J86239C RECTIFIER
OPERATING METHODS

CONTENTS PAGE

1. GENERAL

1.01 This section covers the operation of a metallic-type rectifier using a saturable reactor control.

1.02 This section is reissued to remove information under the headings How the Rectifier Works, Regulation, and Manual Control, to remove the simplified schematic diagram, and to amplify the information covering replacement of rectifier stacks. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 This rectifier was designed to provide a regulated voltage for supplying a continuous or intermittent load, with or without a small battery connected to its output, in accounting centers for the AMA system. It is rated at 53 volts, 130 amperes direct current and should give voltage regulation within ±0.5 per cent for output currents between zero and 130 amperes. This includes input voltage variations of ±8 per cent and frequency variations of ±2 per cent, but does not include variations in output voltage due to low-frequency transients which may occur due to sudden load variations of appreciable magnitude. The unit is designed to use 210-volt, 3-phase, 60-cycle power but may be connected to 230- or 250-volt service by using transformers. It is self-regulating and is suitable for use in room temperatures from 50 F to 104 F (10 C to 40 C).

Caution: Voltages inside the rectifier case are over 150 volts to ground. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time, as destructive or dangerous short circuits may occur. The circuit breaker marked RECT, when in the OFF position, disconnects the power from the transformers but leaves one side of the AC contactor and circuit breaker connected to the service voltage, and also leaves some terminals and contacts connected to the regulating battery (when used), which leaves them at voltage to ground. Before opening the rear doors to do work inside the rectifier, disconnect the ac supply. When regulating battery is used, battery voltage will be present on the studs of the LOAD TRANSFER switch and elsewhere in the rectifier when the CHARGE FUSE is not removed. When the rectifier is shut down, the regulating battery (when used) shall be disconnected.

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

1.05 Keeping the ventilating passages and rectifier cells clean is especially important to prevent excessive heating.

1.06 Routine checks are intended to detect defects, particularly in infrequently operated parts of the equipment, and insofar as possible, to guard against circuit failures liable to interfere with service. 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 The instructions are based on drawing SD-81243-01. For detailed description of the operation, see the corresponding circuit description.

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

1.09 Jacks mounted on the front panel provide connections for a portable voltmeter for checking the voltage in various parts of the circuit when locating troubles.

2. LIST OF TOOL, GAUGES, AND MATERIAL

CODE OR SPEC NO.	DESCRIPTION
TOOL	
—	3-Inch C Screwdriver (or the replaced 3-inch cabinet screwdriver)
GAUGES	
KS-8039	Volt-Milliammeter
R-1032, Detail 1	Thermometer
MATERIAL	
—	Felt Pad

3. OPERATION

Preparing to Start Initially

3.01 When putting the rectifier into service initially, check that:

(a) The HV TST and OVER V switches on the control panel are in the NOR position.

(b) If input transformers are provided, the taps used are correct for the power supply voltage.

(c) The tap used on the T4 transformer is correct for the power supply voltage.

(d) Correct tubes are in the sockets.

(e) The VM and AC CONTROL circuit breakers are in the ON position.

(f) The LOAD TRANSFER switch is on SPARE.

(g) Proper ac power supply fuses are in place.

(h) The HV CUTOFF potentiometer is in the extreme cw position and the ADJ VOLTS, OVER V, and MAN potentiometers are in the extreme ccw position.

(i) A suitable meter, such as KS-8039 volt-milliammeter or an equivalent, having an accuracy within 1/2 of 1 per cent is available.

(j) REG switch is in the MAN position.

(k) The RECT circuit breaker is in the OFF position.

(*l*) The VM key is in the LOAD position.

(m) A variable resistor test load capable of carrying rated output of the rectifier is provided.

Initial Adjustments

3.02 ***Manual Operation:*** To adjust the rectifier output voltage for manual operation, observe the directions in 3.01. Add test load. (The battery, when provided, shall be disconnected.) Connect a KS-8039 volt-milliammeter or equivalent to measure the voltage at the distributing fuse cabinet or at the REG+ and REG− jacks on the control panel. Operate the RECT circuit breaker to ON. Allow approximately 30 to 50 seconds warmup time for the tubes in the electronic regulating circuit. Slowly adjust the MAN potentiometer cw to bring up the output voltage to the desired value and observe that the saturating current is indicated on the SAT CURRENT milliammeter. Rotate the MAN potentiometer to maximum ccw position.

