

J86240. A or B RECTIFIER UNIT

1. GENERAL

1.01 This section covers the operation of automatically regulated electron tube type rectifier units using phase shift grid control of mercury vapor type tubes, for floating and charging storage batteries. They were designed originally for the 425 type telephone power plants in the TD2 radio relay system where the B unit is combined with the A unit to give a total of 250 volts. The A and B units are identical as far as operating methods are concerned. Each unit is rated 130 volts 8 amperes but is capable of floating and charging storage batteries consisting of 49, 55, 56, 61, 63, 66 or 70 cells in series at 8 amperes up to 2.30 volts per cell. Regulation should be within ± 1 per cent for loads from 0.5 to 8 amperes with power services of 200 to 250 volts ± 5 per cent at 60 cycles ± 2 per cent. The units are designed for use in room temperatures between 40 and 104F (4 to 40C).

Caution: Voltages inside the rectifier cases are higher than those usually encountered in telephone power plants. Avoid all contacts with terminals as high voltages are present. Do not allow a test pick to touch two metal parts at the same time as destructive and dangerous short circuits may occur. Remove all a-c fuses and the d-c charge and regulation fuses associated with the rectifier units before removing any protective guards behind the covers to work on the inside of the units. Even with switch AC in the OFF position, the power supply is connected to several terminals inside the rectifier units and the battery connections are not opened.

1.02 Routine checks are intended to detect defects particularly in infrequently operated parts of the equipment and, insofar as possible, 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.

1.03 In this section the term capacitor is used for all apparatus coded as either a capacitor or a condenser and the term resistor is used for all apparatus coded as either a resistor or a resistance.

1.04 The instructions are based on drawings SD-81076-01 and SD-81077-01.

1.05 More detailed information on the operation and maintenance of individual pieces of apparatus, such as keys, relays, etc., is given in other sections and the attendant should, of course, be familiar with them. All relays, etc., are assumed to have been adjusted in accordance with these sections and the circuit requirements tables of the circuit drawings. Refer also to such sections as:

A401.508	KS-15072 Contactor
A401.522	Ammeter Relay
A401.562	Meters and Instruments
A438.961	Electrolytic Capacitors
A702.661	Vacuum Tube Tester
A702.662	
A702.664	

1.06 Information in this section is arranged under the following headings:

1. GENERAL
2. OPERATION

- 2.01 How the Rectifiers Work
- 2.15 Preparing to Start
- 2.16 Initial Adjustments
- 2.21 Routine Adjustments

