RECTIFIER J86273

48 VOLTS, 200 AMPERES

VOLTAGE-REGULATED OUTPUT CONTROL

OPERATING METHODS

CONTENTS PAGE

1. GENERAL

1.01 The J86273 semiconductor-type, voltage-regulated rectifier using saturable reactor control is used in the 301C and 302A power plants to charge and float storage batteries.

1.02 This section is reissued to bring the section up-to-date. Since this is a general revision, arrows ordinarily used to indicate changes have been omitted.

Note: The J86273A rectifier has been rated Mfr Disc. and is replaced by the J86295A rectifier. The J86273B (voltage-regulated) and J86273C (current-regulated) rectifiers have been rated A & M only and are also replaced by the J86295A rectifier (see Sections 169-630-301 and 169-630-302).

1.03 The J86273 rectifier requires a 3-phase, 3-wire, 206-, 220-, 230-, or 240-volt ±7 percent, 60-Hz ±2 percent ac input. The rectifier provides a positive grounded dc output of 46 to 62 volts, 5 to 200 amperes and is used to automatically float and charge the battery. In response to signals from the connecting circuits, the rectifier circuit connects to the ac supply and thereafter automatically regulates its battery charging output. A four position switch (S1) is provided to select the desired battery condition (BAT OFF, BAT, GR1, or GR1 & GR2). S1 is a ganged switch which also selects the correct T1 primary connections to provide suitable voltage adjustment range for each battery condition. RECT FAIL, OVERLOAD, and FAN FAIL lamps provide an indication of trouble and aid in localizing the source of trouble. An EM CELL lamp indicates operation of the S1 switch to the GR1 or GR1 & GR2 position.

Caution: Voltages inside the rectifier case are over 150 volts to ground. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time, as destructive or dangerous short circuits may occur. Battery voltage will be present on the terminals of the S1 rotary switch.

1.04 The abbreviations cw and ccw refer to clockwise and counterclockwise, respectively.

1.05 Routine checks and adjustments, other than those required by trouble conditions, should be made during a period when they will least interfere with service.

1.06 The instructions are based on circuit schematic drawing SD-81317-01, Fig. 1 and 2, for the rectifier and SD-81411-01 for the VR network (CPS1). For a detailed description of operation, see the corresponding circuit descriptions.

1.07 For more detailed information on operation and maintenance of individual equipment or apparatus, refer to the appropriate Bell System Practice.

1.08 Battery voltage readings called for may be made with the plant voltmeter or a KS-8039 volt-milliammeter, provided that the instrument is connected at the battery and has been calibrated for accuracy at float voltage. The accuracy of the meter when compared with a standard shall be within ±0.2 volt. These limits apply at any point in the float range.

2. TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
418A	5/16- and 7/32-Inch Open Double-End Flat Wrench
—	Blocking and insulating tools as required. Use tools and apply as covered in Section 069-020-801.
TEST APPARATUS	
—	3-Inch C Screwdriver
—	Electronic Voltmeter, Ballantine Laboratories, Inc, Model 300U/3
	or
—	Electronic Voltmeter, Hewlett-Packard Co, Model 400D
—	Oscilloscope, A. B. DuMont Lab Inc, Type 304. This apparatus is not required for normal maintenance (see 5.06).
KS-3008	Stopwatch
KS-8039	DC Volt-Milliammeter
KS-14510	Volt-Ohm-Milliammeter

3. OPERATION

PREPARING TO START

3.01 When preparing to put the rectifier into service, check that:

(a) The RECT switch is in the OFF position.

(b) The S1 rotary switch is in the BAT position.

(c) The NOR-TST R key is in the NOR position.

(d) The AMPL switch is in the NOR position.

(e) The 48V CONT 1 (CB1), 48V CONT 2 (CB2), and BLOWER (CB3) circuit breakers are closed.

(f) Sufficient office load or a variable resistance load, capable of carrying the rated output of the rectifier, is provided.

(g) The associated supply and control fuses are installed.

STARTING THE RECTIFIER

3.02 To start the rectifier proceed as follows:

(1) With the S1 rotary switch at BAT, operate the RECT switch to NOR.

(2) Adjust the ADJ VOLTS-COARSE and FINE potentiometers on the VR network, as required, until the voltage output of the rectifier is equal to the battery float voltage (49.9 volts for 23 cells).

(3) In the connecting plant, operate the FLOAT-CHG key to the CHG position.

(4) In the rectifier, adjust the CHG potentiometer cw to obtain 50.6 volts (23 cells).

Note: When the rectifier is used in the 301C plant, the CHG potentiometer is shorted out and the charge voltage is adjusted with the CHARGE potentiometer in the plant.

(5) In the connecting plant, operate the FLOAT-CHG key to the FLOAT position. Observe that the rectifier output voltage returns to the float value.

