J86295A RECTIFIER
48 VOLTS, 200 AMPERES
VOLTAGE-REGULATED OUTPUT CONTROL
23- OR 24-CELL OPERATION (REGULAR CELLS ONLY)
OPERATING METHODS

1. GENERAL

1.01 The J86295A semiconductor-type, self-regulating rectifier using saturable reactor control is used to float and charge storage batteries of the 111A and 303A power plants.

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 Current Limit Circuit, and the Overload OL Relay.

(c) Add routine checks for the rectifier Ventilating Passages, Magnetic Amplifier Range Adjustment, Output Fuse Failure Shutdown, and the Plant TR Lead Shutdown.

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. Under manual control, the rectifier may be used to charge the battery at approximately 2.5 volts per cell.

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.

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

SD-81410-01, ▶Issue 13◀ —Rectifier Circuit (Fig. 1, 4,and 6)

SD-81411-01, ▶Issue 3◀ —VR-824 Network

For a detailed description of the operation, see the corresponding circuit description. ▶If this section is to be used with equipment or apparatus reflecting a 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	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.
—	Brush, Radiator, Blade-type or other approved dusting tool
—	3-Inch C Screwdriver
TEST APPARATUS	
—	Ballantine Laboratories, Inc, Model 300U/3 Electronic Voltmeter ▶(or equivalent digital voltmeter or vacuum tube voltmeter)◀
—	A.B. DuMont Lab, Inc, Type 304 Oscilloscope. This apparatus is not required for normal maintenance (see 5.07).
KS-3008	Stopwatch
KS-8039	DC Volt-Milliammeter
KS-14510	Volt-Ohm-Milliammeter

3. OPERATION

Note: All controls are accessible when the front doors are opened with the exception of the COMM SUPPR and BAL 1 through BAL 6 potentiometers. These controls are accessible when the hinged control panel (J86295D) is swung out. The ADJ VOLTS COARSE, ADJ VOLTS FINE, CON CUR-H, CON CUR-L, GAIN ADJ, and ANTI-HUNT controls are located on the VR network (CPS 1). For this application (23 or 24 cells only), the rectifier does not require a CUR REG potentiometer or an EM CELL lamp.

3.01 ***Preparing to Start:*** When preparing to start the rectifier, check the following.

(a) The rectifier controls are positioned as follows:

RECT (S2) switch to OFF

NOR-TST R key to NOR

AUTO-MAN key to AUTO

AMPL (S9) switch to NOR

▶REG (S11) switch 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: Do not reposition any other control at this time.◀

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

(c) 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.)

(d) 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) ▶Connect the KS-8039 dc volt-milliammeter (or equivalent digital multimeter), set on the 75 VOLTS DC scale, across the (+) and (−) terminals of the VM output voltmeter.◀

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

Requirement: The rectifier starts and the RECT FAIL lamp extinguishes.

(4) Observe the indication on the plant voltmeter and the KS-8039 meter.

(5) Adjust as necessary, the ADJ VOLTS COARSE and FINE potentiometers until the KS-8039 meter and the plant voltmeter indicate the float voltage as specified in the appropriate power plant Bell System Practice. (Typical float voltage requirement is 49.9 volts dc for 23 cells or 52.0 volts dc for 24 cells.)

The plant output voltmeter indicates the voltage that is available at the battery. The plant voltmeter and the KS-8039 meter may not indicate the same voltage, due to loop voltage drop of the charge leads. The rectifier output voltage must be adjusted until the voltage requirement is met at the plant voltmeter.

Note: The nominal float voltage for the battery in a standard plant is usually 2.17 volts per cell. For additional information on the required float voltage, refer to Section 157-601-301.

(6) On the power plant control panel, operate the FLOAT-CHARGE key to the CHARGE position.

Requirement: The rectifier output voltage should increase approximately 1 volt.

(7) Observe the indication on the plant voltmeter and the KS-8039 meter.

(8) Adjust as necessary, the CHG (R71) potentiometer until the KS-8039 meter and the plant voltmeter indicate the charge voltage as specified in the appropriate power plant Bell System Practice. (Typical charge voltage requirement is 50.6 volts dc for 23 cells or 52.8 volts dc for 24 cells.)

