

RECTIFIER
J87222
24 VOLTS, 100 AMPERES
OPERATING METHODS

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- (b) To revise 4.02
- (c) To add additional information to Table A
- (d) To incorporate the Addendum (Issue 1).

1.03 This rectifier is adaptable for connection to a 190- to 250-volt or 380- to 500-volt, 60 Hz ± 1.2 Hz, 3-phase power source and has a rated output of 0 to 100 amperes at 24 volts dc. The dc output voltage regulation is ± 0.5 percent for load and line variation. The rectifier utilizes PNPN devices for 3-phase, full-wave rectification and a self-contained transistorized regulating circuit which controls the PNPN devices and automatically limits the output current. In addition, an alarm circuit is provided to shut down the rectifier when the charge fuse or control fuse blows or when the rectifier is putting out current at higher than normal voltages.

⚠ Danger: ⚠ 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 or destructive and dangerous short circuits may occur. Disconnect the alternating current supply before working on the rectifier except when necessary to make tests.

1. GENERAL

1.01 This section covers the operation of the J87222A and J87222B rectifiers in conjunction with the J87214C regulator unit and the J87222C and J87222D rectifiers in conjunction with the J87277 regulator unit. The J87222A, J87222B, J87222C, and J87222D rectifiers are intended to automatically charge and float storage batteries of the 110A, 111A, and 300-type power plants.

1.02 This section is reissued for the reasons listed below. Revision arrows are used to emphasize the more significant changes. The Equipment Test List is affected.

- (a) The addition of a fuse in series with the output filter capacitors

1.04 This rectifier is designed to mount on a 23-inch relay rack and can be serviced and maintained from the front. Access to the rear is made possible by a removable rear cover.

1.05 The meter, controls, and fuses are mounted on a hinged panel for easy access, maintenance, or replacement.

NOTICE

Not for use or disclosure outside the
Bell System except under written agreement

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1.06 Options are provided for operation as follows (with any option, the output current meter is in the ground lead):

- (a) For use in a 24-volt positive plant (negative ground)
- (b) For use in a 24-volt negative plant (positive ground).

1.07 The following options have been added to the J87222C and J87222D rectifiers:

- (a) A new gradual increase in output current circuit (walk-in) feature is provided as Option "ZF" to eliminate an undesirable output surge when ac power is applied at the input of the rectifier. Option "A" that provided a thermistor to mask the effect of the output surge is rated "Mfr. Disc." and Option "T" is reinstated as standard.
- (b) Diode CR13 has been added to prevent the operation of the RFA 2 and TR relays when the HV and TR leads are multiplied to HV and TR leads of other rectifiers and a CONTR ALM fuse is removed.
- (c) Option "ZD" is rated "Mfr. Disc." and Option "ZE" is rated Standard and has been added to the circuit to prevent the rectifier from going to full output when the "REG" fuse in the associated power plant is removed or operated.
- (d) Because of excessive ripple current decreasing the life of the output filter capacitor, a "YF" option has been added. This option supersedes the "YE" option which has been "Mfr. Disc." The "YF" option requires the addition of a 70-type fuse and a class K5, 250V 6-amp cartridge fuse over the "YE" option.

1.08 Routine checks are intended to detect defects in the equipment and, insofar as possible, to guard against circuit failures. Checks other than those required by trouble conditions should be made during a period when they will not interfere with service.

1.09 This issue of this section is based on the following drawings:

SD-81553-01, Iss 13D J87222A, J87222B Rectifiers

SD-81753-01, Iss 25D J87222C, J87222D Rectifiers

SD-81543-03, Iss 8—J87214C, Regulator Unit

SD-81760-01, Iss 6—J87277, Regulator Unit

If this section is to be used with equipment or apparatus reflecting a later issue of the drawing, reference should be made to the SDs and CDs to determine the extent of the changes and the manner in which this section may be affected.

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

Note: When a rectifier is connected to the plant load and controlled by the plant control circuit, the appropriate plant Bell System Practice supersedes the individual rectifier Operating Methods Bell System Practice.

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
141	Cord Tip
411C	Test Pick
—	3-Inch C Screwdriver
720A	Test Battery Pickup
TEST APPARATUS	
KS-14510	Volt-Ohm-Milliammeter
KS-8039	Volt-Milliammeter
W1AF	Cord

3. OPERATION

Preparing to Start

3.01 When preparing the rectifier for service, check that:

- (a) The ON-OFF key is in the OFF position.
- (b) The proper size fuses are provided and removed from the rectifier.