(6) Block the CR relay operated to remove the short from the CUR REG potentiometer.

(7) Rotate the CUR REG potentiometer cw to obtain 50.9 volts (23 cells).

(8) Remove the block from the CR relay and observe that the rectifier output voltage returns to the float value.

3.03 To operate the rectifier ***manually,*** proceed as follows:

(1) Operate the RECT switch to OFF.

(2) Operate the S1 rotary switch to BAT, GR1, or GR1 & GR2 position, as applicable.

(3) Operate the AUTO-MAN switch to MAN.

Note: In a 301C power plant, operate the 48V GEN REG key on the main control board to the MAN position.

(4) Operate the NOR-TST R key to TST R.

(5) Check that the MAN potentiometer is in the maximum ccw position.

(6) Operate the RECT switch to NOR.

(7) Rotate the MAN potentiometer cw to increase the rectifier output to the desired value.

Note: Continuity of service is provided by this manual control. The MAN potentiometer should always be restored to its maximum ccw position at the completion of a check or when returning to automatic regulation.

3.04 ***Summary of Nominal Settings:*** For normal operation on 23-cell battery, the following adjustments should prevail unless plant requirements differ.

(a) ADJ VOLTS-COARSE and FINE potentiometers adjusted to 2.17 volts per cell (49.9 volts).

(b) CHG potentiometer adjusted to 2.20 volts per cell (50.6 volts).

(c) CUR REG potentiometer adjusted to 50.9 volts.

(d) AR1 ammeter relay:

(1) Low contact set at 10 amperes.

(2) High contact set at 200 amperes.

(e) AR2 ammeter relay:

(1) Low contact set at 25 percent.

(2) High contact set at 75 percent.

(f) CON CUR-H potentiometer adjusted for an indication of 206 amperes on the OUTPUT CURRENT (AR1) ammeter relay.

(g) CON CUR-L potentiometer adjusted for an indication of 150 amperes on the OUTPUT CURRENT ammeter relay (100 to 150 amperes for No. 5 X-BAR).

(h) OL relay operates at 225 amperes in 20 to 60 seconds and at 250 amperes in less than five seconds.

4. ROUTINE CHECKS

4.01 As often as local experience demands, the contactor and relays should be inspected for adjustment and condition of contacts, making sure that they are in accordance with the circuit requirements table and Bell System Practices which apply.

4.02 Periodically as local conditions require, perform the checks in 4.03 through 4.11. To facilitate maintenance, the rectifier may be operated with a dummy load while disconnected from the plant circuit. With the S1 rotary switch at BAT OFF and the NOR-TST R key at TST R, the rectifier will regulate at its own terminals rather than at the battery. For these checks, the following switch and potentiometer positions are in effect prior to beginning the checks.

CONTROL	POSITION
RECT switch	OFF
S1 rotary switch	BAT
NOR-TST R key	TST R
AMPL switch	TST
AUTO-MAN switch	AUTO
GAIN ADJ, CON CUR-H, CON CUR-L, and ANTI-HUNT potentiometers	Max cw
BIAS potentiometer	1/4 turn cw
REG TST, ADJ VOLTS-COARSE, ADJ VOLTS-FINE, CUR REG, CHG, CON CUR TST, and MAN potentiometers	Max ccw

All other switches are in the normal position.

Note: When adjusting the ADJ VOLTS-COARSE, GAIN, OL ADJ, ANTI-HUNT, CON CUR-H, and CON CUR-L potentiometers, use the 418A tool to unlock the locking nut of the potentiometer. When the required setting is obtained, use the tool to lock the potentiometer.

4.03 ***Automatic Operation:*** To check the rectifier for automatic operation, proceed as follows:

