

J86296 RECTIFIER
48 VOLTS, 400 AMPERES
CURRENT-REGULATED OUTPUT CONTROL
FOR 23-, 25-, OR 27-CELL PLANT (REGULAR AND EMERGENCY CELLS)
OPERATING METHODS

1. GENERAL

1.01 This section covers the operation of the J86296 semiconductor-type self regulating rectifier using saturable reactor control. This rectifier is initially intended to float, charge, and overcharge storage batteries of the 301C and 302A power plants under manual control, or under control of a rectifier that gives raise and lower signals.

1.02 This section is reissued to make the following changes.

- (a) Add information on the KS-20522 Solid State Controller.
- (b) Revise the adjustment procedures for the Automatic Control Circuit, the Maximum Current Limit Circuit, the OL Relay Circuit, and the Raise and Lower Rate Check.
- (c) Add routine checks for the rectifier Ventilating Passages and the adjustment of the AR1 Ammeter Relay High and Low Settings.

This reissue does affect the Equipment Test List.

1.03 This rectifier provides regulated dc power from ac power source. The dc output has a positive ground. The output range for automatic and manual operation is 46 to 62 volts, 20 to 400 amperes. The input power requirement is 3-phase, 3-wire, 60-Hz ± 2 percent, 196, 208, 220, 232, or 245 volts ± 7 percent ("T" option) or 410, 435, 455, or 480 volts ± 7 percent ("S" option). The output is automatically adjusted by the operation of relays in response to signals from the connecting circuits.

Warning: 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 This issue of the section is based on the following drawing:

SD-81398-01 ♦ Issue 9 ♦ —Rectifier Circuit (Fig. 1 and 3)

For a detailed description of the operation, see the corresponding circuit description. ♦ If this section is to be used with equipment or apparatus reflecting an earlier or later issue of the drawing, reference should be made to the SD and CD to determine the extent of the changes and the manner in which the section may be affected. ♦

1.05 ♦ The mechanical contacts of the AR1 ammeter relay may be replaced with the solid state contacts of the KS-20522, L13 Controller. ♦ The controller contains no moving parts or heated filaments, which provides more reliable service with less maintenance than the mechanical contacts. The KS-20522, L13 Controller is available as part of a modification kit which includes mounting hardware, wire, installation and wiring information, and, where required, some minor external components. The modification kit for this rectifier is coded as J86741A, List 4. For additional information, refer to the following:

♦ SD-82023-01—KS-20522 Solid State Controller Circuit ♦

Section 024-360-201—KS-20522 Solid State Controller Operation and Adjustment.

SECTION 169-631-303

1.06 ♦ Routine checks and adjustments, other than those required by trouble conditions, should be made during a period when they will cause the least unfavorable reaction to service.♦

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

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch Screwdriver
—	Blocking and Insulating Tools as required (Use tools and apply as covered in Section 060-020-801.)
418A	♦5/16- and 7/32-Inch Double-Ended Flat Wrench♦
TEST APPARATUS	
—	Ballantine Laboratories, Inc, Model 300U/3 Electronic Voltmeter or
—	Hewlett-Packard Co Model 400D Electronic Voltmeter
—	AB DuMont Lab, Inc, Type 304 Oscilloscope
	[Electronic Voltmeter and Oscilloscope are not required for normal maintenance (see 5.06).]
KS-3008	Stopwatch
KS-14510	Volt-Ohm-Milliammeter

3. OPERATION

Note: All controls are accessible with the front doors open except the BAL 1 through BAL 6 potentiometers. These controls are accessible when the hinged control panel (J86296C) is swung out.

3.01 Preparing to Start: When preparing to put the rectifier into service, check the following.

(a) The rectifier controls are positioned as follows:

RECT (S2) switch to OFF

*S1 dc output switch to BAT

TST-NOR-MAN key to NOR

CON CUR TST (R33) potentiometer fully ccw

MAN (R32) potentiometer fully ccw

CONT (CB1) circuit breaker to ON

48V CONT 1 (CB2) circuit breaker to ON

48V CONT 2 (CB3) circuit breaker to ON

♦Associated ac switch and fuse unit located in bus duct or power service cabinet to ON.

