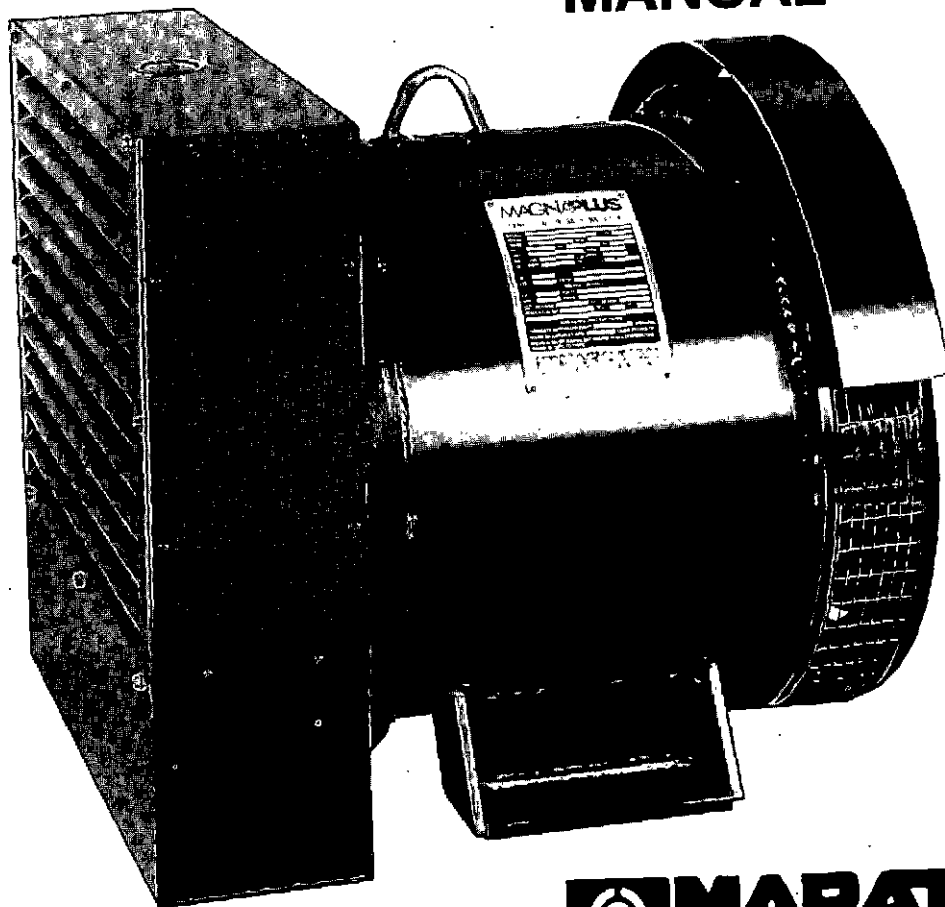


MAGNAPLUSTM GENERATOR

INSTALLATION,
OPERATION, AND
MAINTENANCE
MANUAL



 **MARATHON[®]
ELECTRIC**

INDEX

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A FEW WORDS ABOUT SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of the MagnaPLUS generator.

Each section has caution and warning messages. These messages are for your safety and the safety of the equipment involved. If any of the cautions or warnings are not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and, where appropriate, lock out all controls, to prevent an unexpected start-up of the generator set. Proper grounding in compliance with local and national electrical codes must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving the MagnaPLUS generator are pointed out in the installation and service sections; incorrect lifting or moving can result in personal injury or property damage to the unit.

Whenever the generator is running, always assume and proceed as if voltage is present. Residual voltage is present at the generator leads and at the regulator panel connections, even with the regulator fuse removed. Caution must be observed, or serious personal injury or death can result.

Whenever solvents, cleaners, or flammable liquids are present, adequate ventilation must be available to avoid fire, explosion, and health hazards. Always avoid breathing vapors and use suitable personal protective equipment to prevent personal injuries. (Such as eyes, face, and hand protection.)

This manual is not intended to be a substitute for properly trained personnel. Repairs should only be attempted by qualified trained people. The cautions and warnings point out known conditions that are potentially dangerous. Each installation will create its own set of circumstances. No manual can cover every possible situation.

When in doubt, ask. Don't be embarrassed to ask "dumb questions". Remember, dumb questions are much easier to handle than dumb mistakes.

GENERAL INFORMATION

SECTION

2

MECHANICAL DESIGN

General

All single and two bearing units are manufactured with cast iron end brackets and adapters, and fabricated steel frames. Flexible drive discs and SAE adapters are machined to SAE standards. Pre-lubricated, sealed ball bearings are used on MagnaPLUS generators. Standard units are fully guarded. Dripproof shields are available as an option.

Conduit Box

The large front end mounted conduit box is constructed of formed sheet steel which will allow the addition of top mounted control packages. Refer to Marathon Electric for top mounted controls of more than 240 lbs. The conduit box cover properly directs outside ventilating air through the generator.

MagnaPLUS Unirotor™ Construction

An aluminum die cast rotor core affords high mechanical integrity and low vibration at operating speeds. Amortisseur winding and coil supports are die cast as an integral part of the rotor. Laminations are 4-Pole, one piece laminations which are shrunk fit and keyed to the shaft. No dovetails, cross bolts or other pole to shaft connecting devices are used. The cast unidirectional aluminum alloy ventilating fan provides even air distribution to maximize cooling and generator efficiency.

Adapters and Drive Discs

All single bearing units are available with several adapter and drive disc arrangements. These can be shipped to order or can be changed in the field with standard shop tools. When changing flexible drive discs, spacers are used between the discs and cast iron hub to maintain SAE standard dimensions.

ELECTRICAL DESIGN

Temperature Rise

All ratings and frame sizes are based on NEMA and CSA Class F temperature rises on both the rotor and stator windings. Ratings for British, German, French,

IEC, and all popular marine agencies are available. All standard products have 2/3 pitch main windings to eliminate the third harmonic. This serves to lower operating temperatures, give lower harmonic content and better wave form, and extend the overall life of the generator.

Standby Generator

Synchronous generators used on emergency backup power can have temperature rises up to 25°C above those for continuous operation. (NEMA MG1-22.40 and MG 1-22.84).

Premium Insulation System

All MagnaPLUS generators are built with Class H or better insulation materials. All standard generators are suitable for continuous duty at Class F temperature rise and will give equivalent or better winding life expectancy to generators supplied with Class A or B insulation systems operated within their temperature limits. The varnishes and epoxies used are synthetic, non-hygroscopic. Multiple dip and bake cycles of the main winding, make the standard winding fungus and moisture resistant. The MagnaPLUS rotor is wet wound with thermo-setting epoxy applied between each layer for moisture and abrasion resistance.

Power Factor

All standard generators are designed for operation at rated kVA at 0.8 power factor but can be operated at rated kVA over the 0.8 to 1.0 power factor range.

MagnaPLUS Voltage Regulator

The standard voltage regulator is a fully encapsulated, static type with a solid state build up circuit. The MagnaPLUS can use several optional regulators. A 3 lead exciter field is used allowing external selection of field resistances to better match various regulator requirements.

GENERAL INFORMATION

SECTION

2

HOW TO READ A MODEL NUMBER

It is extremely important to properly identify the machine when requesting parts or service.

Always have the generator model number and serial number when requesting information from the factory. We cannot help you without this information.

AN EXAMPLE FOR MAGNA PLUS GENERATORS

Example: 43 2 S 1268 3286 A A-F A
① ②③ ④ ⑤ ⑥⑦⑧⑨

- ① 43 — 430 Frame
- ② 0 — 4-Pole
1 — 6-Pole
2 — 4-Pole, extra length
3 — 6-Pole, extra length
- ③ S — SER Generator
M — MAC Generator
R — Synchronous Motor
D — DOD Generator
- ④ Winding Model Number
- ⑤ Mechanical Model Number
- ⑥ Electrical modification — minor modification, used in sequence A, B, C, etc.
- ⑦ Mechanical modification — minor modification used in sequence A, B, C, etc.
- ⑧ Mounting arrangement — indicates adapter size and drive disc size. (Figure 2-1)
- ⑨ A — Lima Manufacturing Plant

FIGURE 2-1

Arrangement	Adaptor SAE Size	Drive Disc SAE Size
A	3	11-1/2
B	2	11-1/2
D	3	10
E	1	11-1/2
F	1	14
H	1	Delco
J	1/2	14
K	2	10
L	1/2	Delco
M	0	14
N	2	Small Delco
O	None	None
S	0	Delco

INSTALLATION

SECTION

3

RECEIVING YOUR MagnaPLUS GENERATOR

Upon receipt of the generator, it is recommended that it be carefully examined for possible damage incurred in shipment. The generator was given to the freight company in good condition, and they are responsible for the product from our dock to yours. Any damage should be noted on the freight bill before accepting the shipment. Claims for damages must be promptly filed with the freight company.

UNPACKING AND HANDLING

Read all instruction cards carefully. When lifting, attach an overhead crane to the lifting lugs on the generator frame. Apply lifting forces in a vertical direction.

WARNING

THE LIFTING LUGS ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT COMPLETE GENERATOR SET BY MEANS OF LIFTING LUGS ON GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

STORAGE

In the event that the generator is not to be installed on the prime mover immediately, it is recommended that it be stored in a clean, dry area which is not subject to rapid changes in temperature and humidity.

PREPARATION FOR USE

Although the generator is carefully inspected and tested in operation before it leaves the factory, it is recommended the unit be thoroughly inspected. The insulation on the wire should be inspected and all bolts should be checked for tightness.

Remove all shipping tapes, bags, blocks, and skids which are used to prevent vibration and rotor movement during shipment. Dry, low-pressure compressed air of approximately 30 PSI (206 KPA) can be used to blow out the interior of the generator. In the case of two bearing machines, it is possible to turn the rotor by hand to make sure that it rotates smoothly without binding.

If the machine has been exposed to damp, humid conditions the insulation resistance should be checked. Refer to section 8.

GENERATOR MOUNTING - SINGLE BEARING

Single bearing generators are provided with an SAE flywheel adapter and flexible drive discs. Very close tolerances are maintained in the manufacture of the generator so that the alignment procedure is extremely simple. A coupling hub of nodular iron is shrunk on the shaft and special steel drive discs are bolted to the hub. Holes are provided in the periphery of the coupling disc which correspond to tapped holes in the flywheel. The outside diameter of the discs fits in a rabbet in the flywheel so that concentricity is assured in all cases.

WARNING

DO NOT APPLY ANY FORCE TO GENERATOR FAN FOR LIFTING OR ROTATING GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

CAUTION: GRADE 8 CAPSCREWS AND HEAVY SERIES LOCKWASHERS OR GRADE 8 PLACE-BOLTS AND HARDENED WASHERS ARE RECOMMENDED TO MOUNT THE DRIVE DISCS TO THE FLYWHEEL.

The SAE adapter and the flywheel housing are designed to match each other with no further alignment necessary. Shims may be necessary under the feet of the generator to insure a solid mounting. See section 6 for more information.

GENERATOR MOUNTING - TWO BEARING

Two bearing generators are provided with a shaft extension and keyway. For direct-coupled units, the assembler furnishes a flexible coupling which is installed between the driver and the generator shaft.

IMPORTANT: Aligning the two machines as accurately as possible will reduce the vibration, increase bearing life, and insure minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

INSTALLATION

SECTION 3

BELT DRIVE

430 frame, two bearing generators can be belt driven. Please refer to Marathon Electric for application assistance involving belt driven installations. Sheave diameters should be chosen according to the table below.

MagnaPLUS Sheave Application for Two Bearing Units ①

Model	Min. Sheave Dia. in Inches @ 10,000 Hr. B-10 Life③		Min. Sheave Dia. in Inches @ 20,000 Hr. B-10 Life③		Max. Sheave Width Inches
	60 Hz	50 Hz	60 Hz	50 Hz	
430S1260	6.6	5.5	8.6	7.3	8.5
430S1261	7.3	5.6	9.4	7.5	8.5
430S1262	8.3	6.5	10.8	8.8	8.5
430S1263	9.8	7.6	12.8	10.2	8.5
430S1264	11.7	9.2	15.3②	12.4	8.5
430S1265	13.8②	10.8	18.1②	14.6②	8.5
432S1266	16.9②	12.4	22.4②	17.0②	8.5
432S1267	16.7②	13.2	22.2②	18.0②	8.5
432S1268	21.3②	14.6	28.6②	20.1②	8.5

① Assumptions:

- A. Belting factor is 1.3.
- B. The drive and the driven sheaves are the same diameter.
- C. The sheave load is located at the center of the shaft extension.
- D. Based upon continuous kW ratings.

② These sheave diameters exceed the maximum recommended belt speed of 6000 ft/min.

③ B-10 Life means 90% of the bearing will last this long or longer.

ENVIRONMENTAL CONSIDERATIONS

Dirt, moisture, heat, and vibration are enemies of electrical equipment. Excessive exposure to the elements will shorten the life of the generator. The ambient temperature should not exceed the value shown on the generator nameplate. The MagnaPLUS is built in a NEMA open type enclosure. Generators for outdoor application should be protected from the elements by housings with proper openings for ventilation. This protection should be designed to prevent the direct contact of wind driven rain, snow, or dust with the generator. In moist or humid areas, such as the Tropics and marine service, additional protection is recommended. Although the standard windings are humidity and moisture resistant, special

insulations and accessories such as space heaters can increase generator life significantly. In extremely dirty and dusty environments, a means of providing filtered cooling air to the generator is recommended. Refer to Marathon Electric for more information.

ELECTRICAL CONNECTIONS

The generator conduit box construction allows conduit to enter the top, bottom, or either side of the box. A hole-saw or any suitable tool can be used to provide for the conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit.

To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical entrance to the generator.

Refer to the connection diagram supplied with the generator and/or the proper diagrams shown in this section. Install all intercomponent and external wiring in accordance with the regulations of the national and local electrical codes. Clean all contact surfaces to assure good electrical bonding with the generator lugs or bus bars. Use heavy duty terminal lugs or good quality clamps for making all connections. Insulate all connections in accordance with national and local regulations.

Be sure the generator frame is grounded to all the other components of the system with a ground wire in accordance with national and local regulations.

GENERATOR LEAD CONNECTIONS

The electrical connections in the conduit box should be made in accordance with the appropriate "connection diagram." Use the diagram appropriate for the number of leads and voltage range required. Refer to the drawings supplied with the generator and to drawings in this section.

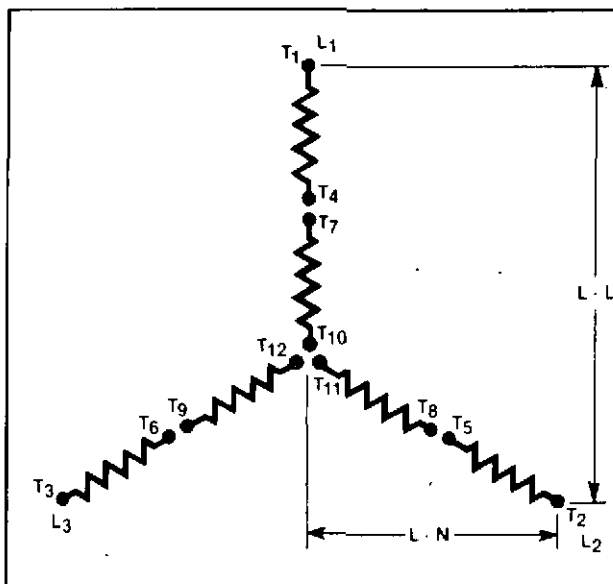
The final voltage setting is established within the selected range by an adjustment of the voltage regulator.

CAUTION: SOME GENERATORS HAVE MULTIPLE, IDENTICALLY MARKED, CABLES FOR EACH LEAD. CONNECT ALL IDENTICALLY MARKED CABLES TOGETHER WHEN MAKING CONNECTIONS.

INSTALLATION

SECTION 3

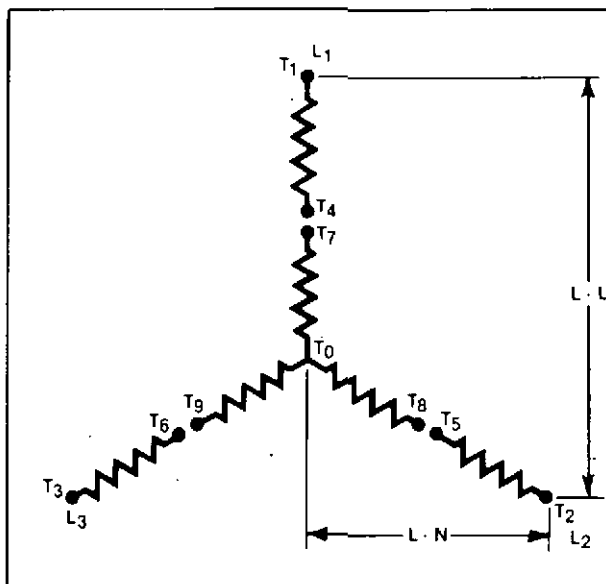
12 LEAD HI WYE



Twelve lead generators are dual voltage generators with six coils which don't have the connection of the three inner coils. There are 12 or 24 cables coming out of the generator.

	VOLTAGE		CONNECT	L ₁	L ₂	L ₃	NEUTRAL
	L-L	L-N					
60 HZ	380	219	T ₁₀ T ₁₁ T ₁₂	T ₁	T ₂	T ₃	T ₁₀ T ₁₁ T ₁₂
	416	240					
	440	254	T ₄ T ₇				
	460	266					
	480	277	T ₅ T ₈				
50 HZ	380	219					
	400	231					
	416	240	T ₆ T ₉				

10 LEAD HI WYE

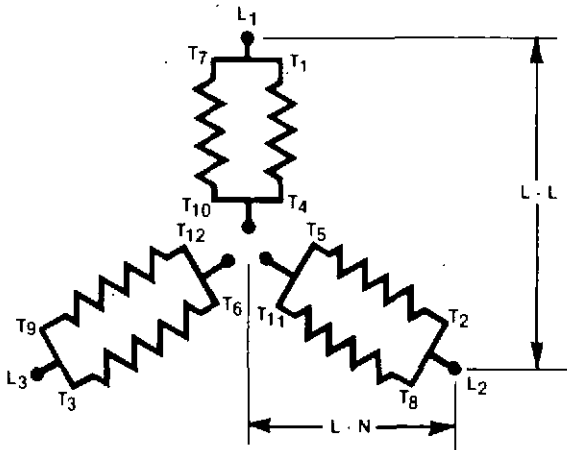


Ten lead generators are dual voltage generators with six coils. One end of the three inner coils is connected together. There are 10 or 20 cables coming out of the generator.