STEP	PROCEDURE
1	Operate the RECT switch to NOR. ***Requirement:*** SAT CURRENT 2 milliammeter indicates some value.
2	Rotate the ADJ VOLTS-COARSE potentiometer cw to decrease the SAT CURRENT 2 milliammeter indication to zero. ***Requirement:*** SAT CURRENT 1 milliammeter indication increases to more than 100 milliamperes.
3	Restore the ADJ VOLTS-COARSE potentiometer to the maximum ccw position.
4	Operate the REG switch to TST. ***Requirement:*** SAT CURRENT 2 milliammeter indicates some value.
5	Rotate the REG TST potentiometer cw to obtain an indication of 5 milliamperes on the SAT CURRENT 2 milliammeter.
6	Hold operated the REG TST switch in the TST position. ***Requirement:*** SAT CURRENT 1 ammeter indication decreases to zero. SAT CURRENT 2 ammeter indication increases to more than 100 milliamperes. ***Note:*** The REG TST is a momentary contact switch and must be held operated in the TST position.
7	Release the REG TST switch and restore the REG TST potentiometer to its maximum ccw position.
8	Operate the REG switch to NOR and the RECT switch to OFF.
9	Operate the S1 rotary switch to BAT OFF.
10	Operate the AMPL switch to NOR and the AUTO-MAN switch to MAN.
11	Operate the RECT switch to NOR. ***Requirement:*** SAT CURRENT 2 milliammeter indicates some value. F blower operates. Rectifier voltmeter (VM) indicates less than 47 volts.
12	Rotate the MAN potentiometer cw until the voltmeter indication increases from minimum voltage to approximately 65 volts. ***Note:*** When the MAN potentiometer is maximum ccw, the voltage should be minimum.
13	Restore the MAN potentiometer to its maximum ccw position.
14	Connect the Ballantine electronic voltmeter to the REG+ and REG— test jacks on the control panel. ***Caution: If one terminal of the electronic voltmeter is grounded, connect that terminal to the REG+ jack.***
15	Operate the AUTO-MAN switch to AUTO.
16	Rotate the ADJ VOLTS-COARSE and FINE potentiometers cw to obtain an indication of 50 volts on the rectifier voltmeter.
17	Rotate the ANTI-HUNT potentiometer until the electronic voltmeter indicates less than 150 millivolts and is fairly steady which indicates minimum cyclic hunting.

STEP	PROCEDURE
	Note: When the previous requirement cannot be met with the best possible anti-hunt adjustment, rotate the GAIN ADJ potentiometer ccw until the requirement is met.
18	After completing the procedure, lock the GAIN ADJ and ANTI-HUNT potentiometers and remove the electronic voltmeter.

4.04 ***Current Limiting Circuit:*** Check the current limiting circuit as follows:

STEP	PROCEDURE
1	With the rectifier output at 50 volts, operate and hold the CON CUR TST momentary contact switch in the TST position. ***Requirement:*** OUTPUT CURRENT (AR1) ammeter relay indicates approximately 100 amperes.
2	Set the high contact of the OUTPUT CURRENT ammeter relay at 250 amperes.
3	Rotate the CON CUR TST potentiometer cw to obtain an indication of 206 amperes on the ammeter relay.
4	Rotate the CON CUR-H potentiometer ccw until the output voltage indication on the rectifier voltmeter decreases one volt. ***Note:*** The CON CUR-H control setting can be checked as follows: Rotate the CON CUR TST potentiometer ccw to reduce the output current to 150 amperes. Then, increase the output current to check that the output voltage droops to 49 volts at 206 amperes.
5	Rotate the CON CUR TST potentiometer to the maximum ccw position and lock the CON CUR-H adjustment.
6	Block the CRL relay operated and repeat Step 4 and 5 with the CON CUR-L potentiometer at 150 amperes (100 amperes for No. 5 X-BAR load).

STEP	PROCEDURE
	Note: The CON CUR-L control setting can be checked as follows: Rotate the CON CUR TST potentiometer ccw to reduce the output current approximately 50 amperes. Then increase the current and check that the voltage droops one volt at 150 amperes.
7	Release the CON CUR TST switch, rotate the CON CUR TST control maximum ccw, unblock the CRL relay, and lock the CON CUR-L adjustment.
8	Insulate contact 8 of the CRL relay.
9	Hold operated the CON CUR TST switch in the TST position and slowly rotate the CON CUR TST potentiometer cw to obtain an indication of 225 amperes on the OUTPUT CURRENT ammeter relay. ***Requirement:*** The OL relay operates within 20 to 60 seconds and shuts down the rectifier. ***Note:*** If the rectifier does not shut down, operate the OLF relay manually to determine whether the failure path is in order. If the rectifier shuts down when the OLF relay is operated manually, the failure path is satisfactory. It may be necessary to adjust the operating point of the OL relay (see 4.07 and 4.08).
10	Release the CON CUR TST switch, restore the CON CUR TST potentiometer to maximum ccw, and remove the insulation from contact 8 of the CRL relay.
11	Operate the RECT switch to OFF.

4.05 ***Manual Operation:*** Check manual operation of the rectifier as follows:

STEP	PROCEDURE
1	With the S1 rotary switch at BAT, operate the AUTO-MAN switch to MAN. ***Note:*** In a 301C power plant, operate the 48V GEN REG key on the main control board to MAN.
2	Operate the RECT switch to NOR.

STEP	PROCEDURE
3	Connect the KS-8039 volt-milliammeter (75-volt scale) to the REG+ and REG— test jacks on the control panel.
4	Rotate the MAN potentiometer cw to raise the charging current until the indication on the meter is 50 volts for currents below the full rated output of the rectifier. Maintain 50 volts as the charging current decreases.
5	When the current drops to less than 50 amperes, operate the AUTO-MAN switch to AUTO and adjust the ADJ VOLTS-FINE potentiometer, as required, to obtain 50 volts output.
6	Add sufficient load to obtain a rectifier output of 100 amperes.
7	Adjust the BIAS potentiometer to obtain equal indications on the SAT CURRENT 1 and SAT CURRENT 2 milliammeters.
8	Restore the MAN potentiometer to the maximum ccw position and operate the RECT switch to OFF. Restore the 48V GEN REG key on the main control board to AUTO.