***Note:** Before operating the S1 switch from one position to another, shut down the rectifier. In an operating plant, shift the load from the rectifier before shutting it down.♦

(b) The AHL (R94) and AHR (R87) potentiometers are adjusted in accordance with 4.06.

Note: Do not reposition any other control at this time.

(c) The input transformer taps used are correct for the ac service available.

(d) If the rectifier is to be used with the 301C plant, disconnect and insulate the connection at contact 8 of the BO relay.

(e) Sufficient office load or a variable resistance load capable of carrying the rated output of the rectifier is provided. For use of the test load, see Section 171-123-101.

(f) All rectifier control fuses and associated load distribution fuses of the proper size are installed.

3.02 Starting: To start the rectifier, proceed as follows.

- (1) Verify that the rectifier controls are positioned as listed in 3.01.
- (2) Operate the RECT (S2) switch to the NOR position.

Requirement: The connecting plant applies battery over the CT lead to start the rectifier. The rectifier responds to raise or lower signals from the plant.

3.03 Stopping: To remove the rectifier from operation, proceed as follows.

- (1) Remove the rectifier from plant service in accordance with the power plant Bell System Practice.
- (2) Operate the RECT (S2) switch to the OFF position.
- (3) If the rectifier is to be out of service for an extended period of time, proceed as follows.

- (a) Operate the S1 dc output switch to the BAT OFF position.
- (b) Operate the control circuit breakers CB1, CB2, and CB3 to the OFF position.
- (c) Operate the associated ac switch and fuse unit located in bus duct or power service cabinet to the OFF position.

(d) **Caution:** Connect the electrolytic capacitors of the output filter to a source of direct current of suitable voltage and polarity in accordance with 032-110-701.

3.04 Manual Operation: To operate the rectifier manually, proceed as follows.

- (1) Operate the RECT (S2) switch to the OFF position.
- (2) Operate the S1 dc output switch to either the BAT, GR1, or GR1 and GR2 position.
- (3) Operate the TST-NOR-MAN key to the MAN position.

(4) Verify that the MAN (R32) potentiometer is fully ccw.

(5) Operate the RECT (S2) switch to the NOR position.

(6) Rotate the MAN (R32) potentiometer cw to increase the rectifier output to the desired value.

Note: Continuity of service is provided by this manual control. The MAN (R32) potentiometer should always be restored to maximum ccw at the completion of a check or when returning to automatic regulation.

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

(a) AR1 ammeter relay:

(1) Low contact set at 20 amperes.

(2) High contact set at 380 amperes.

(b) OL relay operates at 450 amperes in less than 5 seconds.

(c) OLF relay operates at 500 amperes in less than 20 seconds.

(d) The AHR (R87) and AHL (R94) potentiometers should be adjusted to raise or lower the output between no load and full load in approximately 30 seconds. (With 301C-type plants, a slower rate may be desirable to prevent over-correction and hunting.)

3.06 Surge Adjustment: (Option F) Some rectifiers, when used in the 301C power plant, may increase rapidly in current on initial start. To avoid a stop-start condition, adjust the R119 potentiometer (if provided) as necessary to correct this condition.

Note: Keep R119 potentiometer turned fully ccw unless the rectifier has problems with surging starts.

4. ROUTINE CHECKS

4.01 It is suggested that the following routine checks be made in accordance with the Equipment Test List, or after the rectifier has been out of service for an extended period of time and is to be returned to service, or if maintenance is performed which may affect the setting of the rectifier controls.

Caution: The MAN (R32) potentiometer should always be turned completely ccw before operating a test switch to avoid excessive voltage and current.

Note: When adjusting the COMP (R70), OL ADJ (R116), and BIAS (R26) 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.