Note 1: The nominal charge voltage for the battery in a standard plant is 2.20 volts per cell.

Note 2: When the rectifier is used in the 111A power plant, the CHG potentiometer is normally shorted out by the connecting plant.

(9) In the connecting plant, operate the FLOAT-CHARGE key to the FLOAT position.

Requirement: The rectifier output voltage, as indicated on the KS-8039 meter, returns to float value.

(10) Lock the setting of the ADJ VOLTS COARSE and ADJ VOLTS FINE potentiometers.

(11) Disconnect the KS-8039 voltmeter.

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

(1) Remove the rectifier from plant service in accordance with the appropriate power plant Bell System Practice.

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

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 AMPL (S9) switch to the NOR position.

(3) Operate the AUTO-MAN key to the MAN position.

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

(5) Check that the MAN (R26) potentiometer is in the maximum counterclockwise (ccw) position.

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

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

Note: The MAN (R26) potentiometer should always be restored to its maximum ccw position at the completion of a check or when returning to automatic regulation.

3.05 ***Summary of Nominal Settings:*** For normal operation on 23- or 24-cell battery, the following adjustments should prevail unless plant requirements differ:

(a) The ADJ VOLTS COARSE and FINE potentiometers adjusted until the voltage output is equal to the battery float voltage requirement (49.9 volts dc for 23 cells or 52.0 volts dc for 24 cells).

(b) The CHG potentiometer adjusted to 2.20 volts per cell (50.6 volts dc for 23 cells or 52.8 volts dc for 24 cells).

(c) AR1 ammeter relay:

(1) Set the low contact at 10 amperes.

(2) Set the high contact at 200 amperes.

Note: ▶On rectifiers equipped with the KS-20522 controller, correct adjustment of the low contact is indicated by operation of the LC relay when the rectifier load is 10 amperes or less. See 1.05.◀

(d) The CON CUR-H potentiometer adjusted so the AR1 ammeter relay indicates 206 amperes.

(e) The OL relay operates at 225 amperes in 20 to 60 seconds. At 250 amperes, the OL relay operates in less than three seconds.

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 settings 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 ADJ VOLTS COARSE, GAIN, ANTI-HUNT, and CON CUR-H 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 voltage. An increase in current on the SAT CURRENT 2 milliammeter decreases the rectifier output voltage.◀

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

(2) ▶Operate the following controls:

NOR-TST R key to TST R

AUTO-MAN key to AUTO

AMPL (S9) switch to TST

REG (S11) switch to NOR

CON CUR TST (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

ADJ VOLTS COARSE 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) Operate the RECT (S2) switch to the NOR position.

Requirement: The SAT CURRENT 2 milliammeter indicates some value.

(4) Rotate the ADJ VOLTS COARSE potentiometer cw to reduce SAT CURRENT 2 milliammeter indication to zero.

Requirement: The SAT CURRENT 1 milliammeter indication increases to more than 100 milliamperes.

(5) Rotate the ADJ VOLTS COARSE potentiometer fully ccw.

(6) Operate the REG (S11) switch to the TST position.

Requirement: The SAT CURRENT 2 milliammeter indicates some value.

(7) Rotate the REG TST (R75) potentiometer cw to obtain 1 to 2 milliamperes on the SAT CURRENT 2 milliammeter.

(8) Operate and hold the REG TST (S10) switch to the TST position. [The REG TST (S10) switch is a momentary contact switch and must be held operated in the TST position.]

Requirement: The SAT CURRENT 1 milliammeter indication decreases to zero. The SAT CURRENT 2 indication increases to more than 100 milliamperes.

Note: If the requirement is not met, the CPS1 VR control circuit is possibly defective.

(9) Release the REG TST (S10) switch.

(10) Rotate the REG TST (R75) potentiometer fully ccw.

(11) Operate the REG (S11) switch to the NOR position.

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

4.04 ***Current Limit Circuit:*** To check the current limiting circuit, proceed as follows.

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

(2) Operate the following controls:

NOR-TST R key to TST R

AUTO-MAN key to AUTO

AMPL (S9) switch to NOR

REG (S11) switch to NOR

CON CUR TST (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

ADJ VOLTS COARSE potentiometer fully ccw

CON CUR-H potentiometer fully ccw

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

(3) Remove the BCF-A (F11) fuse, the F9 alarm fuse, and then the CHG (F8) fuse.

