

RECTIFIER UNITS

ELECTRON TUBE TYPE

AUTOMATIC REGULATION

J86207A, D, E, G, H, J, K, L, M, AND U

1. GENERAL

1.01 This section covers the operation of rectifier units having automatic regulation and coded as follows:

J86207 Rectifier	Output - Continuous	
	Volts	Amperes
A	17 to 45	0.6
D	50	3
E	50	8
G	120 or 130	0.6
H	48 or 74	0.6
J	50	8
K	34 or 48	3
L	24 or 34	8
M	24 or 34	8
U	120 or 130	3

All of these units except the A, G, and H are full wave. The G, H, and U are designed for resistance loads and have no current limiting protection for use on batteries. In some cases, these units have been used with an external current limiting device for floating batteries. The principal differences between the E and J rectifier units, as well as between the L and M are in mounting methods and in the amount of supplementary facilities such as fuse mountings, voltmeters, and optional alarm equipment available as part of the rectifier unit.

1.02 This section is reissued to add an alternative method of adjusting the voltage, to add a caution note, and to rearrange the text. Changes except for re-location of text material are marked with arrows.

Caution: Voltages inside the rectifier case are higher than those usually encountered in telephone power plants. Avoid all contact with terminals as high voltages are present. Do not allow a test pick to touch two metal parts at the same time or destructive and dangerous short circuits may occur. The door switch, when open, disconnects only one side of the power supply, so that some a-c terminals may be alive or at service voltage to ground. The door switch, when furnished, is provided for the protection of

personnel and should not be made in-operative. Disconnect both the a-c supply and the d-c output before opening the cover to work inside of the rectifier case.

1.03 The term "rectifier unit" as used in this section is an assembly consisting of a rectifier and its accessories such as transformers, filters, switches, etc.

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

1.05 As this section covers a number of rectifier units, all items do not necessarily apply to any one unit.

1.06 The alternating current is usually disconnected by pulling the rectifier a-c plug or a-c fuses. The direct current is usually disconnected by pulling the d-c plug or by pulling the charge fuse and the regulating lead fuse, if any.

1.07 Grid batteries should be less than 3 months old when installed. It is important that the correct number of cells be used. Do not add cells to compensate for decreased battery voltage. When the regulated voltage can no longer be obtained by adjustment of the regulating rheostat R, check the grid battery voltage with a voltmeter and replace batteries which measure less than 90 per cent of the nominal voltage. A small automatically regulated metallic rectifier unit is sometimes used instead of a grid battery and such unit is called the grid rectifier unit.

1.08 Unless otherwise specified, all current readings are to be taken on the rectifier ammeter and all voltage readings are to be taken on the rectifier voltmeter. Where there is no rectifier voltmeter, the power plant voltmeter may be used and in any case an M9B meter, a model 280 portable voltmeter or better, connected across the battery terminals, is satisfactory.

1.09 On some models, there is an appreciable fixed d-c load in the rectifier unit that reads on the ammeter even when no external load is applied. Where the

term "no load", or "low load" is used, it refers to external load and does not refer to this internal load.

1.10 On some models, at low loads, the output voltage will vary slightly as indicated by nervousness of the voltmeter needle and flickering of the haze in the rectifier tubes. This is caused by the filter capacitors charging for a few cycles after which the tube cuts off for a few cycles while the capacitor discharges. Flicker is also to be expected where the rectifier is connected to a ringing battery.

1.11 Routine checks should be made during a period when they will cause the least service reaction.

1.12 More detailed information on the operation and maintenance of relays is given in other sections and the attendant should, of course, be familiar with them. Relays are assumed to have been adjusted in accordance with them and the circuit requirements on the circuit drawings. Refer also to such sections as:

A401.562 Indicating Instruments
A438.961 Electrolytic Capacitors
A462.012 Time Delay Relay
A801.303 Regulated Tube Rectifiers

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

1. GENERAL

2. OPERATION

- 2.01 How the Rectifier Unit Works
- 2.02 Preparing to Start Initially
- 2.03 Initial Adjustments
- 2.07 Routine Adjustments (Normal operation)

3. ROUTINE CHECKS

4. TROUBLES

2. OPERATION

How the Rectifier Unit Works

2.01 A description of the theory of the magnitude control operation of these rectifier units is given in the Educational Information Section A801.303.

