J86295A RECTIFIER
48 VOLTS, 200 AMPERES
CURRENT-REGULATED OUTPUT CONTROL
23-, 25-, OR 27-CELL PLANT (REGULAR AND EMERGENCY CELLS)
OPERATING METHODS

1. GENERAL

1.01 The J86295A semiconductor-type, current-regulated rectifier using saturable reactor control is used in the 301C and 302A power plants to float and charge storage batteries.

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 The J86295A 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 or charge the battery. The current-regulated control responds automatically to signals from connecting circuits to connect to the ac supply and to increase or decrease its output current in response to raise and lower signals.

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 dc output switch.

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

SD-81410-01 ▶Issue 13◀ —Rectifier Circuit (Fig. 1, 3, and 6)

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 6. 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.

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.

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
418A	4/16- and 7/32-Inch Double-Ended Flat Wrench
—	▶Brush, Radiator, Blade-type or other approved dusting tool◀
—	3-Inch C Screwdriver
TEST APPARATUS	
KS-3008	Stopwatch
KS-8039	DC Volt-Milliammeter
KS-14510	Volt-Ohm-Milliammeter
—	A. B. DuMont Lab, Inc, Type 304 Oscilloscope (This apparatus is not required for normal maintenance. See 5.06.)
—	Ballantine Laboratories, Inc, Model 300U/3 Electronic Voltmeter ▶(or equivalent digital voltmeter or vacuum tube voltmeter)◀

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 (J86295C) 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 (R18) potentiometer fully ccw

MAN (R26) 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

▶Fuses F8, F9, and F11 are installed

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 (R66) and AHR (R61) potentiometers are adjusted in accordance with 4.07.

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 (R26) potentiometer is fully ccw.

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

(6) Rotate the MAN (R26) potentiometer cw to increase the rectifier output to the desired value.

Note: Continuity of service is provided by this manual control. The MAN (R26) 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 10 amperes.

(2) High contact set at 200 amperes.

(b) OL relay operates at 225 amperes in 20 to 60 seconds.

(c) OLF relay operates at 250 amperes in 10 to 60 seconds.

(d) The AHR (R61) and AHL (R66) 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.)

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 (R26) potentiometer should always be turned completely ccw before operating a test switch to avoid excessive voltage and current.

Note: When adjusting the COMP (R45), OL ADJ (R88), and BIAS (R20) 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 (R18) potentiometer fully ccw

MAN (R26) potentiometer to midposition

Fuses F8, F9, and F11 are installed

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 about 100 milliamperes.

(4) Rotate the MAN (R26) potentiometer fully ccw.

Requirement: The SAT CURRENT 2 milliammeter indication increases and at 190 to 250 milliamperes the TC relay operates and the SAT CURRENT 1 milliammeter indicates some current value.

(5) Adjust the MAN (R26) potentiometer to give a 100-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 between 90 and 120 milliamperes.

(6) Adjust the MAN (R26) potentiometer until the AR1 ammeter relay indicates 10 amperes (5 percent of full load).

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

(7) Adjust the MAN (R26) potentiometer until the AR1 ammeter relay indicates 200 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 (R26) potentiometer fully ccw.

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

4.04 ***Magnetic Amplifier Range Adjustment:*** To adjust the magnetic amplifier range of control, 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 MAN

CON CUR TST (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

COMP (R45) potentiometer fully ccw

BIAS (R20) potentiometer fully cw

Fuses F8, F9, and F11 are installed

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.◀

(4) Slowly rotate the MAN (R26) potentiometer cw until the SAT CURRENT 2 milliammeter decreases to 110 milliamperes.

(5) Slowly rotate the COMP (R45) potentiometer cw until the AR1 ammeter relay indicates 100 amperes at float voltage or until the SAT CURRENT 1 milliammeter indicates 370 milliamperes. The MAN (R26) potentiometer may be readjusted, if necessary, to maintain 110 milliamperes on the SAT CURRENT 2 milliammeter. Use artificial load, as required, to maintain the battery at its float value.

(6) If the 370-milliampere indication in (5) is reached before the 100-ampere output is obtained, slowly rotate the BIAS (R20) potentiometer ccw and readjust the COMP (R45) potentiometer slightly to obtain the following requirements.

(a) AR1 indicates 100 amperes.

(b) SAT CURRENT 1 indicates less than 370 milliamperes.

(c) SAT CURRENT 2 indicates 110 milliamperes.

Note: Some rectifiers may not require any adjustment of the BIAS (R20) potentiometer.

(7) Slowly rotate the MAN (R26) potentiometer cw until the ammeter relay indicates 200 amperes.