3. ROUTINE CHECKS
4. TROUBLES
5. POINT-TO-POINT VOLTAGES

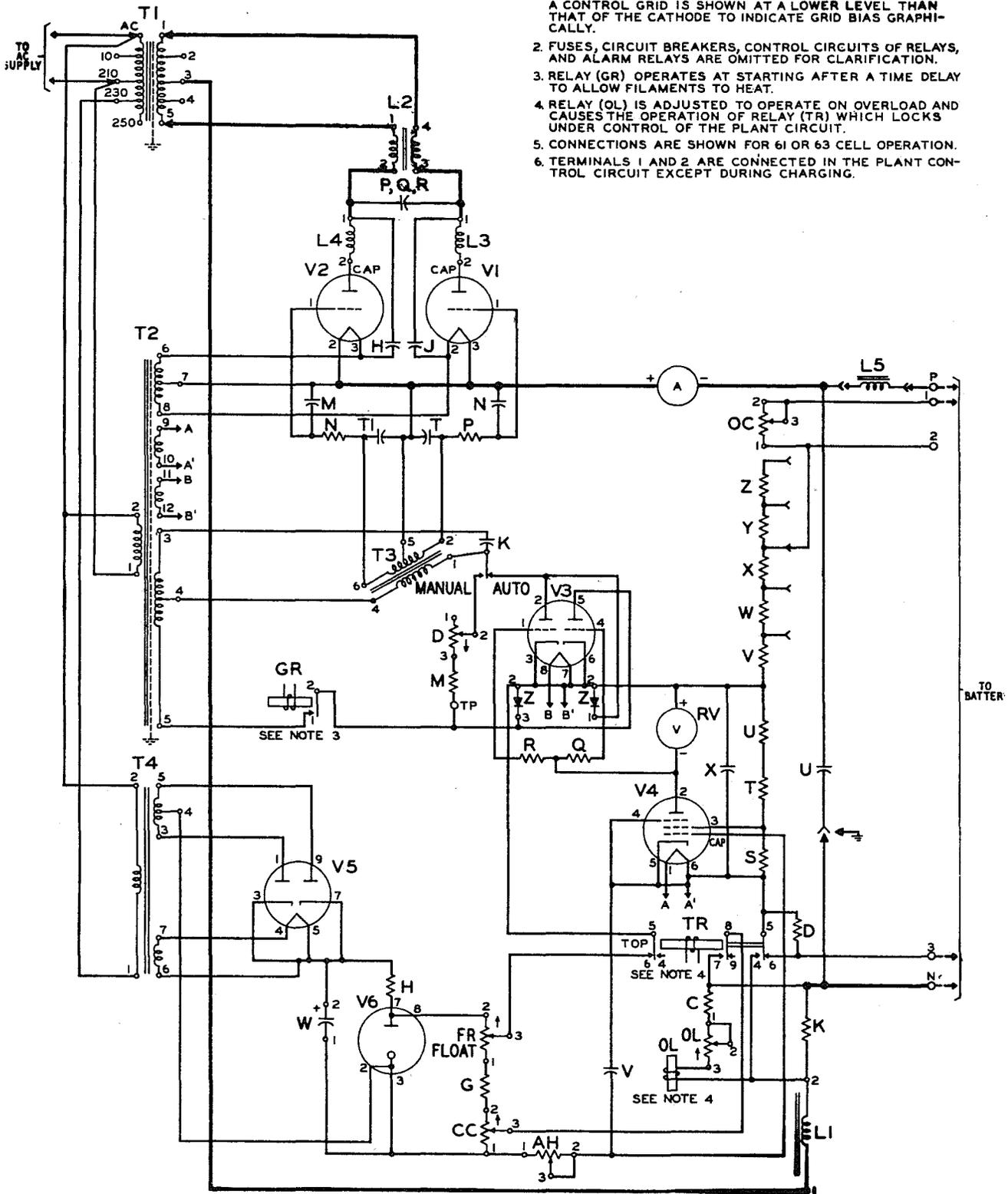
1.07 List of Gauges
(Equivalents may be substituted)

M9B Meter
Volt-milliammeter, KS-8039

2. OPERATION

How the Rectifiers Work (See Fig. 1 Functional Schematic)

2.01 In these rectifier units a-c power through transformer T1 is converted to direct current by 3-element grid controlled tubes V1 and V2 arranged for full wave rectification. In the main rectifying circuit there is an ammeter to indicate the output current, retard coil L1 and in some cases L5 and capacitor U to filter the output by reducing its ripple voltage, and resistor K to provide means for transferring the control from a voltage to a current basis and for obtaining current regulation. Regulation is secured by shifting the phase relation between the plate voltages and the grid voltages applied to tubes V1 and V2. When



- NOTES:
1. A RESISTANCE WHOSE VOLTAGE AFFECTS OPERATION IS SHOWN VERTICALLY. THE VOLTAGE PICK-UP POINT OF A CONTROL GRID IS SHOWN AT A LOWER LEVEL THAN THAT OF THE CATHODE TO INDICATE GRID BIAS GRAPHICALLY.
 2. FUSES, CIRCUIT BREAKERS, CONTROL CIRCUITS OF RELAYS, AND ALARM RELAYS ARE OMITTED FOR CLARIFICATION.
 3. RELAY (GR) OPERATES AT STARTING AFTER A TIME DELAY TO ALLOW FILAMENTS TO HEAT.
 4. RELAY (OL) IS ADJUSTED TO OPERATE ON OVERLOAD AND CAUSES THE OPERATION OF RELAY (TR) WHICH LOCKS UNDER CONTROL OF THE PLANT CIRCUIT.
 5. CONNECTIONS ARE SHOWN FOR 6I OR 63 CELL OPERATION.
 6. TERMINALS 1 AND 2 ARE CONNECTED IN THE PLANT CONTROL CIRCUIT EXCEPT DURING CHARGING.

