L1 T2 is L2 T3 is L3

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

CAUTION: Properly insulate all unused terminations.

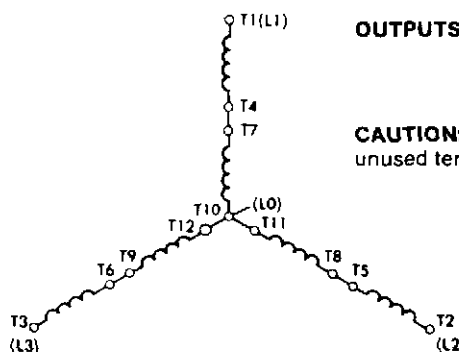
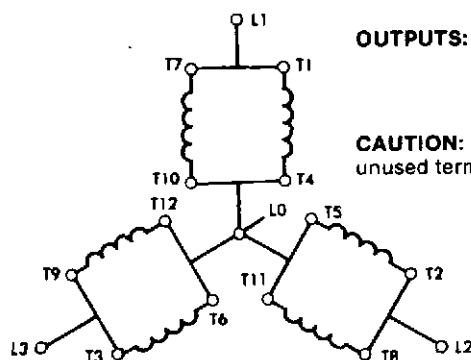


DIAGRAM C**12-Lead Unit, Low Voltage, Wye Connected, 3 Phase**

Connect together the following four sets of terminations:

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

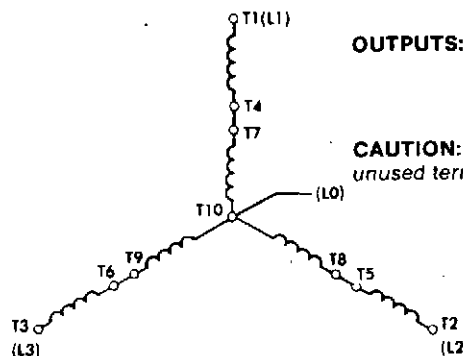


OUTPUTS: 120V, 1Ø 208V, 3Ø
 L1 to L0 L1 to L2
 L2 to L0 L2 to L3
 L3 to L0 L1 to L3

CAUTION: Properly insulate all unused terminations.**DIAGRAM D****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

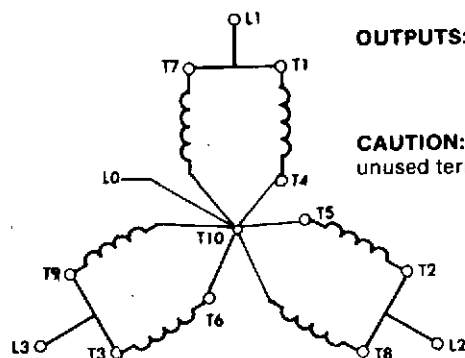


OUTPUTS: 277V, 1Ø 480V, 3Ø
 L1 to L0 L1 to L2
 L2 to L0 L2 to L3
 L3 to L0 L1 to L3

CAUTION: Properly insulate all unused terminations.**DIAGRAM E****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

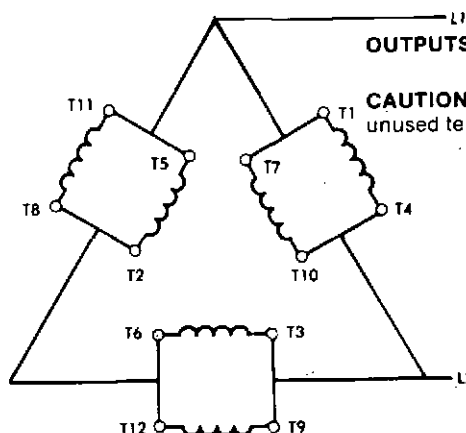


OUTPUTS: 139V, 1Ø 240V, 3Ø
 L1 to L0 L1 to L2
 L2 to L0 L2 to L3
 L3 to L0 L1 to L3

CAUTION: Properly insulate all unused terminations.**DIAGRAM F****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

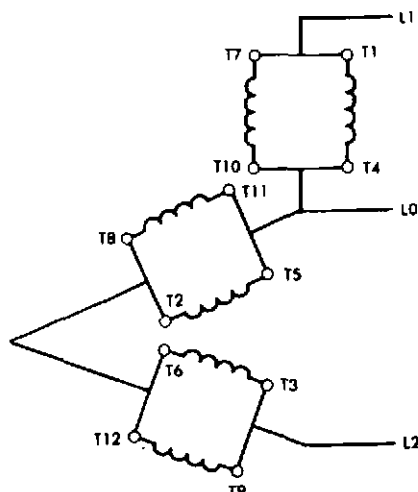


OUTPUTS: 120V, 1Ø
 L1 to L2

CAUTION: Properly insulate all unused terminations.**DIAGRAM G****12-Lead Unit, 240 Volt, Zigzag, 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