	VOLTAGE		CONNECT	L ₁	L ₂	L ₃	NEUTRAL
	L-L	L-N					
60 HZ	380	219	T ₄ T ₇	T ₁	T ₂	T ₃	T ₀
	416	240					
	440	254	T ₅ T ₈				
	460	266					
	480	277	T ₆ T ₉				
50 HZ	380	219					
	400	231					
	416	240					

INSTALLATION

12 LEAD LOW WYE

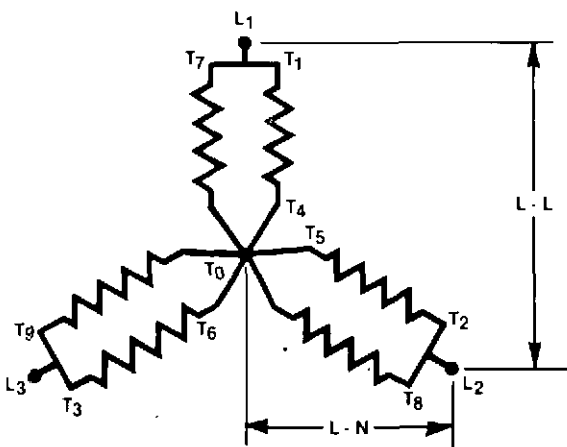


Twelve lead generators are dual voltage generators with six coils which don't have the connection of the three inner coils. There are 12 or 24 cables coming out of the generator.

VOLTAGE			CONNECT	L1	L2	L3	NEUTRAL
	L-L	L-N					
60 HZ	190	110	T ₁₀ T ₁₁ T ₁₂	T ₁	T ₂	T ₃	T ₁₀ T ₁₁ T ₁₂
	208	120	T ₄ T ₅ T ₆				
	220	127					
	230	133	T ₁ T ₇				
50 HZ	190	110	T ₂ T ₈	T ₁	T ₂	T ₃	T ₄ T ₅ T ₆
	200	115					
	208	120	T ₃ T ₉				

SECTION
3

10 LEAD LOW WYE



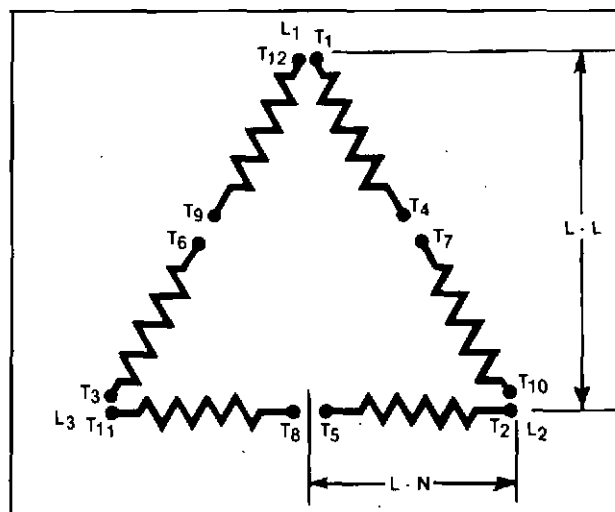
Ten lead generators are dual voltage generators with six coils. One end of the three inner coils is connected together. There are 10 or 20 cables coming out of the generator.

VOLTAGE			CONNECT	L1	L2	L3	NEUTRAL
	L-L	L-N					
60 HZ	190	110	T ₁ T ₇	T ₁	T ₂	T ₃	T ₄ T ₅ T ₆ T ₀
	208	120	T ₂ T ₈				
	220	127					
	230	133	T ₃ T ₉				
50 HZ	190	110	T ₄ T ₅ T ₆ T ₀	T ₁	T ₂	T ₃	T ₄ T ₅ T ₆ T ₀
	200	115					
	208	120					

INSTALLATION

SECTION 3

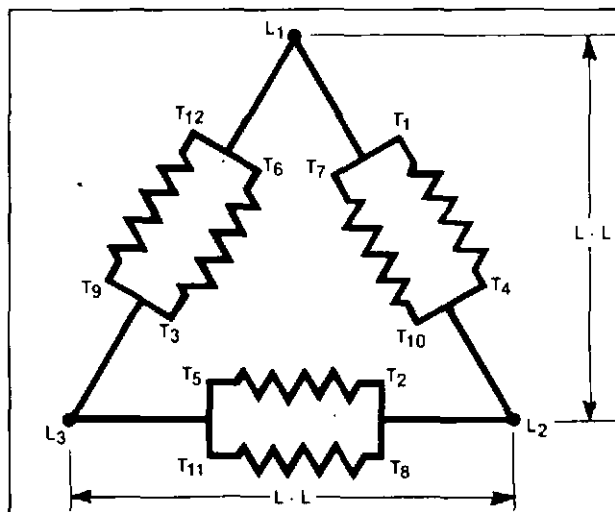
12 LEAD HI DELTA



Delta connection with 12 lead generators only.

	VOLTAGE		CONNECT	L ₁	L ₂	L ₃
	L-L	L-N				
60 HZ	240	120	T ₄ T ₇	T ₁	T ₂	T ₃
	277	139	T ₅ T ₈			
50 HZ	200	100	T ₆ T ₉			
	220	110	T ₁ T ₁₂			
	240	220	T ₂ T ₁₀			
			T ₃ T ₁₁			

12 LEAD LOW DELTA

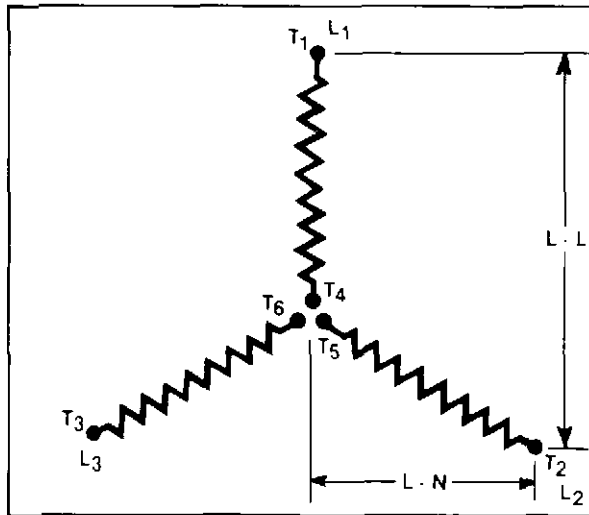


Delta connection with 12 lead generators only.

	VOLTAGE		CONNECT	L ₁	L ₂	L ₃
	L-L	L-N				
60 HZ	120	139	T ₁ T ₇ T ₆ T ₁₂	T ₁	T ₂	T ₃
			T ₂ T ₈ T ₄ T ₁₀			
50 HZ	100	120	T ₃ T ₉ T ₅ T ₁₁			

INSTALLATION

6 LEAD WYE

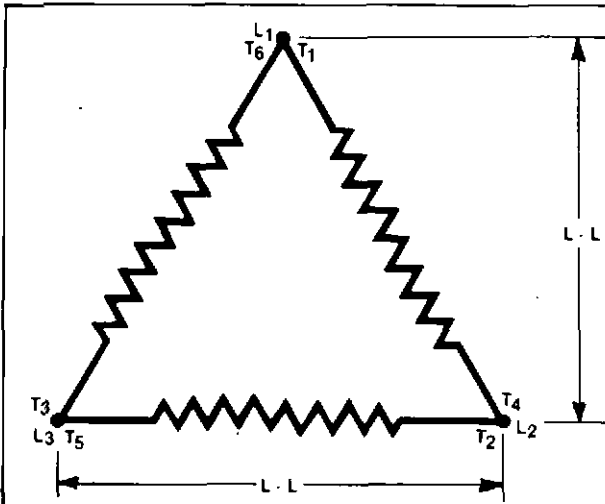


Six lead generators have 3 coil groups with 6 or 12 cables or bus bars coming out of the generator.

	VOLTAGE		CONNECT	L ₁	L ₂	L ₃	NEUTRAL
	L-L	L-N					
60 HZ	190	110	T ₄ T ₅ T ₆	T ₁	T ₂	T ₃	T ₄ T ₅ T ₆
	203	120					
	220	127					
	230	133					
	240	139					
	3300	1905					
50 HZ	190	110					
	200	115					
	208	120					
	3300	1905					

SECTION
3

6 LEAD DELTA



Six lead generators have 3 coil groups with 6 or 12 cables coming out of the generator.

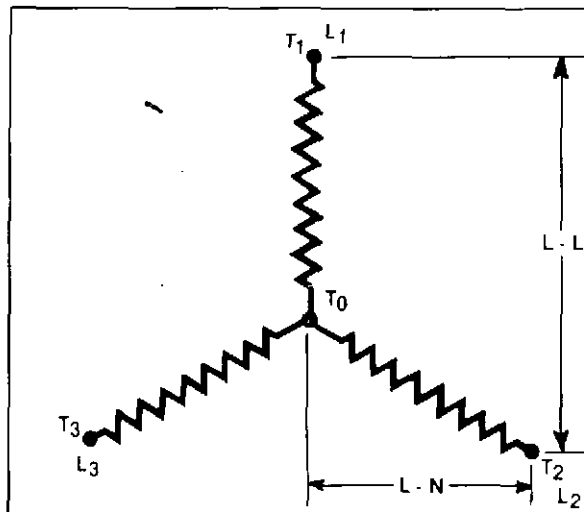
VOLTAGE		CONNECT	L ₁	L ₂	L ₃
	L-L				
60 HZ	2400	T ₁ T ₆	T ₁	T ₂	T ₃
		T ₂ T ₄			
50 HZ	1905	T ₃ T ₅			

INSTALLATION

SECTION

3

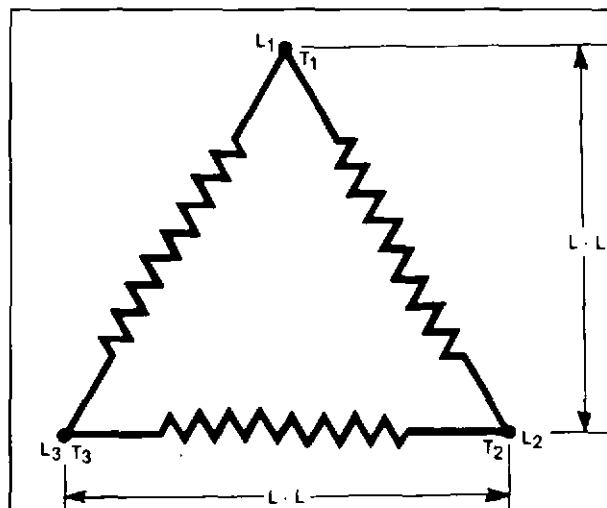
4 LEAD WYE



Four lead generators have 3 coil groups with one end of each group connected together. There are 4, 8 or 16 cables or 4 bus bars coming out of the generator.

VOLTAGE			L ₁	L ₂	L ₃	NEUTRAL
	L-L	L-N				
60 HZ	380	219	T ₁	T ₂	T ₃	T ₀
	416	240				
	440	254				
	460	266				
	480	277				
50 HZ	600	346				
	380	219				
	400	231				
	416	240				
	480	277				

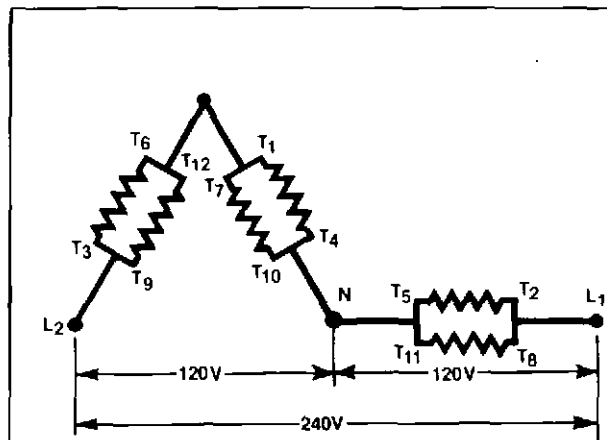
3 LEAD DELTA



Three lead generators have 3 coil groups with one end of each group connected into a Delta internally. There are 3, 6, or 12 cables or 3 bus bars coming out of the generator.

VOLTAGE		L ₁	L ₂	L ₃
	L-L			
60 HZ	480	T ₁	T ₂	T ₃

12 LEAD ZIGZAG



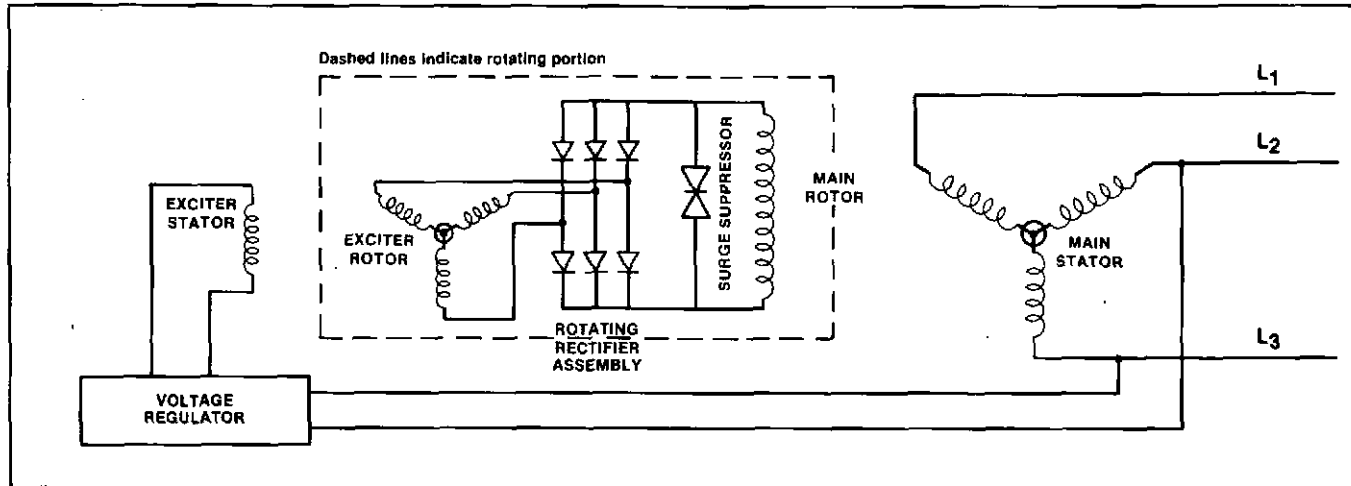
ZIG-ZAG connection with 12 lead machine only.

VOLTAGE		CONNECT	L ₁	L ₂	NEUTRAL
	L-L				
60 HZ	120/240	T ₃ T ₉	T ₂	T ₃	T ₄
		T ₂ T ₈			
		T ₁ T ₆ T ₇ T ₁₂			
		T ₄ T ₁₀ T ₅ T ₁₁			

INSTALLATION

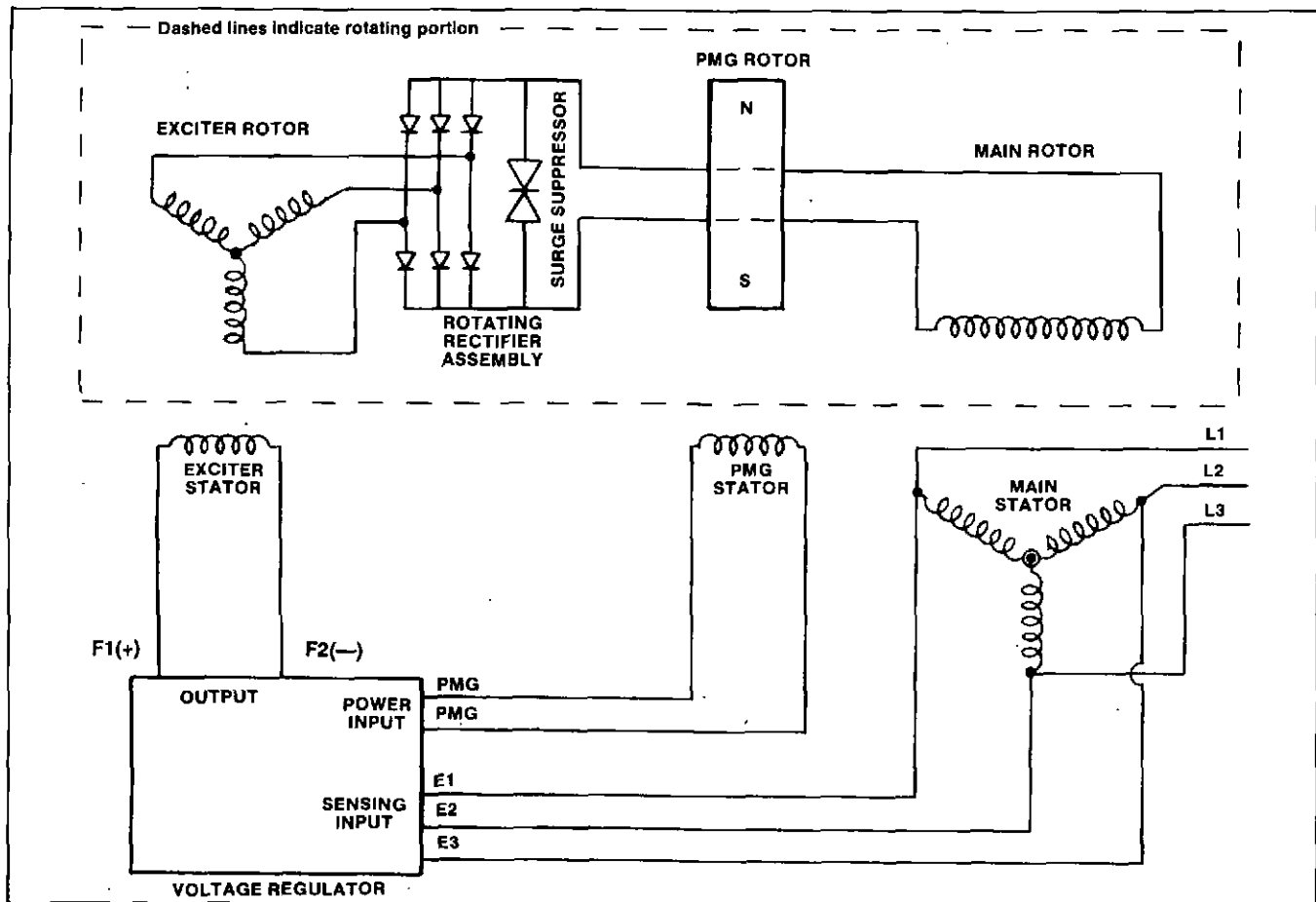
NOTE: The MagnaPLUS is provided with a dual winding on the exciter field. Three leads are brought out F1, F2, and F3. Use F1 and F2 for a field resistance of 18.6 ohms. Use F1 and F3 for a field resistance of 28.7 ohms. See manual for installed regulator for specific interconnection diagrams and exciter field requirements.

TYPICAL SYSTEM DIAGRAM WITH STANDARD REGULATOR SYSTEM



SECTION
3

TYPICAL SYSTEM DIAGRAM WITH OPTIONAL PMG INSTALLED



INSTALLATION

SECTION

3

PARALLELING OPERATIONS

MagnaPLUS generators come standard with amortisseur windings die cast as an integral part of the rotor. This exclusive Unirotor construction makes all MagnaPLUS generators suitable for paralleling operations when the proper control equipment is added. Paralleling with other generator sets and/or with the utility power grid offers a number of advantages. Multiple unit installations increase power capacity; they can be added or removed from the line depending on the load requirements; they can be better maintained and repaired (since single source breakdown would mean total loss of power), and they often provide more reliable, efficient, and economical operation.

Successful parallel operation means that the generators deliver power to the external system without delivering power to each other, or accepting power from the load bus or power grid. Additional equipment is necessary to insure safe and successful operation.

Prime Mover

The prime mover provides the speed and torque which will be necessary to keep the machines in synchronized operation. The governor will directly control the frequency (speed) of the unit. When in parallel, the governor will control the amount of power (kW) supplied to the bus. The governor must have special paralleling provisions to permit parallel operation.