Fig. 1 - Functional Schematic

the grid voltages are in phase with the plate voltages, the output is maximum. The output decreases as the grid voltages become more and more out of phase with the plate voltages.

2.02 The control equipment produces this shift in phase relationship by varying the resistance in series with capacitor K across terminals 3 and 5 of transformer T2, the primary of the phase shift transformer T3 being bridged between the mid-point terminal 4 of T2 and the junction of the capacitor K and the series resistance. This resistance may be resistor M and rheostat D under manual control or the plate resistance of tube V3 under automatic control. When the resistance in series with capacitor K is a maximum, the grid voltages are nearly out of phase with tube V1 and V2 plate voltages and the output is very small. As the resistance decreases the grid voltages become more nearly in phase and the output increases.

Manual Control

2.03 For manual control the rheostat switch AUTO/MANUAL is in the MANUAL position and the effective resistance in rheostat D is varied to secure the rectifier output required. With maximum resistance the output is low and as the resistance is decreased the output can be increased to rated capacity. With manual control the output voltage once adjusted is subject to variation with changes in load and power supply line voltage.

Automatic Control

2.04 With automatic control, the AUTO/MANUAL rheostat-switch is in the AUTO position and the plate resistance of tube V3 is substituted for resistor M and rheostat D. The plate resistance of tube V3 is controlled by the output of amplifier tube V4 which is governed by a grid bias which is the result of a continuous comparison of a portion of the regulated voltage with a reference voltage.

2.05 A reference voltage for the control amplifier is provided by transformer T4, rectifying tube V5, resistor H, and voltage reference tube V6 in parallel with potentiometers FLOAT and CC and resistor G. Variations in output voltage of V5 caused by power supply voltage variations are absorbed in resistor H, the characteristic of tube V6 being to maintain practically a constant voltage across its terminals 3-7. This controls the voltage applied to the potentiometer consisting of potentiometers FLOAT and CC and resistor G. From this potentiometer reference voltages are obtained for voltage and current control.

2.06 The regulation leads for the rectifier unit are connected from the bat-

tery or other point of control to rectifier terminals 1 and 3 across which is a potentiometer consisting of resistors S, T, U, rheostat OC, and one or more of resistors V, W, X, Y, Z depending on the number of cells in series in the battery. Terminals 1 and 2 are normally short circuited by the plant control relays, rheostat OC being used in the potentiometer circuit only during charging. Resistor D avoids an open during the operation of relay TR.

2.07 Amplifier tube V4 is connected to this potentiometer across the regulation leads in such a way as to amplify slight variations in battery voltage and cause appropriate variations in the grid bias of tube V3. These changes in grid bias change the plate resistance of V3 causing a phase shift in the grid voltages applied to the main rectifying tubes V1 and V2 thereby producing a change in the output of the rectifier unit.

Voltage Control

2.08 When the load on the battery increases, it causes a slight decrease in the battery voltage which reduces the voltage across the resistor S, T, U part of the potentiometer connected to the regulation leads. The junction of resistors U and V is connected to terminal 3 of rheostat FR through top contacts 5-6 or relay TR. In this way the voltage across resistors S, T, and U is constantly compared with the reference voltage across FR(3-1), G, and CC, giving a negative grid bias for tube V4 of about 1 volt. When the voltage across resistors S, T, and U decreases the grid bias on V4 increases, increasing V4 plate resistance and reducing the voltage on voltmeter RV. This voltage is the grid bias for tube V3. A reduced grid bias for tube V3, reduces the plate resistance of V3 causing the grid voltages from grid transformer T3 to be more nearly in phase with the plate voltages on tubes V1 and V2 and increasing the rectifier output to correct for the increased load. A decrease in load would, of course, have the opposite effects.