3.03 ***Automatic Operation:*** To adjust the rectifier output voltage for automatic operation, see that the REG switch is in the AUTO position. Rotate the ADJ VOLTS potentiometer slowly cw until the voltage is close to the required value. Add test load in an amount equal to the anticipated average for the office. Bring the voltage accurately to the required value and recheck after the rectifier has been carrying load for 1/2 hour.

3.04 To adjust for ***high-voltage cutoff,*** which protects the connected equipment from excess voltage, see that the HV CUTOFF potentiometer is set so that the rectifier will automatically de-energize itself if the output voltage

exceeds a value approximately 5 volts above the normal output voltage as indicated on OUT VOLTS meter. The following procedure should be followed.

(a) Set the ADJ VOLTS potentiometer at its normal operating position and the HV CUTOFF potentiometer at the maximum cw position.

(b) Operate the LOAD TRANSFER switch to the SPARE position and remove the CHARGE FUSE.

(c) With the rectifier energized, set the output voltage (as read on OUT VOLTS meter) at 5 volts above normal output voltage, throwing the REG switch to the MAN position and adjusting the MAN potentiometer from the maximum ccw position.

(d) Since the HV relay is a thermal relay, fairly large ccw adjustments on the HV CUTOFF potentiometer should be made initially, with a 20-second delay between each change, to locate an approximate setting. When the rectifier shuts off, rotate the HV CUTOFF potentiometer slightly cw and restart the rectifier. Again allow 20 seconds between adjustments and rotate the HV CUTOFF potentiometer cw in smaller increments until the rectifier shuts down. With this adjustment, restart the rectifier and operate the HV TST switch. The rectifier should shut down in less than 2 seconds.

(e) Subsequent periodic checks of high-voltage cutoff should be made using the HV TST switch. With the rectifier operating normally at 53 volts output, operate the HV TST switch. The rectifier should shut down in less than 2 seconds.

3.05 ***Overcharge Voltage Adjustment:*** If the rectifier is used as a battery charger, an overcharge voltage adjustment is provided to permit charging the batteries. Operation of the OVER V switch to the CHG position will remove a short from the OVER V potentiometer. The output voltage may then be adjusted to the desired value with this potentiometer without changing the ADJ VOLTS potentiometer setting. Operation of the OVER V switch to the CHG position also inserts a resistor in the high-voltage cutoff circuit, raising the voltage necessary to operate the HV relay to prevent false operation.

3.06 ***Connecting the Rectifier to the Office Load:*** Remove test load. If the rectifier output voltage previously has been set at the proper value (see 3.02, 3.03, and 3.04), the rectifier can be connected to the office load by turning the RECT circuit breaker to the ON position and allowing the rectifier to warm up before inserting the CHARGE FUSE and before connecting the battery (when provided). The rectifier then will deliver power. If it is desired to start or operate the rectifier with the CHARGE FUSE removed when a battery is provided, the LOAD TRANSFER switch must be in the SPARE position. Otherwise the VM circuit breaker will open due to one of two reasons.

(a) If battery voltage is higher than the rectifier output voltage (as it will be before the rectifier is turned on), an inrush surge of current will flow from the battery through the negative regulating lead and the VM circuit breaker into capacitors (C6-C39).

(b) If the rectifier output voltage is higher than the battery voltage, the rectifier will deliver power to the load through circuit breaker (VM) and the negative regulating lead.

The rectifier may then be started as covered in 3.02.

Routine Adjustments (Normal Operation)

3.07 If a battery is provided, adjust OVER V potentiometer, with the rectifier adjusted for normal floating operation and the charge and regulation fuses (distributing fuse and alarm unit) in their respective places. Operate OVER V switch to CHG, connect the charging load, and rotate the OVER V potentiometer until the OUT VOLTS voltmeter indicates the desired voltage. Operate the OVER V switch to NOR after adjustment. If a battery is not provided, this adjustment is not required.