Voltage Regulator

The voltage regulator controls the generator output voltage and the reactive power supplied by the generator. When two or more ac generators operate in parallel, the voltage regulator must have paralleling provisions (either internally or external to the regulator) to permit it to control the reactive power (kVAR) supplied to the bus while in parallel operation. A separate paralleling current transformer is required to sense the reactive current and signal the voltage regulator. This additional paralleling circuitry is absolutely necessary to control the reactive current flowing between the generator sets.

Switchgear

There are additional relays and breaker controls which are necessary to insure safe, trouble free operation of paralleled units. Reverse power relays monitor the direction of power flow to insure that

the generator is delivering power, not accepting it. These power relays control breakers, which are a means of connecting and disconnecting the generator from the load. The total system can include over-voltage, overcurrent protection, under frequency protection, power factor correction provision and various associated control equipment from manual switchgear to micro-processors. The amount of control gear and level of sophistication will be determined by the needs and requirements of the particular application.

Paralleling Basics

The following points are basic criteria which must be met before two units can be paralleled. THIS IS NOT MEANT TO BE SPECIFIC INSTRUCTIONS FOR PARALLELING OPERATION.

1. Additional paralleling circuitry
 - A. Voltage regulator - paralleling provisions
 - B. Paralleling current transformer(s)
 - C. Paralleling provisions on governor controls
 - D. Switchgear
2. The voltage and frequency must be the same for all sets with voltages in phase.
3. The voltage regulation characteristics of the individual generators should be similar.
4. The generators must have the same phase rotation.
5. The driving engines should have the same speed regulation characteristics and the governors should be adjusted to give the same speed regulation.

Before operating generator sets in parallel, each set should be checked by starting, operating, and adjusting the sets as individual units before attempting paralleling.

Reactive Load Control

When two identical generators are operating together in parallel and an unbalance occurs in field excitation, circulating currents begin to flow between the generators. This current will appear as a lagging power factor or inductive load to the highly excited generator, and as a leading power factor or capacitive

INSTALLATION

SECTION 3

load to the generator with the lower field current. This is known as the reactive circulating current and there are two methods of controlling it in parallel operation:

1. Reactive droop compensation. (Formerly known as parallel droop compensation.)

The bus voltage droops, or decreases, as the reactive lagging power factor load is increased.

2. Reactive differential compensation. (Formerly known as cross current compensation.)

The reactive differential compensation circuit allows parallel generators to share reactive loads with no decrease or droop in generator voltage. The circuit must meet the following criteria:

- A. All paralleling current transformers for all the generators being paralleled must be included in the secondary interconnection loop.
- B. When different size generators are paralleled, all paralleling current transformers must have the same or proportional ratios that give approximately the same secondary current.
- C. Voltage regulator paralleling circuitry must be the same.
- D. Current transformer secondaries and the generator lines must be isolated electrically.

Because of the above criteria, reactive differential compensation cannot be used when paralleling with the utility power grid. There is no limit, however, in the number of generators that can be included in this type of circuit.

- E. It is also desirable to have an auxiliary contact on the main generator breaker to short the parallel CT secondary when that breaker is open (not connected to the load bus).

Paralleling Circuitry

Because of the number of variables involved in paralleling generator sets, every installation will have its own circuitry and methods or procedure of bringing paralleled units on line. There are numerous

ways of connecting paralleled units and an almost unlimited variety of applications and associated equipment.

When parallel operation is desired, it is important that the control manufacturer, the generator manufacturer, and the systems engineer work together to insure the proper selection of all components. Please refer to Marathon Electric for application assistance.

THYRISTOR OR SCR LOADING

Solid state electronic control devices which utilize thyristors or SCR firing circuits (such as variable frequency induction motor controls, precision motor speed controls, no-break powered battery chargers, etc.) can introduce high frequency harmonics which adversely affect or destroy the normal waveform of the generator. This creates additional heat in the generator stator and rotor, and can cause overheating. These devices can and do present problems to non-utility power generating equipment or any limited power bus system. The problems which can occur are not limited to the generator itself, but can effect the solid state control device, the equipment it controls, other associated loads, monitoring devices or a number of combinations over the entire system.

MagnaPLUS generators can supply power to thyristor or SCR loads when properly applied. When SCR loads are more than 25% of the total load, select the generator based on the 80° CR/R rating. The optional PMG and PM100 regulator is recommended. The PM100 senses 3 phase RMS voltages for maximum stability against severely distorted wave forms. SCR type applications such as cranes, shovels, etc., require special consideration of the generator insulation system due to greater dielectric stress and severe environmental conditions. It is important that the control manufacturer, the generator manufacturer, and the systems engineer work together to insure the proper selection of all components. Please refer to Marathon Electric for application assistance.

OPERATION

SECTION

4

PRE-START INSPECTION

Before operating the generator for the first time, the following checks are recommended.

1. A visual inspection should be made to check for any loose parts, connections, or foreign materials. Refer to section 8.
2. Check for clearance in the generator and exciter air gap. Be sure the generator set turns over freely. Bar the generator over by hand at least 2 revolutions to be sure there is no interference.

WARNING

DO NOT APPLY ANY FORCE TO GENERATOR FAN WHEN ROTATING GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

3. Check all wiring against the proper connection diagrams and make sure all connections are properly insulated.
4. Be sure the equipment is properly grounded.
5. Inspect for any remaining packing materials and remove any loose debris, building materials, rags, etc., that could be drawn into the generator.
6. Check fasteners for tightness.
7. Check to be sure no tools or other hardware have been left inside or near the machine.
8. Install and check to be sure all covers and guards are in place and secure.

WARNING

RESIDUAL VOLTAGE IS PRESENT AT THE GENERATOR LEADS AND AT THE REGULATOR PANEL CONNECTIONS, EVEN WITH THE REGULATOR FUSE REMOVED. CAUTION MUST BE OBSERVED OR SERIOUS PERSONAL INJURY OR DEATH CAN RESULT. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

STARTING-UP THE GENERATOR

The following procedure should be followed for starting-up the generator for the first time:

1. The generator output must be disconnected from the load. Be certain that the main circuit breaker is open.
2. Disable the voltage regulator by removing the fuse.

WARNING

DO NOT OVERSPEED THE GENERATOR. EXCESSIVE CENTRIFUGAL FORCES COULD DAMAGE THE ROTATING FIELDS. BE PREPARED FOR AN EMERGENCY SHUTDOWN.

3. Follow the manufacturers instructions and start the prime mover. Check the speed and adjust to the RPM shown on the generator nameplate.
4. Replace the regulator fuse and adjust the voltage to the required value by means of the voltage adjust rheostat. Check all line to line and line to neutral voltages to be sure they are correct and balanced. If the voltages are not correct, shut down immediately and recheck all connections. See Section 3.
5. Close the main circuit breaker and apply the load.
6. Monitor the generator output current to verify it is at or below nameplate amps.
7. Adjust engine speed at full load to 1800 rpm for 60 hertz, 1500 rpm for 50 hertz. (Refer to prime mover/governor instruction manuals.)
8. Before stopping the engine, remove the load by tripping the main circuit breaker.

VOLTAGE ADJUSTMENTS

The generator output voltage is adjusted by the voltage adjust rheostat located under the panel on the side of the generator conduit box. Refer to the regulator manual for detailed information. In cases where special or remote mounted regulators are used, refer to instructions supplied by the generator set assembler and to the voltage regulator manual.

OTHER ADJUSTMENTS

Depending upon application, adjustments to other protective and control gear may be required. Refer to instructions supplied by the generator set manufacturer.

MAINTENANCE

MAINTENANCE - GENERAL INFORMATION

Dirt, heat, moisture, and vibration are common enemies of a generator. Keeping the generator clean and dry, maintaining proper alignment of the generator and its prime mover, and preventing overloads will result in efficient operation and long life.

Generators that are outdoors should be protected from the elements by suitable houses or enclosures.

Dirt and dust will conduct electricity between points of different electrical potential. Moisture will aggravate the problem further. Insulation system failure can result if corrective action is not taken. The condition of the insulation system can be tested by measuring insulation resistance. (See section 8 - Generator Testing.)

Insulation resistance should be checked when putting the generator into service after it has been in storage and anytime contamination by moisture and dirt is suspected. Normally, moisture buildup is not a problem when the generator is running since heat produced internally will tend to keep it dry. Moisture can collect in the generator when it is shut down. The problem will be worse in humid environments or in areas where extreme temperature changes cause condensation (dew) to form inside the generator. Space heaters, air filters, and premium insulation systems should be considered in difficult environments.

Accumulations of dust and dirt not only contribute to insulation breakdown, but they can also increase temperature by restricting ventilation and by blocking the dissipation of heat. Some machines are exposed to accumulations of materials such as talc, lint, rock dust, or cement dust, which may obstruct the ventilation. The most harmful types of foreign materials include carbon black, metallic dust and chips, and similar substances which not only impede the ventilation, but also form a conductive film over the insulation, increasing the possibility of insulation failure. Machines operating in dirty places should be disassembled and cleaned periodically.

AIR INTAKE AND EXHAUST

Check the area around the air intake and exhaust openings to be sure they are clean and unobstructed. Remove all foreign material and clean all screens (Figure 5-1).

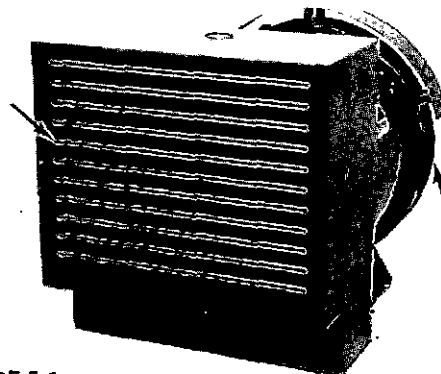


FIGURE 5-1

ELECTRICAL CONNECTIONS AND WINDINGS

Inspect for loose or contaminated connections. Check wires for cracked or frayed insulation. Tighten connections and replace defective or oil soaked insulation.

If inspection shows that varnish coatings on the windings have deteriorated, they should be recoated with insulating varnish. Please refer to Marathon Electric for insulation system requirements.

LUBRICATION

All MagnaPLUS generators use a sealed ball bearing. It is lubricated at the factory and requires no further attention for the life of the bearing.

If the bearing is changed, a sealed type should be used for replacement.

DRYING ELECTRICAL INSULATION

Electrical components must be dried before placing in operation if tests indicate that the insulation resistance is below a safe value. (See section 8 - Generator Testing for test procedure.)

Machines that have been idle for sometime in unheated and damp locations, may have absorbed moisture. Sudden changes in temperature can cause condensation or the generator may have become wet by accident. Windings should be dried out thoroughly before being put into service. The following are recommended drying methods.

SECTION

5

MAINTENANCE

Space Heaters

Electric space heaters can be installed inside of the generator. When energized (from a power source other than the generator) they will heat and dry the inside of the generator. If an alternate source of electricity is not available, enclose the generator with a covering and insert heating units to raise the temperature 15-18 degrees F (8-10 degrees C) above the temperature outside of the enclosure. Leave a hole at the top of the enclosure to permit the escape of moisture.

Oven

SECTION

5

Place the machine in an oven and bake it at a temperature not to exceed 194°F (90°C). The voltage regulator and any electronic component accessories must be removed from the generator when using this method.

Forced Air

A portable forced air heater can be used by directing heat into the air intake (conduit box) and running the generator with no load and without excitation (this can be accomplished by removing the regulator fuse). Heat at point of entry should not exceed 150°F (66°C).

"Short Circuit" Method

The generator can be dried out quickly and thoroughly by using this method.

WARNING:

BE SURE THAT ALL OF THE FOLLOWING STEPS ARE PERFORMED AND ALL PRECAUTIONS TAKEN AS PERSONAL INJURY OR SERIOUS DAMAGE TO THE GENERATOR COULD RESULT.

1. Disconnect exciter leads F1 and F2 from the regulator.
2. Connect a battery or other dc power source of approximately 20-35 volts to the exciter leads F1 and F2. An adjustable voltage source is desirable, however, a rheostat (rated approximately 2 amps) in series with the dc power source will work.

3. Short circuit the generator output lead wires to each other (L1 to L2 to L3). If using jumpers, be sure they are large enough to carry full load amps.
4. Start the generator and measure the current through the output leads with a clip-on ammeter.
5. Adjust the voltage source to produce approximately 80% of the rated ac nameplate current, but in no case exceed nameplate amps. If an adjustable source is not available and current is excessive, use a lower dc source voltage or a larger resistor in series with the source.

Running time will be determined by the amount of moisture present in the machine. Insulation resistance checks should be taken every one to four hours until a fairly constant value is obtained. (See section 8 - Generator Testing for instructions on measuring insulation resistance.)

6. After the generator is dry and the insulation resistance is brought up to specifications, remove the short circuit from the line leads, disconnect the dc source and reconnect the F1 and F2 leads at the regulator. Be sure all connections are tight and correct before attempting to run the generator.

CLEANING METHODS

When electrical components get dirty, the insulation must be cleaned. There are a number of acceptable methods for cleaning the generator, each of which will necessitate disassembly of the unit. The method of cleaning will be determined by the kind of dirt, and when the unit must be returned to service. Drying after cleaning is necessary.

Whenever the generator is disassembled, the windings should be given a thorough inspection and the insulation cleaned, if necessary. The inspection should include the connection of the windings, insulation, and varnish coverage. Check the winding ties and coil supports. Look for any signs of coil movement or looseness and repair as required.

An electric motor repair shop in your area can normally assist with the proper cleaning of the generator windings. They may also be experienced in special problems (such as seacost, marine, oil rig, mining, etc.) that may be peculiar to a certain area.

MAINTENANCE

SOLVENTS

A solvent is usually required to remove accumulated soil containing oil or grease.

Only petroleum distillates should be used for cleaning electrical components.

Petroleum solvents of the safety type with a flash point greater than 100°F (38°C) are recommended.

CAUTION: WINDING VARNISHES ARE EPOXY OR POLYESTER BASED. A SOLVENT THAT DOES NOT ATTACK THESE MATERIALS SHOULD BE USED.

WARNING

ADEQUATE VENTILATION MUST BE AVAILABLE TO AVOID FIRE, EXPLOSION AND HEALTH HAZARDS WHERE SOLVENTS ARE USED. AVOID BREATHING SOLVENT VAPORS. RUBBER GLOVES OR OTHER SUITABLE PROTECTION FOR THE HANDS SHOULD BE USED. WEAR EYE PROTECTION.

Apply the solvent with a soft brush or rag. Be careful not to damage the magnet wire or insulation on the windings.

Dry components thoroughly with moisture-free, low pressure compressed air.

CLOTH AND COMPRESSED AIR

Cleaning with a dry cloth may be satisfactory when components are small, the surfaces are accessible and only dry dirt is removed.

Blowing dirt out with compressed air is usually effective particularly when the dirt has collected in places which cannot be reached with a cloth. Use clean dry air at 30 PSI (206 KPA).

BRUSHING AND VACUUM CLEANING

Dry dust and dirt may be removed by brushing with bristle brushes followed by vacuum cleaning. Do not use wire brushes. Vacuum cleaning is an effective and desirable method of removing dry and loose dirt.

SHELL BLASTING

Air blasting with ground nut shells may be satisfactory for removal of hard dirt deposits from insulation. Use mild abrasives such as 12-20 mesh ground walnut shells.

STEAM CLEANING

If the generator is completely disassembled, including bearings and electronic components, steam cleaning of the major parts and windings is very effective. However, the windings must be thoroughly dried in an oven to remove all moisture before the generator can be put back into service.

SECTION

5

REMOVAL FROM PRIME MOVER

WARNING

BE SURE ALL POWER IS OFF BEFORE SERVICING. FAILURE TO FOLLOW ALL SAFETY INSTRUCTIONS CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

NOTE: Before disconnecting any electrical wiring, be sure it is marked and can be identified for reinstallation. Remark as required.

1. Remove conduit box covers (Figure 6-1 and 6-2).

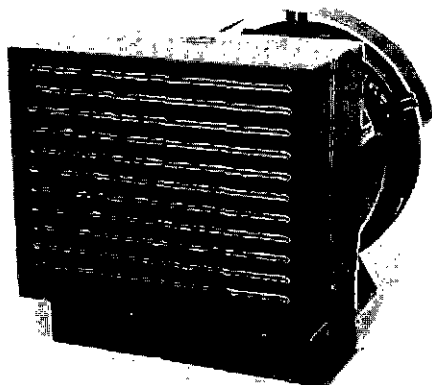


FIGURE 6-1

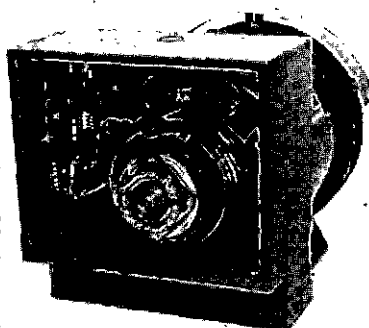


FIGURE 6-2

2. Disconnect all external wiring from the generator leads (or bus bars) inside the conduit box.
3. Remove all conduit or ducting from the conduit box.

4. Attach a suitable hoist to the generator lifting lugs.
5. a. For single bearing generators, remove the bolts mounting the screen assembly to the SAE adapter and remove the screen. (Figure 6-3.) (NOTE: Do not remove the dripcover from the screen assembly if so equipped.) Remove the capscrews attaching the drive discs to the flywheel and remove the capscrews attaching the SAE adapter to the flywheel housing.

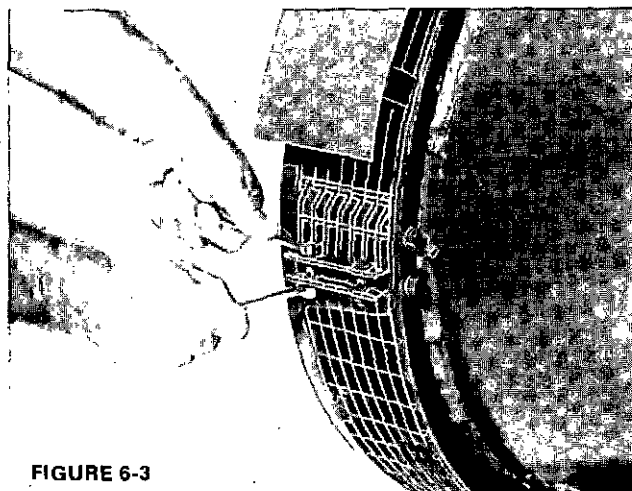


FIGURE 6-3

- b. For two-bearing generators, disconnect the coupling or sheave and belts between the generator and prime mover. (Follow the coupling manufacturer's instructions for disconnection.)

WARNING

DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

6. Remove the mounting bolts which secure the generator to the base. To make reinstallation easier, note the position of and save any shims that were used under the feet for alignment.
7. Raise the generator slightly and move the generator away from the prime mover. Raise or lower the generator to take pressure off of the drive discs so they slide easily out of the flywheel.
8. On single bearing generators, if generator is to be shipped, see Shipping Instructions Section 11 for proper rotor support.

CONDUIT BOX REMOVAL

1. Note the location and markings (re-mark as required) and remove connections from voltage regulator terminal strip and any other conduit box mounted control. (Figure 6-4.)