2.09 The plate resistance of V3 is effective for both halves of the a-c voltage cycle from T2 in this way. Assuming the plate resistance to be low and terminal 4 of T2 to be instantaneously positive with respect to terminal 5, then current will flow from terminal 4 of T2 through the primary of T3, through V3(2-3), the 2-3 half of varistor Z and contacts 2-1 of relay GR to terminal 5 of T2. During the next half cycle, terminal 5 of T2 will be positive with respect to terminal 4 and current will flow through contacts 1-2 of relay GR, V3(5-6), the 2-1 half of varistor Z, the primary of grid transformer T3 (in the opposite direction to the previous half cycle), to terminal 4 of transformer T2.

Current Control

2.10 When the load on the battery increases to a value in excess of the capacity of a rectifier unit, the control is changed automatically from a voltage basis to a current basis by operation of relay TR. This limits the output preventing overload due to increased load on the battery or to decreased battery voltage because of a power failure. The plate resistance of tube V3 is under control of amplifier tube V4 as under voltage control. In this case, however, tube V4 is responsive to the output current due to a grid bias which is a continuous comparison of the voltage drop across resistance K with a reference voltage.

2.11 For current control, the reference voltage is the voltage across the 1-3 portion of potentiometer CC. When the output current of the rectifier unit exceeds a predetermined amount, relay OL operates causing relay TR to operate. This transfers the cathode of tube V4 to the negative end of resistor K and connects the reference voltage to the positive end of resistor K. This provides a negative grid bias on tube V4 of about one volt. If the output current decreases, the drop across resistor K decreases thereby increasing the grid bias on tube V4 and the output current is increased, as under voltage control, to the current for which the current control is adjusted. An increase in output current above this value would, of course, have the opposite effect.

2.12 The rectifying tubes V1 and V2 require time for the filaments to heat before being allowed to carry load to avoid destruction of the coating on the cathodes. This is provided by grid relay GR which keeps the resistance arm of the phase shift circuit open for a minimum of 33 seconds. With the resistance arm open, the grid voltages on tubes V1 and V2 are maximum out of phase with the plate voltage, keeping the output at zero. Time delay relay TD (not shown) is operated directly from transformer T2. Grid relay GR is under control of relay TD, power for this relay coming from the full wave varistor rectifier A (not shown) and transformer T2. The circuit is arranged to lock relay GR operated as long as power is available and to disconnect time delay relay TD with operation of relay GR. In the released position of relay GR one pair of contacts short circuits capacitor V associated with tube V4. This avoids an output current surge when relay GR operates and a rectifier unit starts with low battery voltage.

2.13 An antihunting feature is provided by rheostat AH and capacitor V which introduces more or less time lag in the control against sudden changes in output or load.

2.14 The power supply is connected to the rectifying and control elements of the rectifier unit through a contactor AC (not shown) which is operated by d-c from an auxiliary rectifier unit Y (not shown) connected to the power supply through transformer T5 (not shown). The contactor normally operates when manually operated switch AC (not shown) is closed and ground is connected to terminal 8 of terminal strip TS1. The contactor will release with power failure. Tap 8 on the transformer provides a higher voltage for use only in case the varistor Y ages to such an extent that reliable operation of contactor AC cannot be secured.

2.15 Two rectifier unit designs are available, the J86240A unit for use when either the positive or negative terminal is grounded and the J86240B unit for use when the negative terminal is 130 volts positive to ground. This makes the positive terminal in the order of 250 volts to ground. For this reason more extensive guarding, shielding and covering of terminals is required and has been provided, to safeguard the attendant. The design is intended to permit checking of the rectifier circuit with the unit operating.