(4) Connect the KS-8039 dc volt-milliammeter (or equivalent digital dc voltmeter) across the REG(+) and REG(−) test jack on the control panel.

Caution: When one terminal of the electronic voltmeter is grounded, connect that terminal to the REG(+) test jack.

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

(6) Rotate the ADJ VOLTS COARSE potentiometer cw until the dc voltmeter indicates 49.9 volts (23 cells) or 52.0 volts (24 cells).

(7) Set the high contact on the OUTPUT CURRENT (AR1) ammeter relay to 250 amperes.

Note: ▶If the AR1 ammeter relay is equipped with the KS-20522 Controller, no adjustment of the high contact is required.◀

(8) 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.)

Requirement: The AR1 ammeter relay indicates approximately 100 amperes.

(9) ▶Slowly rotate the CON CUR TST (R18) potentiometer cw until the AR1 ammeter relay indicates 206 amperes.

(10) Observing the dc voltmeter connected at REG(+) and REG(−) test jacks,◀ rotate the CON CUR-H potentiometer ccw until the voltage indication decreases 1 volt.

(11) Release the CON CUR TST (S3) switch and rotate the CON CUR TST (R18) potentiometer fully ccw. Lock the setting of the CON CUR-H potentiometer.

(12) Check the current limit setting by holding the CON CUR TST (S3) switch operated and rotating the CON CUR TST (R18) potentiometer slowly cw until the voltage indication on the dc voltmeter drops 1 volt.

Requirement: The AR1 ammeter relay indicates 206 amperes.

(13) ▶When the requirement is met, release the CON CUR TST (S3) switch and rotate the CON CUR TST (R18) potentiometer fully ccw.

(14) Operate the RECT (S2) switch to the OFF position.◀

(15) Insulate the ▶6 EMB◀ contacts of the BO relay. ▶(Refer to Section 069-020-801 for procedure to insulate contacts.)◀

(16) ▶Operate the RECT (S2) switch to the NOR position.

(17) Operate and hold the CON CUR TST (S3) switch to the TST position and slowly rotate the CON CUR TST (R18) potentiometer cw until the AR1 ammeter relay indicates 206 amperes. Now ***very slowly,***◀ 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 OLA relay and shut down the rectifier. ▶The OVERLOAD lamp lights.◀

Note: If the rectifier does not shut down within the specified time, operate the OLA relay manually to determine whether the failure circuit path is operative. If the rectifier shuts down when the OLA relay is operated manually, the circuit path is satisfactory, but the OL relay circuit or OL relay may not be properly adjusted. (See 4.07.)

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

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

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

(21) Remove the insulation from the 6 EMB contact of the BO relay.

(22) Replace the CHG (F8) fuse, the F9 alarm fuse, and then the BCF-A (F11) fuse.

(23) Disconnect the dc voltmeter from the REG(+) and REG(−) test jacks.

(24) Readjust the high contact of the AR1 ammeter relay to 200 amperes.

4.05 ▶***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:

NOR-TST R key to TST R

AUTO-MAN key to MAN

AMPL (S9) switch to NOR

REG (S11) switch to NOR

CON CUR TST (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

ADJ VOLTS COARSE-FINE potentiometer set for float voltage

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-8039 dc volt-milliammeter (or equivalent digital dc voltmeter) across the REG(+) and REG(−) test jacks on the control panel.

Caution: When one terminal of the voltmeter is grounded, connect that terminal to the REG(+) test jack.

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

(5) Rotate the MAN (R26) potentiometer cw to increase the charging current until the indication on the dc voltmeter is 49.9 volts dc (23 cells) or 52.0 volts dc (24 cells) for currents below the full rated output of the rectifier. Maintain 49.9 or 52.0 volts dc, as applicable, as the charging current decreases.

(6) When the current indicated on the OUTPUT CURRENT (AR1) ammeter relay is less than 50 amperes, operate the AUTO-MAN key to the AUTO position.