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

(8) Slowly rotate the MAN (R26) potentiometer ccw until the AR1 ammeter relay indicates 10 amperes.

Requirement: SAT CURRENT 2 milliammeter indicates approximately 140 to 160 milliamperes.

Note: If the requirements are met in (7) and (8), lock the setting of the COMP (45) potentiometer and the BIAS (R20) potentiometer. ▶If the requirements are not met in (7) and (8), repeat (4), (5), and (6).◀

(9) Rotate the MAN (R26) potentiometer fully ccw.

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

4.05 ***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 (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

Fuses F8, F9, and F11 are installed

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 250 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 (R18) potentiometer cw until the AR1 ammeter relay indicates 225 amperes.

Requirement: The OL relay operates within 20 to 60 seconds to operate the RL relay.

Note: If the requirement is not met, check the OL relay adjustment in accordance with 4.06.

(9) Rotate the CON CUR TST (R18) potentiometer cw until the AR1 ammeter relay indicates 250 amperes.

Requirement: The OLF relay operates within 60 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 Section 040-674-701.◀

(10) Release the CON CUR TST (S3) switch.

(11) Operate the RECT (S2) switch to the OFF position. ▶The OVERLOAD lamp extinguishes.◀

(12) Rotate the CON CUR TST (R18) potentiometer fully ccw.

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

(14) Readjust the high contact of the AR1 ammeter relay to 200 amperes in accordance with 4.08.◀

4.06 ***Overload (OL) Relay Adjustment:*** ▶Adjust the OL relay only if the requirement is not met in the overcurrent test in 4.05.◀

(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 (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

Fuses F8, F9, and F11 are installed

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 250 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 (R88) potentiometer fully cw.

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

(6) Operate and hold the CON CUR TST (S3) switch to the TST position.

(7) Rotate the CON CUR TST (R18) potentiometer cw until the AR1 ammeter relay indicates 206 amperes.

(8) Wait for 5 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 (R18) potentiometer cw until the AR1 ammeter relay indicates 225 amperes.

Note: It is important that the 225-ampere setting be made exactly, as the OL relay is very sensitive to small current variations. Do not overshoot the 225-ampere division on the AR1 ammeter relay.

(10) While holding the CON CUR TST (S3) switch in the TST position, rotate the OL ADJ (R88) potentiometer slowly ccw, ***in steps,*** until the OL relay operates within 20 to 60 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 (R18) potentiometer fully ccw.

(12) ▶Repeat (6) through (9) to check the setting.

Requirement: The OL relay operates within 20 to 60 seconds at the 225-ampere level to operate the RL relay.◀

Note: If the requirement is met, proceed to (27). If the adjustment range of the OL ADJ (R88) potentiometer is not sufficient to meet the requirement, continue with (13).

(13) Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R18) potentiometer fully ccw, and then operate the RECT (S2) switch to the OFF position.

(14) ***Warning: Verify that the RECT (S2) switch is in the OFF position.***

Disconnect the OL ADJ (R88) potentiometer from the rectifier circuit.

(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 (R18) potentiometer cw until the AR1 ammeter relay indicates 206 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 (R18) potentiometer cw until the AR1 ammeter relay indicates 225 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 (R18) potentiometer fully ccw.

(23) ▶Repeat (17) through (20) to check the OL relay setting.

Requirement: The OL relay operates (RL relay operates) within 2 seconds at the 225-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 2 seconds.

(24) Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R18) potentiometer fully ccw, and then operate the RECT (S2) switch to the OFF position.

(25) Reconnect the OL ADJ (R88) potentiometer in the circuit.

(26) Rotate the OL ADJ (R88) potentiometer fully cw and repeat (5) through (12) to adjust the overload circuit.

(27) Release the CON CUR TST (S3) switch, rotate the CON CUR TST (R18) potentiometer fully ccw, and then operate the RECT (S2) switch to the OFF position.

(28) Readjust the high contact of AR1 ammeter relay in accordance with 4.08.

4.07 ***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 (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

Fuses F8, F9, and F11 are installed

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 250 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.

Requirement: ▶The AR1 ammeter indicates less than 4 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 200 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 (R61) 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 200 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 200 amperes.

(13) Adjust the AHL (R66) 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 4.08.◀

4.08 ▶***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 (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

Fuses F8, F9, and F11 are installed

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 test point TP4 and ground. [Test point TP4 is located on the rear of the upper meter panel near the RECT (S2) switch.]

(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 (R26) potentiometer cw until the KS-14510 meter indicates voltage.

Requirement: The AR1 ammeter relay indicates 10 ± 0.2 amperes.