Preparing to Start

2.16 When putting the rectifier unit into service initially, check against the circuit drawing, with the a-c power supply and the d-c charge and regulation fuses removed, to see that:

- (a) Switch AC is OFF and switch AUTO/MANUAL is in the MANUAL position and turned as much counterclockwise as possible without snapping the switch to the AUTO position.
- (b) Correct transformer taps on T1 and T5 have been used for the power service voltage.
- (c) Correct tubes are in the sockets.
- (d) Fuses F1 and F2 in the rectifier unit are correctly wired. In the J86240A unit these fuses are furnished only when specified.
- (e) Proper a-c supply and d-c charge and regulation fuses are available.
- (f) Rheostats AH and OL are turned completely clockwise.
- (g) Potentiometers FLOAT and CC, and rheostat OC are turned completely counterclockwise.
- (h) Correct potentiometer tap has been connected to terminal 2 on terminal strip TS1 for the number of cells in the battery.

- (i) Correct tap connections of transformer T1 secondary have been made for the number of cells in the battery.
- (j) The resistor F in series with time delay relay TD in the J86240A unit is short circuited unless otherwise specified.
- (k) An adjustable load capable of carrying 9 amperes at 150 volts is available.
- (l) Capacitor U is connected in the J86240A unit as specified.
- (m) That retard coil L5 is furnished in the J86240A unit if specified.
- (n) That resistors Z, Y, X, and W are wired as specified.

Initial Adjustments

2.17 After observing the directions in 2.16, install the a-c supply and d-c charge and regulation fuses. Turn switch AC to the ON position. After a delay for filament heating, relay GR should operate. The time delay relay is not in itself adjustable. A series resistance F is furnished in the J86240A unit to secure longer delay and is strapped out to secure shorter delay. During the delay while the filaments are heating, the rectifying tubes V1 and V2 may show a blue haze but the ammeter should indicate no output.

2.18 When relay GR has operated, increase the rectifier output with the AUTO/MANUAL switch rheostat until the desired rate is secured. This should be kept below 8 amperes. When the battery has been charged to floating voltage, adjust rheostat FLOAT until voltmeter RV indicates 30 to 40 volts. Make sure that lamp RC is not lighted. If lamp RC is lighted, manually release relay TR, reducing the output current if necessary to keep it released. Then quickly turn the MANUAL/AUTO switch rheostat to the AUTO position and adjust potentiometer FLOAT to secure the floating voltage.

2.19 To adjust rheostat OL to secure transfer to current control at the proper output current, use MANUAL control and set the output current at the transfer value desired. This can be any value between 6 and 9 amperes. Maintaining the desired value, slowly turn rheostat OL counterclockwise until relay OL operates. This should cause relay TR to operate and should light lamp RC. Switch the control from MANUAL to AUTO and adjust potentiometer CC to secure the specified output at about floating voltage. This output may be almost any value up to 8 amperes, but should always be less than the value at which relay OL operates. Relay TR normally locks in the operated position until released by some relay in the plant control. Release relay TR.

2.20 Rheostat AH should be adjusted with the rectifier operating automatically on voltage control, lamp RC unlighted, and at full load current. Full load current may be obtained by adjusting the OC rheostat with any short between control terminals 1 and 2 open, to avoid disturbing the floating adjustment. Beginning with the AH rheostat maximum clockwise, turn it counterclockwise until it begins to affect the voltage as indicated on voltmeter RV. Then turn it clockwise approximately 1/4 turn. Too far counterclockwise may cause the rectifier output to hunt. Too far clockwise with large batteries will cause the rectifier to follow variable loads too slowly. If, due to changing storage battery conditions, the rectifier begins to "hunt" after this adjustment has been made, it is necessary to repeat it. "Hunting" is evidenced by a regular flickering of the rectifier tubes together with instability of the voltmeter RV reading. If no hunting is experienced with rheostat AH in its extreme counterclockwise position, leave it there.

