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J86239A Rectifier - Operating Methods

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connected across the load. This will cause a similar change between jack REG- and cathode 6 of V5. The voltage between grid 4 of V5 and REG- remains substantially unchanged, the grid being connected to terminal 3 of potentiometer ADJ V whose voltage to REG- is a part of the voltage across 1-2 of varistor RV3. The design characteristic of RV3 is such that a practically constant voltage is maintained across terminals 1-2 with normal variations in voltage across terminals 1-3. The grid-to-cathode voltage in V5 is continuously a comparison of the voltage across R13 and terminals 1-3 of potentiometer ADJ V with the voltage across R12 and R17. Since the former is constant and the latter is decreased, the net grid-to-cathode voltage is reduced.

2.07 This reduction in grid bias reduces the plate-to-cathode resistance of the 4-5-6 half of V5 and causes an increase in the current flow through R9 and, therefore, in the voltage across it. This reduces the voltage of plate 5 and cathode 3 of V5. Since the voltage of grid 1 of V5 remains constant, the grid bias is reduced and there is an increase in the current flow through the 1-2-3 half of V5 and through R10, resulting in a decrease in the voltage of plate 2 of V5 and of the cathodes of series tubes V2, V3, and V4 while the grids remain at their original voltage. This produces a reduction in the grid bias of these tubes, with a consequent increase in the saturating current and in the output voltage of the main rectifier, as covered in 2.05. A decrease in load would have effects opposite to those described.

2.08 The voltage at which the rectifier will regulate is adjustable by means of the ADJ V potentiometer. Higher voltages for charging the battery may be obtained, without disturbing the floating voltage adjustment, by means of potentiometer OVER V which, during normal floating operation, remains in the CCW position.

Manual Control

2.09 Potentiometer MAN and resistor R8 form a potentiometer across the two amplifier supply voltages. They provide an adjustable voltage for use in testing the various parts of the control circuit. With the TST1-TST2 key operated in the TST1 position the cathodes of series tubes V2, V3, and V4 are connected to terminal 3 of potentiometer MAN. Adjustment of MAN varies the grid bias on these tubes, controls the saturating current to give manual regulation, and provides a means of testing the series tubes apart from the amplifiers. The TST1 position of this key is locking. In the TST2 position of the key the setting of MAN determines the cathode voltage of the second control stage (cathode 3 of V5) and provides a means of checking this stage of the amplifier. This position of the key also, is locking.

2.10 Aging taps (not shown) are provided on transformer T4. They are for use when the associated rectifier element has aged, usually after a long period of use. The connection should not be changed from terminals 3 to terminals 2 until the rated output cannot be obtained from the rectifier and until a thorough check has been made to be sure that there are no other troubles. If rated output can be secured with manual control, it will indicate that the transformer taps do not need to be changed. Similarly, aging taps are provided on transformer T8. The connection should not be changed unless, with the supply voltage at the nominal value, the d-c output voltage of varistor RV1 is less than 45.6 volts with contactor AC operated.

2.11 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.

Preparing to Start

2.12 When putting the rectifier unit into service initially, check against the circuit drawing to see that:

(a) Key unit TST1-TST2 is in the non-operated position.

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

(c) The tap used on transformer T8 is correct for the power supply voltage.

(d) Correct tubes are in the sockets.

(e) The charge fuse is removed from the rectifier.

(f) Circuit breaker VM is in the ON position.

(g) The LOAD TRANS switch (not shown) is on SPARE.

(h) Proper a-c power supply fuses (not shown) are in place.

(i) Potentiometer HV CUTOFF is in the extreme CW position and potentiometers ADJ V, OVER V, and MAN are in extreme CCW position.

(j) A 25-cell battery and a variable load capable of carrying 150 amperes at 49 to 57 volts are available and connected between the (-) terminal of the main rectifying element and the load side of the AM ammeter shunt.

(k) A suitable voltmeter, having an accuracy within 1/2 of 1 per cent is available.

Initial Adjustments

2.13 Observe the directions in 2.12. Operate ON-OFF switch (not shown) to ON. Operate RESET switch momentarily to RESET. Allow five minutes for heating the control tubes. Operate the key unit to TST1. Slowly turn potentiometer MAN clockwise and observe that saturating current is indicated on milliammeter SAT CUR. Bring up the output voltage to its rated value, and adding load as required, continue the adjustment of MAN until full-load current and voltage are obtained. Reduce the load, at the same time returning MAN to its CCW position. Operate the key unit to TST2 and repeat the above check of output. Return MAN to its CCW position and the key unit to its nonoperated position.

