

POWER RECTIFIER

MAGNET POWER SUPPLY

MANUAL



**OHIO MAGNETICS, INC.**  
A SUBSIDIARY OF PEERLESS-WINSMITH, INC.

The logo for Stearns Magnetics, featuring the word "Stearns" in a stylized, cursive script font above the word "magnetics" in a simple, lowercase, sans-serif font. The entire logo is set against a light green rectangular background.

*Stearns*  
magnetics

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## **INDEX**

1. INTRODUCTION

2 . INSTALLATION AND ADJUSTMENTS

3. OPERATION

4 . TROUBLESHOOTING GUIDE & MAINTENANCE

5. OPTIONAL PACKAGES

6. DRAWINGS

7. EQUIPMENT DATA & SPARE PARTS

## **INTRODUCTION**

### **1 . 1 Ohio Magnetics Warranty - DC Power Supplies**

Ohio Magnetics, Inc. a subsidiary of Peerless-Winsmith, Inc. warrants to the original purchaser of each new DC Power Supply, manufactured by and sold by Ohio Magnetics, Inc., to be free from manufacturing defects in material and workmanship under normal service for a period of ninety (90) days, from and after the date of shipment from our Maple Hts., Ohio plant.

Ohio Magnetics' obligation under this warranty is expressly limited to the replacement or repair of any part or parts which are proven to our satisfaction to be defective under normal use and service, at the Ohio Magnetics, Inc. plant at Maple Heights, Ohio or at a point designated by it.

Ohio Magnetics, Inc. will not be held responsible for the cost of consequential labor , loss of profit, down time, or any transportation charges incurred in connection with the replacement of or repair of said DC Power Supply or parts thereof found to be defective. It shall not be responsible for consequential damages or contingent liabilities arising from the use of, or performance of, Ohio DC Power Supplies.

This warranty does not apply to any Ohio DC Power Supplies or parts thereof, which have been subject to accident, negligence , alteration, abuse or misuse , or upon which repairs or alterations have been made by other than Ohio Magnetics, Inc., except where said repairs are made by others with its prior written approval.

Ohio Magnetics, Inc. makes no warranty with respect to accessory equipment manufactured by others and sold by Ohio Magnetics, Inc.. These items are subject to the warranties the manufacturer and any warranty claims on these items shall be directed by the user to the respective manufacturer.

Ohio Magnetics, Inc. makes no other express, implied or statutory warranties, nor is anyone authorized to make any on its behalf .

## 1.2 RECEIVING

If damage incurred in shipping is observed upon receipt of rectifier, notify and file claim with carrier.

**BEFORE YOU FULLY UNPACK THIS UNIT READ THIS FOR YOUR PROTECTION!**  
(This information applies only on shipments within the United States)

### DAMAGE

This shipment was packaged and delivered to the carrier with the utmost care to insure safe delivery of goods. When shipment is received and signed for by the transportation company, consignor's responsibility ceases. Do not accept shipment which evidences damage or shortage until agent of carrier endorses a statement of the irregularity on the face of the transportation receipt. Without documentary evidence, claim can not be filed.

### CONCEALED DAMAGE

Interstate Commerce Commission has indicated that a carrier is as much responsible for concealed damage as for visible damage in transit. Upon receipt of shipment, promptly unpack and check thoroughly. If concealed damage is discovered, cease further unpacking and request immediate inspection by local agent of carrier. A written report of the agent's findings, with his signature, is necessary to support claim.

### SHORTAGE

Check shipment against shipping papers. Do not discard packing materials or packing cases until contents have been found to be correct. The removal of badly needed items, before shipment has been checked, may create a shortage. Check all possibilities before reporting a shortage.

### CLAIMS

If your agent or carrier has been given an opportunity to inspect the shipment, any claim for a shortage or damaged merchandise can be handled as a simple and routine procedure. Claims must be filed by consignee. Shipping terms are F.O.B. Cleveland, Ohio.

### LOSS

In the event of complete loss, claim will be handled in the same manner as for Shipping Damage or Shortage.

## 1.2 (Cont.) SHIPPING DAMAGE OR SHORTAGE

### TRUCK SHIPMENT

The original destination freight bill bearing notation of damage or shortage by the carrier and the inspector's report, attached to a certified copy of the original\* bill of lading of the transportation company at point of origin, must be available to support claim. All claims will be initiated at point of destination.

### EXPRESS SHIPMENT

Should there be damage or shortage, claim must be supported by a certified copy of the original\* paid express receipt (whether issued at point of origin or destination) bearing the agent's notation of damage or shortage, or the inspector's report of same attached.

### AIR EXPRESS

Claim must be initiated at point of destination. The express agent at point of destination will fill out a "Bad Order Report" which will be returned to party submitting claim. The original invoice, original\* air express receipt, "Bad Order Report" and a letter of transmittal, must be submitted in support of claim.

### RAIL FREIGHT

Claim will be initiated at point of destination. However, inspection papers filled out by the consignee and endorsed by the freight office of destination along with paid freight bill, original\* bill of lading, original invoice or certified copy of same, plus a bill to the freight agent for claim charges, must be forwarded to the Freight Agent at point of origin in support of claim. Shipping charges reimbursed will be those prorated over total weight of shipment involved in the claim.

### AIR FREIGHT

Claim must be initiated at point of destination. Claim must be filed by submitting a letter on company stationery with an explanation of the extent of damage or loss and forwarded with a copy of the original\* air bill, and original invoice or Photostat of same, to the airline having carried the shipment.

\* Upon request certified photostatic copies of original papers held by Ohio Magnetics, Inc. required in support of claims, will be made available.

### 1.3 **CHECKING BEFORE INSTALLATION**

If damage is not incurred in shipping, proceed checking the nameplate data of the equipment against the nameplate data, and inquiry sheet in this section of the manual. The two should agree, The nameplate is located on the door.

Before installing equipment, it is recommended that a thorough visual inspection be made. All terminal connections should be checked for loose connections that could have occurred in transit. Careful check should be made for any frayed wiring or cracked insulation.