Note: The charge (CHG) and associated alarm fuses, the control alarm fuse, and a fine voltage adjust feature may be located externally, but in close proximity to the rectifier.

- (c) All external connections are made in accordance with the schematic drawing covering the associated circuit of which the rectifier is a part.
- (d) The option wiring is correct for the service to be used.
- (e) The T1, T2, and T3 input transformer taps used are correct for the power supply voltage as measured with a KS-14510 volt-ohm-milliammeter.

⚠Danger:⚠ *When using a portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the power should first be disconnected from equipment being tested or, if test picks are being used, they should be removed from the equipment under test.*

- (f) The VOLTS ADJ (R11 for J87222A and J87222B rectifiers, R14 for J87222C and J87222D rectifiers) potentiometer is in the maximum counterclockwise (ccw) position.
- (g) The FINE ADJ VOLTS (R27 for J87222A and J87222B rectifiers, R40 for J87222C and J87222D rectifiers) potentiometer is in the center position.

Starting

3.02 When placing the rectifier into service, proceed as follows.

- (1) Install all fuses except the CHG and the associated alarm fuse.
- (2) Install the CHG fuse and then the associated alarm fuse.
- (3) Connect the KS-8039 meter, or the battery voltmeter in the associated plant, to the output terminals of the rectifier.
- (4) Apply the input power by operating the ON-OFF key to the ON position.
- (5) Rotate the VOLTS ADJ potentiometer clockwise (cw) until the rectifier is delivering current without increasing the battery float voltage. The current should be less than the current limit value of 100 amperes. If there are no other voltage requirements, adjust the output voltage to 2.17 volts per cell.
- (6) Adjust the FINE ADJ VOLTS potentiometer if a vernier adjustment is required. Rotate the potentiometer cw to increase the output and ccw to decrease the output.
- (7) Disconnect the KS-8039 meter.

Note: The CC potentiometer on the J87222A and J87222B rectifier (CL on the J87222C and J87222D rectifiers) is factory set to current limit at 100 amperes. If an adjustment is required, see 4.05.

Stopping

3.03 Remove the input power by operating the ON-OFF key to the OFF position.

Note: It will not be necessary to remove the fuses or adjust the potentiometers unless the rectifier will be out of service for an extended period of time.

4. ROUTINE CHECKS

4.01 If the relays are mounted on circuit boards, they cannot be checked and must be replaced in case of malfunction. If possible, periodically

check all other relays for condition of contacts, making sure that they are in accordance with the circuit requirements table and Bell System Practices which apply.

4.02 Output Voltage Check:

◆**Note:** Output voltage check instructions on the associated power plant maintenance Section supersede the information in the following paragraph.

Check the battery float voltage on the associated power plant voltmeter. TST (S2) switch should be in the midposition. This check should be made only when the rectifier is at a partial load below its current limit setting. Output voltage adjustments when the rectifier is in current limit or at no load are not valid. If output voltage adjustment is needed, the VOLTS ADJ potentiometer should be adjusted to the desired output. If a vernier adjustment is required, adjust the FINE VOLTS ADJ potentiometer. The full range of the FINE VOLTS ADJ potentiometer is about one volt.◆

4.03 Regulator Check: To check the regulator unit, proceed as follows.

- (1) Momentarily operate the TST (S2) switch to the FL position.

Requirement: The rectifier output increases.

- (2) Momentarily operate the TST (S2) switch to the NL position.

Requirement: The rectifier output decreases.

- (3) Verify that rectifier output goes back to normal after TST (S2) switch is released.

Note: The TST (S2) switch should be held operated only long enough to check the proper operation of the regulator unit. Do not hold it operated longer than necessary since it can affect plant operation.

- (4) If requirements in (1) and (2) are not met, refer to Part 5.

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

4.05 Current Limiting Potentiometer Check:

To check the adjustment of the current limit potentiometer, proceed as follows:

Note 1: The current limit potentiometer is designated CC for J87222A and J87222B rectifiers; CL for J87222C and J87222D rectifiers.

Note 2: A minimum load of 110 amperes must be available to load the rectifier to be checked either by using the office load or adding an artificial load or a combination of both.

Warning: Do NOT exceed 110 amperes if the rectifier fails to limit.

- (1) Operate ON-OFF key to OFF.
- (2) Rotate the VOLTS ADJ potentiometer fully ccw.
- (3) Set the FINE VOLTS ADJ potentiometer to midposition.
- (4) Connect the KS-8039 meter, ◆or the battery voltmeter in the associated plant,◆ to the output terminals.
- (5) Operate ON-OFF key to ON.
- (6) Rotate the VOLTS ADJ potentiometer cw.