2.14 To adjust for float voltage, see that the key unit, TST1-TST2, is in the nonoperated position and that the several potentiometers are as covered in 2.12(i). Connect a voltmeter, KS-8039 or any other of ±0.5 per cent accuracy, to measure the voltage at the rectifier output terminals. Rotate potentiometer ADJ V slowly CW until the voltage is close to the required value. Add 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 one-half hour.

2.15 To adjust for high voltage cutoff see that potentiometer ADJ V is in its normal operating position and potentiometer HV CUTOFF at maximum CW. Set the output voltage by rotating potentiometer OVER V clockwise at a value, as measured by voltmeter VM (not shown), of 10 volts above the normal output for the particular rectifier. Normal output voltage will be float voltage for a regular rectifier and overcharge voltage for a spare. Slowly rotate potentiometer HV CUTOFF counterclockwise until the rectifier automatically shuts down. Leave the potentiometer in this position and return potentiometer OVER V to its CCW position.

Routine Adjustments (Normal Operation)

2.16 To adjust potentiometer OVER V, with the rectifier adjusted for normal floating operation and the charge and regulation fuses in their respective places, connect the charging load and rotate the potentiometer until voltmeter VM indicates the desired voltage.

2.17 The rectifier has no disconnecting switches and is connected to a-c power and the battery when the associated fuses are in place. The ON-OFF switch is used to connect and disconnect a-c power for the main transformers and the electronic regulating circuit. The LOAD TRNS switch is used to allow change-over to the spare rectifier without interruption of the load current.

3. ROUTINE CHECKS

3.01 Routine checks of the vacuum tubes can be made with a vacuum tube tester to determine when a tube is in poor condition and should be replaced. For this purpose, refer to Sections 100-630-101, 100-633-101 or 100-640-101. A periodic check is desirable.

3.02 J86239B rectifiers are equipped with pin jacks to check that the load is balanced between tubes V2, V3, and V4. Connect the negative lead of a portable voltmeter to pin jack S+. Connect the positive voltmeter lead successively to pin jacks J1, J2, J3, J4, J5, and J6 and record each voltage. The voltages should be approximately equal. If the voltage on either section of any tube differs by more than 50 per cent from the average of the six voltages, replace that tube (Example: If J1 is 1.9v, J2 is 2.1v, J3 is 2.2v, J4 is 4.1v, J5 is 2.5v, and J6 is 1.8v, replace tube V4).

4. TROUBLES

4.01 This rectifier unit 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 unit provision has been made for opening the loop by means of keys, which permit checking the performance of each major subdivision of the equipment until the trouble is located. See 2.09 and 2.13.

Caution: The MAN rheostat should always be turned completely counterclockwise to the NOR position before operating a TEST key to avoid excessive voltage and current.

4.02 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 saturating current milliammeter is to give a continual indication of the output of the 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 test key unit is provided to permit, in the TST1 position, the application of a manually adjustable potential in the grid-to-cathode circuit of the three parallel tubes which directly control the saturating current in the reactors and, in the TST2 position, in the grid-to-cathode circuit of the second stage of the voltage amplifier. The grid-to-cathode potential of the first stage of the voltage amplifier may be varied by adjusting potentiometer ADJ V.

4.03 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 unit has been designed to make parts accessible for testing with the power connected. 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 alert for the need for quickly shutting down the retifier at any time until the trouble is localized and cleared.

> Caution: Avoid contact with terminals 3 and 4 of the L- saturable reactors. While this is nominally a low-voltage dc winding, ac voltages as high as 500 volts may be present under normal operating conditions.

4.04 In general, the only items likely to become defective with use are the vacuum tubes which are subject to aging but should have long useful life.

4.05 Control potentiometers KS-13790, rotary snap switches KS-13674, and door switches KS-5649 should be replaced if they become defective in any respect.

4.06 Varistors will age with use, and after a period of years, may require adjustment of the connection from the NEW to the AGED tap. See the circuit drawing.