**MODEL No.:****SERIAL No.:****INPUT POWER:**

Voltage:	V-ac
Phase:	3 Ø
Frequency:	Hz
Current:	A-ac
Power Factor:	0.90 ~ 0.96

**OUTPUT POWER:**

Power:	KW
Voltage:	V-dc
Current:	A-dc
Ripple:	4.6 %
Regulation	8.0 %

**ENVIRONMENTAL DATA**

Ambient Temperature (maximum):	60°C
Altitude (maximum):	1000 m

**OPTIONS:**

Enclosure:	NEMA	IP (IEC 529)
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	LOCAL	REMOTE
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Lockable Latch (1,12)  
 Disconnect Switch  
 Input Control (Pushbuttons)  
 Input Control (Selector Switch)  
 Output Indication (Pilot Light)  
 Output Indication (Meter Package)  
 Undercurrent Limit Alarm  
 Relay Switcher  
 Local/Remote Selector Switch

## 2.) INSTALLATION AND ADJUSTMENTS

### 2.1) MOUNTING - LEVELING

Rectifiers up to 10 kW of ratings are packaged in wall mounted enclosures. Above 10 kW rating, the standard enclosures are floor mounted units. 15-25 kW rectifiers are available optionally as wall mount units. The enclosure's should be situated in a leveled position, and bolted to the wall or to the floor as the situation demands it. Install the rectifier in a location suited to its NEMA/IP(IEC-529) rating . (See outline drawing in Section 5) Punch holes in the bottom of the enclosure for input and output cables and for control cables if needed.

### 2.2) CONNECTION OF RECTIFIER

Before connecting rectifier power supply to power line check power line voltages (all three phases) to confirm that values are the same as indicated on equipment name plate. When connecting rectifier all wiring must conform to national and local codes. If input line does not have a ground conductor, then the enclosure must be grounded properly. Grounding provisions are provided on the terminal block (green/yellow terminal) for this purpose.

Next step is to connect the unit.

- a . Input power cable to TB1; L1-L2-L3 (T1-T2-T3 on units with remote mounted starters)
- b. Output power (load) cable to TB3; E1 (+), E2(-)
- c. Control cable (if applicable) to TB2

The sizes of recommended cables and wires are given in the equipment data sheet of this section. Use proper schematic and wiring drawings located in Section 5.

### 2 . 3 MANUAL OR AUTOMATIC RESET ON OVERLOAD RELAYS

The overload relay can be operated in two different modes:

Manual Reset Mode, and Automatic Reset Mode (Electrically operated starters only - Siemens).

In manual reset mode the arrow on the top of blue reset button points to "H". This is the recommended and safe mode of operation. In this mode, if the relay is activated by an overload condition, the blue button has to be pushed to reset the overload relay.

In the automatic mode of operation (for test purposes only), the blue button is depressed, and turned CCW so the arrow on top of: blue button points to "A" position. In this mode, if the overload relay is activated by an overload condition the relay will reset itself as soon as the heater element in the overload relay cools off. This mode of operation is not recommended with 2-wire switch control in the starter coil circuit.



Manual Reset Mode, and Automatic Reset Mode (Electrically operated starters only - ABB).

In the top center of the overload relay is an off white colored switch with a Phillips type adjustment screw. The factory setting is in the manual position as the arrow on the switch points to the word "MAN" at about 8 o'clock. To switch to automatic (for test purposes only) rotate the switch CCW so that the arrow points to the word "AUT" at about the 4 o'clock position. In this mode, if the overload relay is activated by an overload condition the relay will reset itself as soon as the heater element in the overload relay cools off. This mode of operation is not recommended with 2-wire switch control in the starter coil circuit.

It is not recommended that the setting be left in the automatic mode. This mode is unsafe for normal operation and should only be used for testing purposes only. Since power can restore itself without warning, it can be a harm to someone or something at the moment power is restored, therefore this setting must remain in the manual position for normal operation.

Manual Reset Mode, and Automatic Reset Mode (Manual Starters).

Manual motor starters used on some rectifiers provided principally for Stearns Separator Service applications are not able to be switched to an automatic position. Reset can only be accomplished by depressing the black button "1" on the front of the unit after the starter has cooled.

## 2.4 OVERLOAD SETTING ADJUSTMENT

The overload current setting is factory set for the maximum allowable current the rectifier can handle. **DO NOT READJUST THIS SETTING.** Readjustment may cause the rectifier to fail. Setting the overload too high may prevent it from tripping in the event of an overload or short circuit. Setting the overload too low may cause it to trip under a normal condition. If there are problems with this device, contact Ohio Magnetics, Inc.

## 2.5 REMOTE STARTERS

Some rectifiers upon customer request do not contain a local method of input control. Yet codes require some sort of circuit protection and control. Upon customer request, Ohio Magnetics, Inc. will not provide a local input starter control on units where a customer informs Ohio Magnetics, Inc. in advance of the desire to remotely locate a suitable starter.

If a customer decides to add a remote starter to control the rectifier, it is advisable to disconnect and by-pass the local starter. If the local starter is not by-passed, random tripping of the overload may occur, especially during startup. Two starters, where the overloads are close in rating, will interact with each other and produce undesired results.

## 2.6 CIRCUIT BREAKERS

Circuit Breakers used as additional input protection are optional devices provided by Ohio Magnetics, Inc. They may be either locally mounted or remote mounted. Locally mounted circuit breakers will also serve the function of locking the rectifier cabinet when power is on. To open the enclosure the circuit breaker must be turned off first. Circuit breakers are sized to 125 % of the full load current of the rectifier.

As with starters, circuit breakers can interact with the starter overload. This problem is reduced if the circuit breaker trip setting is much greater than the overload. If both units are set to trip at the same current rating, false tripping will occur, most notably at start up.

## 2.7 ON-OFF CONTROL

On rectifiers with electrically controlled starters, some type of on-off control is required. Two popular methods in use are pushbuttons or a two position selector switch. Ohio Magnetics, Inc. offers both types as an optional package. If either type is requested for local mounting, they are pre-wired in the factory. Remote mounted power on-off controls must be connected by the customer.

If no type of on-off control is intended, then in order for the rectifier to work, the switch connections must be jumped out. In this case it usually means connecting wire terminal 20 to 24. Some optional packages might require a different connection. Refer to the system schematic or interconnection diagram for alternative connection schemes.

On rectifiers with manual starters, the starter itself is the on-off control. The red button “0” is depressed to turn the system off and the black button “1” is used to turn the system on. If the manual relay tripped due to an overload, allowing the element to cool first is required before the system can be repowered. The manual starter will not reset if the elements are still hot.

The manual starter also has a provision to lock out the black button to prevent unauthorized operation of the rectifier.

## 2.8 OPTIONAL PACKAGES & OTHER DEVICES

See Section 3 for a description and operation of standard and other optional devices compatible with the rectifier.