Requirement: The rectifier current limits at 100 amperes.

Warning: The current limit potentiometer is factory adjusted for 100 amperes. Do NOT exceed 110 amperes.

Note: If the requirement in (6) is met, proceed to (9). If the rectifier limits under 100 amperes, proceed to (7). If the rectifier limits above 100 amperes, proceed to (8).

- (7) If the rectifier current limits under 100 amperes, rotate the current limit potentiometer cw until the rectifier limits at 100 amperes. It may be necessary to readjust the VOLTS ADJ potentiometer.
- (8) If the rectifier current limits above 100 amperes, rotate the current limit potentiometer ccw until the rectifier limits at 100 amperes.

- (9) Readjust the output voltage in accordance with 3.02(5) and (6).
- (10) Operate ON-OFF key to OFF.
- (11) Disconnect the KS-8039 meter.

4.06 70-Type Fuse Check: To check the 70-type fuses, proceed as follows:

Note: The later designed fuse caps for 70-type fuses contain an aperture or slot adjacent to the hole for the colored bead, providing access to the alarm test point. (See Fig. 1.) The new P-344900 fuse cap assembly is for use on nonmodular fuse block (18A, 19A, and 21A) and the P-11F667 fuse cap assembly is for use on modular fuse blocks (22- through 27-type). This style cap should be used when testing fuse alarms.

Warning: Due to possible fuse and/or equipment damage, the former procedure of testing fuse alarms by inserting a 411C tool or a 266C tool (wire burnisher) held in a 265C tool (contact burnisher holder) beside the colored bead on older fuse caps without the slot or aperture should be discontinued.

- (1) Prepare the alarm test cord by connecting one end of the W1AF testing cord to the 141 cord tip and 720A battery pickup tool. (The KS-6278 connecting clip may be used to replace the 720A battery pickup tool.) On the opposite end of the W1AF testing cord, connect the 411C test tool. (See Fig. 2.)
- (2) Install the 720A battery pickup tool in a spare 70-type fuse position.

Note: If the rectifier is equipped with F6 FL ALM fuse per YF option, no spare positions will be available on the rectifier. However, there might be a spare position on the associated plant.

(If the 720A tool is not available, obtain the same polarity voltage supply by connecting a KS-6278 connecting clip with the W1AF testing cord to the positive or negative bus bar.)

Warning: Test only the fuses associated with the same polarity voltage supply.

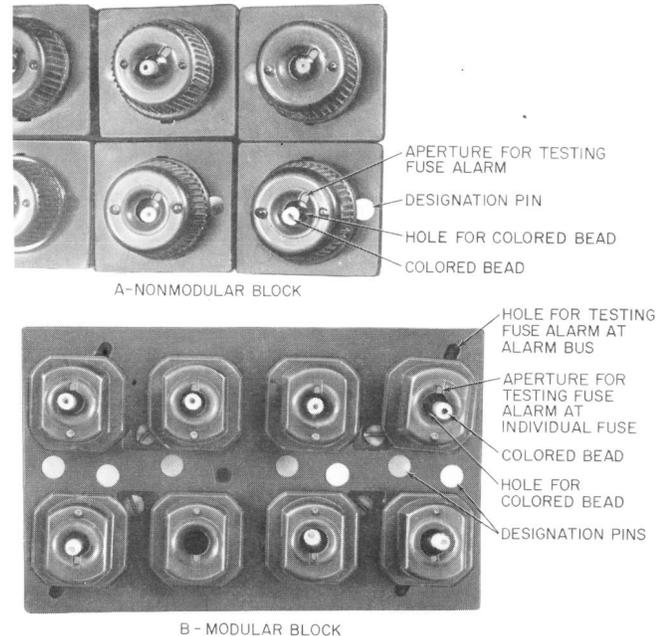


Fig. 1—Typical 70-Type Fuse Cap

- (3) With the tip of the 411C tool (attached to the battery connected W1AF cord), touch the exposed alarm test point on the fuse cap of the CHG B ALM (F2) fuse. (Rectifiers equipped with P option.)

Requirement: The RFA lamp is lighted; the rectifier shuts down and locks out.

- (4) Remove the 411C tool from the fuse cap.
- (5) Operate the ON-OFF switch to OFF and then to ON to restart the rectifier.
- (6) Repeat (3), (4), and (5) for the F3, F4, and F5 fuses. Also repeat for F1 CHG B and F5 CONT ALM on rectifiers equipped with N option, F3 CONTR, F4 ALM, F6 FL ALM on rectifiers provided with YF option.
- (7) Remove the 720A tool from the spare fuse position. (If the KS-6278 connecting clip is used, disconnect the clip from the bus bar.)