Trouble Chart

4.07 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 voltage table 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
No d-c output current	Power failure Blown a-c supply, or a-c control fuses Blown charge fuse Failure of tube V1, V5, or all of V2, V3, and V4 ADJ V (or OVER V) potentiometer out of adjustment No saturating current HV potentiometer adjusted too low VM circuit breaker OFF
Low d-c output Low saturating current	ADJ V (or OVER V) potentiometer out of adjustment Line voltage more than 8 per cent low Low emission in tubes V1,V2,V3,V4, or V5 Aged voltage reference tube V6
Rated output current not obtainable with saturating current maximum, under MAN control	High resistance at some contact in main power circuit Aged main rectifying element
High d-c output current or voltage High saturating current	ADJ V (or OVER V) potentiometer out of adjustment Line voltage more than 8 per cent high Aged varistor RV3 Excessive grid current in tubes V2, V3, V4, or V5

High d-c output voltage with saturating current minimum under MAN control	Line voltage more than 8 per cent high

5. POINT-TO-POINT VOLTAGES

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

5.02 High voltages to ground 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, 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 connections are to be changed from one instrument range to another, the alternating current 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.

5.03 The readings given in the table are approximate, and typical of a rectifier unit adjusted as indicated. They are made with the M9B meter, which has an accuracy of ±5 per cent on alternating current and ±2 per cent on direct current. It does not appreciably affect the rectifier output when connected for making the readings. This meter is provided with test pick leads and with 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. Connect the apparatus terminal specified under TO in the table to the -V jack of the meter. Where the 600V jack is specified and the available M9B meter has no 600V jack, the connection should be made using a multiplier (D-176926 plug) plugged into the 300V jack, or 600,000 ohms may be connected in the lead to the 300V jack.

5.04 Access for making measurements depends on the location of the equipment, as given in the table of point-to-point voltages.

> Caution: The readings shown in the following table are for a typical rectifier unit in good working condition. A defect in a rectifier unit may leave a high voltage charge on a capacitor and other parts of the circuit with the power off. A defective rectifier unit with the power connected may have quite different voltages than those shown. Therefore, it may be desirable to use a higher voltage jack in the meter until readings indicate the proper jack to use for the defective condition. Remove all a-c and d-c fuses before removing any protecting guards behind the covers to work inside rectifier unit.

(a) For equipment located on the front of the panel, open the doors on the front of the cabinet. This will expose the panel, which is partly covered by a plastic guard, and will not affect the operation of the rectifier unit.

(b) For equipment located on the rear of the panel, with the doors open, unfasten and swing the panel out. This will open a door switch and shut down the rectifier unit but will not disconnect it from line and battery.

(c) For equipment located in the rear of the cabinet, open the rear doors. This will open a door switch and shut down the rectifier unit but will not disconnect it from line and battery.

(d) When making measurements of the voltages of equipment located on the rear of the panel or in the rear of the cabinet, test clip leads will be required. Attach the leads to the terminals of the equipment, swing the panel into position, or close the doors, taking care to keep the leads from being damaged. Allow about one minute for the output voltage to stabilize before making the measurement.

Table of Point-to-Point Voltages

5.05 Rectifier unit adjusted to 53.2 volts at the point of regulation, 110 amperes output with 230-volt, 60-cycle power supply connected through the input autotransformers.

Voltage Across	Measurements Taken From App.	From Term.	To App.	To Term.	M9B Meter Jack	Toggle Switch	Reading Volts
			Front of Panel				
C1, R32	Jack	S+	Jack	S-	150	D-C	86
C5	Jack	S+	Jack	P	600	D-C	28
C13	Jack	P	Jack	GRD	300	D-C	146
C18	Jack	B	Jack	P	300	D-C	114
R16	R16	Bot.	R16	Top	150	D-C	56
R17	R17	Bot.	R17	Top	150	D-C	7
R30	R30	Top	R30	Bot.	300	D-C	76
R8	R8	Top	R8	Bot.	150	D-C	36
R12 Note	R12	Top	R12	Bot.	150	D-C	51
R14	Jack	GRD	Jack	REG +	3	D-C	0.22
R7	Jack	REG-	R15	Top	3	D-C	0.34
V1 Output	Jack	SP	Jack	S-	300	D-C	260
V2,V3,V4	Jack	SP	Jack	S+	300	D-C	186
			Rear of Panel				
RV3	RV3	2	RV3	1	600	D-C	72
RV1	RV1	3	RV1	1	150	D-C	49
V5	V5	5	V5	6	600	D-C	67
R9	Jack	B	V5	5	600	D-C	52
			Rear of Cabinet				
SR	T4	AC1	T4	AC2	150	A-C	41
SR	T4	AC2	T4	AC3	150	A-C	41
SR	T4	AC3	T4	AC1	150	A-C	41

Note: R12 measured with OVER V set at maximum CCW.