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

(8) Adjust the ADJ VOLTS FINE potentiometer, as required, to obtain an output of 49.9 or 52.0 volts dc.

(9) Add sufficient load to obtain a rectifier output of 100 amperes.

(10) Observe the SAT CURRENT 1 and SAT CURRENT 2 milliammeters.

Requirement: The current indication on SAT CURRENT 1 milliammeter should equal the current indication on SAT CURRENT 2.

(11) Adjust, as required, the BIAS (R20) potentiometer until the indications on the SAT CURRENT 1 and SAT CURRENT 2 milliammeters are approximately equal.

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

(13) Disconnect the voltmeter from REG(+) and REG(−) jacks.

4.06 ***Float and Charge Voltage Adjustment:*** Adjust the float and charge voltage in accordance with 3.02.

4.07 ***Overload (OL) Relay Adjustment:*** Adjust the OL relay ***only*** if the requirement is not met in the overload shutdown test in 4.04.

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

(2) Operate the following controls:

NOR-TST R key to TST R

AUTO-MAN key to AUTO

AMPL (S9) switch to NOR

REG (S11) switch to NOR

CON CUR TST (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

ADJ VOLTS COARSE and FINE potentiometer set for float voltage

CON CUR-H potentiometer set in accordance with 4.04

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

(3) Remove the BCF-A (F11) fuse, the F9 alarm fuse, and then the CHG (F8) fuse.

(4) ▶Set the high contact on the OUTPUT CURRENT (AR1) ammeter relay to 250 amperes.

Note: If the AR1 ammeter relay is equipped with the KS-20522 solid state controller, no adjustment of the high contact is required.◀

(5) Insulate the 6 ▶EMB◀ contacts of the BO relay. ▶(Refer to Section 069-020-801 for procedure to insulate contacts.)◀

(6) Rotate the OL ADJ (R90) potentiometer fully cw.

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

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

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

(10) 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 (11).

(11) 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.

(12) While holding the CON CUR TST (S3) switch in the TST position, rotate the OL ADJ (R90) potentiometer slowly ccw, ***in steps***, until the OL relay operates and the rectifier shuts down within 20 to 60 seconds after the adjustment is made.

(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) After one minute, operate the RECT (S2) switch to the NOR position and repeat (8) through (11) to check the setting.

Requirement: ▶The OL relay operates within 20 to 60 seconds at the 225-ampere level to operate the OLA relay and shut down the rectifier.

Note: If the requirement is met, proceed to (29). If the adjustment range of the OL ADJ (R90) potentiometer is not sufficient to meet the requirement, continue with (15).◀

(15) 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.

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

Disconnect the OL ADJ (R90) potentiometer from the rectifier circuit.

(17) 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.

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

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

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

(21) 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 (22).

(22) Slowly readjust the CON CUR TST (R18) potentiometer cw until the AR1 ammeter relay indicates 225 amperes.

(23) 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 relay operates and shuts down the rectifier.

(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) Operate the RECT (S2) switch to the NOR position and repeat (19) through (22) to check the OL relay setting.

Requirement: The OL relay operates within 2 seconds at the 225-ampere level.

Note: If the requirement is met, continue with (26). If the requirement is not met, repeat (24) to turn the rectifier off and then repeat (17) through (25) until the OL relay does operate within 2 seconds.◀

(26) 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.

(27) Reconnect the OL ADJ (R90) potentiometer in the circuit.

(28) Rotate the OL ADJ (R90) potentiometer fully cw and repeat (7) through (14) to adjust the overload shutdown circuit.

(29) 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.

(30) Remove the insulation from the 6 EMB contact of the BO relay.

(31) Replace the CHG (F8) fuse, the F9 alarm fuse, and then the BCF-A (F11) fuse.

(32) Readjust the high contact of the AR1 ammeter relay to 200 amperes.

4.08 ▶*Gain and Anti-Hunt Adjustment*

Note: This procedure should eliminate cyclic hunting of the rectifier output voltage.

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

(2) Operate the following controls:

NOR-TST R key to TST R

AUTO-MAN key to AUTO

AMPL (S9) switch to NOR

REG (S11) switch to NOR

CON CUR TST (R18) potentiometer fully ccw

MAN (R26) potentiometer fully ccw

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

(3) Remove the BCF-A (F11) fuse, the F9 alarm fuse, and then the CHG (F8) fuse.