4.06 ***Float and Charge Voltage:*** To check the float and charge voltage, proceed as follows:

STEP	PROCEDURE
1	With the S1 rotary switch at BAT, operate the NOR-TST R key to NOR.
2	Operate the RECT switch to NOR. ***Note:*** The rectifier connects to the battery and regulates as required by the plant control circuit.
3	Readjust the ADJ VOLTS-FINE potentiometer, if required, to obtain the desired float voltage.
4	Operate the FLOAT-CHG key in the connecting plant to CHG.
5	Rotate the CHG potentiometer cw to obtain 50.6 volts at the battery. ***Note:*** When used in the 301C power plant, the CHG potentiometer in the rectifier is shorted out and the CHARGE potentiometer in the general regulation circuit controls the charge voltage.
6	Restore the FLOAT-CHG key to FLOAT. ***Requirement:*** Rectifier output voltage returns to float value.
7	Operate the CR relay manually and rotate the CUR REG potentiometer cw to obtain a 50.9-volt rectifier output.
8	Release the CR relay. ***Requirement:*** Output voltage returns to float value.
9	Add sufficient load to decrease the output voltage approximately one volt. ***Note:*** The output current should be limited to the value of the CON CUR-H setting in 3.04 (206 amperes).
10	Manually operate the CRL relay and repeat the procedure with the CON CUR-L potentiometer in the circuit.
11	Remove the load, release the CRL relay, and operate the RECT switch to OFF.

4.07 ***OL Relay Circuit:*** Check the OL relay circuit as follows.

Note: Perform 4.07 and 4.08 only when required.

STEP	PROCEDURE
1	With the RECT switch at OFF and the NOR-TST R key at TST R, operate the S1 rotary switch to BAT OFF.
2	Insulate contact 8 of the CRL relay.
3	Rotate the OL ADJ potentiometer to the maximum cw position.

STEP	PROCEDURE
4	Operate the RECT switch to NOR.
5	Operate and hold the CON CUR TST switch in the TST position.
6	Rotate the CON CUR TST potentiometer cw to obtain an indication of 206 amperes on the OUTPUT CURRENT (AR1) ammeter relay. Wait five minutes with CON CUR TST switch at TST for the OL relay to stabilize.
7	***Slowly*** readjust the CON CUR TST potentiometer to obtain an indication of 225 amperes on the ammeter relay. ***Note:*** When 225 amperes on the ammeter relay is specified in the following, it is important that this setting be made exactly, as the OL relay is very sensitive to small current variations. Do not overshoot the 225-ampere division.
8	While still holding the CON CUR TST switch in the TST position, rotate the OL ADJ potentiometer ccw very slowly, in steps, until the OL relay operates in 20 to 60 seconds. (Rotating the OL ADJ potentiometer cw increases the operate time to greater than 60 seconds and ccw decreases the operate time to 20 seconds or less.) ***Requirement:*** Rectifier shuts down.
9	Release the CON CUR TST switch.
10	Rotate the CON CUR TST potentiometer to maximum ccw and operate the RECT switch to OFF then to NOR. ***Requirement:*** Rectifier starts.
11	After one minute, repeat the procedure to verify that the OL relay operates within 20 to 60 seconds and shuts down the rectifier. ***Note:*** If the rectifier does not shut down, operate the OLF relay manually to determine whether the circuit failure path is in order. If the failure path is satisfactory, it may be necessary to adjust the operating point of the OL relay (see 4.08).
12	When the time requirement is met, lock the OL ADJ potentiometer in position, rotate the CON CUR TST potentiometer to maximum ccw, and remove the insulation from contact 8 of the CRL relay.
13	Operate the RECT switch to OFF, the S1 rotary switch to BAT, and the NOR-TST R key to NOR.