## 2.9 ADJUSTMENT OF POWER TRANSFORMER PRIMARY TAPS

Transformers supplied with Ohio Magnetics' rectifiers are supplied with transformers to match the normal supply voltage for the region where the rectifier is used. Each transformer has a set of primary taps used to match the input voltage to the prevailing line conditions. Transformers are shipped from the factory with the taps wired to the nominal voltage for the region the rectifier is used. If the output of the transformer is too low or too high, the taps will need to be changed in the field to provide the desired output voltage. When voltage conditions are not matched to the proper tap connections, overheating of the transformer and unsatisfactory voltage conditions at the load will result. NEVER change the taps while power is on. There is a danger of electrocution and fire if taps are changed while the power is on. Rectifier outputs should never exceed 125/250 V-dc on a continuous basis.

RECTIFIERS SOLD IN NORTH AMERICA where the nominal supply voltage is designated as 240 V; 60 Hz alternating current have transformer taps for following voltages:

240 V nominal: 230 V (-5 %); 240 V (RATED); 250 V (+5 %)

480 V nominal: 460 V (-5 %); 470 V (-2.5 %); 480 V (rated); 490 V (+2.5 %); 500 V (+5 %)

These transformers are designated as series multiple type. When wired in the multiple (parallel) configuration, the input voltage is 240 V. When wired in the series condition, the input voltage is 480 V. This transformer is is not used for 480 V inputs as of July 2001. See information below for 480 V input systems.

To determine the correct tap, reference the schematic diagram that came with this manual. NEVER change the taps while power is on. There is a danger of electrocution and fire if taps are changed while the power is on.

RECTIFIERS SOLD IN NORTH AMERICA where the nominal supply voltage is designated as 480 V; 60 Hz alternating current have transformer taps for following voltages:

480 V nominal: 460 V (-5 %); 480 V (RATED); 500 V (+5 %)

To determine the correct tap, reference the schematic diagram that came with this manual. NEVER change the taps while power is on. There is a danger of electrocution and fire if taps are changed while the power is on.

RECTIFIERS SOLD IN CENTRAL AMERICA AND SOME PARTS OF ASIA where the nominal supply voltage is 220 V; 50 or 60 Hz alternating current have rectifier taps for following voltages:

220 V nominal: 200 V (-10 %); 220 V (RATED); 240 V (+10 %)

440 V nominal: 400 V (-10 %); 440 V (-5 %); 440 V (rated); 460 V (+5 %); 480 V (+10 %)

These transformers are designated as series multiple type. When wired in the multiple (parallel) configuration, the input voltage is 220 V. When wired in the series condition, the input voltage is 440 V. This transformer is is not used for 440 V inputs as of July 2001. See information below for 440 V input systems.

To determine the correct tap, reference the schematic diagram that came with this manual. NEVER change the taps while power is on. There is a danger of electrocution and fire if taps are changed while the power is on.

RECTIFIERS SOLD IN CENTRAL AMERICA AND SOME PARTS OF ASIA where the nominal supply voltage is designated as 440 V; 50 or 60 Hz alternating current have transformer taps for following voltages:

440 V nominal: 420 V (-5 %); 440 V (RATED); 460 V (+5 %)

To determine the correct tap, reference the schematic diagram that came with this manual. NEVER change the taps while power is on. There is a danger of electrocution and fire if taps are changed while the power is on.

RECTIFIERS SOLD IN CANADA where the nominal supply voltage is 575 V; 60 Hz alternating current have transformer taps for following voltages:

550 V (-5 %); 575 V (rated); 600 V (+5 %)

To determine the correct tap, reference the schematic diagram that came with this manual. NEVER change the taps while power is on. There is a danger of electrocution and fire if taps are changed while the power is on.

RECTIFIERS SOLD EVERYWHERE ELSE where the nominal supply voltage is 400 V; 50 Hz alternating current have rectifier taps for following voltages:

380 V (-5 %); 400 V (rated); 415 V (+4 %)

The 380 V setting is found mostly in South America, parts of Europe, Asia and Africa. The 400 V setting is used primarily for western Europe. The 415 V setting is found in Britain and former British colonies in Asia.

To determine the correct tap, reference the schematic diagram that came with this manual. NEVER change the taps while power is on. There is a danger of electrocution and fire if taps are changed while the power is on.

## OUTPUT TAP CONFIGURATIONS

Transformers up to 15 kW (25 kW previous to July 2001) are equipped with a dual secondary for connecting to either 115 V-dc or 230 V-dc magnets. On transformers 20 kW (35 kW previous to July 2001) and higher only 230 V is available. On dual output transformers, the transformer is connected to the proper setting for the rectifier. Never change this connection or damage to the rectifier and/or magnet may occur. The rectifier is fused wired for the proper current based on the output voltage. If you need to change the output voltage setting for any reason, first contact the factory for details.

The output of the transformer itself is usually about 90 V-ac line to line for 115 V-dc systems and 180 V-ac line to line for 230 V-dc systems.

Transformers designed for boost systems will normally have voltages around 225 V-ac in order to generate a 300 V-dc output.

### 3A.) **OPERATION** (LIFTING MAGNET RECTIFIER FIXED DC OUTPUT)

3A.1 Make sure all connections and adjustments are made and power is available.

3A.2 Turn on input power to rectifier via circuit breaker or disconnect switch, or what ever is applicable. The power is then present at the input power terminal Block TB1.

***WARNING: Once power is applied to the rectifier dangerously high voltages are present inside the rectifier. Do not place your hands near any exposed terminals. Make connections and disconnections only when power is off.***

3A.3 Use optional pushbutton or optional selector switch to energize MS starter and to extend input power to power transformer TX1. This will be indicated by pilot light PL1. If starter fails to energize, check to make sure that overload is reset by depressing reset button on starter overload.

3A.4 The power transformer TX1 steps down the standard available voltage applied to it. This step down voltage is rectified by a three phase full wave diode bridge, to create the necessary DC voltage.

3A.5 The three phase full wave bridge is protected by ac power fuses F1-F3, and by dc power fuses F4, F5 and by the transient voltage suppressor against ac and dc voltage transients and spikes. The transient voltage suppressor (TVS) also protects the inductive load against self-generated transient voltages.

3A.6 Optional DC pilot light and/or optional meter package (voltmeter & ammeter) will indicate that DC voltage and current is present at the DC output terminal block TB3.

3A.7 The starter overload relay is protecting the rectifier power supply against flagrant overloads. The overload relay will open the starter circuit above 125 % of load. The starter also is sensitive to single phasing of the three phase input. The starter will open input circuit within 2 minutes of single phasing occurrence.