2.21 To charge the battery, any artificial load should be disconnected, and, with any short between control terminals 1 and 2 open, rheostat OC should be slowly turned clockwise keeping the output current less than the value at which relay OL operates until the desired charging voltage is secured. If the control should transfer to a current basis and light lamp RC, rheostat OC will no longer be in control and the control must be returned to a voltage basis. Turn rheostat OC counterclockwise and release relay TR. Then again slowly turn rheostat OC clockwise until the desired charging voltage is secured. The connections of this rheostat are brought to terminal strip TS1 so that the rheostat may be short circuited automatically by the plant control for float and the short removed for automatic charging. If this feature is not used, it will be necessary to turn rheostat OC completely counterclockwise to return the control to the floating voltage.

Routine Adjustments (Normal Operation)

2.22 To start or stop the rectifier unit, turn switch AC to ON or OFF position. Unless the power supply is interrupted or the associated plant control causes contactor AC to release, the rectifier unit operates continuously on voltage control as long as the output is below the current value for transfer to current control. With these loads, voltmeter RV indicates normally 0 to 25 volts depending on the output current and voltage and power supply voltage. When the output current reaches the transfer value, the control is changed automatically from a voltage to a current basis and lamp RC lights. Current control will continue until relay TR is released, usually by control in the associated plant.

3. ROUTINE CHECKS

3.01 Routine checks of the vacuum tubes may be made with a vacuum tube tester to determine when a tube is poor and needs to be replaced. For this purpose, refer to Sections A702.661, A702.662 or A702.664. A periodic check is desirable. The grid current test of tubes V3 and V4 is particularly important. If tube V4 or V6 is replaced for any reason, it will be necessary to readjust potentiometers FLOAT and CC as outlined in 2.18 and 2.19.

3.02 Periodically observe the output voltage on the plant voltmeter. If the voltage does not appear to be correct, it should be checked with a recently calibrated portable voltmeter. This check and any consequent adjustments should only be made with the rectifier unit operating on voltage control.

3.03 Periodically check the output current of the rectifier unit operating on current control (lamp RC lighted). If the current is not at approximately the usual value, with the battery at floating voltage, readjust potentiometer CC to secure the desired output. To check this adjustment for a rectifier unit not operating on current control, shut down enough associated rectifier units in the plant to cause this unit to operate on current control and observe the output current. If only one rectifier unit is regularly in use, quickly turn the AUTO/MANUAL switch to the MANUAL position and increase the output until relay TR operates as indicated by the lighting of lamp RC. Turn the control back to AUTO and observe the output current, readjusting potentiometer CC if necessary.

4. TROUBLES

4.01 When any kind of trouble is encountered in the rectifier unit, it is necessary to decide first whether to try to locate the trouble with the unit operating or de-energized. This rectifier has been designed to make parts accessible for testing with power connected. All parts over 150 volts to ground have been covered or shielded by guards. Trouble is easier to locate if the equipment can be energized. If the trouble is of a nature to cause excessive output, it will be necessary to limit operation to only short periods 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 parts. It is essential to be alert for quickly shutting off the rectifier unit at any time until the trouble is cleared.

4.02 In general the only items likely to become defective with use are the tubes. These, of course, are subject to aging but should have long life.

4.03 Control rheostats and potentiometers are totally enclosed and should be replaced if they become defective in any respect.

4.04 Time delay relay TD is not adjustable. If it becomes defective in any respect, it should be replaced.

4.05 Short life of rectifying tubes may be due in part to low filament emission, short time delay for heating of filament, and dirty corroded surface with insufficient spring tension in anode clip. The low filament emission may be due to dirty contacts in the tube socket. This can be corrected by burnishing the prongs on the tube base and the springs in the socket. For the latter, use abrasive cloth over a match or tooth pick to brighten the spring contact surfaces within the socket. The anode lead at the top of the tube is soldered to the cap and may become unsoldered due to heating caused by dirty contact surfaces between the cap and the clip. Every three months and whenever tubes are replaced, the anode cap connector should be cleaned on the contact surface with abrasive cloth. If the cap connector has lost its spring tension and is loose, it should be replaced. The tube caps should similarly be cleaned. Caps which become unsoldered can usually be resoldered if the lead and cap surfaces can be cleaned. Only a very short amount of anode lead sticks through the depression in the cap and careful work will be required.