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

(7) Rotate the MAN (R26) potentiometer fully ccw and adjust the AR1 low setting upscale. Adjust the MAN (R26) potentiometer cw until the AR1 ammeter relay indicates 10 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 (R26) 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 test point TP4. Reconnect the meter between test point TP5 and ground. (Test point TP5 is located near test point TP4.)

(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 (R18) potentiometer cw until the KS-14510 meter indication drops to zero. ***Do not exceed 205 amperes on AR1 ammeter relay before readjusting the high setting of AR1.***

Requirement: The AR1 ammeter relay indicates 200 $\pm$4 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 (R18) 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 (R18) potentiometer cw until AR1 ammeter relay indicates 200 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 (R18) 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.***

4.09 ***Electron Tube (V1):*** The electron tube (V1) should be checked with the electron tube tester available in the office, in accordance with the standard information on the tester.

4.10 ***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

5.01 In general, the only item likely to become defective with use is the V1 electron tube which is subject to aging. The functional units of the rectifier are shown in Fig. 1.

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 or bolt assembly which is part of the rectifying element.

5.04 Although it may vary widely in extreme conditions, the saturating current, when observed in daily routine and compared with operating experience, can serve as a guide to the causes of unusual operation or trouble conditions.

5.05 ***Trouble Chart:*** Should any of the following troubles develop, it is suggested that the possible cause be checked in the order given. If

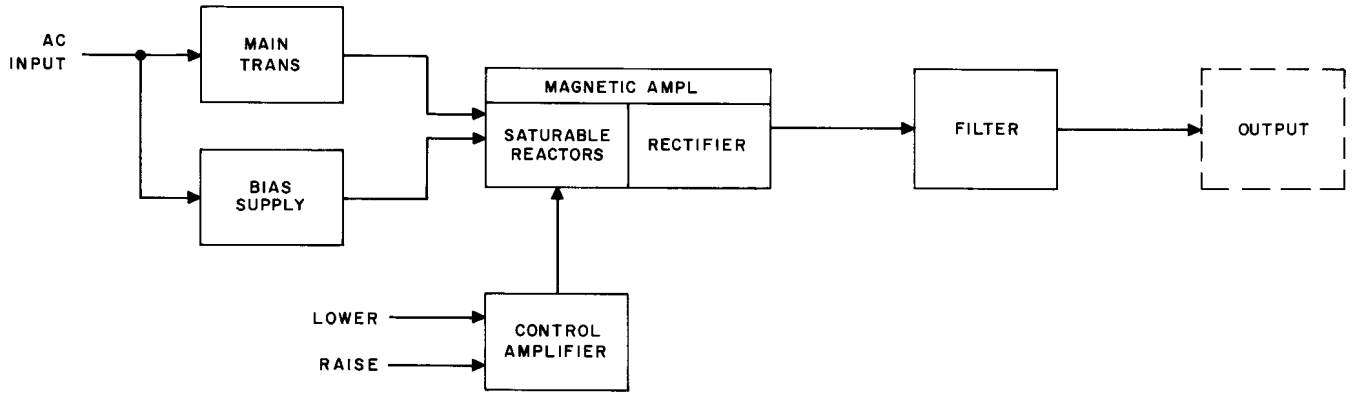

Fig. 1—J68295A Rectifier-Block Diagram

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 below 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. See Part 7.

	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 R44 resistor or COMP (R45) potentiometer (open winding).
(c)	No dc output current (high SAT CURRENT 2, normal SAT CURRENT 1)	LC or RL relay failure. Faulty R53, V1, CR7, CR8, C24.
(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 6 potentiometers misadjusted (see 5.06). Open CR1 to CR6 germanium rectifiers.
(g)	Rectifier shuts off after short interval of operation	OL relay misadjusted.
(h)	Too fast raising or lowering of the dc output current upon application of the raise or lower signal	AHR (R61) or AHL (R66) potentiometers misadjusted.

5.06 ***Check for Defective Saturable Reactor:*** 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. 2. 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 below for use after a saturable reactor is replaced.

(f) The adjustment of any of the BAL potentiometers affects the lower position (opposite TOP Fig. 2) 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 match the core characteristics of ***all*** of the saturable reactors as follows.

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

(2) 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. 2).

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

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

(5) With the vacuum tube voltmeter (or equivalent digital ac voltmeter) (see Caution) connected across terminals F and G of TS7 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 voltmeter is grounded, connect this side to the G terminal.

6. POINT-TO-POINT VOLTAGES

6.01 Point-to-point voltages are intended for use when unsatisfactory operation is encountered, in which case they may prove useful in locating the defective conditions. They are not operating requirements to be checked in routine and are not needed while the rectifier unit is operating satisfactorily. As given in 6.04, they are approximate and typical of a unit connected to normal power supply, adjusted to the voltage and carrying load as indicated.