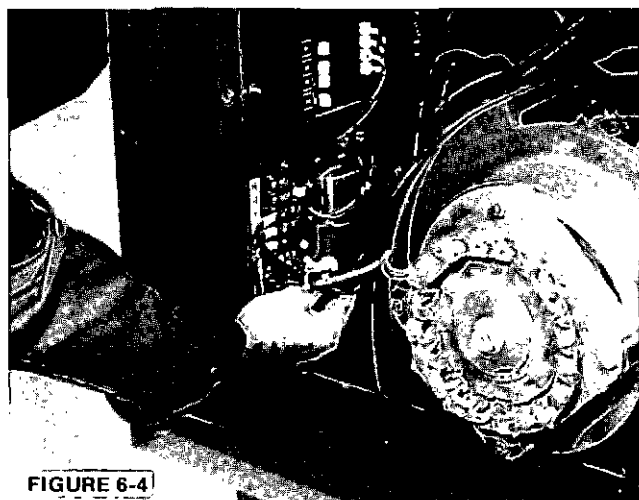


FIGURE 6-4



FIGURE 6-5

2. Remove the regulator panel assembly and conduit box extension ring (if used). (Figure 6-5 and 6-6.)
3. Remove bolts holding conduit box in place. (Figure 6-7.)

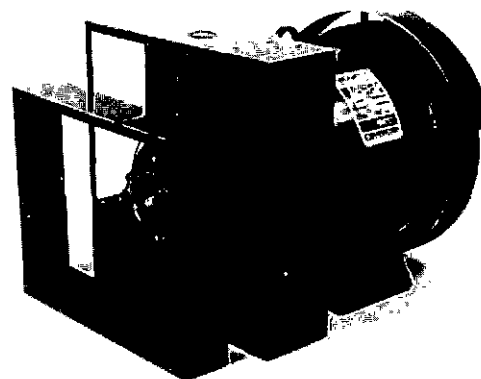


FIGURE 6-6

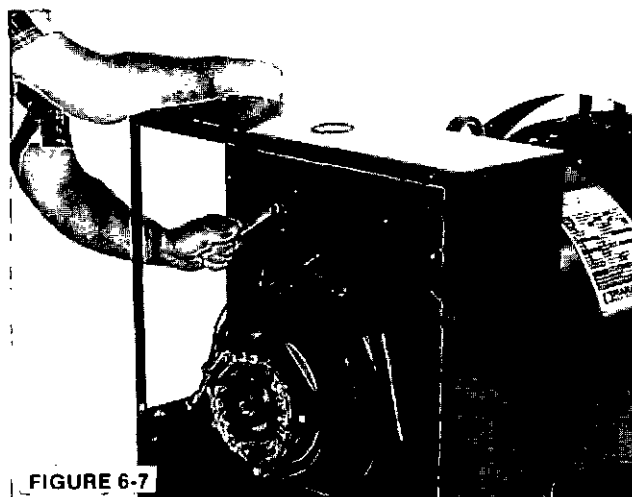


FIGURE 6-7

4. Remove conduit box. (Figure 6-7.)

NOTE: The MagnaPLUS generator can be equipped with a permanent magnet generator (PMG) as a factory modification. If your unit is not equipped with a PMG, disregard instructions pertaining to it.

PMG STATOR REMOVAL

1. Remove the PMG leads (Figure 6-8) and loosen all cable ties so the leads can be removed with the PMG stator.
2. Note the position of the PMG stator leads which exit at the left outboard side or mark the stator so it can be reinstalled in the same position.
3. Remove the four mounting capscrews. (See Figure 6-9.)

SERVICE

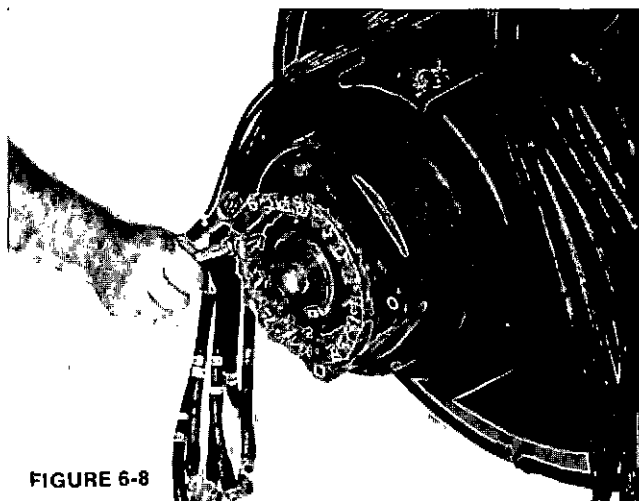


FIGURE 6-8

4. Using 2 screwdrivers, gently pry the PMG stator from the mounting pad and slide over the PMG rotor. The magnets used in the PMG are very strong. They will resist removal of the PMG stator. (Figure 6-9.)

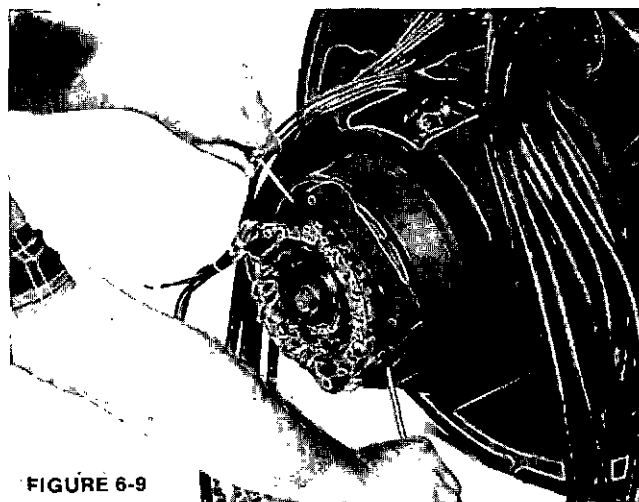


FIGURE 6-9

PMG ROTOR REMOVAL

1. The PMG rotor is mounted to the generator shaft using a stub shaft extension. Remove the center cap screw and pull the assembly off of its locating pin. (See Figure 6-10 and 6-11.)

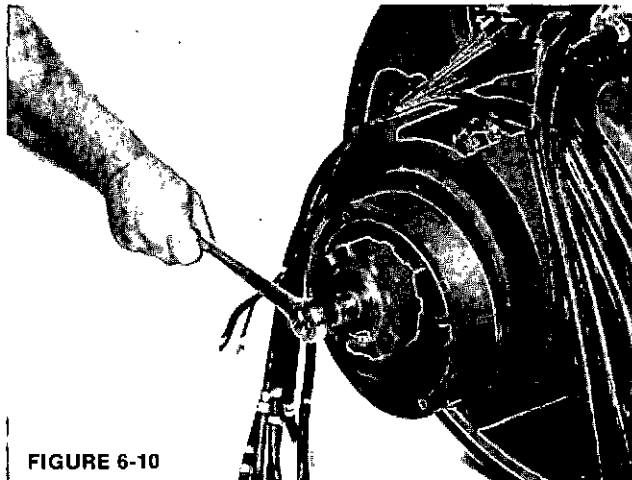


FIGURE 6-10

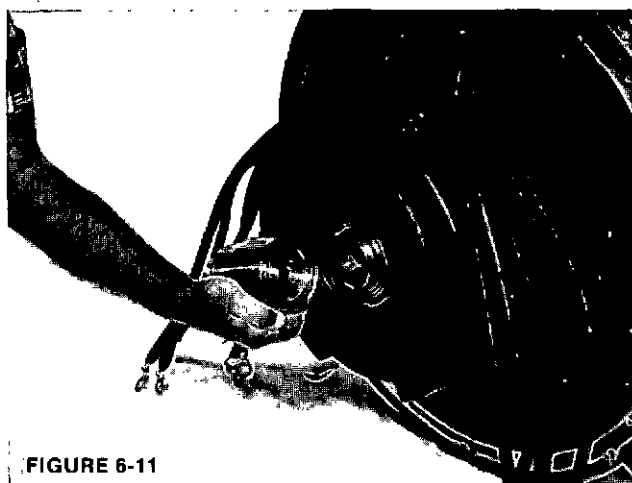


FIGURE 6-11

2. To remove the PMG rotor from the stub shaft, use a snap ring plier, remove the snap ring and slide the PMG rotor off the shaft. A loading spring behind the PMG rotor keeps tension on the snap ring to prevent movement. (See Figure 6-12 and 6-13.)

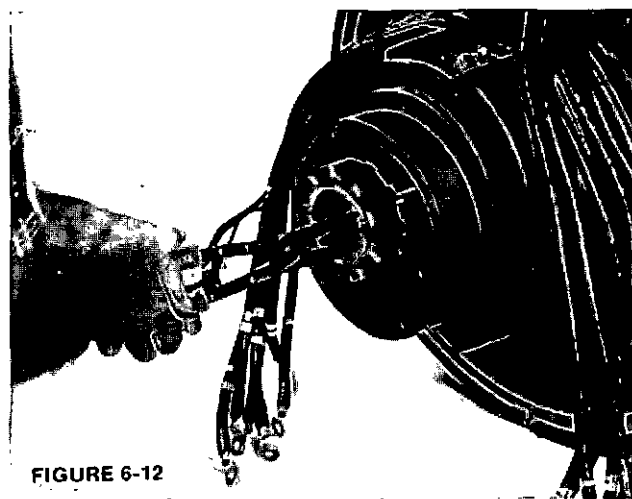


FIGURE 6-12

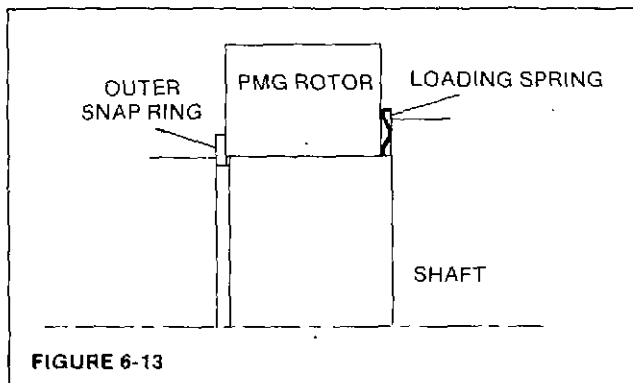


FIGURE 6-13

MAIN ROTOR REMOVAL

1. Remove the PMG. (Follow instructions found earlier in this section.)
2. If the screen assembly is still mounted, remove the bolts securing the screen assembly to the drive end bracket or the SAE adapter and remove the screen assembly. (Figure 6-14.) (NOTE: Do not remove the drip cover from the screen assembly if so equipped.)

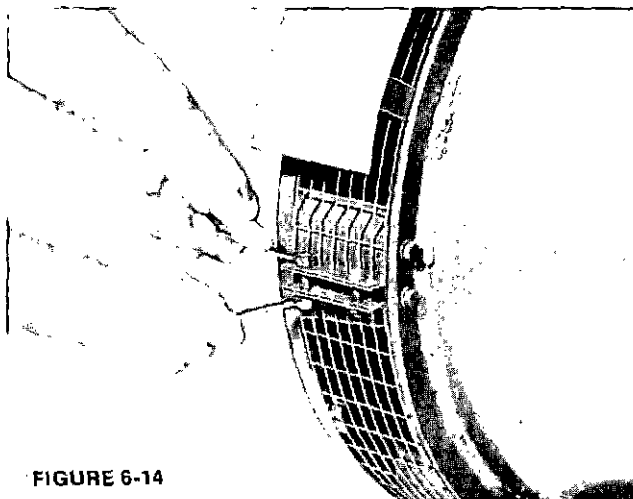


FIGURE 6-14

3. a. For single bearing generators, remove the capscrews and hardened washers holding the drive discs to the drive hub. (Figure 6-15.) Remove all drive discs (and spacers if any).

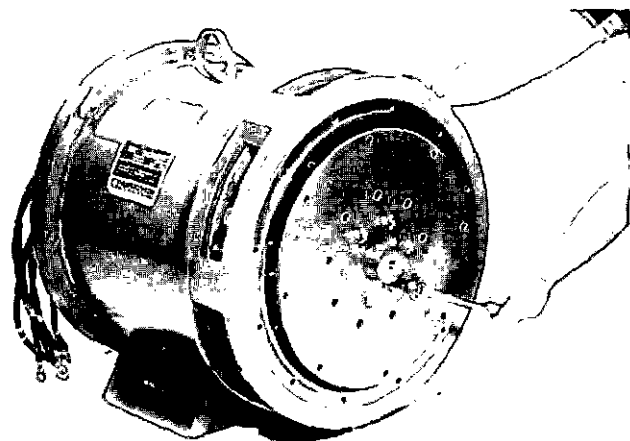


FIGURE 6-15

- b. For two-bearing generators, remove the drive coupling half or sheave from the shaft extension.
4. a. For single bearing generators, remove the capscrews holding the SAE adapter to the generator and remove the adapter. (Figure 6-16 and 6-17.)

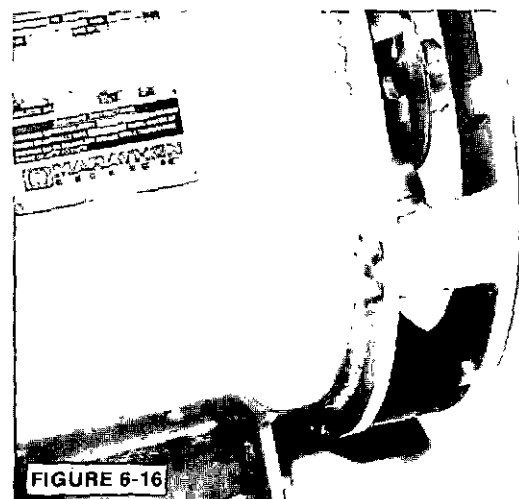


FIGURE 6-16

SECTION

6

SERVICE

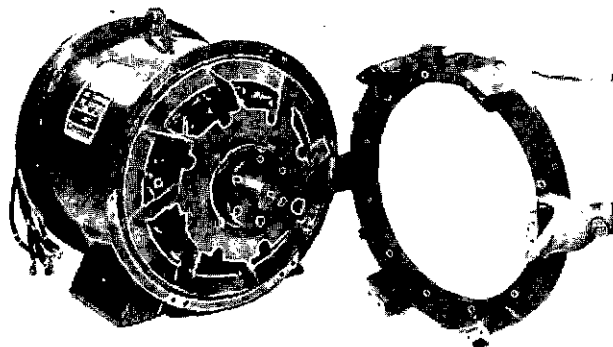


FIGURE 6-17

- b. For two-bearing generators, remove the cap-screws holding the drive end bracket to the generator and remove the bracket.

SECTION 6

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN DRIVE END BRACKET OR SAE ADAPTOR REMOVAL.

WARNING

DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

5. If the generator fan requires service it can be removed at this time. See main rotor inspection later in this section for details. (Figure 6-18.)

NOTE: The fan does not need to be removed in order to remove the rotor assembly from the generator.

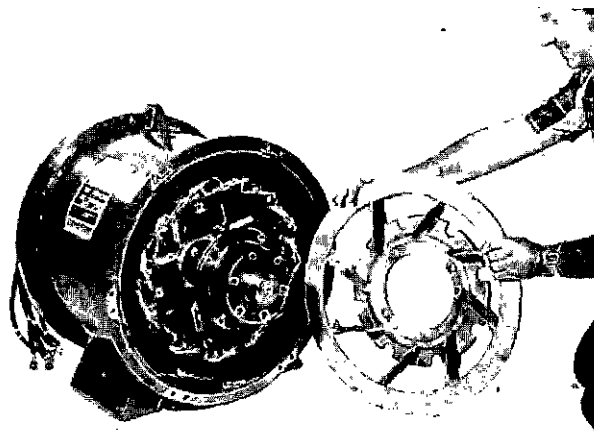


FIGURE 6-18

6. Using a rotor lifting fixture and a suitable hoist, carefully remove the rotor assembly from the main stator and frame assembly through the drive end. (Figure 6-19.)

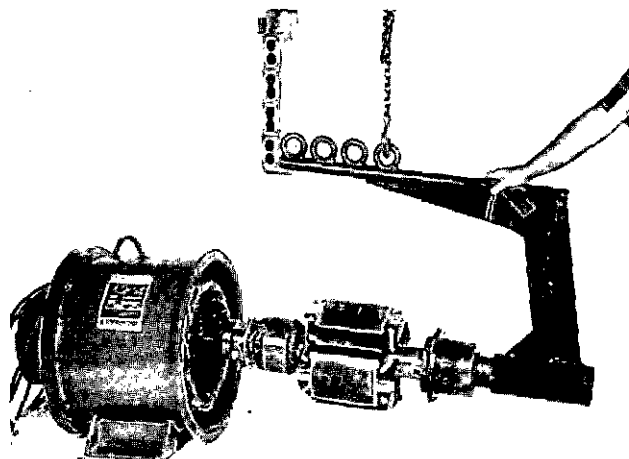


FIGURE 6-19

CAUTION: SPECIAL CARE SHOULD BE TAKEN WHEN REMOVING THE MAIN ROTOR, WINDING DAMAGE COULD RESULT IF THE ROTOR IS ALLOWED TO HIT THE MAIN STATOR.

FRONT END BRACKET REMOVAL

1. Remove front bracket mounting screws.
2. Remove the front end bracket from the main stator assembly. (Figure 6-20.)

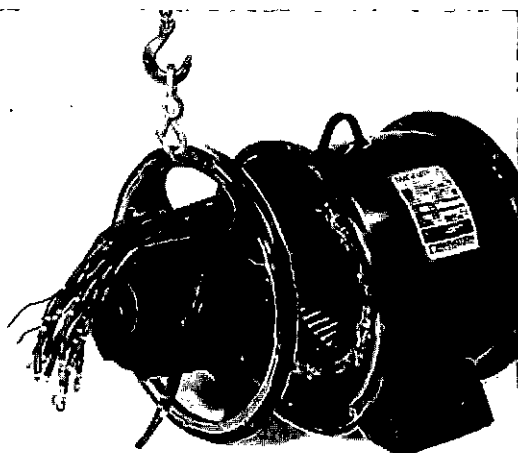


FIGURE 6-20

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN THE FRONT END BRACKET REMOVAL.

EXCITER STATOR (FIELD) REMOVAL

1. Remove the exciter stator retaining screw. (Figure 6-21.)
2. Note the position of the exciter stator in the housing, remove stator.

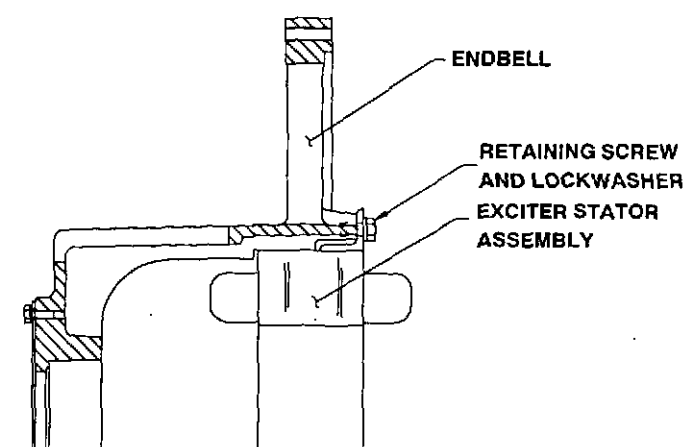


FIGURE 6-21

EXCITER ROTOR (ARMATURE) REMOVAL

1. The exciter armature is a shrink fit to the shaft. It is not easily removed.
2. If the winding is intact, do not remove.
3. If the winding is damaged, use a bearing puller to remove the assembly from the shaft.