(4) Connect an ac vacuum tube voltmeter (or equivalent digital voltmeter set on ac millivolt scale) across REG(+) and REG(−) test jacks.

Caution: When one terminal of the voltmeter is grounded, connect that terminal to the REG(+) test jack.

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

(6) Adjust, as required, the ADJ VOLTS COARSE and FINE potentiometers until the VM output voltmeter indicates 49.9 volts dc (23 cells or 52.0 volts dc (24 cells).

Requirement: The ac voltmeter indicates a ripple voltage of less than 150 millivolts. The indication should be nearly steady, indicating minimum cyclic hunting.

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

(7) Slowly rotate the ANTI-HUNT potentiometer ccw until the requirement is met.

Note: When the requirement cannot be obtained with the best possible adjustment of the ANTI-HUNT potentiometer, rotate the GAIN ADJ potentiometer ccw until the requirement is met.

(8) When cyclic hunting is eliminated, lock the GAIN ADJ and ANTI-HUNT potentiometers.

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

(10) Disconnect the ac voltmeter.

(11) Install the CHG (F8) fuse, the F9 alarm fuse, and then the BCF-A (F11) fuse.

4.09 ***Shutdown Feature—CHG (F8) Fuse Failure***

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

(2) Operate the following controls:

NOR-TST R key to TST R

AUTO-MAN key to MAN

AMPL (S9) switch to NOR

REG (S11) switch to NOR

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

(4) Remove the F9, 1/2 ampere alarm fuse and replace it with a blown fuse.

Requirement: The RFA relay operates, the rectifier shuts down, and the RECT FAIL lamp lights.

(5) Replace the F9 alarm fuse with a good fuse.

Requirement: The rectifier ***will not*** restart and the RECT FAIL lamp remains lighted.

(6) Operate the RECT (S2) switch first to OFF and then to NOR.

Requirement: The rectifier ***will*** restart and the RECT FAIL lamp extinguishes.

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

4.10 ***Shutdown Feature—Plant TR Lead***

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

(2) Operate the following controls:

NOR-TST R key to TST R

AUTO-MAN key to MAN

AMPL (S9) switch to NOR

REG (S11) switch to NOR

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

(4) Place a temporary frame ground, using a suitable cord to the TR lead picked up at Terminal 3 of terminal strip TS6.

Requirement: The TR relay operates, the ST relay releases, and the rectifier shuts down.

(5) Remove the temporary frame ground.

Requirement: The rectifier ***will*** restart immediately.

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

4.11 ***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 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 into 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. Refer to block diagram—Fig. 1.

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 whose output controls the output of the main power rectifying circuit. The saturating current supply and main power circuits 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 manually control this saturating current, 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 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. The jacks are mounted in the face of the panel and are accessible when the front door is 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 the trouble 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 in the stack or bolt assembly which is part of the rectifying element.