6.02 ***High voltages*** are present within the rectifier unit and every precaution should be observed to avoid any contact with exposed metal parts or terminals when the rectifier unit is in operation.

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 connections are to be changed from one instrument range to another, the ac should first be disconnected from the equipment being tested, or, if test picks are being used, they should be removed from the equipment under test.

6.03 Readings in 6.04 may be made with the KS-14510 volt-ohm-milliammeter, the resistance of which is 20,000 ohms per volt, or with any available instrument having higher resistance. Values of voltage given in 6.04 are obtained with the KS-14510 meter. The output of the rectifier will not be appreciably affected by connecting either of these instruments to check the values given in the table.

6.04 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 in Table A.

7. COMPONENT TEST PROCEDURES

7.01 Component tests are made with the rectifier completely de-energized (disconnected from the ac input power and from the output load). Momentarily shunt all high voltage capacitors with a 100-ohm resistor to be certain that they are completely discharged. Any charge left on the

TABLE A

OUTPUT VOLTS = 50 VOLTS
OUTPUT CURRENT = 100 AMPERES
SAT CURRENT 2 = 110 MILLIAMPERES

METER CONNECTIONS TEST POINT	TEST POINT	METER SCALE VOLTS	READING VOLTS
Contactor AC:			
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
Transistor Q1:			
*Emitter (Can)	Base TP13	0.300	0.125 DC
*Base TP13	Collector TP12	60	17 DC
Transistor Q2:			
*Emitter (Can)	Base TP15	0.300	0.150 DC
*Base TP15	Collector TP14	60	17.5 DC
Transistor Q3:			
*Emitter TP9	Base TP10	0.300	0.150 DC
*Base TP10	Collector TP11	60	17.5 DC
Resistors:			
R3	Across	60	22.5 DC
R8	Each	60	40 DC
R9	Resistor	60	38 DC
R12 & R14		12	5.5 DC

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

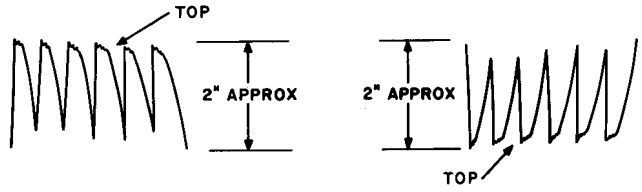

Fig. 2—Voltage Waveshape at Input to Filter

capacitors will cause inaccuracies in resistance readings.

Caution: In making continuity checks, use the ohmmeter portion of the KS-14510 meter. Do not use the X10,000 position for testing transistors, as the higher voltage used may damage them.

7.02 Before disconnecting leads, mark or record the connections. Do not solder or unsolder connections to transistors or diodes before referring to appropriate Bell System Practice.

7.03 ***Transistors:*** Using the lowest possible ohm range, connect the plus (+) lead of the meter to the collector and the minus (−) lead to the emitter of the transistor. The measured resistance should be greater than zero. A zero reading indicates a shorted transistor.

7.04 ***Capacitors:***

(a) Disconnect the capacitor to be tested.

(b) To check the resistance of a capacitor, use the X1000 switch position on the volt-ohm-milliammeter. Plug the red lead into the minus (−) jack of the meter and connect the other end of this lead to the plus (+) terminal of the capacitor. Plug the black lead into the plus (+) jack of the meter and connect the other end of this lead to the minus (−) terminal(s) of the capacitor. Measure the resistance across the capacitor. The resistance should be low initially and then should increase as the capacitor charges. If the resistance remains low, the capacitor is shorted. If resistance is high initially, there is high resistance or an open circuit in the capacitor.

(c) Reconnect the capacitor, being careful to observe proper capacitor polarity.

Note: In checking any of the following components, one of their leads should be disconnected from the circuits, otherwise additional circuit elements will affect measurement of its resistance.

7.05 ***Transformers:*** Use the KS-14510 meter to check for continuity between terminals of the transformer.

7.06 ***Inductors:*** Connect the KS-14510 meter across the inductor to check for continuity.

7.07 ***Diodes:*** Connect the KS-14510 meter across the diode and read the resistance. Reverse the meter leads and again read the resistance. One reading should be high and the other low. If both readings are high or low, replace the diode. (See 5.03.)

7.08 ***Resistors:*** Rotate the range switch on the KS-14510 meter to the appropriate ohm range. Connect the test prods or clips across the resistor and measure its resistance. Compare the measured value with the value given in the schematic drawing.