4.06 Excessive grid current may be due to grid emission, to defective insulation, or in vacuum tubes to abnormally high gas content. Grid emission occurs due to cathode material which has been carried over to the grid. The effect of this is negligible until the temperature of the tube becomes high enough to cause this active material on the grid to give off electrons which causes the grid to lose control. This effect disappears as the tube cools. In thyatron tubes satisfactory operation may be possible at light loads when it is not possible at full load.

4.07 If any trouble is being experienced, turn the combined rheostat and switch from automatic to manual control, and if the charging current can be controlled, the trouble is in the regulating circuit. This may be confirmed by operation of the float regulating rheostat with combined rheostat and switch still in the manual control position. If battery is at approximately float voltage, failure to affect voltmeter RV reading indicates trouble in the regulating circuit.

4.08 Voltmeter RV is used to indicate the internal voltage relationships inside the rectifier and readings on it are neither input nor output voltages. When on manual control, at approximately float voltage, voltmeter RV should read between

0 and 25 if the automatic equipment is ready to take over control. The combined rheostat and switch should be snapped from manual to automatic only when voltmeter RV reads between 10 and 25. After switching to automatic control, voltmeter RV should read between 0 and 25 if circuit is functioning properly depending on output.

4.09 With the rectifier unit on AUTC control, if adjusting potentiometer FLOAT causes even a small change in the indication on voltmeter RV and the rectifier output as indicated by ammeter A does not change, replace tube V3.

4.10 If voltmeter RV reads less than 10 with manual control at floating voltage, turn the FLOAT potentiometer from one extreme to the other.

(a) If voltmeter RV responds only slightly, make gain test per 4.12.

(b) If voltmeter RV makes no response, replace tube V6. If voltmeter RV still makes no response, replace tube V4.

4.11 If the voltmeter RV reads over 50 with manual control at floating voltage, replace tube V5.

4.12 To make gain test of amplifier tube V4, raise the output current with manual control until the float voltage is reached. Adjust the FLOAT potentiometer until voltmeter RV reads 5 or 6 volts. Increase the rectifier output until the battery is 2 volts above the floating voltage. Voltmeter RV should then read 20 volts or more if amplifier tube is satisfactory. Restore the rectifier unit to automatic control if the tube tests are satisfactory. Otherwise, replace tube V4 and repeat the test.

4.13 Irregular output or "kicks" on the ammeter needle may be caused by a defective tube V6.

4.14 Where more than one tube may cause a trouble, replace those tubes with new ones until the trouble is corrected. Then put back the used tubes one at a time until the defective tube or tubes have been located and discarded

Trouble Chart

4.15 Should any of the following troubles develop, it is suggested that the possible causes be checked. If the trouble is not found, look for open or loose connections or foreign material lying across wiring terminals. If one 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 measure-

ments with the circuits completely de-energized and comparing the measurements with the values shown on the circuit drawing.

<u>Trouble</u>	<u>Possible Cause</u>
No d-c output current	Power failure Blown a-c supply fuse or charge fuse Failure of tube V1, V2, V3 or V5 FLOAT potentiometer out of adjustment Contactor AC open due to open AC switch, open in plant control, or aged varistor Y Failure of relay GR to operate Failure of time delay relay TD Aged varistor A Relay GR contacts fail to open short on capacitor V
Low d-c output current	FLOAT potentiometer out of adjustment Failure of tube V1 or V2 (voltmeter RV near zero) Line voltage more than 5 per cent low Potentiometer CC out of adjustment on current control Tube V4 defective (see 3.01)
High d-c output current, charge fuse blown	Potentiometer CC out of adjustment on current control Tube V4 failure Tube V6 aged and high resistance or failed Grid emission in tube V1 or V2 (current cannot be reduced to 10 per cent with manual control) Rheostat OL out of adjustment, rectifier unit operating on voltage and should be on current control, failure of relay OL to operate Tube V3 defective (see 3.01)
Output excessively noisy	Defective capacitor U Retard coil L1 or L5 short or partially short circuited
Output voltage varying	Rheostat AH incorrectly set Defective V6
Output surge at starting	Flashover of tube V1 or V2

