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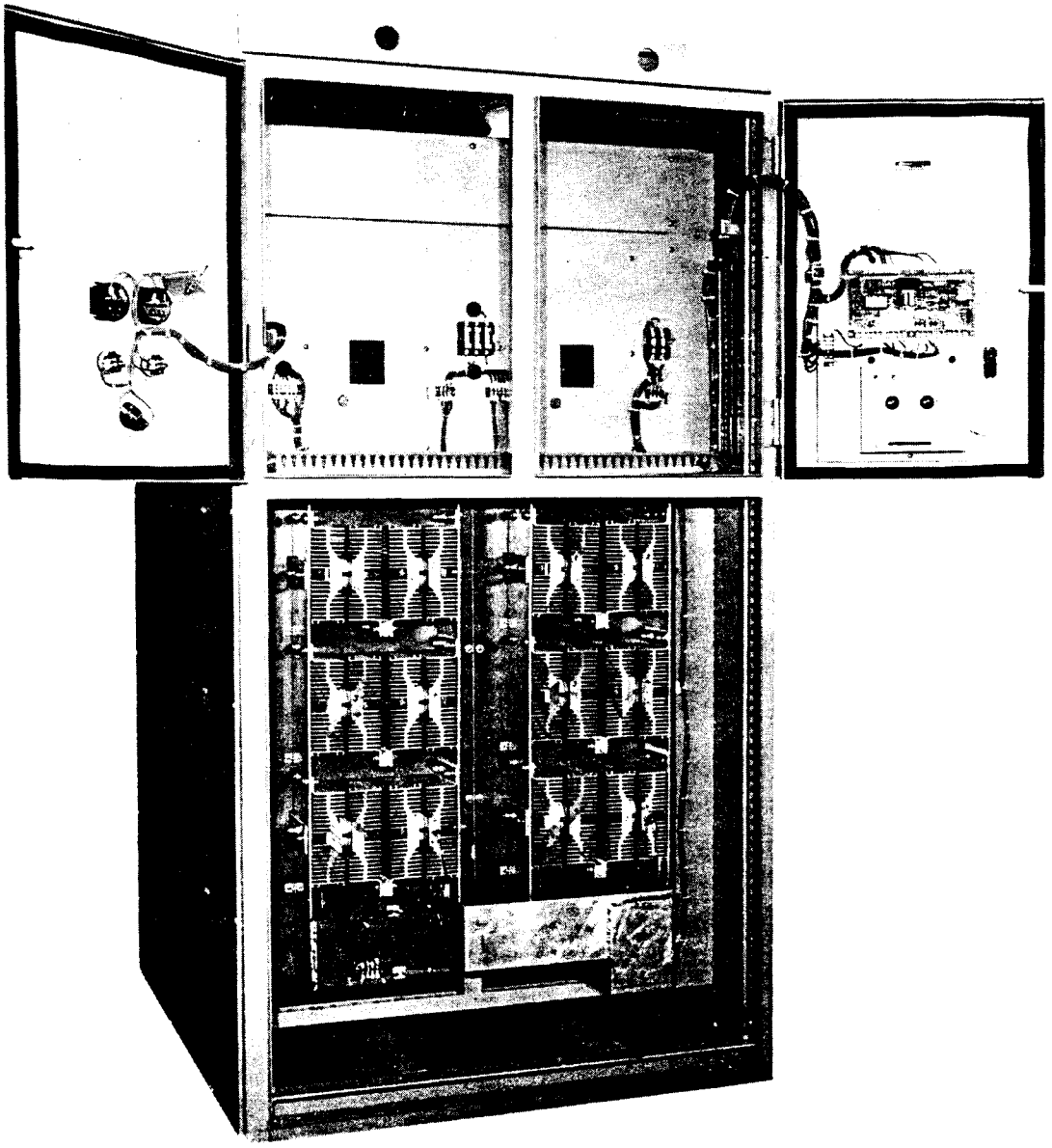
R1000
RECTIFIER POWER SYSTEM
AND
FIELD START-UP PROCEDURE



R1000 RECTIFIER POWER SYSTEM

Effective July, 1972

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I. INTRODUCTION

The R1000 Rectifier Power System is designed to provide an unregulated d-c output voltage at full load of 125V or 250V.