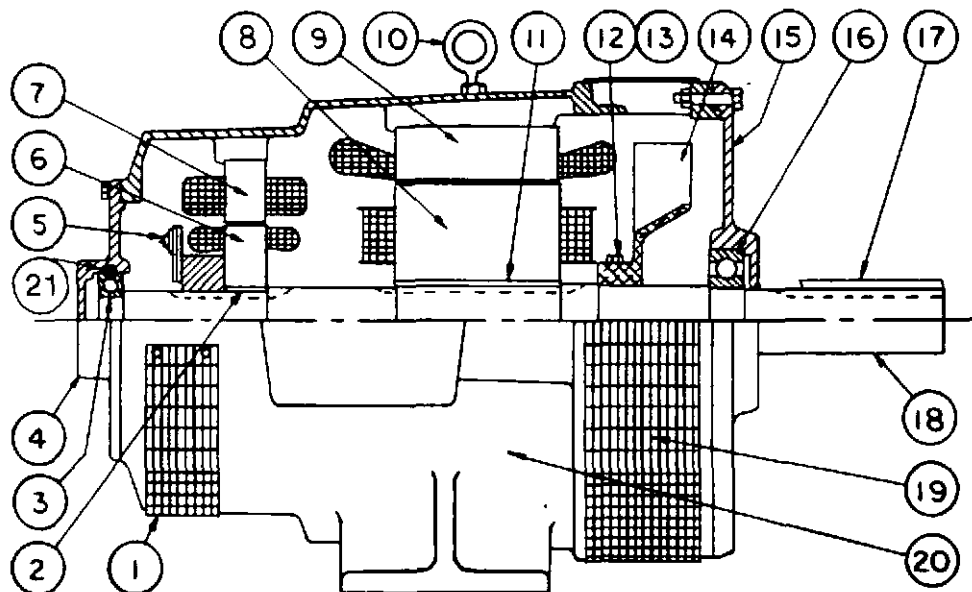


OUTPUTS: 120V, 1Ø 240V, 1Ø
 L1 to L0 L1 to L2
 L2 to L0

CAUTION: Properly insulate all unused terminations.

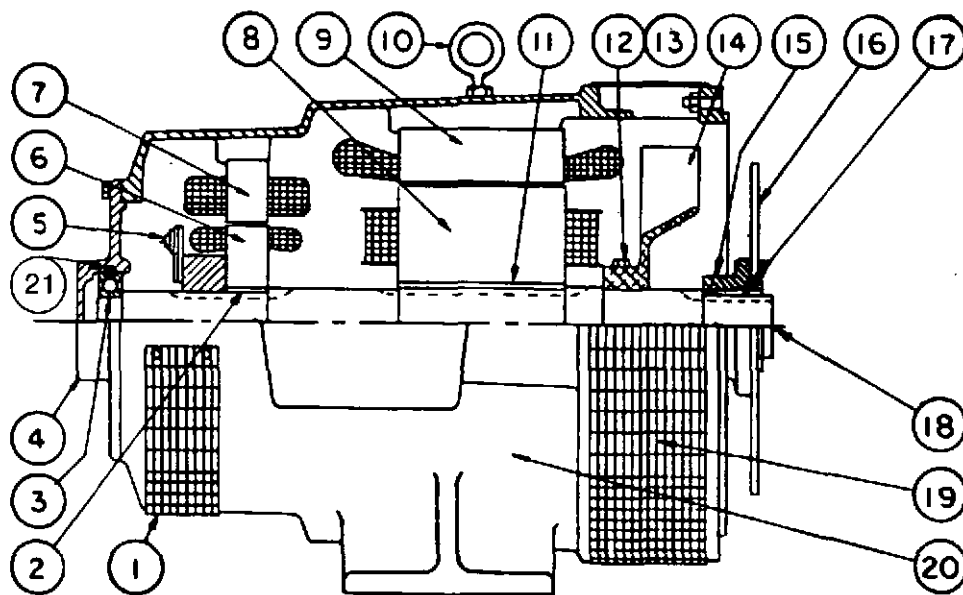
DRIPPROOF GENERATOR PARTS LIST **280 FRAME** **TWO BEARING**

Part No.	Part Name
1	Screen, Intake
2	Key, Rectifier
3	Bearing
4	Bearing, Cap
5	Rectifier Assembly
6	Exciter Rotor
7	Exciter Stator
8	Generator Rotor
9	Generator Stator
10	Eyebolt
11	Key, Rotor
12	Screw, Hex Hd.
13	Nut, Hex
14	Fan
15	Endplate, Sheave End
16	Bearing
17	Key, Output
18	Shaft
19	Screen
20	Generator Frame
21	O-Ring



DRIPPROOF GENERATOR PARTS LIST **280 FRAME** **SINGLE BEARING**

Part No.	Part Name
1	Screen, Intake
2	Key, Rectifier
3	Bearing
4	Bearing, Cap
5	Rectifier Assembly
6	Exciter Rotor
7	Exciter Stator
8	Generator Rotor
9	Generator Stator
10	Eyebolt
11	Key, Rotor
12	Screw, Hex Hd.
13	Nut, Hex
14	Fan
15	Hub
16	Drive Discs
17	Key, Output
18	Shaft
19	Screen
20	Generator Frame
21	O-Ring





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