4.02 **Ventilating Passages:** Keep the ventilating passages of the rectifier unobstructed to ensure adequate cooling during operation. The interior of the rectifier should be cleaned periodically while the rectifier is shut down. Remove dust from all accessible components inside the rectifier cabinet with a long handle, blade-type brush. Using a suitable vacuum cleaner, vacuum the floor area inside the rectifier cabinet to remove all dust and dirt. The period between cleanings should be determined by local conditions.

4.03 **Automatic Control Circuit:** To check the operation of the automatic control circuit, proceed as follows.

Note: An increase in current on the SAT CURRENT 1 milliammeter increases the rectifier output current. An increase in current on the SAT CURRENT 2 milliammeter decreases the rectifier output current.

- (1) Operate the RECT (S2) switch to the OFF position.
- (2) Operate the following controls:

S1 dc output switch to BAT

TST-NOR-MAN key to MAN

CON CUR TST (R33) potentiometer fully ccw

MAN (R32) potentiometer to midposition

Associated ac switch and fuse unit located in bus duct or power service cabinet to ON

- (3) Operate the RECT (S2) switch to the NOR position.

Requirement: The SAT CURRENT 2 milliammeter indicates some current value.

- (4) Rotate the MAN (R32) potentiometer fully ccw.

Requirement: The SAT CURRENT 2 milliammeter indication increases and the TC relay operates. The SAT CURRENT 1 milliammeter indicates some current value.

- (5) Adjust the MAN (R32) potentiometer to give a 200-ampere output with the battery maintained at float voltage. (Artificial load may be required to hold battery voltage at float value when the rectifier starts to deliver output current.)

Requirement: The SAT CURRENT 2 milliammeter indicates approximately 120 milliamperes.

- (6) Adjust the MAN (R32) potentiometer until the AR1 ammeter relay indicates 20 amperes (5 percent of full load).

Requirement: The SAT CURRENT 2 milliammeter indicates less than 160 milliamperes.

- (7) Adjust the MAN (R32) potentiometer until the AR1 ammeter relay indicate 380 amperes.

Requirement: The SAT CURRENT 2 milliammeter indicates approximately 60 to 100 milliamperes.

Note: If the requirements in (6) and (7) are not met, check the saturable reactor in accordance with 5.06.

- (8) Rotate the MAN (R32) potentiometer fully ccw.

- (9) Operate the RECT (S2) switch to the OFF position.◆

4.04 Maximum Current Limit: ◆To check the current limit circuit, proceed as follows.

- (1) Operate the RECT (S2) switch to the OFF position.

- (2) Operate the following controls:

S1 dc output switch to BAT OFF

TST-NOR-MAN key to TST

CON CUR TST (R33) potentiometer fully ccw

MAN (R32) potentiometer fully ccw

Associated ac switch and fuse unit located in bus duct or power service cabinet to ON.

- (3) Set the high contact of AR1 ammeter relay to 500 amperes. If the AR1 ammeter relay is equipped with the KS-20522 Controller, rotate the H CONT potentiometer, located on the controller, fully cw.

- (4) Block nonoperated the overcurrent (OC) relay in the *plant*. (Refer to Section 069-020-801 for procedure to block relays.)

- (5) Operate the RECT (S2) switch to the NOR position.

- (6) Observe the RL relay on the control panel.

Requirement: The RL relay is released.

- (7) Operate and hold the CON CUR TST (S3) switch to the TST position. (The CON CUR TST switch is a momentary contact switch and must be held operated in the TST position.)

- (8) Rotate the CON CUR TST (R33) potentiometer cw until the AR1 ammeter relay indicates 450 amperes.

Requirement: The OL relay operates within 5 seconds to operate the RL relay.

Note: If the requirement is not met, check the OL relay adjustment in accordance with 4.05.

- (9) Block the RL relay nonoperated.

- (10) Rotate the CON CUR TST (R33) potentiometer cw until the AR1 ammeter relay indicates 500 amperes.

Requirement: The OLF relay operates within 20 seconds to operate the OLF1 relay and shut down the rectifier. The OVERLOAD lamp lights and the RF relay operates to provide an alarm in the connecting plant.

Note: If the requirement is not met, check the OLF relay adjustment in accordance with 4.05.