The R1000 rectifier power system consists of the following components:

a. Rectifier bridge and load sharing reactor.
(1 to 4 depending on KW rating).

b. Power transformer

c. Bridge breaker (one per rectifier bridge).

d. Reverse current sensor (two per rectifier bridge).

e. Light load resistor.

f. Fault detector panel.

g. Fault monitor and test panel (optional).

The R1000 system may be either non-redundant or redundant.

In a non-redundant system, when a rectifier bridge is lost due to diode failure, the power system is shut down.

In a redundant system, by having one more rectifier bridge than is necessary, the loss of one rectifier bridge will allow the power supply to remain on the line supplying its continuous ratings.

A. Ratings

The standard R1000 is normally supplied from a 460V, 2400V, or 4160V 60 Hz a-c line. The KW increments for the above a-c and d-c voltages are as follows:

KW	d-c volts	a-c volts
100 - 500	125	460, 2400, 4160
200 - 500	250	460
200 - 1000	250	2400, 4160

B. Construction Features

The R1000 has the following standard construction features:

1. Dead front, free standing enclosure with hinged upper front doors and removeable bottom front cover(s) which contain intake air filters which can be replaced without removing the bottom cover(s).

2. Removeable rear cover(s) for access to transformer, current transformers, and fan(s).

3. The enclosure is either right or left handed with respect to the d-c bus exit when viewed from the front of the cabinet.

4. The R1000 enclosure is normally designed to close-couple with d-c switchgear and a-c primary disconnect in one line-up.

5. The rectifier bridges and power transformer are forced ventilated by an integral fan(s).

II. DESCRIPTION OF OPERATION

A. Rectifier Bridge Assembly

The basic building block of the R1000 consists of a rectifier bridge with its associated breaker, load sharing reactors, surge surpressor, reverse current sensors, and thermoswitch. (See Figure 1)

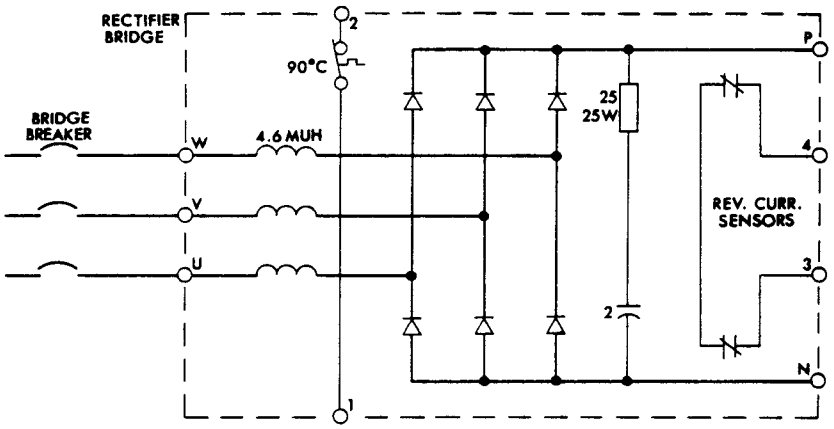


Figure 1

A rectifier bridge consists of 6 POW-R-DISC rectifiers connected in a six phase, double-way circuit (three-phase bridge) plus a load sharing reactor in series with each a-c leg. By paralleling up to 4 rectifier bridge assemblies, we can get a power system capable of supplying 1000 KW @ 250V d-c.

The technique of specifying the per unit impedance of the power transformer such that the half cycle surge current of the diodes is not exceeded permits us to eliminate fuse protection for the individual diodes and replace fuses with a coordinated a-c circuit breaker for each bridge. Each breaker is controlled by a central electronic trip intelligence which will be discussed under "Fault Detector Panel".

The maximum current of the transformer under fault conditions is forced to be equal in all of the conducting diodes because of the series load sharing reactors. This prevents exceeding the maximum rating of the diodes and subsequent device destruction.

The P bus and the N bus of each rectifier bridge contain a reverse current sensor. Each sensor is an encapsulated, magnetically biased, normal closed reed switch which will open only under reverse current. In the case of a redundant system the reverse current sensor will only open the circuit breaker associated with the faulted bridge.

Each rectifier bridge assembly contains a thermoswitch which will shut the power system down in case of cooling fan loss or clogged intake air filters or any other conditions that might cause the heat sink to exceed its safe temperature rise.