4.08 ***OL Relay:*** To adjust the OL relay, proceed as follows:

STEP	PROCEDURE
1	With the RECT switch at OFF, disconnect the OL ADJ potentiometer (if present) from the circuit.
2	Turn the adjusting screw at the top of the OL relay about two turns downward.
3	Operate the RECT switch to NOR.
4	Operate and hold the CON CUR TST switch in the TST position. Slowly rotate the CON CUR TST potentiometer cw to obtain a current indication of 206 amperes on the OUTPUT CURRENT (AR1) ammeter relay. Wait five minutes with CON CUR TST switch at TST before proceeding.
5	Slowly rotate the CON CUR TST potentiometer cw to obtain 225 amperes on the ammeter relay. Immediately start turning the adjusting screw in ***very slowly*** until the relay operates and the rectifier shuts down.
6	Rotate the CON CUR TST potentiometer to the maximum ccw position. Operate the RECT switch to OFF and then to NOR to restart the rectifier.
7	Rotate the CON CUR TST potentiometer cw until the OUTPUT CURRENT am-

STEP	PROCEDURE
	meter relay indicates 206 amperes. Wait five minutes before proceeding.
8	Rotate the CON CUR TST potentiometer cw to obtain 225 amperes on the ammeter relay. ***Requirement:*** OL relay operates within two seconds to shut down the rectifier.
9	If the relay operate time is greater than two seconds, repeat the procedure as required to obtain operate requirements.
10	Reconnect the OL ADJ potentiometer, if applicable, and repeat 4.07 to verify that the OL relay operates within 20 to 60 seconds.
11	After completing the checks in 4.04 through 4.08, return the high contact of the OUTPUT CURRENT (AR1) ammeter relay to 200 amperes.

4.09 ***VR Network (CPS1):*** Check the VR network as follows:

STEP	PROCEDURE
1	With the RECT switch at OFF, the S1 rotary switch at BAT, the AUTO-MAN switch at AUTO, the AMPL switch at TST, and the NOR-TST R key at TST R, operate the REG switch to TST.
2	Operate the RECT switch to NOR.
3	Rotate the REG TST potentiometer until the SAT CURRENT 2 milliammeter indicates five milliamperes.
4	Operate and hold the REG TST switch momentarily. ***Requirement:*** Indication on SAT CURRENT 1 milliammeter decreases to zero while the SAT CURRENT 2 milliammeter indication increases to more than 100 milliamperes. Failure to operate in this manner indicates a faulty VR network.

4.10 ***Constant Current Setting:*** Check constant current setting as follows:

STEP	PROCEDURE
1	With the RECT switch at OFF and the NOR-TST R key at TST R, operate the S1 rotary switch to BAT OFF.
2	Operate the AMPL switch to NOR.
3	Operate the RECT switch to NOR.
4	Operate and hold the CON CUR TST switch in the TST position. ***Requirement:*** OUTPUT CURRENT (AR1) ammeter relay indicates approximately 100 amperes.
5	Rotate the CON CUR TST potentiometer cw. The ammeter relay indication should increase. The rectifier voltmeter indication should decrease when the ammeter relay indication is the desired maximum current.
6	Block the CRL relay operated to check the CON CUR-L adjustment.
7	Rotate the CON CUR TST potentiometer to the desired value.
8	Connect the KS-8039 volt-milliammeter to the CC IN jacks on the front panel.
9	Adjust the CON CUR TST potentiometer until two volts is indicated on the meter.
10	Connect the volt-milliammeter to the CC OUT jacks. ***Requirement:*** Volt-milliammeter indicates 0.20 ±0.004 volt. OUTPUT CURRENT ammeter relay indicates 200 ±7.5 amperes.
11	Release the CON CUR TST switch, disconnect the meter, and unblock the CRL relay.
12	Operate the RECT switch to OFF, the S1 rotary switch to BAT, and restore the CON CUR TST potentiometer to its maximum ccw position.

4.11 ***Fan Failure Alarm:*** Check the fan failure alarm circuit as follows:

STEP	PROCEDURE
1	Operate the RECT switch to NOR.
2	Block the air intake of the blower at the rear of the rectifier cabinet with a piece of cardboard. ***Requirement:*** Vane switch opens, rectifier shuts down, and FAN FAIL lamp lights.
3	Remove the cardboard and operate the RECT switch to OFF and then to ON to restart the rectifier. ***Requirement:*** Vane switch closes and FAN FAIL lamp extinguishes.

4.12 Changing the air filter as required and keeping the rectifier cells clean are especially important to prevent excessive heating.

4.13 Electrolytic capacitors should be maintained in accordance with Section 032-110-701.

5. TROUBLES

5.01 This rectifier consists of a main power circuit controlled through a semiconductor regulating circuit whose input is battery voltage through the regulating leads of the main unit. In addition, a signal from the current sensing circuit is introduced from the regulating circuit for the purpose of current limitation. The output of the regulating circuit is introduced into saturable reactors in the main power circuit in order to make the desired corrections in the power output. In the maintenance of intricate equipment, trouble must be localized in an orderly way. This is difficult in the case of a circuit having this feedback loop arrangement because trouble anywhere in the loop will give faulty operation of other parts of the loop which may be trouble free. In this rectifier, provision has been made for opening the loop by means of switches which permit checking the performance of each major subdivision of the equipment until the trouble is located.

Caution: The MAN potentiometer should always be rotated completely ccw before operating a test switch to avoid excessive voltage and current.