- (11) Release the CON CUR TST (S3) switch.

- (12) Operate the RECT (S2) switch to the OFF position. The OVERLOAD lamp extinguishes.

- (13) Rotate the CON CUR TST (R33) potentiometer fully ccw.

- (14) Remove the block from the OC relay in the *plant* and the RL relay.

- (15) Readjust the high contact of the AR1 ammeter relay to 380 amperes in accordance with 4.07.◆

4.05 Overload (OL) and OLF Relay Adjustment:

◆Adjust the OL and OLF relays only if the requirement is not met in the overcurrent test in 4.04.

- (1) Operate the RECT (S2) switch to the OFF position.

- (2) Operate the following controls:

S1 dc output switch to BAT OFF

TST-NOR-MAN key to TST

CON CUR TST (R33) potentiometer fully ccw

MAN (R32) potentiometer fully ccw

SECTION 169-631-303

Associated ac switch and fuse unit located in bus duct or power service cabinet to ON.

- (3) Set the high contact on the AR1 ammeter relay to 500 amperes. If the AR1 ammeter relay is equipped with the KS-20522 Controller, rotate the H CONT potentiometer, located on the controller, fully cw.
- (4) Rotate the OL ADJ (R116) potentiometer fully cw.◆
- (5) Operate the RECT (S2) switch to the NOR position.
- (6) Operate and hold the CON CUR TST (S3) switch to the TST position.
- (7) Rotate the CON CUR TST (R33) potentiometer cw until the AR1 ammeter relay indicates 412 amperes.
- (8) Wait for 2 minutes with the CON CUR TST (S3) switch in the TST position to stabilize the heater of OL relay, then continue with (9).
- (9) Slowly readjust the CON CUR TST (R33) potentiometer cw until the AR1 ammeter relay indicates 450 amperes.

Note: ◆It is important that the 450 ampere setting be made exactly, as the OL relay is very sensitive to small current variations. Do not overshoot the 450 ampere division on the AR1 ammeter relay.

- (10) While holding the CON CUR TST (S3) switch in the TST position, rotate the OL ADJ (R116) potentiometer slowly ccw, *in steps*, until the OL relay operates within 5 seconds after the adjustment is made.

Note: The operation of the OL relay is indicated by the operation of the RL relay and not by shutdown of the rectifier.◆

- (11) Release the CON CUR TST (S3) switch and rotate the CON CUR TST (R33) potentiometer fully cw.
- (12) ◆Repeat (6) through (9) to check the setting.

Requirement: The OL relay operates within 5 seconds at the 450 ampere level to operate the RL relay.◆

Note: *If the requirement is met, proceed to (26).* If the adjustment range of the OL ADJ (R116) potentiometer is not sufficient to meet the requirement, continue with (13).

- (13) ◆Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R33) potentiometer fully ccw, and then operate the RECT (S2) switch to the OFF position.
- (14) Rotate the OL ADJ (R116) potentiometer fully ccw.
- (15) Turn the small adjusting screw, accessible through a hole in the top cover of the OL relay, out about 2 turns, and then press the adjusting screw firmly downward.
- (16) Operate the RECT (S2) switch to the NOR position.
- (17) Operate and hold the CON CUR TST (S3) switch to the TST position.
- (18) Rotate the CON CUR TST (R33) potentiometer cw until the AR1 ammeter relay indicates 412 amperes.
- (19) Wait for 5 minutes with the CON CUR TST (S3) switch in the TST position to stabilize the heater of the OL relay, then continue with (20).
- (20) Slowly readjust the CON CUR TST (R33) potentiometer cw until the AR1 ammeter relay indicates 450 amperes.
- (21) While holding the CON CUR TST (S3) switch in the TST position, immediately start turning the adjustment screw of the OL relay in, *very slowly*, until the OL relay operates (RL relay operates).◆
- (22) Release the CON CUR TST (S3) switch and rotate the CON CUR TST (R33) potentiometer fully ccw.
- (23) ◆Repeat (17) through (20) to check the OL relay setting.