3.08 The rectifier has no disconnecting switches and the ac conductor is connected to ac power when the associated fuses are in place. The battery (when provided) can be disconnected in the associated plant. The ac CONTROL circuit breaker is used to connect and disconnect ac power to the control transformers for the electronic regulating circuit. The RECT

circuit breaker is connected to the auxiliary rectifier consisting of T4 and the RV1 rectifier stack. The LOAD TRANSFER switch is used to allow change-over to the spare rectifier in the AMA plant.

4. ROUTINE CHECKS

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

4.02 Periodically, as local conditions require, operate the HV TST switch to the TST position in order to check the high-voltage cutoff. This switch shorts out a resistor and thus causes an artificial high voltage to be applied to the HV relay.

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

5. TROUBLES

5.01 This rectifier consists of a main power circuit controlled through an electronic regulating circuit whose input is the output voltage of the main unit. The output of the regulating circuit is introduced into the main power circuit to effect 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 or 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 a REG switch. Pin jacks permit checking the performance of each major subdivision of the equipment until the trouble is located. (See 3.02.)

Caution: The MAN potentiometer should always be turned completely ccw to the NOR position before operating the REG switch to avoid excessive voltage.

5.02 The saturating current, although it may vary widely with extreme conditions 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 SAT CURRENT milliammeter is to give a continual indication of the output of the electronic regulating circuit, which output also controls the input to the main power rectifying circuit. The saturating current supply circuit and main power circuit are generally performing satisfactorily if increasing the amount of saturating current increases the rectifier output, and decreasing the saturating current 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. The REG switch is provided to permit, in the MAN position, the application of a manually adjustable potential to the filament and cathodes of the V1 current amplifier tube which directly controls the saturating current in the reactors.

5.03 When any kind of trouble is encountered, it is necessary first to decide whether to locate the trouble with the equipment operating or de-energized. This rectifier has been designed to make parts accessible for testing with the power connected. Pin jacks on the front panel provide for most maintenance and operational voltage measurements. In addition to the pin jacks, numerous other points in the circuit are brought out to connections on rear of panel terminal strips. All parts over 150 volts to ground have been covered or shielded by insulating guards. Trouble is easier to find if the equipment can be fully energized, but if it is of a nature that causes excessive output from the equipment, it will be necessary to take the initial steps with the system de-energized, energizing it in subdivisions for short periods only while electrical measurements are made. Also, operation for more than a few minutes at a time while trouble exists, even though the output may not be excessive, may result in overheating of some component. It is essential, when testing, to be on the alert for the need of quickly shutting down the rectifier at any time until the trouble is localized and cleared.

5.04 Electron tubes may become defective with use. Check the tubes in any available tube tester in accordance with the information for the tester. Certain typical defects, such as grid emission or cathode-to-grid shorts, may not be detected on the tester as they might occur only after the tube has heated for some time.

5.05 Rectifier stacks will age with use so that, after a period of years, it may be necessary to change the transformer connection from the NEW to the AGED tap. (See 5.06.) When replacement is required due to aging, replace the stacks as covered in 5.07.

5.06 Aging taps are provided on the T4 transformer for use when the auxiliary rectifier RV1 has aged. The connection should not be changed to the next highest voltage value unless, with the supply voltage at the nominal value, the dc output voltage of the RV1 rectifier stack is less than 50 volts with contactor ac control operated.

5.07 Selenium rectifier cells may fail due to aging, which is an increase in the resistance of the cells. The replacement of only the defective stack in the rectifying element that consists of more than one stack may result in an unbalanced condition in the rectifying element. To avoid unbalance, replace stacks as follows.

(a) When replacing a defective stack or stacks in a multiple stack element, replace all other stacks in the element that have been in service 2 years or longer.

(b) Do not combine stacks of different list numbers or different manufacturers.

(c) Do not attempt to replace part of the rectifier cells in a stack or bolt assembly. Always replace the entire stack.

5.08 If the rectifier stacks seem hot, check the temperature with the R-1032 thermometer as follows. Hold the bulb of the thermometer against the stack, covering that part of the bulb which is not in contact with the stack with a piece of felt or equivalent. If the temperature exceeds 90 C, the stacks are probably nearing the end of their useful life and the supervisor should be notified so that replacement of stacks may be considered.

Trouble Chart

5.09 Should any of the following troubles develop, it is suggested that the possible causes be checked in the order given. If 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 referred to on drawing SD-81243-01, does not lead to the location of the trouble, it is advisable to make resistance measurements with the circuit completely de-energized, comparing the measurements with the values shown on the circuit drawing.