3A.8 The primary of the power transformer TX1 can be adjusted to match the variation of input voltage up to and including  $\pm 5\%$  (10 % on some models) of standard input voltage value. The details are described in Section 2 (Installation and Adjustments) and shown on schematic drawings for the rectifier.

3A.9 The control terminal block TB2 (where applicable) is actively used when operational equipment is used in a remote operation. TB2 serves the following optional equipment: Pushbuttons, selector switches, pilot lights, meter packages.

3A.10 Use optional selector switch or optional pushbutton to turn off power supply.

### 3B.) OPERATION (LIFTING MAGNET RECTIFIERS VARIABLE DC OUTPUT)

3B.1 Make sure all connections and adjustments are made and power is available.

3B.2 Turn on input power to rectifier via circuit breaker or disconnect switch, or what ever is applicable. The power is then present at the input power terminal Block TB1.

***WARNING: Once power is applied to the rectifier, dangerously high voltages are present inside the rectifier. Do not place your hands near any exposed terminals. Make connections and disconnections only when power is off.***

3B.3 Use optional pushbutton or optional selector switch to energize MS starter and to extend input power to power transformer TX1. This will be indicated by pilot light PL1. If starter fails to energize, check to make sure that overload is reset by depressing reset button on starter overload.

3B.4 The power transformer TX1 converts the standard line voltage available to the voltage necessary to produce 115 or 230 V-dc output at the rated power. The voltage is rectified to its dc value via a full wave SCR bridge. The SCRs allow the output voltage to be varied and regulated from zero to the maximum limit of the rectifier.

A FIRING and REGULATING board is used in conjunction with the SCRs to vary and regulate the output voltage and to limit and regulate the output current. This is accomplished by a potentiometer to adjust and limit the maximum voltage.

**PLEASE NOTE: THE FIRING AND REGULATOR BOARDS ARE ALL PRESET AND CALIBRATED TO FUNCTION PROPERLY WITH THE SCRs. THERE ARE NO CUSTOMER ADJUSTMENTS OR REPAIRS TO BE DONE TO THESE BOARDS THE BOARDS CONTAIN NO USER SERVICEABLE PARTS. ATTEMPTS TO SELF-SERVICE THE BOARDS COULD RESULT IN PERMANENT DAMAGE TO THE SCRs, THE BOARDS THEMSELVES, INJURY TO THE PERSON ATTEMPTING TO SELF-SERVICE THE BOARDS, AS WELL AS VOIDING ANY AND/OR ALL WARRANTIES. IF YOU EXPERIENCE ANY PROBLEMS WITH THE OPERATION OF THE RECTIFIER, PLEASE CONTACT THE MANUFACTURER.**

The potentiometer for reducing the output voltage is located on the operators console. The "REDUCE VOLTAGE" control is a push to activate type. Normally, the control is in the full voltage condition. When reduced voltage is desired, the button is depressed and the potentiometer is rotated CCW to the desired voltage level. CW is the full voltage condition. when it is desired to reapply full voltage, the "REDUCED VOLTAGE" control is released and full voltage returns to the rectifier output, even if the potentiometer is not set to full ON. See section 3B.5 Voltage Limiting.

3B.5 Voltage Limiting/Regulating:

The voltage is limited by the transformer to a maximum output of about 115 or 230 V-dc, depending

on the maximum output for the rectifier being used. Also, there is a feedback resistor on the regulator board designated as FR that scales the potentiometer control to a maximum limit of 115 or 230 V dc. To limit the voltage to a lower value, turn the potentiometer CCW, until the desired magnet characteristic occurs. The voltage limiting is a "Push to activate" type, which means that in order to activate the voltage lowering capability of the SCR rectifier the "REDUCED VOLTAGE" control must be switched in by depressing the pushbutton. The knob on the control is a single turn type. The change in voltage can be observed by monitoring the voltage meter, located on the remote console.

### 3B.6 Current Limiting:

The current is limited to a maximum value as that determined by the shunt. whatever current produces 50 mV in the shunt is the current limit. The current limit can be determined by observing the highest value on the ammeter. The current limit prevents the rectifier from trying to output more current than the components are designed to handle. The current limit is not a protection against short circuits, but against overloading. The response time of the current limiting circuitry is too long to prevent damage from shorts. The Rectifier is protected from shorts by fast acting fuses.

3B.7 The three phase full wave SCR Bridge is protected by AC power fuses F1-F3 by DC power fuses F4 and F5, by a transient voltage suppressor, and by MOV snubber networks, to guard against AC and DC voltage transients and spikes. The transient voltage suppressor (TVS) also protects the inductive load against self generated transient voltages.

3B.8 A local or remote meter/control package (voltmeter, Ammeter, and Potentiometer) is used to indicate the voltage and current as well as to set the voltage limits that are present at the output terminal block TB3.

3B.9 The starter overload relay is protecting the rectifier power supply against flagrant overloads. The overload relay will open the starter circuit when current is above 125 % of full load. The starter is also sensitive to single phasing of the three phase input. The starter will open the input circuit within 2 min of the occurrence of single phasing.

3B.10 The primary of the power transformer can be adjusted to match the variation of the input voltage, up to and including  $\pm 5$  % of standard input value on transformers rated 60 Hz only. On transformers rated 50/60 Hz, the input variation is  $\pm 10$  %. The details of the transformers and their tap configurations are described in section 2 (Installation and adjustments) and on the schematic drawings.

3B.11 The control terminal block TB2 is actively used when an instrument package is used in remote operation. TB2 serves the following optional equipment: Pushbuttons, pilot lights, meter packages, and potentiometers.

3B.12 Please note, the voltage and current setting will vary somewhat depending on the operating temperature of the components. This is normal. Once the unit is operating for a short time, conditions will stabilize. The Power supply can be turned off by use of optional selector switch, or off push-button.



### 3B.13 LOAD POWER:

The rated power of the rectifier is the maximum rating at 115 or 230 V dc. As the voltage is reduced the power of the rectifier is derated by the same factor. This is because the current is limited by the transformer and shunt to a maximum value power is the product of the voltage and the current. If the voltage is lowered to a value less than maximum, the maximum power is also lowered. The regulator board via the shunt, limits the output current to a value that produces 50 mV in the shunt, but it is possible that long before this limit is reached, the transformer itself will limit the current by reducing the output voltage. As an example, the voltage is limited to 50 % of maximum, then the maximum power is no longer the nameplate power, but 50 % of it.