EXCITER INSPECTION

A. Exciter Stator

1. Clean dust and dirt from the stator winding. (See section 5.)
2. Check the exciter stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance. (See section 8.) Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.
3. Look for score marks in the bore of the exciter core caused by rubbing. (This could indicate bearing or assembly problems and should be investigated.)

B. Exciter (Rotor) Armature

1. Clean dust and dirt from the exciter armature and rectifier assembly. (See section 5.)
2. Check the rectifiers and surge protector for proper operation. (See section 8.) Replace defective parts.

CAUTION: THREE FORWARD POLARITY AND THREE REVERSE POLARITY DIODES ARE USED. BE SURE YOU HAVE THE CORRECT PART INSTALLED IN THE CORRECT LOCATION. THE SURGE SUPPRESSOR IS POLARIZED. OBSERVE POLARITY MARKINGS WHEN CHANGING THE SURGE SUPPRESSOR. (Figure 6-22.)

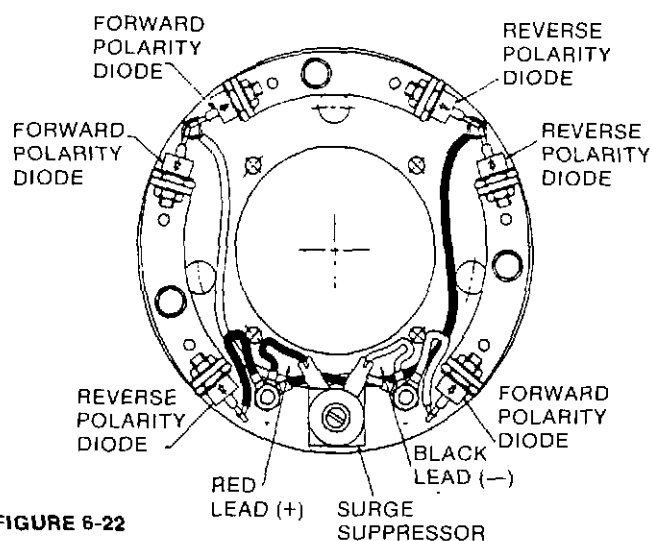


FIGURE 6-22

Torque diode mounting nut to 25 inch-pounds. Use a heat sink when soldering diode leads.

SECTION

6

SERVICE

3. Check the exciter armature and rectifier assembly for a loose, frayed, or burnt winding or loose connections. Measure winding resistance and insulation resistance. (See section 8.) DO NOT megger diodes or surge suppressor. Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.
4. Look for score marks on the outside diameter of the armature core caused by rubbing. (This could indicate bearing or assembly problems and should be investigated.)

PMG INSPECTION

A. PMG Stator

1. Clean dust and dirt from the PMG stator winding. (See section 5.)
2. Check PMG stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance. (See section 8.) Repair or replace as necessary. Contact Marathon Electric for special winding procedures and materials.
3. Look for score marks in the bore caused by rubbing. (This could indicate bearing or assembly problems and should be investigated.)

B. PMG Rotor

WARNING

THE PMG ROTOR USES VERY STRONG MAGNETS. KEEP AWAY FROM IRON AND STEEL PARTS THAT COULD BE DRAWN TO THE MAGNETS. KEEP AWAY FROM OTHER COMPONENTS THAT CAN BE DAMAGED BY STRONG MAGNETIC FIELDS.

1. Clean dust and dirt from the PMG rotor. (See section 5.)
2. Check to be sure all magnets are tightly bonded to the PMG rotor.
3. Check for burrs or corrosion in the bore and keyway where the rotor mounts to the shaft.
4. Look for score marks on the outside diameter caused by rubbing. (This could indicate bearing or assembly problems and should be investigated.)
5. Inspect snap rings and loading spring, replace as required.

MAIN ROTOR INSPECTION

A. Bearing

1. Check the bearing for damage or wear. Clean the old grease from the bearing cap, and fill the bearing cap grease cavity 1/3 to 1/2 full of new Chevron SRI (or equivalent) grease.

CAUTION: If the bearing needs to be removed, for any reason, always install a new bearing.

2. If the bearing is to be replaced, remove with a suitable puller. (Figure 6-23.)

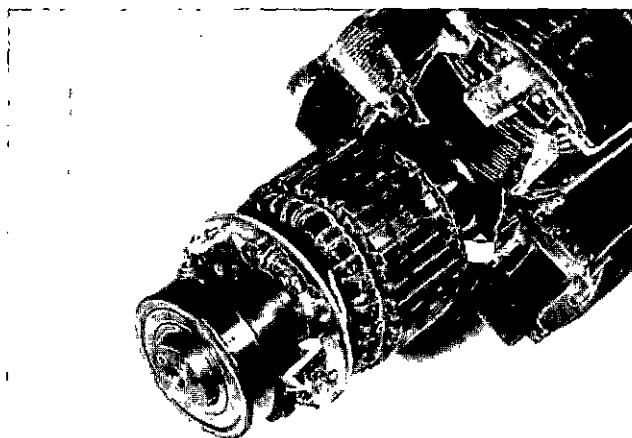


FIGURE 6-23

3. Heat the new bearing in an oven to a maximum temperature of 212°F (100°C). Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. (Figure 6-24.) The bearing should slide on the shaft and be seated without excessive force. If the bearing binds on the shaft before being fully seated, a piece of tubing, slightly larger than the press-fit area, can be used to drive the bearing into place. Using light taps with a soft mallet, apply pressure to the inner race only.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD PRESSURE BE APPLIED TO THE OUTER RACE OF THE BEARING, AS PERMANENT BEARING DAMAGE COULD RESULT.

Allow the bearing to cool for one hour before attempting to assemble the generator.

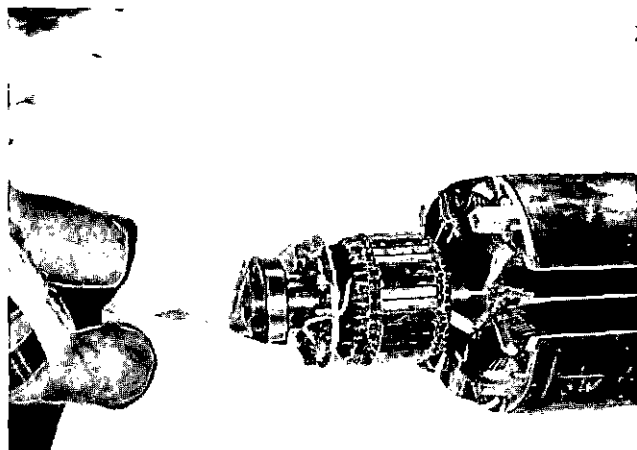


FIGURE 6-24

B. Fan

1. Check the fan for cracks or broken blades. Replace the fan if defective.
2. Mark the hub and fan for alignment. This is necessary to be sure the balance weights will be in the same position when the fan is re-installed.
3. a. For single bearing generators. Remove the fan mounting capscrews (Figure 6-25.) and slide the fan off the shaft. (Figure 6-26.)
- b. For two-bearing generators, remove the drive end bearing and bearing cap. (See bearing removal instructions.) Remove the fan mounting capscrews and slide fan off the shaft. (Figure 6-25 and 6-26.)

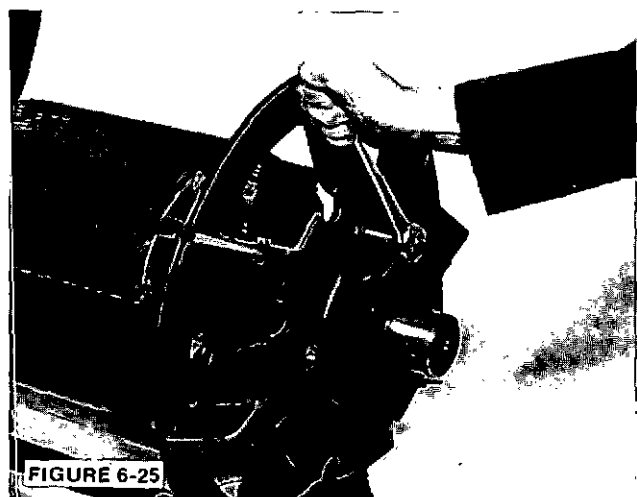


FIGURE 6-25

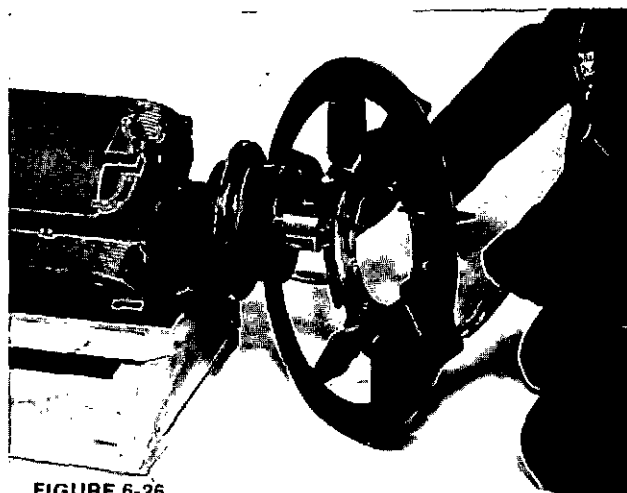


FIGURE 6-26

4. To reinstall, slide the fan on the shaft making sure the fan mounting surface is toward the drive hub. Align reference marks (this is important for assembly balance) and mount the fan to the drive hub with the capscrews and belleville washers. (Figure 6-27.) Torque the capscrews to 60 ft-lb. (81 N-m).

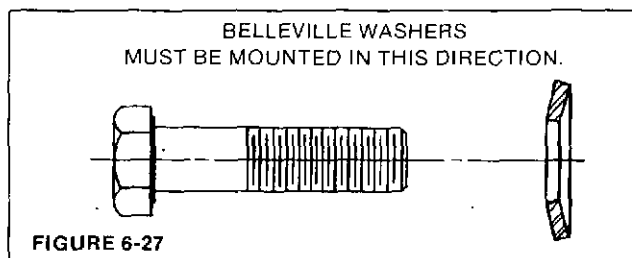


FIGURE 6-27

5. **NOTE:** Balance weights on the fan are for balance of the complete rotor assembly. The rotor assembly should be rebalanced if a new fan has been installed.
6. On two-bearing generators, install bearing cap and new bearing according to the bearing assembly instructions. (Item A.)

C. Drive Hub (Single Bearing Generators Only)

1. Check the drive hub for cracks or stripped drive disc mounting holes. Replace the hub if defective.
2. If the hub is to be replaced, remove the fan (See Item B) and install a suitable puller to the hub. Remove the setscrew (if used) in the hub over the key. Using a torch, rapidly heat the hub at the outer diameter while tightening the puller. (This must be done rapidly before the heat can expand the shaft.) Remove the hub. (Figure 6-28.)

SERVICE

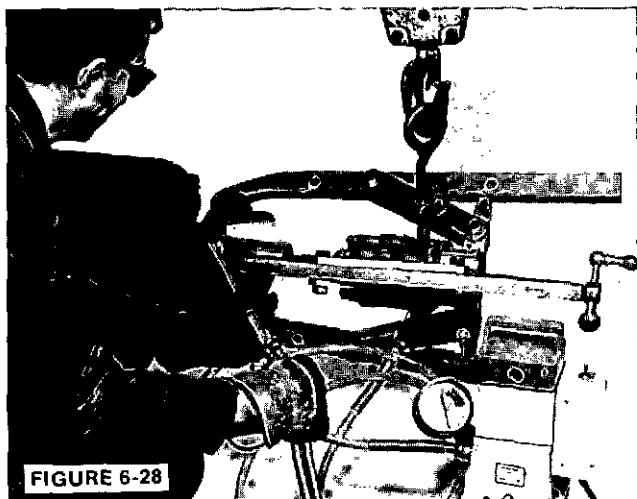


FIGURE 6-28

3. To insure proper fan location, mark the new hub in the same place as the old hub relative to the keyway. Install key in shaft. Heat the new hub in an oven to 500°-600°F (260°-316°C). Using suitable heat resistant gloves, slide the hub over the key in the shaft until it seats against the shaft shoulder. (Figure 6-29.)

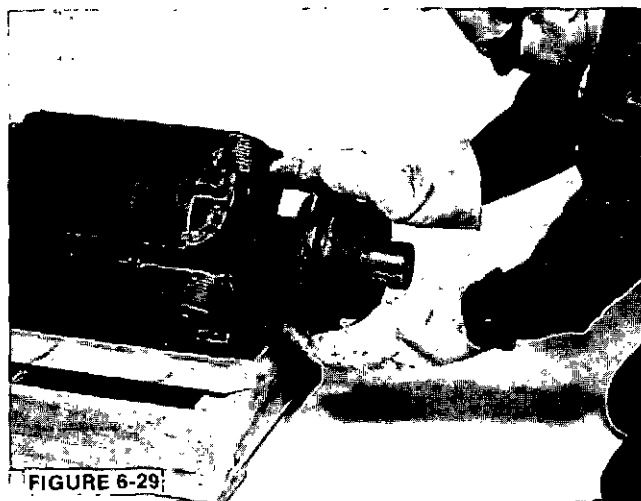


FIGURE 6-29

4. Allow the hub to cool for one hour. After the hub has cooled, tighten the setscrews in the hub to 50 ft-lbs (68 N.m) torque. Match the alignment marks on the fan and hub and mount the fan. (See item B.)
5. Rebalancing the rotor assembly is not necessary if only the hub is replaced and the fan is mounted in the same location relative to the hub and shaft.

D. Main Rotor Core and Windings

1. Clean all parts. Remove dust and dirt from the rotor windings. (See section 5.)

Remove any accumulated dust or dirt in the winding air passages with a piece of wire or with low-pressure, moisture-free air. (Figure 6-30.)

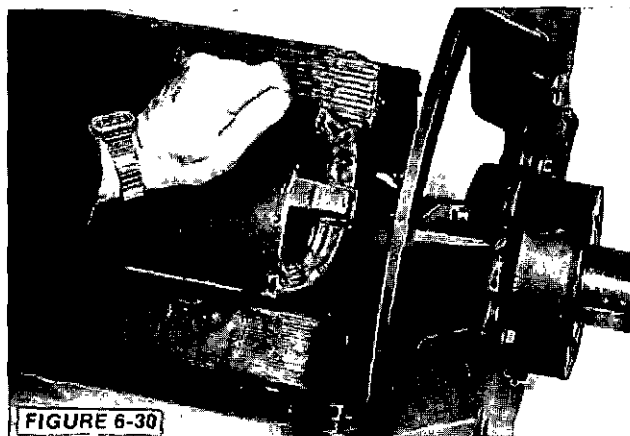


FIGURE 6-30

CAUTION: IF A PIECE OF WIRE IS USED FOR CLEANING THE AIR PASSAGES: CARE MUST BE TAKEN NOT TO SCRATCH THE WINDING AS THIS COULD CAUSE AN INSULATION FAILURE.

2. Check the rotor for loose, frayed, or burnt windings. Measure winding resistance and insulation resistance. (See section 8.) Test for shorted turns using an A-C impedance test. (See section 8.) A defective rotor winding must be rewound by Marathon Electric. The rotor assembly must be rebalanced after any rework or repair has been completed.

E. Drive Discs (Single Bearing Generators Only)

1. Inspect the drive discs for distorted or bent edges. (Figure 6-31) Inspect for worn mounting holes. Replace any defective discs.

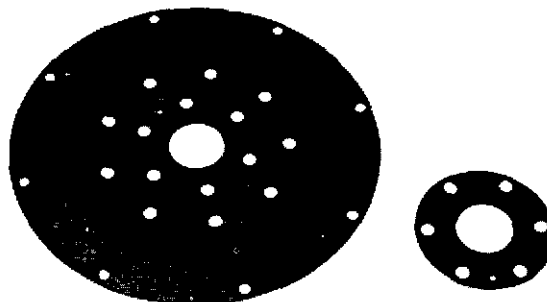


FIGURE 6-31

2. Inspect the drive disc mounting capscrews for damaged threads. Replace capscrews if damaged.

FRONT (EXCITER) END BRACKET INSPECTION

1. Clean the end bracket, bearing bore, and capscrews to remove all dust, dirt, and grease.
2. Inspect the capscrews for stripped threads and replace if defective.
3. Inspect the end bracket for stripped threads, cracks, and burred or rough mating surfaces. Inspect the bearing bore for burrs or wear. If the bracket shows excessive bearing bore wear, it should be repaired or replaced. (Figure 6-32.)



FIGURE 6-32

4. Inspect the mounting area for the PMG stator and exciter stator. Be sure they are smooth, clean, and free of any burrs or rust. That could interfere with proper alignment.

DRIVE END BRACKET OR SAE ADAPTER INSPECTION

1. Clean the bracket or adapter, capscrews and screen assembly to remove all dust, dirt, and grease.
2. Inspect the capscrews for stripped threads and replace if defective.
3. Inspect the bracket or adapter for stripped threads, cracks, and burred or rough mating surfaces.
4. For two-bearing generators, inspect the bearing bore for burrs or wear. If the drive end bracket shows excessive bearing bore wear, it should be repaired or replaced.

MAIN STATOR INSPECTION

1. Clean dust and dirt from the stator frame and winding. (Figure 6-33.) (See section 5.)

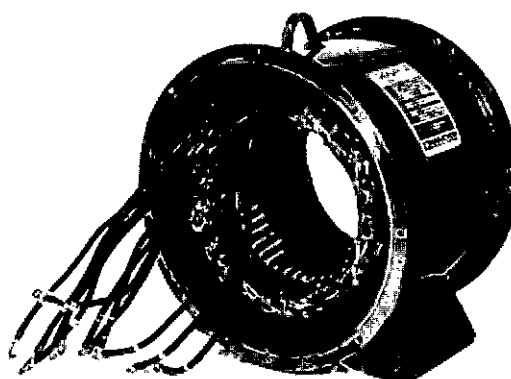


FIGURE 6-33

2. Inspect the frame for stripped threads, cracks, burred mating surfaces, or other damage.
3. Inspect the stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance. (See section 8.) Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for winding data.

FRONT END BRACKET INSTALLATION

1. Install two guide pins (threaded rod can be used) into the generator side of the end bracket mounting holes. Align the guide pins with the holes in the generator frame and slide the bracket onto the frame. (Figure 6-34.) Install bracket mounting capscrews.

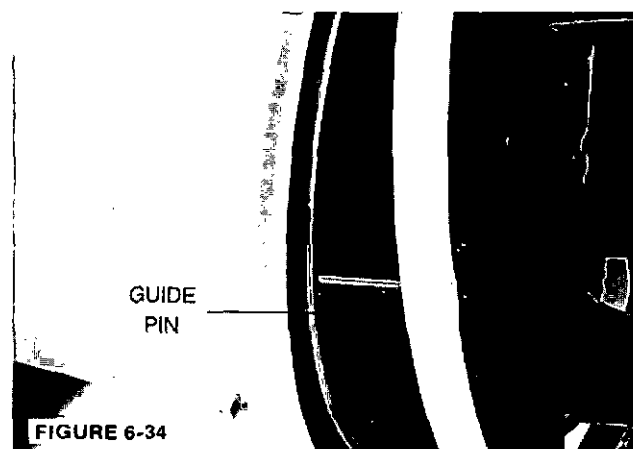


FIGURE 6-34

SERVICE

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN THE FRONT END BRACKET INSTALLATION.