Requirement: The OL relay operates (RL relay operates) within 5 seconds at the 450 ampere level.⚡

Note: If the requirement is met, continue with (24). If the requirement is not met, repeat (15) through (23) until the OL relay does operate within 5 seconds.

- (24) Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R33) potentiometer fully ccw, and then operate the RECT (S2) switch to the OFF position.
- (25) Rotate the OL ADJ (R116) potentiometer fully cw and repeat (5) through (12) to adjust the overload circuit.
- (26) Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R33) potentiometer fully ccw.
- (27) Lock the OL ADJ (R116) potentiometer in position, being careful not to disturb its setting.
- (28) Operate and hold the CON CUR TST (S3) switch to the TST position.
- (29) Block RL relay nonoperated.
- (30) Rotate the CON CUR TST (R33) potentiometer until AR1 ammeter relay indicates 500 amperes.

Requirement: Rectifier shuts down in 20 seconds.

Note: If the requirement is met, proceed to (36). If the requirement is not met, continue with (31).

- (31) Manually operate OLF1 relay.

Requirement: Rectifier should shut down, indicating the circuit path is operative.

- (32) Rotate the CON CUR TST (R33) potentiometer fully ccw.
- (33) Allow OLF relay to cool 5 minutes.

- (34) Rotate the CON CUR TST (R33) potentiometer until AR1 ammeter relay indicates 500 amperes.

- (35) Slowly rotate the adjusting screw of OLF relay cw until OLF1 relay operates and shuts down the rectifier.

Note: Repeat (32) through (35) as necessary until the rectifier shuts down in 20 seconds.

- (36) Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R33) potentiometer fully ccw, and operate the RECT (S2) switch to OFF.
- (37) Remove block from RL relay.
- (38) Readjust the high contact of AR1 ammeter relay in accordance with 4.07.

4.06 ♦ Raise and Lower Rate: To check the time required between minimum load to maximum load, proceed as follows.

- (1) Operate the RECT (S2) switch to the OFF position.
- (2) Operate the following controls:

S1 dc output switch to BAT

TST-NOR-MAN key to TST

CON CUR TST (R33) potentiometer fully ccw

MAN (R32) potentiometer fully ccw

Associated ac switch and fuse unit located in bus duct or power service cabinet to ON.

- (3) Set the high contact of AR1 ammeter relay to 500 amperes. If the AR1 ammeter relay is equipped with the KS-20522 Controller, rotate the H CONT potentiometer on the controller fully cw.
- (4) Operate the RECT (S2) switch to the NOR position.
- (5) Observe the AR1 ammeter relay and the KS-3008 stopwatch.

SECTION 169-631-303

Requirement: The AR1 ammeter indicates less than 20 amperes.

Raise Rate

(6) Operate and hold the RAISE (S7) switch to the RAISE position while using the KS-3008 stopwatch to check the time required for the rectifier to increase from minimum to maximum current. When AR1 ammeter relay indicates 380 amperes, release the RAISE (S7) switch.

Requirement: The raise rate must meet the requirement in the plant Bell System Practice. In the absence of a plant requirement, the raise rate should be 30 seconds.

Note: If the requirement is met, proceed to (10). If the raise rate is too slow or too fast, continue with (7).

(7) Operate the LOWER (S8) switch to the LOWER position and hold operated until the AR1 ammeter relay indicates minimum current.

(8) Adjust the AHR (R87) potentiometer 1/8 turn cw to increase the raise rate or 1/8 turn ccw to decrease the raise rate.

(9) Repeat (6) to check the raise rate. Repeat (7) and (8) until a satisfactory raise rate is obtained.

Lower Rate

(10) Verify that the AR1 ammeter relay indicates 380 amperes. [Operate the RAISE (S7) or LOWER (S8) switches as required.]

(11) Operate and hold the LOWER (S8) switch to the LOWER position while using the KS-3008 stopwatch to check the time required for the rectifier to decrease from maximum to minimum current. When AR1 ammeter relay indicates minimum current, release the LOWER (S8) switch.