5.02 Although it may vary widely with extreme conditions, the saturating current, when observed in connection with daily routine and compared with operating experience, can serve as a guide to the causes of unusual operation or trouble conditions. The purpose of the saturating current milliammeters is to give a continuous indication of the output of the semiconductor regulating circuit. This output controls the output of the main power rectifying circuit. The saturating current supply circuit and main power circuit are generally performing satisfactorily if increasing the amount of saturating current SAT CURRENT 1 increases the rectifier output, and increasing the saturating current SAT CURRENT 2 decreases the rectifier output. Provision is made to control this saturating current manually, in which case, most of the features of the more complex regulating circuit are temporarily disabled.

5.03 When any kind of trouble is encountered, it is necessary first to decide whether to locate the trouble with the equipment operating or de-energized. This rectifier has been designed to make some parts accessible for testing with the power connected. Test jacks, mounted in the face of the panel, are accessible when the front doors are open. All parts over 150 volts to ground have been covered. Trouble is easier to find if the equipment can be fully energized but if it is of a nature that causes excessive output from the equipment, it will be necessary to take the initial steps with the system de-energized, energizing it in subdivisions for short periods only, while electrical measurements are made. Also, operation for more than a few minutes at a time while trouble exists, even though the output may not be excessive, may result in overheating of some component. It is essential, when testing, to be on the alert for the need of quickly shutting down the rectifier at any time until the trouble is localized and cleared.

5.04 The control potentiometers and switches should be replaced if they become defective in any respect.

5.05 To avoid unbalance, only the complete rectifying element (stack) should be replaced. In no case should any attempt be made to replace part of the rectifier cells or the bolt assembly which is part of the rectifying element.

TROUBLE CHART

5.06 Should any of the following troubles develop, it is suggested that the possible cause be checked in the order given. If the trouble is not found, look for loose or open connections or short circuits due to foreign matter lying across wiring terminals. If a check of the possible causes listed or the use of the point-to-point voltages does not lead to the location of the trouble, it is advisable to make resistance measurements with the circuit completely de-energized, comparing the measured values with the values shown on the circuit drawing.

TROUBLE	POSSIBLE CAUSE
(a) No dc output current (no saturating current)	Blown ac supply or control fuse.
	CB3 circuit breaker in OFF position.
	BIAS supply failure.
	BO relay failure.
	AC contactor not operated.
(b) No dc output current (high SAT CURRENT 1)	CHG fuse blown.
	Bias adjustment incorrect —excessive bias current.
(c) Low dc output current (low SAT CURRENT 1)	ADJ VOLTS-FINE or ADJ VOLTS-COARSE potentiometer misadjusted.
	CON CUR-H potentiometer misadjusted.
	Low line voltage or T1 transformer taps incorrect.
	Faulty transistor amplifier.
(d) Low dc output current (high SAT CURRENT 1)	Excessive charging lead drop.
	Rectifier operating single phase.
	Excessive bias current.
(e) High dc output current (output voltage normal or nearly so)	CON CUR-H potentiometer misadjusted.
	Defective VR network (CPS1).
(f) Output current high (output voltage high)	Defective VR network or adjustment.
	High line voltage or incorrect T1 transformer taps.
	Insufficient bias current.
(g) High dc output voltage (output current less than full load)	Rectifier in MAN condition.
	CHG fuse blown.
	REG fuse blown.
(h) Output excessively noisy	Defective filter capacitors.
	Unbalanced ac line voltage (more than 5 percent).
	Defective rectifier stacks.
	BAL 1 through BAL 6 potentiometers misadjusted.
(i) Unstable output (hunting)	ANTI-HUNT potentiometer misadjusted.
	Defective C16, C17, C18, C19 capacitors or defective ANTI-HUNT potentiometer.
	GAIN potentiometer misadjusted.
(j) Rectifier shuts down after short interval of operation	OL relay misadjusted.
(k) Poor regulation at battery	CON CUR-H potentiometer misadjusted.
	Excessive charging lead drop.

TROUBLE	POSSIBLE CAUSE
	NOR-TST R key in TST R position.
(*l*) Ripple indication greater than 200 millivolts	Defective L1, L2, or L3 saturable reactor.
	Open balancing BAL 1 through BAL 6 potentiometers.
	Defective filter (see 5.06).

5.07 To check for a defective saturable reactor, proceed as follows:

(a) Connect the oscilloscope to the input of the main filter, terminals 2 and 3 of the L2 saturable reactor.

Caution: If one side of the oscilloscope is grounded, connect the grounded side to terminal 2 of the L2 saturable reactor which is ground bus.