Preparing to Start Initially

2.02 When putting a rectifier unit into service initially, check against the circuits to see that:

- (a) There is nothing in or on the rectifier unit to interfere with its operation or prevent free ventilation.

(b) Tubes are in the correct sockets

(c) Relays are properly adjusted.

(d) Correct power service voltage is to be used.

(e) Correct transformer taps are connected, except that, in the case of the A rectifier, selection of secondary taps should be deferred until called for later under 2.06(g).

(f) Proper grid battery or grid rectifier unit is in circuit and, in the case of the A, K, L and M rectifier units, that proper grid battery taps are selected.

(g) Fusing shown on circuit or called for in notes has been provided.

(h) Regulating rheostat R is in its maximum counter-clockwise position.

Initial Adjustments

2.03 Connect power to the rectifier unit.

Note: Some early models of A, D, and E units as described in the circuit information, required connection to the battery during starting to protect the rectifier tubes. Later models are self-protecting.

2.04 Check time between turning on of power and operation of TD relay as evidenced by the operation of the GR relay. Readjust relays if this time is other than 45 ±10 seconds. This does not apply to some G rectifier units having manual start where the MAN ST key should be held in the FIL HT position for 45 ±10 seconds before switching to the START position where it should be held for approximately 3 seconds and then switched to the RUN position.

2.05 Initial adjustment of rectifier units such as the G, H, and U which are not connected to batteries shall be made with rheostat R until voltage is at the locally specified value. Clockwise rotation of R increases the voltage.

2.06 Initial adjustment of rectifiers connected to batteries shall be as follows:

Note: Voltmeters used for this purpose should have been calibrated so that the deviation from the correct value at the floating voltage does not exceed 0.2 volt for batteries up to about 50 volts or 0.5 volt for 130-volt batteries.

(a) Charge the battery to a value between 2.16 and 2.18 volts per cell. (See (d), (e), and (f)). If the office load is too much for the rectifier unit to carry and still charge the battery to this value, adjust rheostat R so that the output is as high as possible but not exceeding rated continuous full load and when external load is lighter, make final adjustment. The regulating lead should, of course, be connected so that the rectifier will regulate during any time it is left unattended.

(b) Reclose regulating lead, if open, and adjust quickly with rheostat R to get from 25 to 35 per cent of rectifier rated continuous output in amperes when the voltage is at the floating value.

(c) Repeat, if necessary, until voltage is at floating value when current is between 25 and 35 per cent of rated continuous output in amperes.

(d) Regulated voltage for charging is obtained by clockwise rotation of rheostat R.

(e) Regulated voltage for battery charging is provided for in some associated power plants and described in the circuit information. An example of this is the provision of counter emf cells and switches with the regulating lead connected on the load side of the counter emf cells.

(f) Higher Unregulated voltage can be obtained by opening the regulating lead, usually designated "-RC". Where there is a fuse in this lead, removal of the fuse is the best means of opening the regulating lead for overcharge. It is to be noted, however, that in some rare cases removal of fuse does not result in higher output voltages. Under these conditions, open the lead to the tube grids by insulating the proper contacts of relay GR. In some power plants, a switch has been provided for convenient opening of the regulating lead to obtain higher voltages. While the regulating lead is open, watch to be sure that neither voltage nor current exceeds limits.