<u>Trouble</u>	<u>Possible Cause</u>
A-C or d-c fuses blown	Failure of relay GR contacts to short capacitor V (voltage meter RV fails to read at least 50 before relay GR operates)
Hunting from current to voltage	Rheostat AH turned too far clockwise Rheostat OL set to operate relay OL at too low an output current compared to the output current on current control. Relay OL should operate on an output current about 1 ampere more than the output current on current control.

from the equipment being tested, or if test picks are being used, they should be removed from the equipment under test.

5.03 The time required for the output voltage to stabilize after the power is connected is about one minute.

5.04 The readings given in the table are approximate and typical for a rectifier unit adjusted as indicated in 5.06. The readings are measured with an M9B meter which is provided with test clip and test pick leads. Connecting the M9B meter to observe readings does not appreciably affect the rectifier output.

5.05 Access for making measurements is as follows:

- (a) Unfasten and remove the front cover which gives access to the adjusting rheostats.
- (b) If access to the tubes and other apparatus is required, unfasten and swing open the two door type halves of the panel.
- (c) When tests are completed, close and fasten the panel halves and replace and fasten the front cover.

Caution: The readings shown in the following table are for a typical rectifier unit in good working condition. A defect in the 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 protective guard behind the covers to work inside the rectifier unit.

5. POINT-TO-POINT VOLTAGES

5.01 As long as the rectifier 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.

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 a-c should first be disconnected

5.06 Table of Point-to-point Voltages

J86240A unit (63-cell battery) adjusted to 136 volts and J86240B (56-cell battery) to 122 volts at the point of regulation for a 7.5-ampere output with a 210-volt, 60-cycle power supply.

<u>Measure</u>				<u>M9B (X)</u>		<u>Readings</u>	
<u>From</u>		<u>To*</u>		<u>Scales</u>		<u>240A</u>	<u>240B</u>
<u>App. Term.</u>		<u>App. Term.</u>		<u>ac/dc</u>	<u>Volts</u>		
T2	7	T1	3	dc	150	143	129
T4	6	T4	4	dc	600**	288	288
V6	7	V6	3	dc	150	98	98
Cap.X	Top	Cap.X	Bot	dc	150	91	89
Cap.W	+	V6	7	dc	300	168	100

Measure		M9B (X)		Readings		
From	To*	Scales		240A	240B	
App. Term.	App. Term.	ac/dc	Volts			
Voltmeter RV Reading				12	7	
T1	1	T1	3	ac 300	218	220
T1	2	T1	3	ac 300	184	184
T1	3	T1	4	ac 300	184	184
T1	3	T1	5	ac 300	218	220
T2	3	T2	4	ac 150	70	70
T2	4	T2	5	ac 150	70	70
T2	6	T2	7	ac 3	2.36	2.36
T2	7	T2	8	ac 3	2.36	2.36
T2	9	T2	10	ac 15	9.3	9.2
T2	11	T2	12	ac 15	6	6
T3	2	T3	6	ac 150	82	93
T4	3	T4	4	ac 300	240	240
T4	4	T4	5	ac 300	240	240
T4	6	T4	7	ac 15	5.8	5.8

*"To Term" should be connected to -V jack of meter.

**Readings indicated for meter jack 600V may be observed using 300V jack with multiplier (D-176926 plug) plugged into the 300V jack if a 600V jack is not on the meter or 600,000 ohms may be connected in the lead from the 300V jack.

(x) The M9B meter has an accuracy of ± 5 per cent on a-c and ± 2 per cent on d-c.

Bell Telephone Laboratories, Inc.