(b) Adjust the sweep frequency so as to have six partial sine waves present on the oscilloscope as indicated in Fig. 1. The trace may appear as either one of the two figures shown. The height of the trace shall be approximately 2 inches. If all waves are approximately of equal height, the cores of the L1, L2, and L3 saturable reactors are balanced and the trouble is elsewhere (check filter). If they are not of equal height, it is an indication of a defective saturable reactor or an open BAL 1 through BAL 6 balancing potentiometer.

(c) Check potentiometers for open circuit with the KS-14510 volt-ohm-milliammeter.

(d) Replace any potentiometer having an open circuit.

(e) Readjust all potentiometers using the same method as specified in (f) through (k) for use after a saturable reactor is replaced.

(f) In checking for a defective saturable reactor, the adjustment of any of the BAL potentiometers affects the lower position (opposite TOP Fig. 1) of two partial sine waves. If the height of any wave cannot be adjusted, it is an indication of a defective associated saturable reactor. Replace the defective saturable reactor and adjust the core characteristics of ***all*** of the saturable reactors as follows:

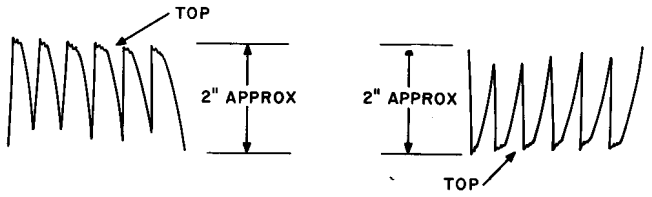

Fig. 1—Core Characteristics of Saturable Reactors

(g) The BAL 1 through BAL 6 balancing potentiometers of the saturable reactors shall be rotated maximum ccw.

(h) Determine which balancing potentiometer affects the height of the longest half wave viewed on the oscilloscope (longest is defined as the longest line from TOP as designated in Fig. 1).

(i) Adjust this potentiometer until the two affected sine waves are of equal height.

(j) Adjust all remaining potentiometers to equal this one.

(k) With the electronic voltmeter (see Caution) connected across the REG+ and REG— jacks and using it as an indicator, readjust all balancing potentiometers to obtain minimum reading without regard to the possible slight unbalance on the oscilloscope.

Caution: If one side of the electronic voltmeter is grounded, plug this side in the REG+ jack.

6. POINT-TO-POINT VOLTAGES

6.01 As long as the rectifier unit operates satisfactorily, point-to-point voltage values (see 6.06) are not needed and are not operating requirements to be checked in routine. In case the rectifier output cannot be obtained, they may be useful in locating defective conditions.

6.02 ***High voltages*** to ground are present within the rectifier and every precaution should be observed to avoid any contact with exposed metal parts or terminals when the rectifier is in operation, or when not in operation, but connected to either line or battery.

Caution: When using any portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be connected at the instrument before making contact with the circuit to be tested. If the leads are to be changed from one jack or terminal to another at the meter, the ac power should first be removed from the rectifier being tested, or if test picks are being used, they should be removed from the rectifier under test.

6.03 The readings given in 6.06 are approximate and typical of a rectifier adjusted as indicated in 6.04 and 6.05. They are made with the KS-14510 meter. This meter has an accuracy of ±5 percent on alternating current and ±2 percent on direct current. It does not appreciably affect the rectifier output when connected for making the readings. This meter is provided with a knob for selecting the proper scale setting and with test pick leads and test clip leads. The test pick leads should be used for connections to jacks and to apparatus terminals which are accessible through holes in the plastic guard. The test clips should be used for the other connections.

Note: The readings shown in 6.06 are for a typical rectifier in good working condition. A defective rectifier with the power connected may have quite different voltages than those shown. Therefore, it may be desirable to use a higher voltage scale on the meter until readings indicate the proper scale setting to use for the defective condition.

6.04 Access for making measurements depends on the location of the equipment.

(a) For equipment located on the ***front of the control panel,*** open the doors on the front of the cabinet. This will expose the panel, and will not affect the operation of the rectifier.

(b) For equipment located on the ***rear of the control panel,*** with the doors open, unfasten and swing the panel out. This will not shut down the rectifier.

(c) For equipment located in the ***rear of the cabinet,*** open the rear doors. This will not shut down the rectifier.

(d) When making measurements of the voltages of equipment located on the rear of the control panel or in the rear of the cabinet, test clip leads will be required.

6.05 The voltage readings in 6.06 represent average values and should be used only as a guide. Normally, malfunctions will result in wide departures from the values shown.

6.06 The voltage readings represent typical values at 206 volts ac line voltage measured at the rectifier input and with the output voltage and current as indicated.