(g) On the A rectifier units, select secondary taps on transformer T₁ so that the output current with regulating rheostat in maximum clockwise position will be limited to full load (0.6 ± 0.05 ampere) when the battery voltage is 2 volts per cell. Operate for about half an hour and change taps if necessary to agree with the above. A 100-ohm variable rheostat or a fixed resistance of approximately the battery

voltage divided by 0.6 may be required across the battery to get the output within this specified range. If voltage is not at 2 volts per cell, set for a load in amperes which is

(1) 0.01 below 0.6 for each 0.025 volt above 2.

(2) 0.01 above 0.6 for each 0.025 volt below 2.

Routine Adjustments (Normal Operation)

2.07 Starting and stopping the rectifier unit is done by connecting and disconnecting the power supply usually by means of the a-c plug. Regulation is entirely automatic at the normal output voltage and should not require adjustment from day to day, but only when an increased output voltage is required as for a boost charge of a battery (See 2.06 (d), (e), and (f)). In the case of list 1, G rectifier units, when manual starting is used, hold the MAN ST switch in the FIL HT position for 45 ± 10 seconds, turn to the START position for approximately 3 seconds, and then turn to the RUN position. When alternating current is to be disconnected for more than a day, disconnect the direct current also by removal of d-c fuses.

3. ROUTINE CHECKS

3.01 At each visit, observe the current and voltage. The voltage may be below the value for which it was adjusted particularly if the output current is greater than the value at which the voltage adjustment was made, namely, about 1/3 rated full-load current. Experience will indicate the voltage to be expected at various loads. See 2.06.

Note: Adjust voltage, if necessary, as outlined below except that adjustments should not be made if the output currents exceed the following:

<u>Rectifiers</u>	<u>Maximum Amperes For Adjustment</u>
A	0.3
D, K, and U	1
E, J, L, and M	3
G and H	0.6

3.02 Adjustment of rectifier units such as the G, H, and U when not connected to batteries shall be made with the R rheostat until voltage is at the locally specified value.

3.03 Adjustment of rectifier units connected to batteries may be made at output currents as specified above by first charging the battery and then allowing the battery to carry part of the load. This may be done as follows:

(a) Increase battery voltage to between 2.16 and 2.17 volts per cell. (See 2.05.)

(b) Adjust quickly with R rheostat to get from 25 to 35 per cent of rated continuous output in amperes when the voltage is at 2.15 volts per cell.

(c) Repeat, if necessary, until voltage is at 2.15 volts per cell when current is between 25 and 35 per cent of rated continuous output in amperes.

3.04 An alternate method of adjusting a rectifier unit used with a battery may be advantageous particularly where the load is liable to be so high, at the time a maintenance man visits the installation, that it does not permit charging the battery as outlined above. The alternate method is essentially one of artificially putting on the regulating potentiometer circuit a voltage equivalent to 2.13 volts per cell at which voltage the rectifying tubes should block or stop firing. To do this, open the potentiometer circuit at the negative end as at the REG fuse or the -RC terminal. Connect a portable voltmeter from the open end of the potentiometer circuit to the positive end. Connect across the open in series with the potentiometer circuit a combination of dry cell block battery (probably 4.5 volt) and a rheostat with the positive end of the battery toward the negative output or the -RC terminal. The rheostat may be in series with the battery or as a potentiometer across the dry battery, depending on the particular rectifier involved. Turn the R rheostat completely clockwise. By varying the test rheostat, the voltage as indicated by the portable voltmeter may be adjusted to 2.13 volts per cell, at which voltage the rectifying tubes should stop conducting in normal operation. With the tubes firing, turn the R rheostat counterclockwise until they just stop. Check this adjustment by use of the test rheostat and then restore the circuit to normal without changing the position of the R rheostat.

3.05 When a tube fails or it becomes necessary to install a new grid battery, adjustment of the R rheostat will usually be required.