TROUBLE	POSSIBLE CAUSE
(a) No dc output current (no saturating current)	Power failure
	Blown ac or CHARGE fuses or circuit breakers
	Auxiliary rectifier failed
	Switches off normal
(b) No dc output current (low saturating current)	ADJ VOLTS potentiometer misadjusted
	REG switch in MAN position
	Low emission in V1, V2, and V3 electron tubes
	Defective V4 electron tube
(c) High dc output current (high saturating current)	Misadjustment of ADJ VOLTS or OVER V controls
	REG switch in MAN position
	Defective V1, V2, V3, and V4 electron tubes
(d) High dc output current (low saturating current)	Incorrect tap on T11, T12, and T13 stepdown transformers
	Excessive voltage at primary of T6, T7, and T8 transformers
(e) Low dc output current (high saturating current)	Aged main rectifiers
	Poor connection
(f) Excessive voltage at light loads	R29, R30, and R31 resistors not in circuit when ac contactor is operated
	Incorrect tap on T11, T12, and T13 transformers

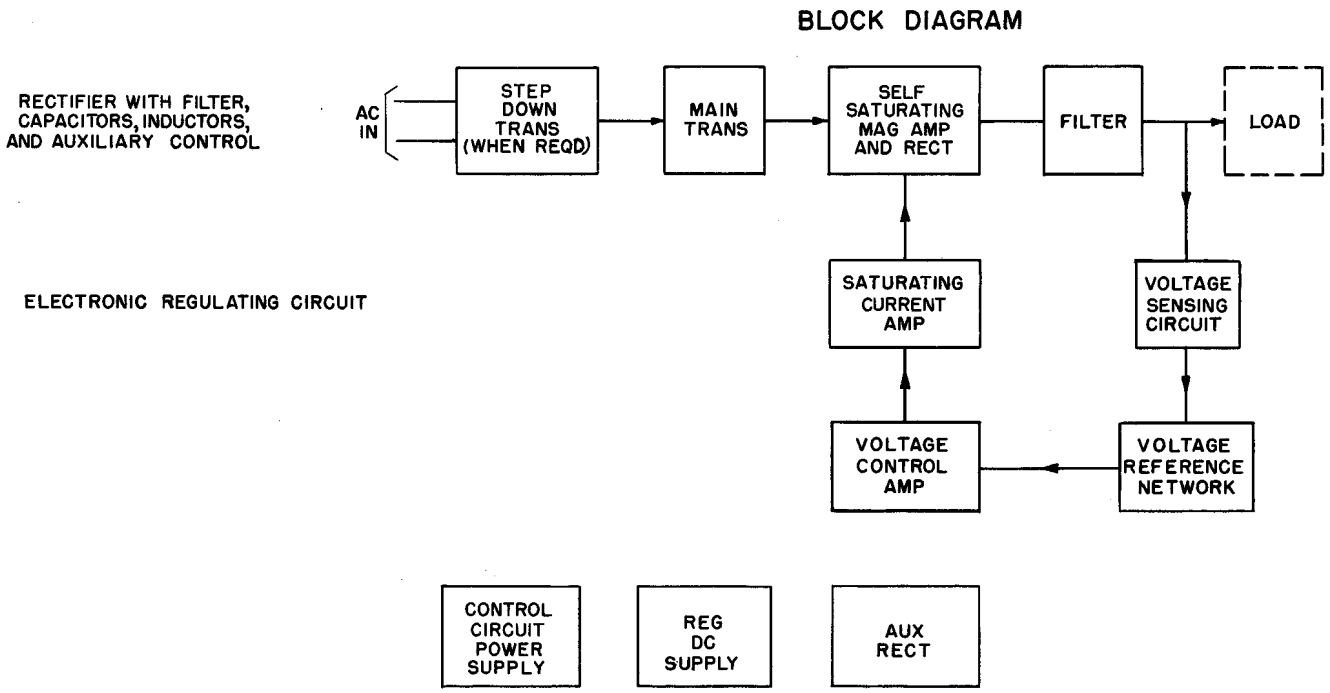

Fig. 1 – Block Diagram of J86239C Rectifier