Requirement: The lower rate must meet the requirement in the plant Bell System Practice. In the absence of a plant requirement, the lower rate should be approximately 30 seconds.

Note: If the requirement is met, proceed to (15). If the lower rate is too slow or too fast, continue with (12).

(12) Operate the RAISE (S7) switch to the RAISE position and hold operated until the AR1 ammeter relay indicates 380 amperes.

(13) Adjust the AHL (R94) potentiometer 1/8 turn cw to increase the lower rate or 1/8 turn ccw to decrease the lower rate.

(14) Repeat (11) to check the lower rate. Repeat (12) and (13) until a satisfactory lower rate is obtained.

(15) Verify that the AR1 ammeter relay indicates minimum load.

(16) Operate the RECT (S2) switch to the OFF position.

(17) Readjust the high contact of AR1 ammeter relay in accordance with 4.07.

4.07 High and Low Settings of AR1 Ammeter

Relay: To check the setting of the AR1 ammeter relay, proceed as follows.

Note 1: The mechanical contacts of the AR1 ammeter relay may be replaced with the solid state contacts of the KS-20522, L13 Controller. The high and low settings are adjustable by the L CONT (low) and H CONT (high) potentiometers on the controller. Clockwise adjustment of the L CONT or H CONT potentiometer increases the setting. Refer to Section 024-360-201 for additional information on the KS-20522 Controller.

Note 2: This adjustment procedure applies to the setting of the mechanical contacts or the adjustment of the KS-20522 Controller.

AR1 Low Contact Setting

(1) Operate the RECT (S2) switch to the OFF position.

(2) Operate the following controls:

S1 dc output switch to BAT

TST-NOR-MAN key to TST

CON CUR TST (R33) potentiometer fully ccw

MAN (R32) potentiometer fully ccw

Associated ac switch and fuse unit located in bus duct or power service cabinet to ON.

(3) Connect the KS-14510 volt-ohm-milliammeter, set on 60 DC VOLTS scale, between terminal 7 of TS6 and ground.

(4) Observe the KS-14510 meter indication to check the low setting of AR1 ammeter relay.

(5) Operate the RECT (S2) switch to the NOR position.

Requirement: The KS-14510 meter indicates no voltage.

(6) Slowly rotate the MAN (R32) potentiometer cw until the KS-14510 meter indicates voltage.

Requirement: The AR1 ammeter relay indicates 20 amperes.

Note: If the requirement is met, proceed to (8). If the requirement is **not** met, continue with (7).

(7) Rotate the MAN (R32) potentiometer fully ccw and adjust the AR1 low setting upscale. Adjust the MAN (R32) potentiometer cw until the AR1 ammeter relay indicates 20 amperes, and then adjust the AR1 low setting downscale until the KS-14510 meter indicates voltage.

AR1 High Contact Setting

(8) Position the rectifier controls as follows:

MAN (R32) potentiometer fully ccw

RECT (S2) switch to OFF

S1 dc output switch to BAT OFF

TST-NOR-MAN key to TST.

(9) Block nonoperated the overcurrent (OC) relay in the **plant**. (Refer to Section 069-020-801 for procedure to block relays.)

(10) Disconnect the KS-14510 meter from terminal 7 of TS6. Reconnect the meter between terminal 8 of TS6 and ground.

(11) Observe the KS-14510 meter indication to check the high setting of AR1 ammeter relay.

(12) Operate the RECT (S2) switch to the NOR position.

Requirement: The KS-14510 meter indicates voltage.

(13) Operate and hold the CON CUR TST (S3) switch to the TST position. (The CON CUR TST switch is a momentary contact switch and must be held operated in the TST position.)

(14) Slowly rotate the CON CUR TST (R33) potentiometer cw until the KS-14510 meter indication drops to zero. **Do no exceed 410 amperes on AR1 ammeter relay before readjusting the high setting of AR1.**

Requirement: The AR1 ammeter relay indicates 380 amperes.

Note: If the requirement is met, proceed to (16). If the requirement is **not** met, continue with (15).