2. Remove the two guide pins and insert the remaining capscrews and torque to specifications given in section 12.

MAIN ROTOR INSTALLATION

1. Grease bearing cavity with Chevron SRI or equivalent. The cavity should be about 1/3 full.
2. Using a rotor lifting fixture and a suitable hoist, carefully install the rotor assembly into the main stator assembly through the drive end. (Figure 6-35.)

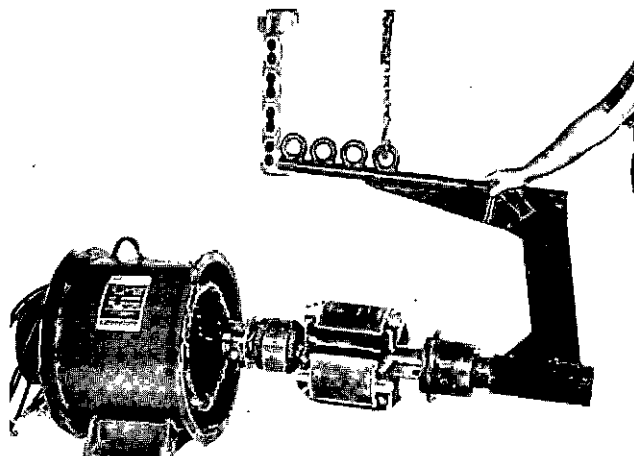


FIGURE 6-35

CAUTION: SPECIAL CARE SHOULD BE TAKEN WHEN INSTALLING THE ROTOR ASSEMBLY. WINDING DAMAGE COULD RESULT IF THE ROTOR IS ALLOWED TO HIT THE MAIN STATOR.

WARNING

DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

3. a. For single bearing generators, slide the SAE adapter over the fan, be sure the locating mark is at the bottom (See Figure 6-36 and 6-37), and secure to the main stator assembly with capscrews. Torque per section 12. (Figure 6-38.) It may be necessary to raise the rotor assembly slightly to allow the mounting of the SAE adapter.

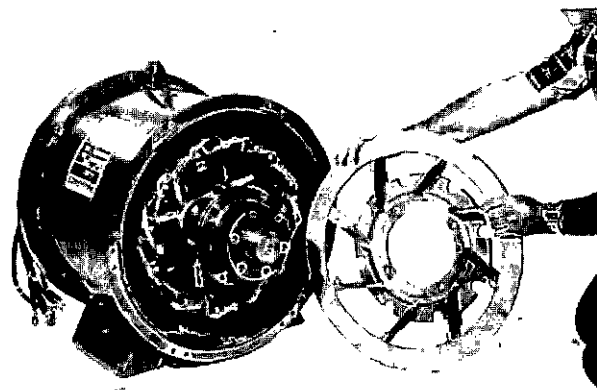


FIGURE 6-36

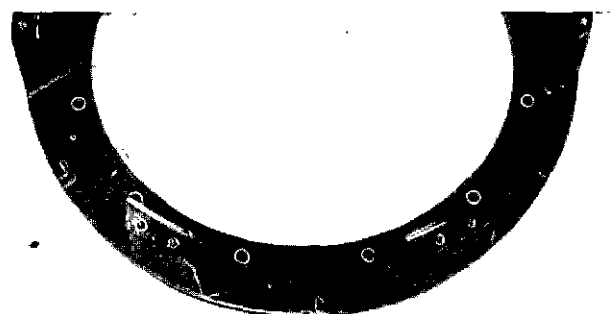


FIGURE 6-37

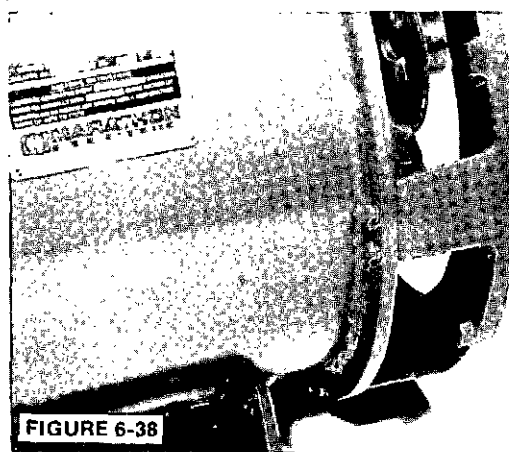


FIGURE 6-38

- b. For two-bearing generators, insert guide pins in the rear bearing lock holes. Fill the grease cavity of the drive end bracket 1/3 full of new grease. Align the drive end bracket and mount with the capscrews. Pin and insert a capscrew and lockwasher into the bearing lock and tighten. Remove the remaining guide pin and replace with the remaining capscrew and lockwasher. Torque bearing cap capscrews to 25 lb-ft (34 N-m). Torque bracket mounting capscrews per specifications given in section 12.

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN THE DRIVE END BRACKET OR THE SAE ADAPTER ASSEMBLY.

4. a. For single bearing generators, insert a guide stud into the drive hub. Position all spacers (if any), then all drive discs, one at a time until all discs are installed. (Figure 6-39.) Make sure that all disc mounting holes at the inner and outer diameter are properly aligned. Secure the discs with the grade 8 5/8-18 capscrews and hardened washers. Torque to 192 ft-lb (260 N-m). (See Figure 6-40 for torquing sequence.)

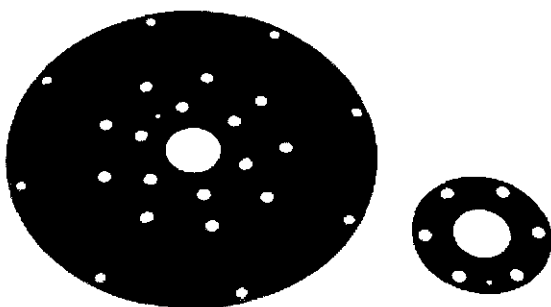
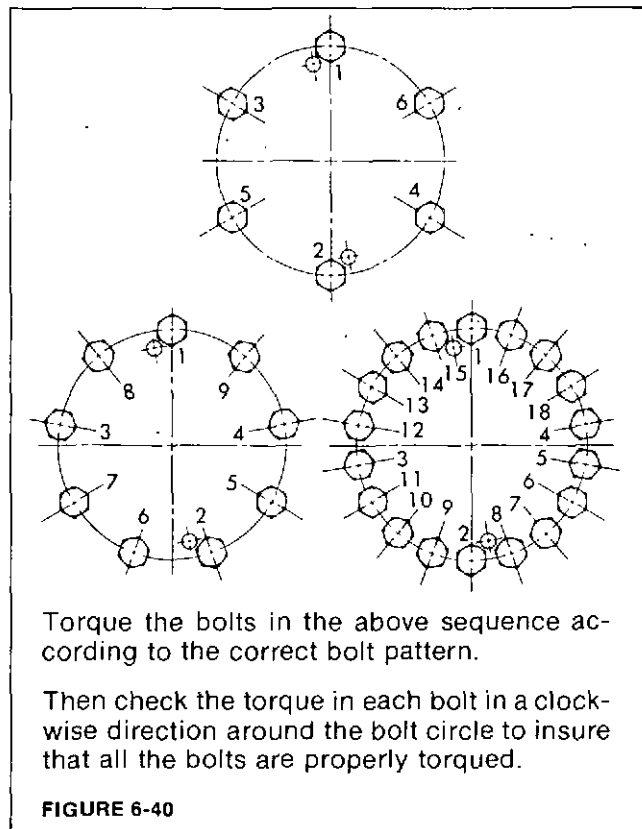


FIGURE 6-39



PMG INSTALLATION (OPTIONAL)

1. If unit is equipped with the optional PMG, install the stub shaft (Figure 6-41.) Torque mounting bolt to 84 ft-lb.

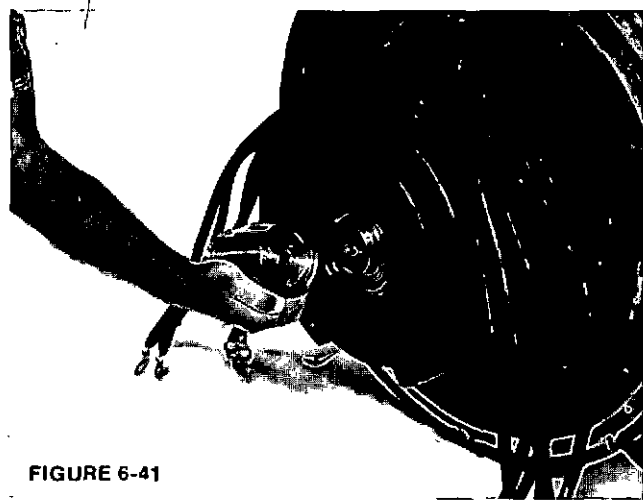


FIGURE 6-41

SERVICE

2. Temporarily hang mounting ring for the PMG stator over the shaft.
3. Install loading spring and PMG rotor on the stub shaft and secure with the snap ring. The loading spring will push out on the PMG rotor. A piece of pipe slightly larger than the shaft can be used to push the snap ring back until it engages in its slot. (Figure 6-42.)

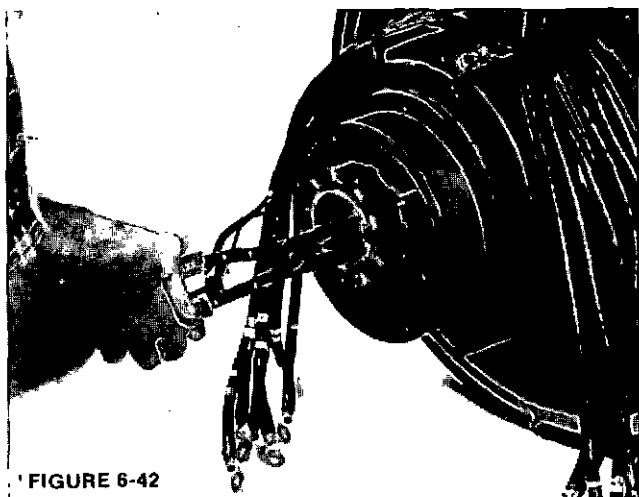


FIGURE 6-42

4. Install the PMG stator on the mounting pad and secure with 4 capscrews. Torque to 4 ft-lb. (Figure 6-43.)

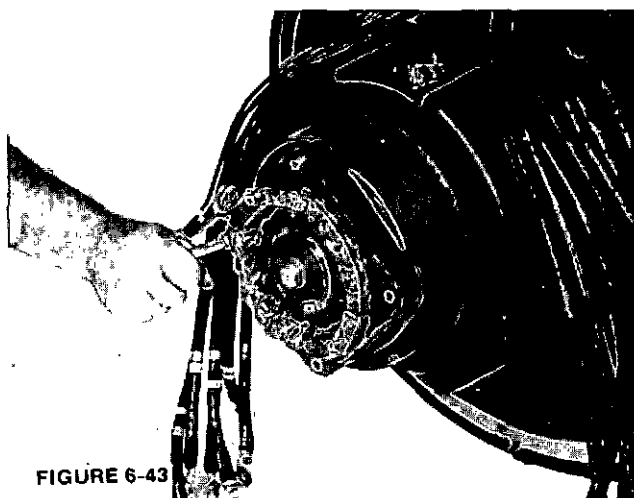


FIGURE 6-43

CONDUIT BOX INSTALLATION

1. Install the conduit box over the main stator leads. Secure with bolts and lock washers. (Figure 6-44.)

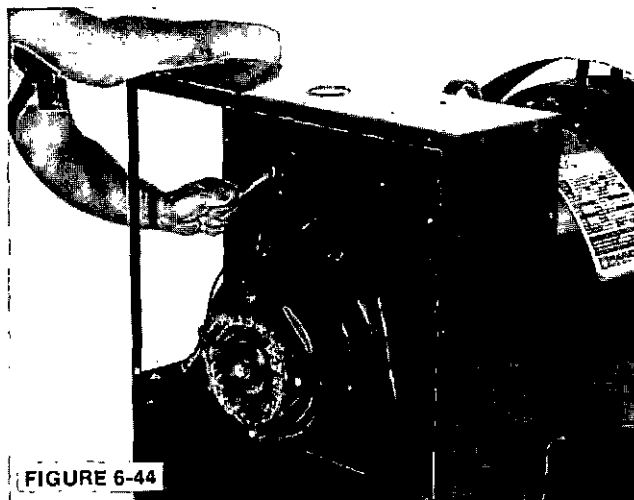


FIGURE 6-44

2. If unit is equipped with the PMG, install the conduit box extension ring. (Figure 6-45.)

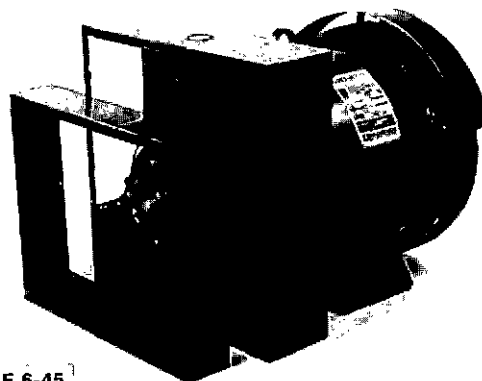


FIGURE 6-45

3. Install regulator panel assembly. (Figure 6-46.)

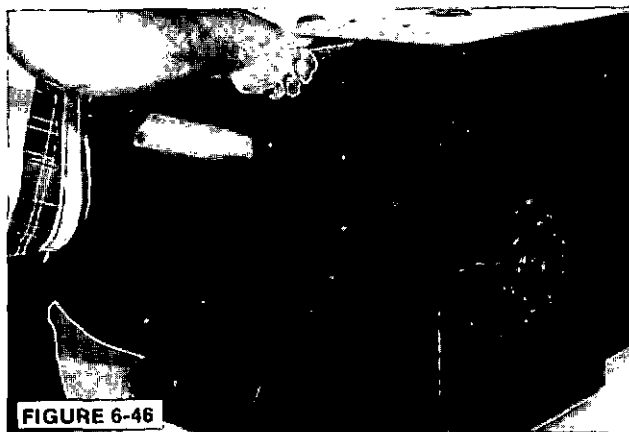


FIGURE 6-46

4. Reconnect exciter leads, PMG leads and other accessories according to the connection prints and markings installed before disassembly. (See Figure 6-47 and connection diagram.)

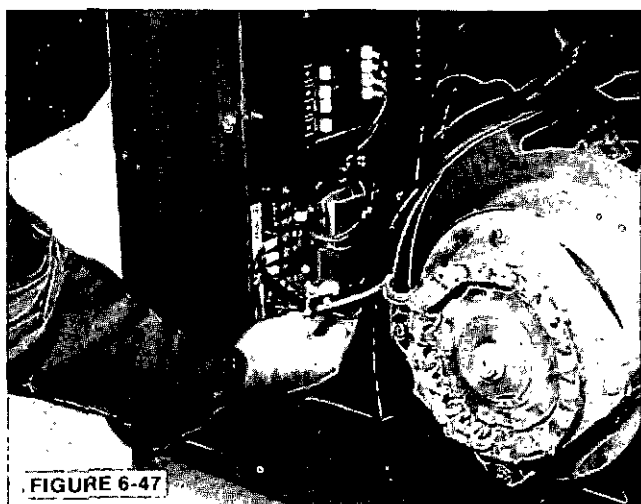


FIGURE 6-47

ASSEMBLY TO PRIME MOVER

1. Attach a suitable hoist to the generator lifting lugs, and move the generator until the generator foot mounting holes are aligned with the base and slightly above.
2. a. For single bearing generators, if the screen assembly is mounted on the adapter, remove the mounting bolts and remove the screen. (Figure 6-48.) (NOTE: Do not remove the drip cover from the screen assembly if so equipped.) Insert two guide pins in the flywheel and two in the flywheel housing. Adjust the generator position until the drive discs are piloted in the flywheel. Remove the guide pins and secure the discs with Grade 8 place bolts and hardened washers or Grade 8 capscrews and heavy series lockwashers. Torque per specifications given in section 12.

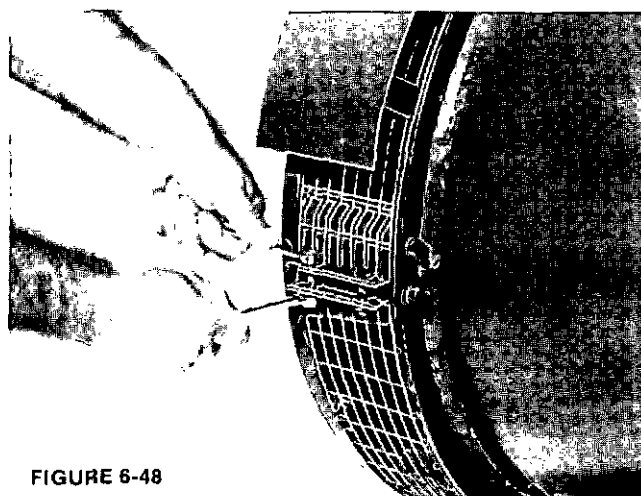


FIGURE 6-48

WARNING

DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

Position the generator so that the SAE adapter mates with the flywheel housing.

CAUTION: DO NOT FORCE THE ALIGNMENT OF THE UNITS. SHIFT THE GENERATOR FROM SIDE TO SIDE OR RAISE OR LOWER WITH A LIFTING DEVICE AS NECESSARY.

It may be necessary to use shims under the mounting feet of either the generator or the prime mover to obtain proper alignment; use the same shims as removed under disassembly or proceed as follows: Using the extreme bottom four capscrews, mount the SAE adapter to the flywheel housing. With a .0015 to .002 inch feeler gauge at the extreme top adapter to flywheel housing to fit, raise the generator or lower the prime mover until the gauge is snug. Relieve just enough to release the feeler gauge and torque the remaining SAE adapter capscrews to the flywheel housing. (Torque specifications given in section 12.)

Mount the screen assembly and tighten the mounting bolts.

- b. For two-bearing generators, align the coupling halves or sheaves between the generator and the prime mover by adding shims under the feet.
3. Shim under the generator feet for proper support, ensuring that the generator mounting surfaces are level.
4. Install the mounting bolts which secure the generator to the base.
5. For two bearing generators, assemble the coupling halves or sheave belts between the generator and the prime mover. (Follow the coupling manufacturer's instruction for assembly and alignment.)
6. Connect all existing conduit or ducting to the conduit box.
7. Connect all external wiring to the generator inside the conduit box.

TROUBLESHOOTING

INTRODUCTION

This section is intended to suggest a systematic approach to locating and correcting generator or regulator malfunctions. The sections are arranged according to the symptoms of the problem. The steps in each section have been arranged in an attempt to, 1. do the easy checks first, 2. prevent further damage when troubleshooting a disabled machine.

The first and perhaps most important step of troubleshooting should be to gather as much information as possible from personnel who may have been present during the failure. Information on how long the generator had been running; what loads were on the line, weather conditions, what protective equipment operated, etc., can help isolate the problem.