### 3B.13 APPLICATION (I):

To utilize the feature of reduced voltage in the application of dropping selected plate(s) (fanning), follow the procedure below:

- 1.) Lift the whole stack via full voltage.
- 2.) Make sure the Voltage adjustment potentiometer is at full CW.
- 3.) Depress the "REDUCE Voltage" pushbutton and while holding the button depressed begin rotating the knob CCW until the desired amount of plate(s) have fallen off the magnet(s). Note the number position on the potentiometer. This will be used in the future for lifting this size and number of plate(s).
- 4.) Release the push-button, allowing magnet to return to full voltage. The magnet(s) will hold the remaining plate(s) securely for travel.
- 5.) Repeat for different size plate(s).

Note: Once it is known where on the dial a desired voltage setting is located, Steps 1 through 3 can be eliminated, and the potentiometer can be set to the known location.

### 3B.14 APPLICATION (II):

To utilize the feature of reduced voltage in the application of lifting of selected plate(s), follow the procedure below:

- 1.) Make sure the Voltage adjustment potentiometer is at full CCW.
- 2.) Place magnet on top of plate(s) to be lifted.
- 3.) Depress voltage control pushbutton.
- 4.) Place magnet controller in "lift".
- 5.) Gradually turn potentiometer CW until desired plate(s) are lifted.
- 6.) Lift Plate(s) from pile, Release "REDUCED VOLTAGE" button. Transport Plate to desired drop location.
- 7.) When the magnet(s) with plate(s) is away from the pile, press "REDUCED VOLTAGE" button, so the plate(s) on the pile is/are not pulled up. Set plate(s) on pile, then release reduced push-button. Discharge magnet(s).

Note: once it is known where on the dial a desired voltage setting is located, steps 1 through 5 can be eliminated, and the potentiometer can be set to there permanently.

### 3C.) OPERATION (SEPARATOR SERVICE RECTIFIER)

3C.1 Make sure all connections are made and power is available.

3C.2 Turn on input power to rectifier via circuit breaker or disconnect switch, or whatever is applicable. The power is then present at the input power terminal block TB1 on the locally mounted starter or at L1, L2, and L3 on the remote mounted starter.

***WARNING: Once power is applied to the rectifier; dangerous high voltages are present inside the rectifier. Do not place your hands near any exposed terminals. Make connections and disconnections only when the power is off.***

3C.3 Using the manual starter, depress the "START" or "1" button. Hold the button in until the unit is outputting dc voltage. This will be indicated by pilot light PL1 on the door of the rectifier being illuminated. if starter fails to energize, check to make sure that there is no overload condition or a short. Also, check to make sure voltage is present on all three lines.

3C.4 The power transformer TX1 converts the standard line voltage available to the voltage necessary to produce the desired dc output at the rated power. The voltage is rectified to its dc value via a full wave diode bridge.

3C.5 The three phase full wave diode bridge is protected by dc power fuses F1 and F2.

3C.6 The dc indicator lamp is used to indicate the presence of dc voltage and to warn that the internal components are live and that a danger exists if the enclosure door is opened while the power is on.

3C.7 The starter overload relay protects the rectifier power supply against flagrant overloads. The overload relay will open the starter circuit when current is above 125 % of full load. The starter is also sensitive to single phasing of the three phase input. The starter will open the input circuit within 2 min of the occurrence of single phasing. if the overload has tripped, let the unit cool before attempting to reset the starter. To reset the starter after an overload, depress the "START" or "1" button. if the button will not stay in and power stay on, then refer to the troubleshooting section of Section 4.

3C.8 The primary of the power transformer can be adjusted to match the variation of the input voltage, up to and including  $\pm 5$  % of standard input value on transformers rated for 240/480 V; 60 Hz only. On transformers rated 220/440; 50/60 Hz, the input variation is  $\pm 10$  %. Other voltage inputs have different input ratios. The details are described in section 2 (Installation and adjustments) and on the schematic drawings.

3C.9 The unit is powered down by depressing the "STOP" or "0" button on the manual starter.

#### 4.1 TROUBLESHOOTING CHART

<b>PROBLEM:</b>	<b>PROBLEM AREA:</b>	<b>PROBABLE CAUSE:</b>	<b>CORRECTION:</b>
NO OUTPUT VOLTAGE	STARTER DE-ENERGIZED STARTER WILL NOT ENERGIZE	STARTER NOT TURNED ON NO CONTROL VOLTAGE PRESENT PHASE 1 OR 2 OPEN TRIPPED OVERLOAD RELAY FAULTY SWITCH OR PB F6 AND/OR F7 OPEN	TURN ON RECTIFIER SEEK POINT OF VOLTAGE LOSS, REPAIR CHECK SOURCE OF OPEN, REPAIR RESET OVERLOAD RELAY REPLACE SWITCH OR PB REPLACE FUSE
	NO VOLTAGE AT CONTROL X-FORMER NO OUTPUT OF DIODE/SCR BRIDGE F1, F2 AND/OR F3 OPEN F4, F5 OPEN	DIODE/SCR BRIDGE OPEN SHORT IN DIODE/SCR OR LOAD OVERLOAD CONDITION IN LOAD	REPLACE FAILED COMPONENT(S) ON BRIDGE CLEAR SHORT, REPLACE FUSE(S) REPLACE FUSE, CHECK CURRENT DRAW OF LOAD REDUCE LOAD TO LESS THAN MAX ALLOWABLE
	F6, F7; OR TX2 OR STARTER COIL OPEN	SHORT CIRCUIT/GROUND OR OVERHEATING	CLEAR SHORT/GROUND; CHECK FOR PROPER COOLING, REPLACE DAMAGED PARTS
	SCR'S NOT FIRING	BAD REGULATOR BOARD BAD FIRING BOARD SINGLE PHASING AT INPUT, BLOWN F1, F2 OR F3 NO INPUT TO SCR BRIDGE, FUSE(S) BLOWN NO CONTROL (0-10 V) @ TERM 26 OR 32 TO 28	REPLACE REGULATOR BOARD REPLACE FIRING BOARD REPLACE FUSE(S) REPLACE FUSE(S) CHECK FOR VOLT AT 27 & 33, IF NO CHECK REG BRD IF REG BRD OK, CHECK CONTROL POT OR RELAY JMP 26 TO 27 & 32 TO 33 FOR TEST, OK BRDS GOOD
	UCLA TIMES OUT, RECTIFIER SHUTS OFF	MAGNET OVER HEATING MAGNET NOT CONNECTED UCLA NOT REGISTERING PROPER CURRENT	REPLACE BRDS OR CNTRL COMPONENTS IF BAD ALLOW MAGNET TO COOL, CHECK FOR BAD MAGNET CHECK FOR BROKEN LEAD, OPEN MAGNET COIL CHECK UCLA REPLACE IF BAD, CHECK SHUNT CHECK UCLA CALIBRATION FOR PROPER SETTING MUST BE ABOUT 65 % OF COLD MAG CURRENT
LOW OUTPUT VOLTAGE	LOW INPUT VOLTAGE TO BRIDGE SINGLE PHASING	WRONG TAP CONNECTION OF PWR X-FORMER OPEN AC FUSE F1, F2, F3 ONE DIODE/SCR IN BRIDGE OPEN (OUTPUT SHORT) ONE SECONDARY COIL IN PWR X-FORMER OPEN TO MUCH HEAT SHORT IN LOAD OVERLOAD RECENTLY TRIPPED (STILL WARM)	CHANGE TAP CONNECTION CHECK FOR SHORT; REPLACE BAD FUSE REPLACE DEFECTIVE DIODE/SCR REPLACE POWER TRANSFORMER CHECK TEMP OF RECT LESS THAN 60°C REMOVE SHORT CONDITION ALLOW OVERLOAD TO COOL BEFORE RESETTING
HIGH OUTPUT VOLTAGE	TRANSFORMER TX1 SCR'S OPERATING AT MAX OUTPUT ALL OF THE TIME (BOOST SYSTEM)	WRONG TAP CONDITION ON PRIMARY SIDE CHECK CONTROL VOLTAGE AT 26 TO 28	CHANGE TAP CONNECTION, REFER TO SCHEMATIC IF ALWAYS 10 V, CHECK RELAYS/TIMERS REPLACE BAD COMPONENTS, CHECK SCHEMATIC FOR PROPER OPERATION