TABLE A — POINT-TO-POINT VOLTAGES

OUTPUT VOLTS = 50 VOLTS
OUTPUT CURRENT = 100 AMPERES
SAT. CURRENT 1 = SAT. CURRENT 2

METER CONNECTIONS		METER SCALE VOLTS	READING VOLTS
TEST POINT	TEST POINT		
AC Contactor			
T1	T2	300	206 ac
T1	T3	300	206 ac
T2	T3	300	206 ac
Transformer T1			
Term 1	Term 4	300	206 ac
Term 8	Term 9	60	50 ac
Transformer T2			
Term 1	Term 2	300	206 ac
Term 8	Term 9	60	28 ac
Term 6	Term 7	300	150 ac

METER CONNECTIONS		METER SCALE VOLTS	READING VOLTS*
TEST POINT	TEST POINT		
Jacks			
J1	GND	60	12 dc
J2	GND	60	12 dc
J3	GND	60	26 dc
J4	GND	60	26 dc
J5	GND	60	12.5 dc
J6	GND	60	12.5 dc
J7	GND	60	26 dc
J8	GND	60	26 dc
J9	GND	60	26 dc
J10	GND	60	12.5 dc
J11	GND	60	26 dc
J12	GND	60	12.5 dc

* The dc voltages shown are negative with respect to ground.

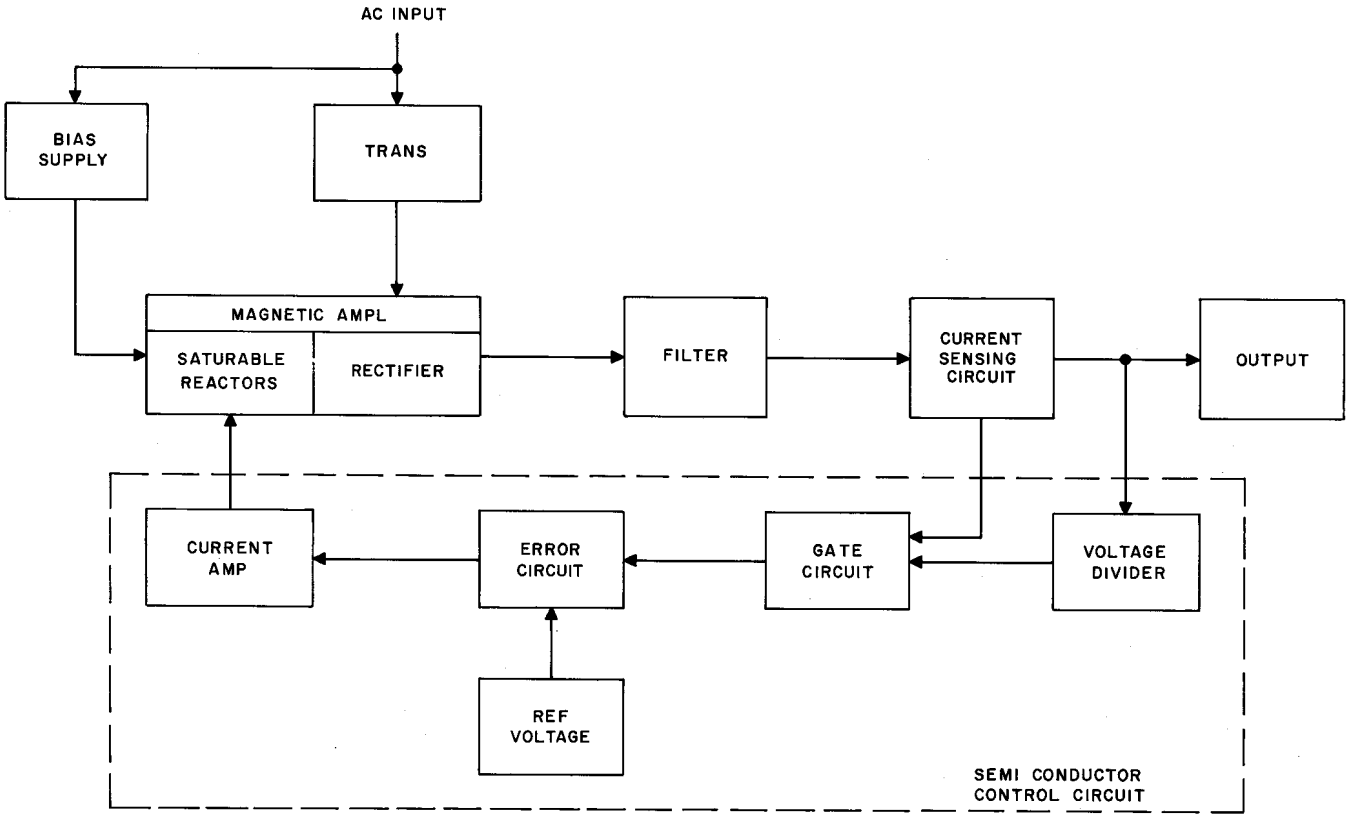

Fig. 2 — J86273 Rectifier — Block Diagram