Always make a thorough visual inspection to check for any obvious problems before attempting to run the generator.

WARNING

HIGH VOLTAGES CAN BE PRESENT AT THE GENERATOR AND REGULATOR TERMINALS. HIGH RESIDUAL VOLTAGES CAN BE PRESENT EVEN WITH THE REGULATOR DISCONNECTED OR ITS FUSES REMOVED. SOME EQUIPMENT (SUCH AS SPACE HEATERS) MAY BE ENERGIZED WHEN THE GENERATOR IS OFF. TOOLS, EQUIPMENT, CLOTHING, AND YOUR BODY MUST BE KEPT CLEAR OF ROTATING PARTS AND ELECTRICAL CONNECTIONS.

SPECIAL CAUTION MUST BE TAKEN DURING TROUBLESHOOTING SINCE PROTECTIVE COVERS AND SAFETY DEVICES MAY BE DISABLED TO GAIN ACCESS AND MAKE TESTS.

BE CAREFUL. SERIOUS PERSONAL INJURY OR DEATH CAN RESULT FROM THESE HAZARDS. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

SECTION

7

SYMPTOM: GENERATOR PRODUCES NO VOLTAGE OR RESIDUAL VOLTAGE

Regulator Fuse Blown	Check fuse with an ohmmeter. Replace bad fuse, refer to regulator manual.
Voltmeter Off	Check to be sure meter phase selector switch is not in the off position.
Incorrect Connections	Verify generator connections. Refer to drawings supplied with generator set and section 3.
Defective Connections/Wiring	Inspect all wiring for grounds, open circuits, short circuits. Refer to section 8.
Defective Voltmeter	Verify proper operation of panel meter with another meter that is known to be accurate. Refer to section 8.
No Regulator Input	Measure voltage at regulator input refer to section 8.
Defective Diodes, Surge Suppressor, or Generator Windings	Test generator with constant excitation (12 volt battery test) refer to section 8 and 12.
Voltage Regulator Protective Shutdown Circuits are Operating	Correct problem and adjust regulator. Refer to regulator manual.
Voltage Regulator Inoperative	Adjust or replace regulator. Refer to regulator manual.

TROUBLESHOOTING

SYMPTOM: GENERATOR PRODUCES LOW VOLTAGE - NO LOAD

Underspeed Operation	Check speed using tachometers and/or frequency meters.
Defective Voltmeter	Verify operation of panel meter with another meter that is known to be accurate. Refer to section 8.
Residual Voltage	Disconnect F1 and F2 leads at the voltage regulator. If voltage goes down continue on to next step, if voltage does not change refer to troubleshooting for symptoms of "No Voltage - Residual Voltage".
Incorrect Generator Connections	Verify generator connections refer to drawings supplied with generator set and section 3.
Defective Connections/Wiring	Inspect all wiring for grounds, open circuits, short circuits, loose connections, dirty connections.
Regulator Adjustments	Adjust regulator. Refer to regulator manual. Check exciter field volts. Refer to section 8 and 12.
Defective Diodes, Surge Suppressor, or Generator Windings	Test generator with constant excitation (12 volt battery test). Refer to section 8 and 12.
Voltage Regulator not Operating Properly	Adjust or replace regulator. Refer to regulator manual.

SYMPTOM: GENERATOR PRODUCES LOW VOLTAGE WHEN LOAD IS APPLIED

Overload	Measure amps and verify that the load does not exceed the nameplate rating of the generator. Refer to section 8.
Overload - Defective Ammeter	Verify operation of ammeter by using a separate meter that is known to be accurate.
Droop Circuit	If the generator set is equipped for paralleling, some voltage droop is normal as load increases. Refer to the regulator instruction manual.
Continue troubleshooting for symptoms "Generator Produces Low Voltage - No Load".	

SECTION

7

TROUBLESHOOTING

SYMPTOM: GENERATOR PRODUCES HIGH VOLTAGE

Defective Voltmeter	Verify operation of panel meter with another meter that is known to be accurate. Refer to section 8.
Incorrect Operating Speed	Verify speed with tachometer or frequency meter.
Incorrect Connections	Verify generator connections. Refer to drawings supplied with generator set and section 3.
Defective Connections/Wiring	Inspect all wiring for grounds, open circuits, short circuits.
Regulator Adjustments	Adjust regulator. Refer to regulator manual.
Diode Polarity Incorrect	Check diodes, verify proper diodes are installed and polarity is correct. Refer to section 6.
Voltage Regulator not Operating Properly	Adjust or replace regulator. Refer to regulator instruction manual.

SECTION

7

SYMPTOM: GENERATOR VOLTAGE IS FLUCTUATING

Incorrect Speed	Verify speed with tachometer or frequency meter.
Unstable Speed	Verify governor stability.
Voltage Regulator Stability	Adjust regulator stability. Refer to regulator manual.
Defective/Loose Connections	Inspect all wiring for loose or dirty connections.
Defective Diodes, Surge Suppressor, or Generator Windings	Test generator with constant excitation (12 volt battery test). Refer to section 8 and 12.
Remote Voltage Adjust Rheostat (If used)	Check operation of rheostat. Refer to regulator manual.
Defective Regulator	Replace regulator. Refer to regulator manual.

TROUBLESHOOTING

SYMPTOM: GENERATOR BUILDS VOLTAGE FROM STARTUP, THEN GOES TO LOW (RESIDUAL) VOLTAGE

Regulator Protective Circuit is
Operating

Check indicators on regulator. Correct problems and adjust regulator as required. Refer to regulator manual.

SYMPTOM: EQUIPMENT RUNS NORMALLY ON UTILITY POWER, BUT WILL NOT RUN ON GENERATOR SET

Voltage Waveform is Distorted

Analyze load. Excessive SCR (Thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Refer to Marathon Electric.

SECTION

7

GENERATOR TESTING

VISUAL INSPECTION

Whenever testing and troubleshooting a generator set, it is always a good practice to make a thorough visual inspection. Remove covers and look for any obvious problems. Burnt windings, broken connectors, leads, mounting brackets, etc., can usually be identified. Look for any loose or frayed insulation, loose or dirty connections, broken wires. Be sure all wiring is clear of rotating parts.

Verify that the generator is connected for the voltage required, this is especially important on new installations.

Check for any foreign objects, loose nuts, bolts, and electrical connectors. Clear paper, leaves, building materials, etc., that could be sucked into the generator. (Generator is air cooled. Air enters through the conduit box.) Check the air gap for clearance or obstructions (main generator and exciter).

If possible, rotate the generator rotor by hand to be sure it turns freely.

If serious problems can be identified before attempting to operate the machine, additional damage can be avoided.

CONSTANT EXCITATION (12V BATTERY) TEST

THEORY: The generator output voltage is dependent on generator speed, generator design, load, and exciter input current. If the generator speed and exciter input are known, the output voltage at no load can be measured and compared to the design value. Problems can be isolated to either the generator or regulator system by using this test.

TEST PROCEDURE:

1. Shut the generator set down.
2. Connect a voltmeter to the generator output.
3. Disconnect the F1 and F2 leads at the regulator.
4. Connect a 12 volt battery capable of supplying 1 amp to the F1 and F2 leads.

CAUTION: Beware of arcing when connecting leads. Stay clear of battery vents. Escaping hydrogen gas can explode. If hazardous conditions exist - use a suitable switch to connect or disconnect the battery.

5. With no load on the generator, (main breakers open) run generator at rated speed (1800 rpm - 60 Hz or 1500 rpm - 50 Hz).
6. Measure the generator output voltage.
7. Shut generator down.
8. Disconnect battery (see Caution - Step 3).
9. Compare voltage reading with value shown in section 12.

Conclusion: If voltage readings are normal, the main generator and exciter are operating properly. Troubleshooting should continue with the regulator. If readings are not normal the problem is in the generator. Continue testing diodes, surge suppressor, windings.

MEASURING VOLTAGES

When testing the generator and regulator, the most frequent (and usually easiest) measurement will be a voltage. The generator will need to be running at rated speed and may have some of the protective guards and covers removed. **BE CAREFUL.** Keep yourself and your test leads out of the way. It is best to shut the unit down when connecting meters. When using alligator clips or push on terminals, be sure the leads are supported so vibration does not shake them loose when running the generator set.

See figure 8-1 for measurement points and expected meter range settings. When in doubt, start with a higher range and work down.

Consult meter instruction manual to verify its operation and limitations.

SECTION

8

GENERATOR TESTING

FIGURE 8-1: TYPICAL VOLTAGE MEASUREMENTS

Voltage Measurement	Test Point	Meter/Range Selection Requirement
Generator Output Voltage	Output "T" leads or bus bars, also main circuit breaker "line" side.	System voltage - volts A.C. See generator nameplate and connection diagram.
Regulator Output (Exciter Stator Input)	F1 and F2 terminals at the regulator.	200 volts D.C. range. F1 is plus (+), F2 is minus (-).
Regulator Sensing Voltage	E1, E2, E3 terminals at the regulator.	Usually the same as the system voltage (generator output volts). However, in some cases, sensing is taken from winding center taps or instrument potential transformers. Maximum 600 volts A.C. Example: Center tap of 480 volt system would give 240 volts at E1, E2, or E3. Example: A 4160 volt system must use a transformer to step voltage down below 600 volts. See the connection diagram supplied with generator set.
Regulator Input Volts on Units Equipped with PMG	"PMG" leads at the regulator or capacitor.	200-240 VAC 300 Hz @ 1800 rpm 180-220 VAC 250 Hz @ 1500 rpm

CURRENT (AMP) MEASUREMENTS

Current measurements (A.C.) can be easily taken with a clamp on type meter.

NOTE: Most clamp on ammeters will not measure D.C.

When measuring generator output current, be sure the clamp is around all cables **for each phase**. If the physical size of the conductors or the capacity of the meters will not permit all cables to be measured at once, each one can be measured individually. Add the individual readings together to get the total. Compare readings to the generator nameplate (nameplate ratings are always given per phase).

Amperage should never exceed the nameplate rating when running the intended load. (Amperage may go above nameplate momentarily when starting large motors.)

When measuring exciter field amps (F1 and F2 leads) a D.C. meter is required. The maximum field current under full regulator forcing is 6.5 amps D.C.

Normal full load reading is approximately 3 amps D.C.

MEASURING RESISTANCE

The generator windings can be measured and compared to the values shown in the service specification section 12.

Main Stator

The main stator winding resistance is very low. A meter capable of readings in the milliohm range would be required. However, a standard V.O.M. can be used to check for continuity, shorts, or grounds.

Example: With leads disconnected, a measurement from T1 to T4 should be very low (continuity on most V.O.M.'s). Measured from T1 or T4 to any other lead should be infinite. Measure from the 'T' lead to the generator frame to check for grounds (reading should be infinite).

SECTION

8

GENERATOR TESTING

Exciter Stator

The exciter stator resistance is measured by disconnecting the F1 and F2 leads at the regulator. Measure the resistance between the leads. Measure from the leads to the frame to check for grounds.

Main Rotor

Note markings and disconnect the main rotor leads from the rectifier assembly. Measure the resistance across the main rotor winding. Compare reading to value shown in service specification section 12. Measure from the leads to the exciter mounting bolt to check for grounds.

Exciter Rotor

Disconnect the 3 exciter rotor leads at the diodes (leave leads disconnected if proceeding to check diodes). Measure resistance between all three leads. Compare value to service specifications section 12. Measure from the leads to the exciter mounting bolt to check for grounds.

TESTING DIODES (RECTIFIERS)

Diodes perform the function of an "electrical check valve". They conduct in one direction only and are used to "rectify" ac current into dc current. To test, measure the resistance first in one direction and then reverse the leads and test in the other direction. The reading should be high in the reverse direction and low in the forward direction. A shorted diode will read low in both directions. An open diode will read high in both directions.

NOTE:

1. Two different polarities of diodes are used. The only difference is in the way the device is mechanically placed in the case. When changing diode, be sure the correct polarity is used. Refer to section 6 figure 6-22.
2. Some meters do not have enough voltage output from their internal batteries to turn the diode on (about 0.6 volts is required), and the voltage can change with different range settings. Consult the instruction manual for your meter.

NOTE: Polarities supplied by the meters internal battery may or may not correspond to the (+) (—) markings on the meter.

INSULATION RESISTANCE - GENERAL

Insulation resistance is a measurement of the integrity of the insulating materials that separate the electrical windings from the generators steel core. This resistance can degrade over time or due to contaminants (dust, dirt, oil, grease, and especially moisture). Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shut down. The problem can be corrected simply by drying out the windings. Section 5.

Normally the resistance of the insulation system is on the order of millions of ohms. It is measured with a device called a "megger" which is a megohm meter (meg is for million) and a power supply. The power supply voltage varies, but the most common is 500 volts. A megger voltage over 500 is not recommended, except for measuring medium voltage (2400/4160) stators only.

CAUTION: First disconnect any electronic components, regulators, diodes, surge protectors, protective relays, etc., will be destroyed if subjected to the high megger voltages.

To measure insulation resistance, connect one megger lead to the leads for the winding to be tested, connect the other megger lead to the generator frame. Be sure the leads of the part being tested are not touching any metal parts of the generator. (If the neutral is grounded, it must be disconnected.) Take megger reading (refer to the manual for the megger).

INSULATION RESISTANCE - MAIN STATOR

CAUTION: Be sure the regulator, and any other electronic components, metering, protective relays, etc., are disconnected before meggering. High megger voltages will destroy these parts.

All stator leads must be isolated from ground and connected together (on most systems with grounded neutrals - the neutral can be isolated from ground and used as a test point). Connect one megger lead to the main stator leads. Connect the other megger lead to the generator grounding stud. Take the megohm reading (refer to instructions for the megger).

GENERATOR TESTING

The minimum acceptable value can be calculated using the following formula.

$$\text{Minimum Insulation Resistance} = \frac{\text{Gen. Voltage}}{1000} + 1$$

(Megohms)

Example: For a 480 volt generator

$$\frac{480}{1000} + 1 = 1.48 \text{ Megohms}$$

If the reading is below the recommended value, the winding must be dried out or repaired.

INSULATION RESISTANCE - MAIN ROTOR

Disconnect the main rotor leads from the diode bridge on the exciter rotor. Connect the leads together with one megger lead. Connect the other megger lead to a good ground on the rotor assembly such as the exciter mounting bolt. Take the megohm reading (refer to instructions for the megger).

The minimum acceptable value is 1.5 megohms.

If the reading is low, the winding must be dried out or repaired.

INSULATION RESISTANCE - EXCITER STATOR

Disconnect the exciter leads F1 and F2 from the regulator. Never subject the regulator to a megger. Connect F1 and F2 together with one megger lead. Connect the other megger lead to the grounding stud. Take the megohm reading (refer to instructions for the megger).

The minimum value is 1.5 megohms.

If the reading is low, the winding must be dried out or repaired.

INSULATION RESISTANCE - EXCITER ROTOR

Disconnect the exciter rotor windings (3 leads from the diodes). Connect all 3 leads together with one megger lead. Connect the other megger lead to a good ground on the rotor assembly such as the mounting bolt. Take the megohm reading (refer to the instructions for the megger).

The minimum acceptable value is 1.5 megohms.

If the reading is low, the winding must be dried out or repaired.

MAIN ROTOR FIELD AC IMPEDANCE TEST

THEORY: The main rotor resistance can be measured with a very accurate meter that is able to measure low (1 ohm) resistance but it is difficult to determine if there are turn to turn shorts in the field pole windings. One shorted turn would only change a resistance reading on the order of one half of one percent.

The ac impedance test measures the impedance (inductance and resistance) of the field pole coils. Shorted turns in the field pole windings change the coil inductance to a much greater degree than the resistance.

PROCEDURE:

Step 1: The rotor must be supported on a non-magnetic surface such as a wooden skid. Do not use a steel table that would create a magnetic "short circuit" between the poles.

Step 2: Apply 120 volts ac to disconnected main rotor leads F1 and F2.

Step 3: Measure and record voltages across each pole. Between points "A" and "B", "B" and "C", "C" and "D", "D" and "E" (Figure 8-1).

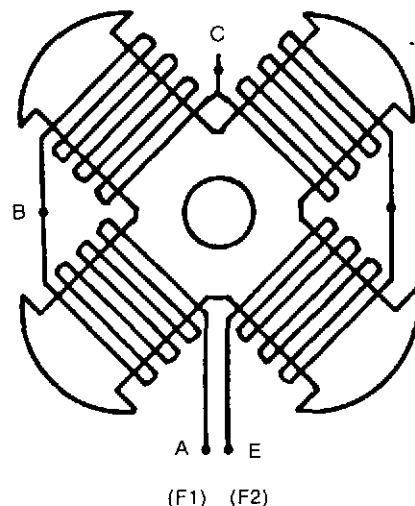


FIGURE 8-1

Step 4: The voltage readings should balance within one volt.

RESULTS: If the ac voltages are not balanced ($30v \pm 1v$ ac with 120v ac input) across each pole, the winding has shorted turns and should be rewound.

Refer to Marathon Electric for further information.

SECTION

8

PARTS

Note: This parts list is for reference only. Always give complete generator model and serial numbers when ordering parts.