CONSULT FACTORY FOR FURTHER ASSISTANCE IN SOLVING RECTIFIER PROBLEMS

## 4.2) MAINTENANCE

4.2a Clean power supply periodically of accumulated dust and dirt. Special attention should be given to the Rectifier Diode or SCR Assembly. This is necessary to eliminate possibility of arcing and to prevent loss of efficiency of heat sinks in unit.

Cleaning is best accomplished by means of a compressed air blower, or soft hair brush.

***CAUTION: Never use any cleaning fluids on electrical parts.***

4.2b Periodically, check all components and connections for tightness. Expansion and contraction of parts along with vibration may cause even the best connections to become loose after long periods of use.

### 4.2c Voltage Checks:

Check input voltages, transformer primary and secondary voltages and input voltages at diode or SCR bridge on ac voltmeter scale. Check diode or SCR bridge output voltage and dc bus plus and minus on the dc voltage scale.

### 4.2d Resistance and Continuity Test

***Warning: Never conduct the following checks with power on.***

#### **Diode Test:**

Disconnect leads at diodes and check for open or short: (disconnect input and output cables)

A. Do not apply a megger or any high potential test equipment which may subject silicon diodes or SCRs to abnormal voltages .

B. Use a good quality multimeter to measure resistance values

C. Select the diode check function on your multimeter. If you are not sure how to do this, consult your multimeter operators manual. You should see either a 1. In the display or some other symbol denoting infinity ( $\infty$ ).

D. Test the meter by shorting the red and black lead together and note a reading of zero (0).

E. Place the black lead on the cathode (side with line marking) of the diode and the red lead on the anode. You should see a reading between 0.4 and 0.7 V on the meter. If the reading remains at  $\infty$ , then the diode is open. If the reading is low or zero, then the diode is shorted.

F. Reverse the multimeter leads on the diode and note the reading. The reading should be  $\infty$ . If it is zero, then the diode is shorted.

G . The diode is generally considered to be good if: 1.) reading is infinite or very high while the other reading is low.

### **Fuse and Wire Test:**

Using a multimeter set on the 200  $\Omega$  (minimum) scale, place the red lead on one end of the wire or fuse and the black lead on the other. If the meter shows infinity, the wire or fuse is open and if it shows zero, then there is continuity in the wire or fuse.

Note: Some meters will not read zero, but will display a number from 0.1 to 0.3  $\Omega$  . This is normal and usually reflects the resistance of the meter leads. Ignore this reading, and assume it to be the same as zero.

### **4.2e AIR FILTER MAINTENANCE**

On some model of power supplies, cooling of the interior is accomplished by use of louvres and air filters. In all cases, it is necessary to clean the louvers and the filters on a regular basis. Failure to do so, will cause heat to build up inside the enclosure, because hot air will be unable to escape through the dirt.

Louvres and air filters should be cleaned once every three months (or sooner in dirtier environments) whether they need it or not. Cleaning is accomplished by first removing the air filters from the louvres. To remove the air filters, grab the edges with the fingers, slide the filter upward, and pull outward from the bottom.

Use compressed air to blow excess dust and dirt from the filters. What the forced compressed air did not remove, can be removed by rinsing the filters in a bucket of warm soapy water. After the filters are satisfactorily clean, rinse off the soap by running cold tap water through the filters. Allow to dry, before reinstalling.

The louvres can be cleaned by running a moist rag over the louver slots to pick up excess dust and dirt. If there is oily dirt or dirt that is hard to remove, the use of an industrial cleaner especially made for a particular or specific dirt can be used.

After the louvres and air filters have been cleaned, the air filters can then be reinstalled in their slots.

## 5.) OPTIONAL RECTIFIER PACKAGES

Optional rectifier packages provide additional control and indication for the rectifier and magnet system. Optional components may be mounted locally to the rectifier or remotely in a separate enclosure. Many of the optional packages may be combined to meet the needs of the customer. Some packages are not available for all applications. Below is a description of various optional packages available with the rectifier:

### 5.1 UNDERCURRENT LIMIT ALARM (SEPARATOR SERVICE USAGE)

When using a undercurrent limit alarm, a three-wire pushbutton control has to be used for turning the power supply on and off.

#### FIELD SETUP:

The Undercurrent Limit alarm (UCLA) senses direct current from a 50 mV shunt. If the current level drops below the limit adjustment value, the UCLA will disconnect the power supply from the line by de-energizing the magnetic starter coil. The limit adjustment value, or drop out point, can be changed by a screw driver adjustment of the “Setpoint”. To increase the drop out point adjust setpoint to CW (clockwise). Maximum drop out point is the maximum current that produces 50 mV across the shunt. To decrease the drop out point adjust setpoint to CCW (counter clockwise). If the drop out point is adjusted higher than the actual current the load requires, the power supply will not remain energized.