B. Power Transformer

The power transformer is forced cooled and contains either one 5% tap above and one 5% tap below for a nominal input voltage of 460V 60 Hz or two 2-1/2% taps above and two 2-1/2% taps below for a nominal input voltage of 2400V or 4160V 60 Hz. The transformer also has an auxiliary 3 phase winding used for the cooling fan motor(s) and control power. Each transformer comes equipped with an overtemperature thermoswitch.

C. Bridge Breaker

There is a coordinated a-c circuit breaker for each rectifier bridge. The breaker contains a 32V flux transfer trip that permits tripping the breaker with a low-energy electrical signal from the fault detector panel.

Each breaker may also be tripped manually by depressing the PUSH TO TRIP button on the front of each breaker or by moving the operating handle to the OFF position.

All the bridge breakers can be tripped simultaneously by depressing the EMERGENCY TRIP button on the front of the left cabinet door. An indicating light for each breaker is mounted on the left front door which indicates which breaker has tripped.

D. Light Load Resistor

The light load resistor is rated at 1/4% of the rectifier bridge rating and is used for the no-load regulation of the power system.

E. Fault Detector

The fault detector is simultaneously self-powered from an auxiliary winding on the rectifier transformer and the current transformers. The current transformer outputs are impressed across zener diodes to produce fault detector power at turn on and in case of an auxiliary winding power loss.

The fault detector provides the electronic intelligence to trip the bridge breaker(s) whenever the thyristor in the breaker trip coil circuit receives a positive gate pulse. This will occur under the following conditions:

1. Undervoltage - If the a-c line dips below 85% of its nominal value for longer than 0.5 seconds, all the bridge breakers will trip if jumper 1J is in position 2. If a common d-c breaker is supplied between the R1000 and d-c feeder breakers, than jumper 1J should be in position 1 so that the undervoltage condition will trip the common d-c breaker through the energization of relay 1KU.

   NOTE: If the undervoltage feature is not required, put jumper 2J in position 2.

2. Rectifier Bridge and Power Transformer Overtemperature

   If any one of the rectifier bridge thermoswitches operate or the transformer thermoswitch operates, all the bridge breakers will trip provided jumper 1J is in position 2. If the jumper is in position 1, the common d-c breaker will be tripped as in (1) above.

3. Timed Overload (Less than 500%)

   A signal that is proportional to the d-c load current is generated by the output of two current transformers connected in an open delta which is rectified and impressed across a burden resistor. When the current signal exceeds 140% rated current, amplifier 1-OA will start to integrate with respect to time until the output of 1-OA reaches 10V.

   When the output of 1-OA reaches 10V, it is sufficient to overcome the positive input bias of the voltage detector amplifier and drives it into saturation. If jumper 1J is in position 2, this signal will fire all the bridge breaker trip coils. If the jumper is in position 1, the common d-c breaker will be tripped as in item (1) above.

4. Instantaneous Overload (Greater than 500%)

   All the bridge breakers will trip out after a 80 ms delay if the current signal exceeds 500% of rated and all the bridge breakers were closed previous to the overload condition. This allows coordination with the d-c feeder breaker.

   NOTE: In a redundant system, if one breaker has already been tripped out by its reverse current sensor, an overload condition of greater than 500% will trip all the breakers with no delay.

5. Single Diode Short

A reverse current sensor is placed on the P and N bus bars of the rectifier bridge to detect the momentary reverse current during diode failure.

The reverse current sensor consists of an incapsulated normally closed reed switch with a magnetic bias such that forward current thru the bus will produce a flux field that aids the bias and a reverse current will oppose the bias. Reverse current of approximately 500 amperes is sufficient to open the reed switch.

The activation of a reverse current sensor is used to open its associated bridge breaker only.

6. Multiple Diode Fault

In a redundant system the bridge breaker becomes selective in that it will trip just the associated rectifier bridge which has a faulted diode as detected by its respective "P" or "N" reverse current sensor. If a second bridge should develop a faulted diode, then the system would shut down.

All appropriate points are brought to a plug so the power supply and amplifier output voltages can be read and test signals may be introduced by use of an optional Fault Monitor and Test Panel.

F. Fault Monitor and Test Panel (Optional Equipment)

The fault monitor panel is basically a first-come first-served fault indicating device. The overall operation is such that a logic "1" (+8.5V to +15V) is introduced to anyone of the five input terminals (13, 16, 17, 18, and 20) and a corresponding LED will be energized and mutually exclude all the remaining LED circuits from being energized.