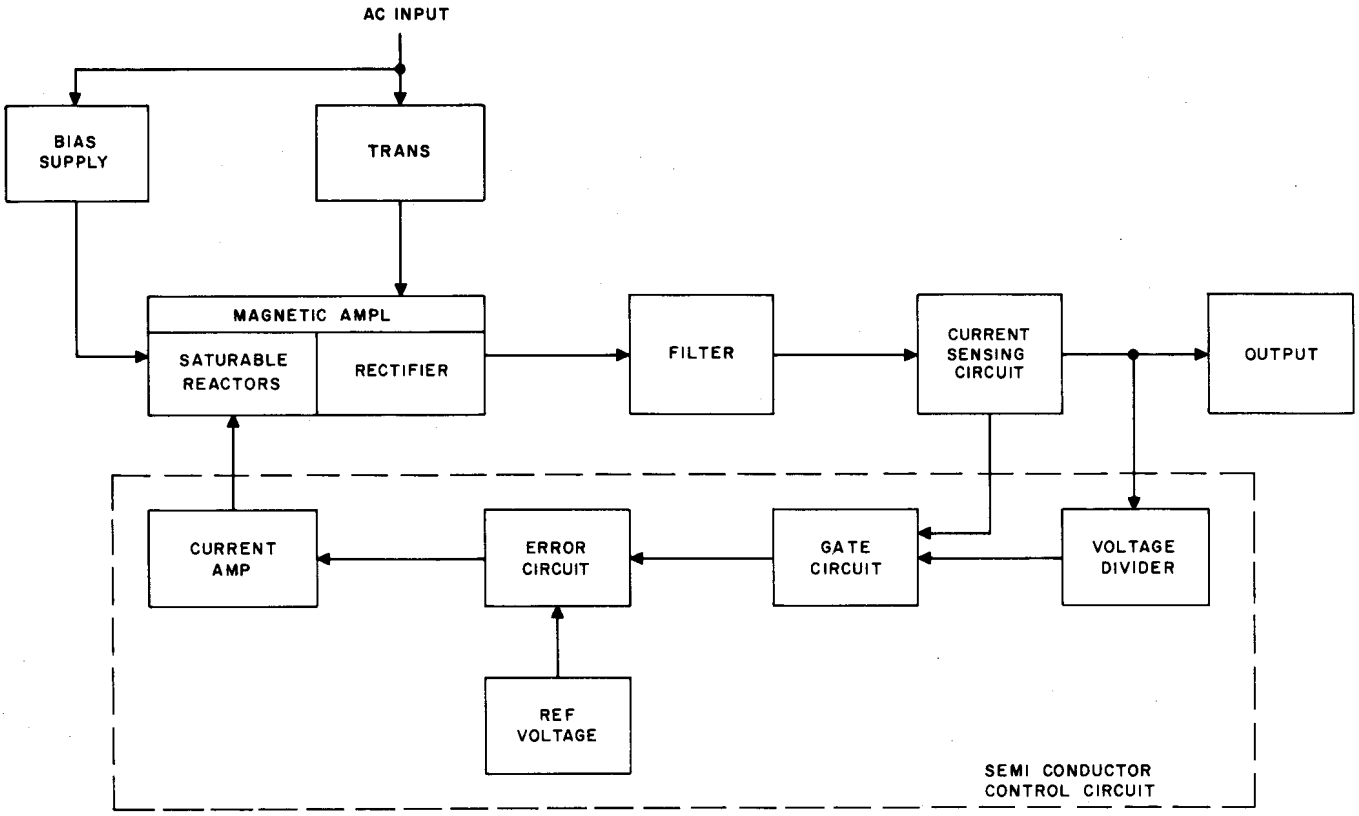

Fig. 1—J86295A Rectifier—Block Diagram

5.06 ***Trouble Chart:*** 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 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 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 (CPS 1).
(f) Output current high (output voltage high)	Defective VR network (CPS 1) 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 mode, 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.
	ADJ 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.
	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 5.07.

5.07 ***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 two 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 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 the saturable reactors as follows.

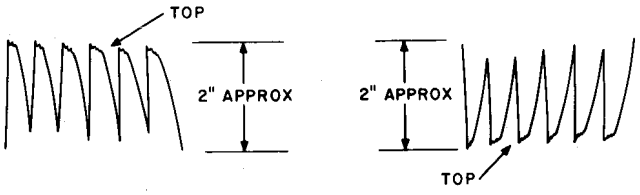

Fig. 2—Voltage Waveshapes at Input to Filter

(1) BAL 1 through BAL 6 balancing potentiometers of the saturable reactors should be turned 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) connected across the REG(+) and REG(−) jacks (see Caution) 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(+) test 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 which 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 range 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. The voltage values shown are with the SAT CURRENT 1 equal to SAT CURRENT 2.

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 in Table A.

7. COMPONENT TEST PROCEDURES

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

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

7.03 ***Capacitors:***

(a) Disconnect the capacitor to be tested.

(b) To check the resistance of a capacitor, use the X1000 switch position on the KS-14510 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.

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

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

7.06 ***Diodes:*** Connect the KS-14510 meter across the diode and read the resistance. Reverse the meter leads and again read the resistance.

TABLE A

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

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

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

One reading should be high and the other low. If both readings are high or low, replace the diode.

Note: If the diode is part of a rectifier stack, replace the entire stack.

7.07 ***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.