The UCLA sensor is set by the factory for 25 mV detection (50 % of shunt value). This setting may not be correct for the field application and therefore must be adjusted at the point of application. To properly set the UCLA in the field, allow the magnet to come up to full temperature. This will be result of the magnet current being about 70 % of its nameplate current (referenced to 25°C). If the sensor cuts the rectifier off before magnet reaches its full temperature, then turn the setpoint CCW about 5 turns. After a few hours of operation and an assurance that the current of the magnet has stabilized, adjust the setpoint s-l-o-w-l-y CW until the red LED on the sensor turns on and the rectifier shuts off. Back the setpoint CCW about one-quarter turn and turn the rectifier back on.

The UCLA should only trip if there is an overheat condition on the magnet or the magnet has been disconnected.

#### NORMAL OPERATION:

When the green “on” button or a remote signal (as from a PLC) is applied to the rectifier, control voltage is applied to the timer and to the control relay through the timer contact. The operating control relay will supply power to the mainline starter, which in turn supplies main power to the power transformer, energizing the rectifier. Direct current flowing to the magnet through the shunt is detected by the UCLA sensor. As the magnet current rises, the voltage across the shunt rises. When the voltage signal from the shunt rises and exceeds the setting of the UCLA sensor, the red trip LED will illuminate and the sensor contact will close shunting the timer contact. If this does not happen within the time range setting of the timer, and the timer times out, the rectifier will shut off. If the UCLA sensor does exceed the setting in time, the rectifier will remain on.

Anytime during the operation of the system that the current in the magnet drops below the setting of the UCLA sensor, the rectifier will shut off. A number of customer usable contacts are available on the UCLA sub panel terminal block for connection to external alarm packages and/or PLC monitoring.

Note: The rectifier must be powered with main 3-phase ac at least 60 s prior to energizing the rectifier in order to the UCLA to go through its power-on internal self testing.

Specifications:

Power Requirement: 120 V or 240 V, 1 Phase, 50/60 Hz

Time Delay for Pickup: 0.1 - 10 s (factory set for 10 s)

Adjustable Drop Out: 0 - 100 % (0 - 50 mV)

Sensing Input: 0 - 50 mV

Relay Contacts:

Sensing Relay: 5 A @ 120 V-ac; 2 A @ 240 V-ac; 5 A @ 28 V-dc

Control Relay: 10 A @ 120 V-ac; 5 A @ 240 V-ac; 2.5 A @ 28 V-dc

Note: Sensor voltage is selected internally via jumpers. DC voltage ratings are for resistive loads only.

## 5.2 INSTRUMENT & CONTROL PACKAGE

The Instrument Package gives a visual assurance either in local, or in remote, application about the working of the power supply. One or more of the following parts could make up the Instrument Package:

1. Voltmeter - measures power supply output. Voltage scale is 0 - 150 V-dc, on 115 V-dc rectifiers and 0 - 300 V-dc on 230 V-dc rectifiers.
2. Ammeter - measures power supply output current. Ammeters work off of a 30 mV shunt.
3. Pilot Light - Indicates that input power is on and power transformer is energized, 120 V-ac or 240 V-ac (depending on control voltage used) neon. This indicator is standard on all lifting magnet rectifiers.
4. Pilot Light - Indicates that DC output voltage is available, 120 V-dc or 240 V-dc (depending on output voltage of rectifier) neon. This indicator is not available on variable volt units and is standard on Separator Magnet rectifiers.

5. On/Off Control - Pushbuttons (3-wire) or selector switch (2-wire) to turn the power supply on and off.

6. Potentiometer Control - Used to control output voltage of rectifier on variable volt systems. Control potentiometers consist of a voltage setting potentiometer and a current setting potentiometer. See section 3B for information on examples of usage.

7. Local-Remote Control - A two position selector switch used to select operation of rectifier from either the local on/off switches or a remote location, such as a PLC. Local selection is mostly used for maintenance purposes.

When the instrument panel is used in remote application, all the wires connect from terminal point of remote package to terminal point in power supply of similar numbers. The size of all wires can be 1.0 mm<sup>2</sup> (#16 AWG) or 2.5 mm<sup>2</sup> (#14 AWG) with an exception of the ammeter leads which have to be 10 mm<sup>2</sup> (#8 AWG). The table below gives approximate errors of ampere reading versus distances when the instrument package is remotely mounted, using 10 mm<sup>2</sup> @ 25°C ambient.

50 m	-- 1.0 % error
100 m	-- 2.0 % error
200 m	-- 4.0 % error

### 5.3 MAGNET CONTROLLER CONTROL RELAY SUB-PANEL (LIFTING MAGNET USAGE)

Various types of relay sub-panels are available for controlling the main magnet controller from a voltage other than the 115 V or 230 V dc required for controller operation. These relay control sub-panels are available in a variety of configurations depending on the need. Examples of available configurations are:

1. Momentary power relay for either auto or manual operation of controller, where latching function for lift is provided by selector switch.
2. Electrical latch (3-wire) momentary buttons. One normal close (drop) and one normal open (lift) momentary pushbutton required.
3. Mechanical latch (3-wire) momentary buttons. Two normal open momentary pushbuttons required.
4. Fixed 115 V-dc or 230 V-dc for use with variable volt type rectifiers. This is necessary to provide a constant voltage to the lift coil (and drop in manual configurations) when voltage is varied.

See schematic diagram supplied with your rectifier for proper connections to control relay sub-panel.

### 5.4 MAGNET SELECTOR PACKAGE (LIFTING MAGNET USAGE)

Used to select any number of combinations of magnets when multiple magnets are used at one time. With rectifier space limited, this option may be mounted in a separate enclosure.



The selector switch that is usually mounted near the operator operator is used to select which magnet or combination of magnets will energize when the magnet lift switch is operated. To select magnet(s), first set the switch to the position that selects the magnet(s) desired to be energized. Then operate the lift pushbutton or selector switch. Once in lift, only the selected magnets will function. During lift, additional magnets may be selected, but none can be deselected. It is unsafe to deselect magnets using the magnet selector.

To deselect, first engage the drop cycle. Once the drop cycle is completed then move the selector switch to the desired position. On some selection packages, a timer prevents deselection until the drop cycle is completed.