The following faults will be indicated:

1. Undervoltage (Supply line).
2. Timed overload (less than 500%).
3. Instantaneous overload (greater than 500%).
4. Transformer or Rectifier Bridge Overtemperature.
5. Multiple Bridge Breaker Trip.

Any one of the above conditions will also energize relay 2KU which may be used for external fault indicating purposes.

The above fault indicating circuits are reset by depressing the RESET pushbutton.

A secondary function of this panel is to introduce test signals into the fault detector panel and measure voltage levels. Switch SW2 connects voltages with a meter and switch SW1 connects momentary logic signals to the fault detector panel by depressing the TEST pushbutton except in position 4 where it energizes a flip-flop that gives a + 10V output on terminal 19 for a timed test signal. When the fault condition is simulated by SW1, the corresponding LED on the monitor panel will be energized indicating that the circuit is functioning correctly.

NOTE: The above tests can be performed with the bridge breakers open.

CAUTION: DO NOT DEPRESS THE "TEST" PUSHBUTTON WHILE THE RECTIFIER POWER SYSTEM IS IN OPERATION.

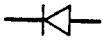
III. START-UP PROCEDURE

A. Recommended Test Equipment

1. A multimeter with an internal impedance of 20,000 ohm/volt.
2. Fault monitor and test panel (S#1649A81G01)

B. Inspection and Preparation

1. Check for transportation damage.
2. Inspect the cabinet for loose connections, loose hardware, etc.
3. Check all external wiring.
4. Make sure that the bridge breakers are open.
5. Check the polarizing dot on the reverse current sensors which are mounted on the bottom of the rectifier bridge "P" and "N" bus such that the polarizing dot is close to the insulated rectifier bridge panel.
6. The power diode orientation should be as follows when viewed from the front of the rectifier bridge:

 (diode symbol points to the left)

C. Dielectric Test

1. Close all bridge breakers.
2. Jumper any one of the primary leads (R or S or T) to ground.
3. Apply 2KV 60 Hz from ground to the P bus.

   NOTE: Shorting jumpers across the power diodes are not necessary.

D. Power on Test (No Load) - Bridge Breakers (Devices 52) Open

1. Open all bridge breakers.
2. Apply rated primary voltage to the rectifier power system.
3. Check phase sequence for RST rotation.
4. All BREAKER TRIPPED lights on the door should be on.
5. Check to see that the ventilation fan is operating and is exhausting air from the top of the cabinet.

   NOTE: If the a-c fan motor is rotating in the incorrect direction, interchange any two of the 3 phase motor leads at the fan motor fuse block.

6. Remove the main a-c supply.

E. Fault Detector Panel Test

By using the fault monitor and test panel, test the fault detector panel as follows:

1. Control voltages

By using switch SW2 and the voltmenter check for the following values:

TEST POSITION	METER READING
+32	+32V ±5V
-32	-32V ±5V
-18	-18V ±1V
+18	+18V ±1V
1-0A Output	Normally 0V. Between 0 and + 10V when inverse time 0A is integrating.

2. Fault Condition Test

To check a particular fault condition perform the following steps:

a. Select the particular fault condition you wish to check with switch SW1.

b. Depress the TEST pushbutton.

c. Observe that the corresponding LED (light emitting diode) is energized.

NOTE: LED delay times are as follows after depressing the TEST pushbutton:

1 thru 3 LED	=	0 sec.
4 LED	=	10 ± 3 sec.
5 LED	=	0.5 sec.

d. Depress the RESET pushbutton.

e. Select another fault condition by SW1 and proceed as in steps b, c, d above.

CAUTION: DO NOT PERFORM THE "FAULT CONDITION TEST" WHILE THE RECTIFIER POWER SYSTEM IS IN OPERATION.

F. Power On Test (No Load) - Bridge Breakers (Closed)

1. Close all bridge breakers.

2. Apply the main a-c supply.

3. All BREAKER TRIPPED lights on the door should be off.

4. Make sure the light load resistor (LLR) is connected across the P and N bus and consuming power.

5. Measure the d-c no load output voltage as follows:

Nameplate Rating (Volts)	d-c No Load Voltage (Volts)
125	132 ± 7
250	267 ± 14

6. Trip all the breakers by using the EMERGENCY TRIP pushbutton on the front door.

7. Remove a-c primary power.