Attachments: Fig. 1

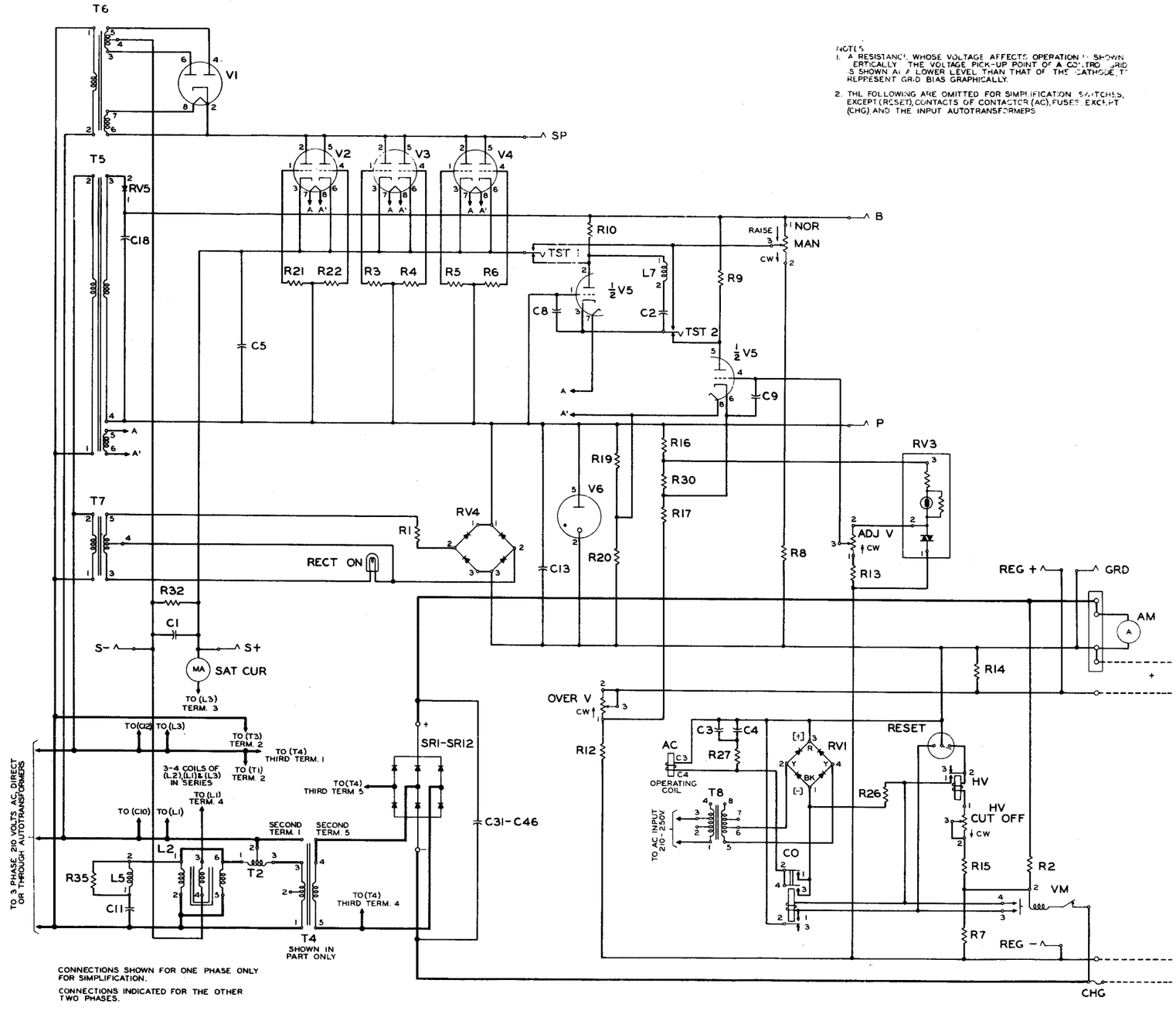

Fig. 1 - Functional Schematic