(15) Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R33) potentiometer fully ccw, and then readjust the AR1 high setting upscale. Operate and hold the CON CUR TST (S3) switch to the TST position and adjust the CON CUR TST (R33) potentiometer cw until AR1 ammeter relay indicates 380 amperes. Adjust the AR1 high setting downscale until the KS-14510 meter indication drops to zero.

(16) Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R33) potentiometer fully ccw, and then operate the RECT (S2) switch to the OFF position.

(17) Disconnect the KS-14510 meter.

(18) Remove the block from the OC relay in the **plant**.

4.08 Electron Tube (V1): The electron tube (V1) should be checked with the electron

SECTION 169-631-303

tube tester available in the office, in accordance with the standard information on the tester.

4.09 Contactor and Relays: The contactor and relays should be inspected for adjustment and condition of contacts to make sure that they are in accordance with the circuit requirements table and Bell System Practices which apply.

5. TROUBLES

General

5.01 In general, the only item likely to become defective with use is the V1 electron tube which is subject to aging but should have long life.

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

5.03 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 in the stack assembly which is part of the rectifying element.

5.04 The saturating current, although it may vary widely in extreme conditions, when observed in daily routine, can serve as a guide to the causes of unusual operation or trouble conditions.

Trouble Chart

5.05 Should any of the following troubles develop, it is suggested that the possible causes 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 fuse. CB3 circuit breaker in OFF position.
(b) No dc output current (high SAT CURRENT 2; no SAT CURRENT 1)	TC relay failure. Faulty R71 resistor or COMP potentiometer.
(c) No dc output current (high SAT CURRENT 2; normal SAT CURRENT 1)	LC or RL relay failure. Faulty R85, V1, CR23, CR24, C27.
(d) High dc output current	AR1 ammeter relay high contact set incorrectly.
(e) Rectifier does not raise or lower the output current (under these conditions rectifier shuts off normally)	Faulty Q1, Q2, or Q3 transistors; RL or RR relay failure.
(f) Output excessively noisy	Defective filter capacitors; unbalanced ac line voltage (more than 5 percent). Defective rectifier stacks; BAL 1 through BAL 12 potentiometers misadjusted (see 5.06). Blown Amp-Trap F1 through F12 fuses or line fuses.
(g) Rectifier shuts off after short interval of operation	OL relay misadjusted.

TROUBLE	POSSIBLE CAUSE
(h) Too fast raising or lowering of the dc output current upon application of the raise or lower signal	AHR or AHL potentiometers misadjusted.
(i) High increase of current on initial start	R119 potentiometer misadjusted.

5.06 To check for a defective saturable reactor, proceed as follows.

- Connect the DuMont type-304 oscilloscope to the SCOPE Y and SCOPE G or SCOPE X and SCOPE G jacks.
- 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 adjusted to approximately equal height, the cores of the L1 through L6 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 12 balancing potentiometer. Badly distorted waves may indicate a defective power diode.
- Check potentiometers for open circuit with the KS-14510 volt-ohm-milliammeter.
- Replace any potentiometer having an open circuit.
- Readjust all potentiometers using the same method as specified below for use after a saturable reactor is replaced.
- If 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 it and adjust the core characteristics of *all* of the saturable reactors as follows. Use SCOPE Y and SCOPE G jacks for BAL 1 through BAL 6, SCOPE X and SCOPE G jacks for BAL 7 through BAL 12 potentiometers.

- BAL 1 through BAL 12 balancing potentiometers of the saturable reactors shall be turned maximum ccw. Increase the load of the rectifier to 200 amperes.
- 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).