4. GENERAL TROUBLES

4.01 If any of the following troubles are found, it is suggested that the possible causes listed below be checked.

<u>Trouble</u>	<u>Possible Cause</u>
No current	A-C supply interrupted (no voltage, blown a-c fuse or disconnected a-c plug). Failure of rectifying tube. Failure of ballast lamp. Failure of main filter capacitor by shorting. Charge fuse blown. Failure of GR relay to operate. Filament lighted but no emission in rectifier tube.

Note: A, H, and U rectifier units have main filter capacitors designated C. The main filter capacitors of older G rectifier units were designated E. In later G rectifier units, they were designated C. Other rectifier units discussed herein have no main filter capacitors.

<u>Trouble</u>	<u>Possible Cause</u>
A-C input fuse blown	Main filter capacitor shorted. Defective rectifying tube. Main filter capacitor out of circuit so long that capacitor film has broken down. (See Section A438.961.)
Low d-c voltage	Grid battery aged. Low output from grid rectifier unit. Low emission in rectifying tube. Tube may still be lighted but should be replaced. (See 4.02.)
High current	Open in regulating circuit, possibly dirty relay contacts or regulating lead fuse blown. Grid emission in rectifying tube. (See 4.02.) R rheostat has lost control of current.
High d-c voltage	Rectifier unit disconnected from the battery.
High battery voltage	Output current high. (See above.) Capacitor associated with varistor either open or of low capacity. R rheostat has control but not smooth control of current. (See 4.03.) Regulated voltage can be reset.

<u>Trouble</u>	<u>Possible Cause</u>
Failure of GR relay to operate	Varistor or associated capacitor shorted. Failure of time delay relay to operate.
Erratic operation of time delay relay	Loose bimetallic strip assembly making tightening of machine screw necessary.
Output erratic under light load	Capacitors associated with varistor defective. Variable voltage from grid rectifier unit or grid battery. (See 4.04.) High firing point. (See 4.02). High drop-out. (See 4.03.)
Series alarm relay chattering	Main filter capacitor defective.

Note: A and H rectifiers have series alarm relays designated AL. Other rectifiers discussed herein have no series alarm relay.

4.02 Unsatisfactory operation of either rectifying tube in a full-wave rectifier using two rectifying tubes gives unsatisfactory operation of the rectifier unit. To eliminate the defective tube, change both tubes to get satisfactory operation. Then put back the old tubes one at a time to determine which is defective. Flash-over of a tube is current passing in the wrong direction through the tube and it renders the tube unsatisfactory for further use. It usually occurs after a tube has been used for sometime and is nearing the end of its life. Flash-over will probably blow the charge fuse and burn out the ballast lamp. Cathode trouble usually consists of open filament or low emission and tubes with cathode trouble are unsatisfactory

for further use. Grid trouble may be high firing point or grid emission. High firing point is the condition where too high voltage is necessary to fire the tube. While this can be compensated for to some extent by changes in R rheostat setting, the tube is inclined to be unstable at light loads. It should be replaced if causing erratic operation. Grid emission sometimes 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 so that satisfactory operation may be possible at light loads when it is not possible at full load after 1 hour of operation.

4.03 When a rectifier unit is functioning properly, clockwise operation of the R rheostat will increase the output and counterclockwise operation decrease it. For battery charging, counterclockwise operation of the R rheostat should decrease output current to 10 per cent of rated output or less and if smooth control stops at a higher value, it is known as high drop-out. High drop-out may be due to the use of the wrong transformer tap or to a tube having a high firing point. (See 4.02.)

4.04 Large fluctuations or "kicks" of the ammeter needle may be due to a depleted grid battery even when regulating rheostat has not been turned to its maximum C.W. position. Any grid battery whose voltage as read on any available voltmeter is less than 90 per cent of nominal value, should be replaced.

4.05 Failure of a rheostat to perform its function or erratic control by the rheostat may be due to dirt on rheostat contacts. Clean, as feasible, including rear contact. Defective rheostats whose construction does not allow cleaning should be replaced.

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