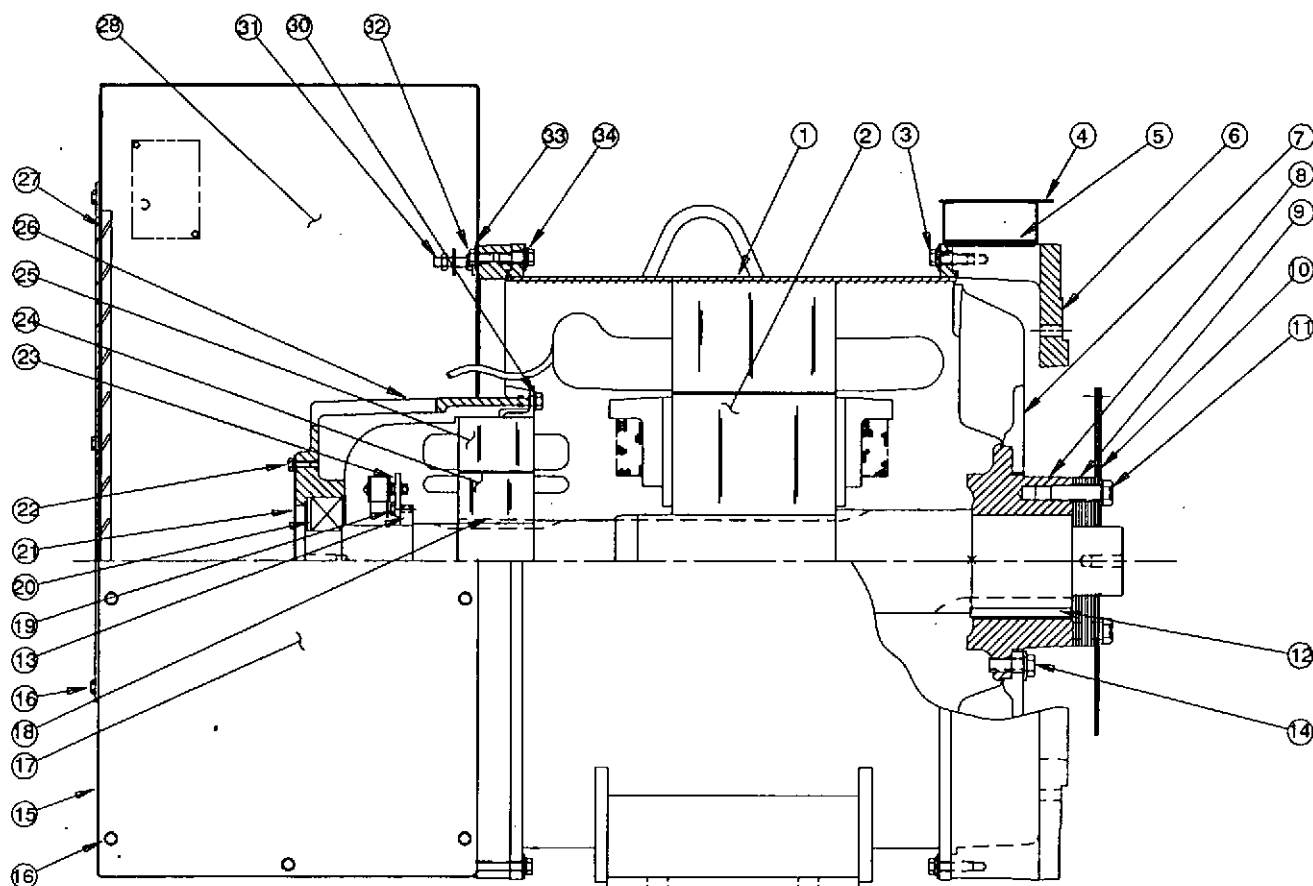


TABLE 9-1: PARTS LIST

Item	Description	Part Number	Quantity
1	Main Body with Stator Winding	R.T.F.	1
2	Main Rotor with Shaft and Winding	R.T.F.	1
3	Adapter Fasteners 3/8-16 x 1.25 3/8 Split Lock Washer 3/8 Flat Washer	801004-06 801065-07 801063-04	12
4	Drip Cover (Optional)	B-525566-1	1
5	Screen	B-525565-1	1
6	Adapter SAE #3 or SAE #2 or SAE #1 or SAE #1/2 or SAE #0	B-525512A B-525512B B-525513A B-525514B B-525514A	1
7	Cooling Fan	B-525510A	1
8	Drive Hub	707717-01	1

R.T.F. = Refer To Factory

PARTS

Item	Description	Part Number	Quantity
9	Drive Disc Spacers for SAE 11-1/2 Disc for SAE 14 Disc	A-525567	14 5
10	Drive Discs SAE 11-1/2 or SAE 14 or SAE 18	A-525506 A-525508 A-525575	
11	Drive Disc Fasteners for 11-1/2 Disc 5/8 x 2.00 Grade 8 for 14 or 18 Disc 5/8-18 x 1.50 Grade 8 5/8 Hardened Washers	A-9674-200 A-9674-150 A-9667-1	6
12	Key 3/4 x 3/4 x 4	A-25658-30	1
13	Rectifier Mounting Hub	707807-01	1
14	Fan Fasteners 1/2-13 x 1.50 1/2 Belleville Washers	801008-05 A-9682-1	4
15	Conduit Box — Standard Conduit Box — Special	723640-0A R.T.F.	1
16	Screws for Conduit Box Covers 1/4-20 x .75 Self Locking	A-9646-75	32
17	Conduit Box Side Panel — Blank	723640-03	1
18	Key 3/8 x 3/8 x 3	A-7605-300	1
19	Rectifier Assembly Fasteners 1/4-20 x .62 1/4 Flat Washer	801000-02 801063-22	4
20	Bearing — Size 312 Double Sealed	831823-01	1
21	End Cap	A-526062	1
22	End Cap Fasteners 1/4-20 x .62 1/4 Split Lock Washer	801000-02 801065-05	4
23	Rectifier Assembly	777062-0A	1
24	Exciter Rotor	791148-0A	1
25	Exciter Stator	789342-0A	1
26	End Bell	B-526005B	1
27	Louvered Conduit Box Cover	C-525562	1
28	Conduit Box Side Panel — Regulator Mounting	723640-04	1
30	Exciter Stator Retaining Screw 3/8 - 16 x 1.00 3/8 Split Lock Washer	801004-05 801065-07	1 1
31	Grounding Screw 3/8-16 x 3.00 3/8-16 Nut Non-Magnetic 3/8 Flat Washer Non-Magnetic	A-26937-300 A-9786-1 A-9787-1	1 2 2
32	Conduit Box Mounting Fasteners 3/8-16 x .75 3/8 Tooth Washer	801004-03 A-7675-2	8
33	Gasket	A-504934-46	1
34	End Bell Fasteners 3/8-16 x 1.25 3/8 Split Lock Washer 3/8 Flat Washer	801004-06 801065-07 801063-04	8

R.T.F. = Refer To Factory

SECTION

9

SPECIAL TOOLS

STANDARD TOOLS

The MagnaPLUS generator is assembled with American standard SAE hardware. Wrench sizes from 5/16 inch to 7/8 inch are used. A socket head set screw is used in the drive hub. A 1/4 inch allen type wrench is required to remove it.

All fasteners should be properly torqued (See section 12). Torque wrenches ranging from 25 in-lb through 200 ft-lb should be available.

Electrical test equipment should include a voltmeter or multimeter (VOM), clamp on ammeter, accurate frequency meter or tachometer, and a megohmmeter. See section 8, Generator Testing for more information.

SPECIAL TOOLS

In addition to the standard tools mentioned above, the following special tools will facilitate removal and installation of large and/or special parts. These tools can be obtained from the Marathon Electric parts department.

Snap ring pliers (Figure 10-1). The PMG rotor is installed to the generator shaft with a snap ring. The nominal shaft diameter is 2-3/4 inches and the ring must be spread approximately 3/4 inches for removal. To install the snap ring, use a piece of pipe with a 2-3/4 inch I.D. (Figure 10-2). Push the PMG rotor and snap ring onto the shaft until the ring snaps into the groove.

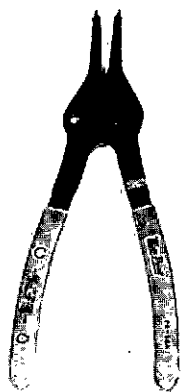


FIGURE 10-1

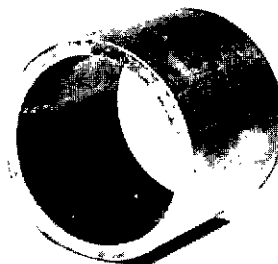


FIGURE 10-2

Rotor lifting fixture (Figure 10-3). The main generator rotor is heavy (approximately 1/2 the weight of the generator) and difficult to handle. The proper fixture should be used whenever removing or installing the main rotor into the main stator. Without proper care and equipment, the windings can be easily damaged.

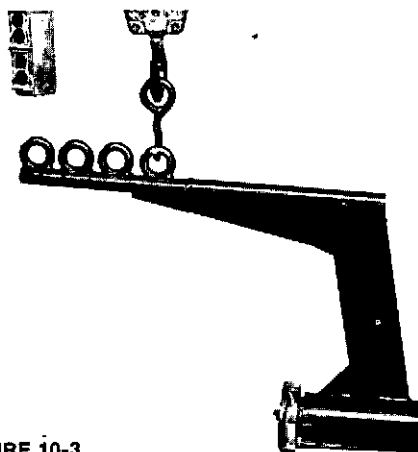


FIGURE 10-3

MISCELLANEOUS

A selection of wiring devices such as electric connectors, tape, cable ties, crimping and stripping tools, etc., should also be a part of the generator service tool kit. The PM100 regulator uses flat 1/4 inch female insulated terminals for AWG #14 wire.

PREPARATION FOR SHIPMENT

SHIPPING INSTRUCTIONS

Shipping and handling will be much easier if the generator is fastened to a suitable shipping skid that will allow handling by a forklift. The skid should extend beyond the generator in all directions. If the original skid is available it should be used. Marathon Electric will supply shipping skid drawings upon request.

Overseas shipping may require special export crating. Check with your freight carrier.

When installed, single bearing generator rotors are supported on the drive end by the drive discs bolted to the engine flywheel. When the engine is removed, the rotor must be supported by an appropriate fixture to prevent main rotor, main stator or exciter damage (Figure 11-1). Before shipping any single bearing generator, the main rotor must be supported by the adapter using an appropriate fixture.

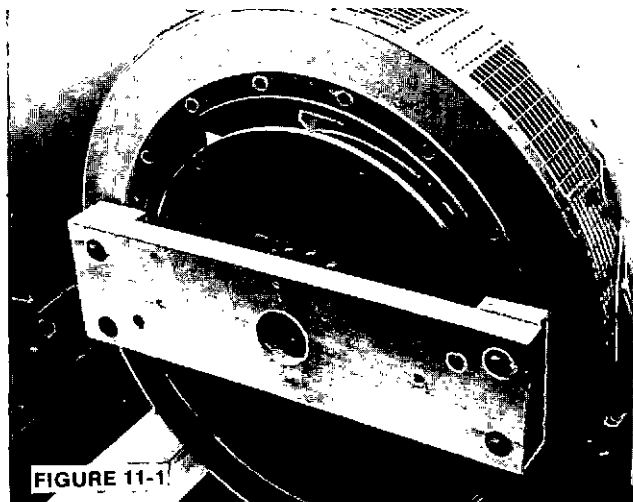


FIGURE 11-1

CAUTION

DO NOT ATTEMPT TO TRANSPORT ANY GENERATOR WITHOUT PROPER ROTOR SUPPORT, EXTENSIVE EQUIPMENT DAMAGE CAN OCCUR.

SECTION

11

SPECIFICATIONS

TABLE 12-1: MAGNA PLUS - FASTENER AND TORQUE SPECIFICATIONS

Part Description	Fastener Spec.③	Size① Dia.-Thread	Torque② Ft-Lb
Front Bracket (End Bell)	Grade 5 capscrews with flat and lock washers	3/8 - 16	25
Drive Disc	Grade 8 capscrews with hardened washers	5/8 - 18	192
Adapter (or rear bracket)	Grade 5 capscrews with flat and lock washers	3/8 - 16	25
Conduit Box	Grade 5 capscrew with star type lock washer	3/8 - 16	25
PMG Stator	Grade 5 capscrews with belleville washers	1/4 - 20	4
Exciter Stator	Socket head set screws	1/4 - 20	6
Cooling Fan	Grade 5 capscrews with belleville washers	1/2 - 13	60
Rectifier Assembly Mounting	Grade 5 capscrews with flat washers	1/4 - 20	4
Drive Hub Set Screw	Socket head set screw	1/2 - 13	50

NOTES:

- ① All fasteners are SAE (American) standard.
- ② All torque values are for plated hardware which is standard on the MagnaPLUS. If hardware is replaced with non-plated, refer to Table 12-2.
- ③ Always use quality hardware of the grade specified.

SPECIFICATIONS

TABLE 12-2: CAPSCREW TORQUE VALUES

Capscrew Dia- meter and Ultimate Tensile Strength (PSI)	To 1/2 - 69,000 PSI To 3/4 - 64,000 PSI To 1 - 55,000 PSI			To 3/4 - 120,000 PSI To 1 - 115,000 PSI			150,000 PSI		
SAE Grade Number	1 or 2			5			8		
Capscrew Head Markings									
Capscrew Body Size (Inches) - (Thread)	Torque ① Ft-Lb (N-m)			Torque ① Ft-Lb (N-m)			Torque ① Ft-Lb (N-m)		
	Dry	Oiled	Plated	Dry	Oiled	Plated	Dry	Oiled	Plated
1/4 - 20	5 (7)	4.5 (6)	4 (5)	8 (11)	7 (9)	6 (8)	12 (16)	11 (15)	10 (14)
- 28	6 (8)	5.4 (7)	4.8 (6)	10 (14)	9 (12)	8 (11)	14 (19)	13 (18)	11 (15)
5/16 - 18	11 (15)	10 (14)	9 (12)	17 (23)	15 (20)	14 (19)	24 (33)	22 (30)	19 (26)
- 24	13 (18)	12 (16)	10 (14)	19 (26)	17 (23)	15 (20)	27 (37)	24 (33)	22 (30)
3/8 - 16	18 (24)	16 (22)	14 (19)	31 (42)	28 (38)	25 (34)	44 (60)	40 (54)	35 (47)
- 24	20 (27)	18 (24)	16 (22)	35 (47)	32 (43)	28 (38)	49 (66)	44 (60)	39 (53)
7/16 - 14	28 (38)	25 (34)	22 (30)	49 (66)	44 (60)	39 (53)	70 (95)	63 (85)	56 (76)
- 20	30 (41)	27 (37)	24 (33)	55 (75)	50 (68)	44 (60)	78 (106)	70 (95)	62 (84)
1/2 - 13	39 (53)	35 (47)	31 (42)	75 (102)	68 (92)	60 (81)	105 (142)	95 (129)	84 (114)
- 20	41 (56)	37 (50)	33 (45)	85 (115)	77 (104)	68 (92)	120 (163)	108 (146)	96 (130)
9/16 - 12	51 (69)	46 (62)	41 (56)	110 (149)	99 (134)	88 (119)	155 (210)	140 (190)	124 (168)
- 18	55 (75)	50 (68)	44 (60)	120 (163)	108 (146)	96 (130)	170 (230)	153 (207)	136 (184)
5/8 - 11	83 (113)	75 (102)	66 (89)	150 (203)	135 (183)	120 (163)	210 (285)	189 (256)	168 (228)
- 18	95 (129)	86 (117)	76 (103)	170 (230)	153 (207)	136 (184)	240 (325)	216 (293)	192 (260)
3/4 - 10	105 (142)	95 (130)	84 (114)	270 (366)	243 (329)	216 (293)	375 (508)	338 (458)	300 (407)
- 16	115 (156)	104 (141)	92 (125)	295 (400)	266 (361)	236 (320)	420 (569)	378 (513)	336 (456)
7/8 - 9	160 (217)	144 (195)	128 (174)	395 (535)	356 (483)	316 (428)	605 (820)	545 (739)	484 (656)
- 14	175 (237)	158 (214)	140 (190)	435 (590)	392 (531)	348 (472)	675 (915)	608 (824)	540 (732)
1 - 8	235 (319)	212 (287)	188 (255)	590 (800)	531 (720)	472 (640)	910 (1234)	819 (1110)	728 (987)
- 14	250 (339)	225 (305)	200 (271)	660 (895)	594 (805)	528 (716)	990 (1342)	891 (1208)	792 (1074)

NOTES:

- ① Capscrews threaded into aluminum may require reductions in torque of 30% or more.

SPECIFICATIONS

NOTE: All excitation data based on measurement using F1 and F2 exciter field winding. For F1 to F3 data refer to factory.

TABLE 12-3: EXCITATION DATA - 60 HZ - 1800 RPM

Model Number	Exciter Field Resistance - Ohms @ 25° C	Exciter Field Volts F1 and F2 at Regulator No Load ^① 240/480 Volts	No Load Output Voltage With Fixed Excitation High Wye Connection ^②	
			12V DC	24V DC
430S1260	18.6	8.9	530	530
430S1261	18.6	10.4	510	600
430S1262	18.6	10.0	510	600
430S1263	18.6	10.2	510	600
430S1264	18.6	9.7	520	610
430S1265	18.6	11.0	500	590
430S1266	18.6	12.1	480	570
432S1267	18.6	11.7	490	580
432S1268	18.6	14.9	440	550

① For rated load exciter field volts - see generator nameplate.

② For low wye connection: divide value shown in table by 2.

For high delta connection: divide value shown in table by 1.732.

TABLE 12-4: EXCITATION DATA - 50 HZ - 1500 RPM

Model Number	Exciter Field Resistance - Ohms @ 25° C	Exciter Field Volts F1 and F2 at Regulator No Load ^① 415 Volts	No Load Output Voltage With Fixed Excitation High Wye Connection ^②	
			12V DC	24V DC
430S1260	18.6	11.0	430	510
430S1261	18.6	12.5	410	490
430S1262	18.6	12.1	410	490
430S1263	18.6	12.1	410	490
430S1264	18.6	11.9	420	500
430S1265	18.6	13.8	400	480
430S1266	18.6	14.9	380	470
432S1267	18.6	13.8	400	480
432S1268	18.6	17.5	360	450

① For rated load exciter field volts - see generator nameplate.

② For low wye connection: divide value shown in table by 2.

For high delta connection: divide value shown in table by 1.732.

① For delta connection: divide value shown in table by 1.732.

SPECIFICATIONS

TABLE 12-5:
RESISTANCE VALUES - MAIN WINDINGS
NOMINAL COLD (25°C) RESISTANCE IN OHMS

Model Number	Winding H-SG-	Main Stator ^①	Main Rotor
430S1260	430601	.204	.482
430S1261	430602	.181	.504
430S1262	430603	.123	.520
430S1263	430604	.0935	.558
438S1264	430605	.0721	.594
430S1265	430606	.0541	.636
432S1266	430607	.0415	.704
432S1267	430608	.0373	.711
432S1268	430609	.0264	.825

① Main stator values shown are line to line on the high wye connection. For low wye connection divide value shown in table by 4.

TABLE 12-6:
RESISTANCE VALUES - EXCITER WINDINGS
NOMINAL COLD (25°C) RESISTANCE IN OHMS

Exciter Stator (Field)	Exciter Rotor (Armature)	PMG Stator
18.6	.105	2.00

GENERATOR FORMULAS①

To Find	Known Values	Three Phase
KW	Volts, Current, Power Factor	$\frac{E \times I \times 1.73 \times PF}{1000} = kVA \times PF$
KVA	Volts, Current	$\frac{E \times I \times 1.73}{1000} = \frac{kW}{PF}$
RKVA	Volts, Current, Power Factor	$\frac{E \times I \times 1.73 \times \sqrt{1 - (PF)^2}}{1000}$
Hp—Engine Output	Generator kW, Generator Eff. Radiator Fan Horsepower Battery Charging Generator hp	$\frac{kW}{Efficiency \times .746} + \frac{Rad. Cooling}{hp} + \frac{Bat. Chg.}{Gen. hp}$
KW—Required for Motor	Motor hp, Eff.	$\frac{Hp \times .746}{Efficiency}$
KVA—Required for Motor	Motor hp, Eff., Power Factor	$\frac{Hp \times .746}{Efficiency \times PF}$
Amps	Hp, Volts	$\frac{Hp \times 746}{1.73 \times E \times Efficiency \times PF}$
Amps	KW, Volts, Power Factor	$\frac{KW \times 1000}{E \times 1.73 \times PF}$
Amps	KVA, Volts	$\frac{KVA \times 1000}{E \times 1.73}$
Frequency	Rpm, Poles	$\frac{Rpm \times Poles}{2 \times 60}$
Poles	Frequency, rpm	$\frac{2 \times 60 \times Frequency}{rpm}$
Rpm	Frequency, Poles	$\frac{2 \times 60 \times Frequency}{Poles}$

① E = Volts
I = Current (Amps)
PF = Power Factor

NOTES

Model Number _____

Serial Number _____

Installed Date _____

Installed By _____

Marathon Electric Mfg. Corp.
100 East Randolph Street
P.O. Box 8003
Wausau, WI 54402-8003
Phone: (715) 675-3311
TWX: 910-281-1521
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