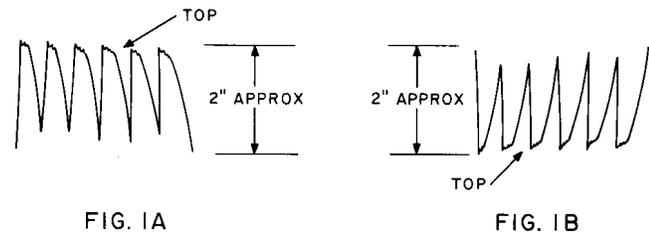


Fig. 1—Core Characteristics of Saturable Reactors

- Adjust this potentiometer until the two affected sine waves are of equal height.
- Adjust all remaining potentiometers to equal this one.
- With electronic voltmeter (see Caution) connected across the REG+ and REG- jacks and using it as an indicator, all balancing potentiometers may be adjusted to obtain minimum reading without regard to the possible slight unbalance on the oscilloscope. The balancing will vary with the load.

Caution: *If one side of the oscilloscope is grounded, connect the grounded side to SCOPE G jack which is ground bus. 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 are not needed and are not operating requirements to be checked routinely. In case the rectifier is not operating satisfactorily, 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 indications given in Tables A and B represent typical values at 206 and 435 volts ac line voltage measured at the rectifier input and with the output voltage and current adjusted as indicated in the tables. These readings are made with the KS-14510 meter.

Caution: The indications shown in Tables A and B 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 the indications are in proper range to use for the defective condition.

TABLE A			
INPUT VOLTS = 206 VOLTS			
OUTPUT VOLTS = 50 VOLTS			
OUTPUT CURRENT = APPROXIMATELY 200 AMPERES			
SAT CURRENT 2 = 110 MILLIAMPERES			
METER CONNECTIONS		METER SCALE VOLTS	INDICATION VOLTS
TEST POINT	TEST POINT		
Contactor AC T1 T1 T2	T2 T3 T3	300 ac 300 ac 300 ac	206 206 206
Transformer T2 ("T" Option) Term. 1 Term. 13 Term. 7 Term. 9 Term. 11	Term. 2 Term. 14 Term. 8 Term. 10 Term. 12	300 ac 60 ac 300 ac 300 ac 300 ac	206 28 150 150 150
Transistor Q1 *Emitter (Can) *Base TP15	Base TP15 Collector TP14	0.300 dc 60 dc	0.150 17.5
Transistor Q2 *Emitter (Can) *Base TP13	Base TP13 Collector TP12	0.300 dc 60 dc	0.150 17.5
Transistor Q3 *Emitter (Can) *Base TP17	Base TP17 Collector TP11	0.300 dc 60 dc	0.125 17
Resistors R89 R79 R80 R72 & R73	Across Each Resistor	60 dc 60 dc 60 dc 12 dc	22.5 40 38 5.5

*In taking meter indications, connect the + side of the meter to the transistor terminals indicated by an asterisk.
AC indications have no polarity.

TABLE B

INPUT VOLTS = 435 VOLTS
 OUTPUT VOLTS = 50 VOLTS
 OUTPUT CURRENT = APPROXIMATELY 200 AMPERES
 SAT CURRENT 2 = 110 MILLIAMPERES

METER CONNECTIONS		METER SCALE VOLTS	INDICATION VOLTS
TEST POINT	TEST POINT		
Contactors AC T1 T1 T2	T2 T3 T3	600 ac 600 ac 600 ac	435 435 435
Transformer T2 ("S" Option) Term. 1 Term. 6 Term. 8 Term. 10 Term. 12	Term. 3 Term. 7 Term. 9 Term. 11 Term. 13	600 ac 300 ac 300 ac 300 ac 60 ac	435 150 150 150 28
Transistor Q1 *Emitter (Can) *Base TP15	Base TP15 Collector TP14	0.300 dc 60 dc	0.150 17.5
Transistor Q2 *Emitter (Can) *Base TP13	Base TP13 Collector TP12	0.300 dc 60 dc	0.150 17
Transistor Q3 *Emitter (Can) *Base TP17	Base TP17 Collector TP11	0.300 dc 60 dc	0.125 17
Resistors R89 R79 R80 R72 & R73	Across Each Resistor	60 dc 60 dc 60 dc 12 dc	40 38 22.5 5.5

*In taking meter indications, connect the + side of the meter to the transistor terminals indicated by an asterisk.
 AC indications have no polarity.