#### 5.5 CIRCUIT BREAKER DISCONNECT SWITCH:

Some rectifiers may be supplied with a circuit breaker or disconnect switch either in addition to or instead of a standard control package. In a locally mounted disconnect, the operators handle is on the right side of the door. The door must be closed to operate and when in the on position, the door can not be opened.

Rectifiers with locally mounted circuit breakers, the wire connections are made directly to the circuit breaker. The factory wires the circuit breaker to TB1.

Remote mounted circuit breakers can be mounted in any location and must be connected between the power grid and the rectifier by the customer. The customer is responsible for correct sizing of wire.

#### 5.6 MAGNET BOOST (LIFTING MAGNET USAGE)

Under certain conditions, it is desired to apply a higher than normal voltage to the lifting magnet during the first few seconds when power is applied to the magnet. This is done to increase lift or overcome high inductance on some large magnets.

Boost packages employ a variable type (SCR) rectifier with a higher than normal output transformer. The boost package employs a sub-panel with a fixed voltage supply for the controller coil, a potentiometer for setting the normal operation voltage, a second potentiometer if a reduced carry voltage is required, and a set of timers and relays to control the boost time.

The package contains no additional components for customer usage. The system functions automatically behind the scenes. When the lift is activated, a timer is activated at the same time. This timer controls the signal sent to the SCRs and causes the SCRs to output the maximum voltage of the rectifier. Usually about 125 % of normal voltage. The timer is set for 5 to 7 s. After the 5 to 7 s, the high voltage is removed from the magnet, and the voltage either returns to the normal operating voltage or to carry voltage about 125 % below normal. This is done to reduce magnet heating, but does not effect the load already clinging to the magnet.

The system returns to normal voltage whenever the drop cycle is engaged.

6.01 Schematic

6.02 Wiring

6.03 Outline

6.04 Interconnection

\_\_\_\_\_

6.05 UCLA

\_\_\_\_\_

6.06 Control Relay

\_\_\_\_\_

6.07 Fixed Voltage

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6.08 \_\_\_\_\_

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6.09 \_\_\_\_\_

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6.10 \_\_\_\_\_

\_\_\_\_\_

6.11 \_\_\_\_\_

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## MODEL NUMBER:

POWER TRANSFORMER	TX1	A-900553-
CONTROL TRANSFORMER	TX2	A-900553-
RECTIFIER DIODE BRIDGE	SDA	A-900589-
*DIODE MODULE	MOD1-MOD3	A-900550-_____
*FAN (_____ V; _____ Hz)	FAN	A-900579-_____
* THERMAL SWITCH (90°C)	THS	A-900516-11
*FAN THERMAL SWITCH (40°C)	FTS	A-900516-12
SCR BRIDGE ASSEMBLY	SCR	A-900588-_____
*SCR MODULE	MOD1-MOD3	A-900580-_____
*FREE WHEELING DIODE	MOD4	A-900550-_____
*FAN (_____ V; _____ Hz)	FAN	A-900579-_____
* THERMAL SWITCH (90°C)	THS	A-900516-11
*FAN THERMAL SWITCH (40°C)	FTS	A-900516-12
*MOV SNUBBERS	SNB	A-900572-03
*FIRING BOARD	FRB	1400C05300__
*PC BRD FUSE (_____ A)	FUF	A-900555-_____
*REGULATING BOARD	RGB	1400B07600__
*INLINE FUSE (_____ A)	FUR	A-900555-_____
STARTER	MS	A-900552-
*OVERLOAD ADJUSTMENT		A
OUTPUT POWER AC FUSE	F1-F3	A-900555-
OUTPUT POWER DC FUSE	F4, F5 (F1, F2)	A-900555-
INPUT POWER AC FUSE	F6, F7	A-900555-
PILOT LIGHT BULB	PL1, 2	A-900275-11
TRANSIENT VOLTAGE SUPPRESSOR	TVS	A-900501-_____

## CABLES &amp; WIRES:

INPUT POWER:		A-950000- (BLK)
OUTPUT POWER (AC):		A-950000- (BLK)
OUTPUT POWER (DC):		A-950000- (BLK)
CONTROL:	AC (HV)	A-950000-44 (BLK)
	AC (LV)	A-950000-70 (RED)
	DC	A-950000-160 (BLU)
GROUNDING (EARTHING):		A-950000-147 (GRN)

## OPTIONS:

VOLTMETER:	VM	A-900230-_____
AMMETER	AM	A-900231-_____
"ON" PUSHBUTTON	PB2	A-900237-_____
OFF" PUSHBUTTON	PB1	A-900237-_____
SELECTOR SWITCH	SW1	A-900237-_____
POTENTIOMETER	_____	_____
FIXED VOLTAGE SUPPLY:	FVS	_____
*BRIDGE RECTIFIER MODULE	RCT	A-900550-31
*FUSES	F8-F10	A-900555-48
BOOST CONTROL KIT	BCK	1400C07300____
*CONTROL RELAY	CR1	A-900568-_____
*POTENTIOMETER	VA, CA	A-900586-_____
UNDERCURRENT LIMIT ALARM	UCLA	1300D014_____
*CONTROL & TIMER RELAY	1CR, TM	A-900568-_____
*TIMER	TM	A-900573-_____
*SUPPRESSOR	Z1	A-900572-_____
*LIMIT ALARM	UCLA	1050A001_____

MAGNET SELECTOR _____	MS	_____
*CONTROL RELAY	CR_____	A-900_____
*RESISTOR	R_____	A-900_____
*DIODE ASSY	D_____	_____
*DIODE	D_____	_____
*TIMER	TM_____	A-900573-_____
* _____	_____	_____
* _____	_____	_____
RELAY SWITCH _____	_____	1300B042_____
* RESISTOR (6 kΩ RESISTOR)	R_____	A-900241-39
*POWER RELAY	PR_____	A-900267-_____
*CONTROL RELAY	CR_____	A-900568-_____
*LATCH RELAY	CR_____	A-900568-_____
*RESISTOR (10 kΩ RESISTOR)	R_____	A-900571-_____
*DIODE ASSY	D_____	1400A074_____
*DIODE	D_____	A-900569-_____
CIRCUIT BREAKER ASSY	_____	_____
*CIRCUIT BREAKER	_____	A-900561-_____
*OPERATOR MECHANISM	_____	A-900513-_____
MOTOR CONTROL	_____	_____
*STARTER	_____	_____
_____	_____	_____