5. TROUBLES

5.01 Troubles which may occur in the rectifier are indicated by the RFA lamp. The RFA lamp indicates a blown 70-type fuse in the

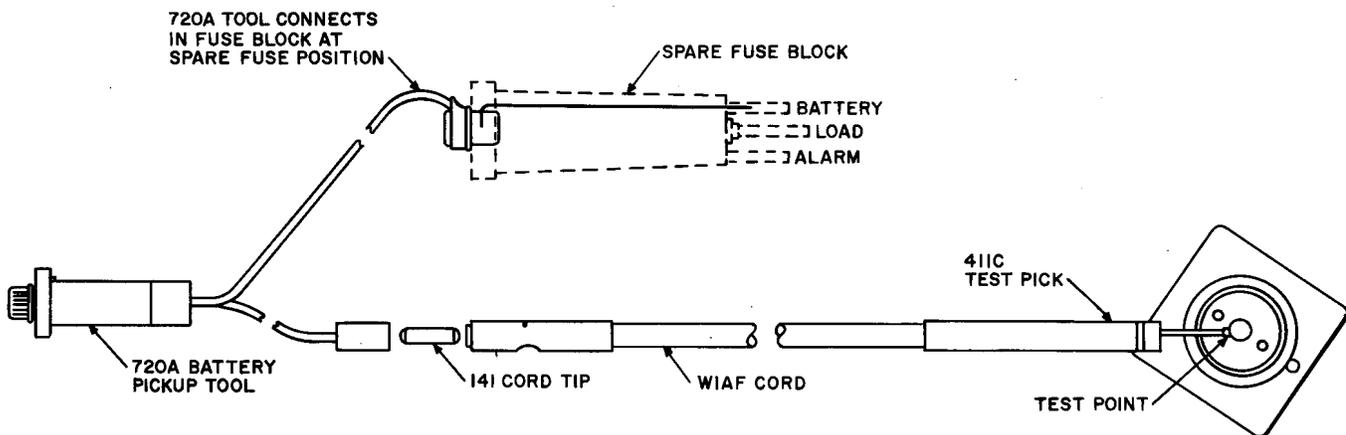


Fig. 2—Fuse Alarm Testing Cord—Tool Connection

rectifier. The ac input power will also be disconnected from the rectifier and the rectifier will remain locked out until the trouble condition is eliminated, the operated fuse replaced and the ON/OFF switch operated to OFF and then to ON to restart the rectifier.

5.02 Failure of the rectifier will be listed in two sections. The first section (Table A) will analyze no dc output current. It will deal with the power components. The second section (Fig. 3 through 8) will troubleshoot the regular circuit and error detector. These figures show component and test point location for the various circuit boards.

5.03 The procedures have been arranged to check the most probable cause of rectifier failure first. The procedures should start with a visual inspection, voltage measurements with a volt-ohmmeter, and finally, signal tracing with an oscilloscope. Typical waveforms are given in the attached trouble charts. The measurement procedures for dc voltages shall be shown with the first terminal number as the positive terminal.

Note 1: To restart the rectifier after a trouble condition has been cleared, follow the procedure in 3.01.

Note 2: The following admonishments should be observed prior to and during the interval of detecting and clearing trouble of a faulty rectifier.

Danger: If, for any reason, the regulator card or error detector card in Fig. 6 is to be removed, care should be taken to prevent a short from the RC or RB lead to the RG lead. It is recommended that the REG fuse in the power plant be removed. These leads will have battery connected to them even though the rectifier is turned off and the CHG fuse is removed.

Warning: When using an oscilloscope, select a properly grounded scope. Connect only one lead from the scope to the rectifier. Do not connect the ground lead of the oscilloscope to any part of the rectifier.

5.04 Other rectifier trouble conditions such as no dc output current or inability to readjust the rectifier to a desired regulating level may be a result of a damaged regulator or error detector card. The conditions which will damage the circuit cards are rare, and an investigation of the regulator or error detector circuits should not be made until the preceding tests and wiring continuity check have been made.

TROUBLESHOOTING PROCEDURES

5.05 The following chart should be consulted for the following rectifiers.

Note: All voltages shown in Fig. 3 thru Fig. 8 are for a rectifier operating with normal output voltage and normal load unless otherwise shown.

RECTIFIER**TROUBLESHOOTING INFORMATION**

J87222A

Fig. 3 and 4

J87222B

Fig. 3 and 4

J87222C

Fig. 5, 6, 7, and 8

J87222D

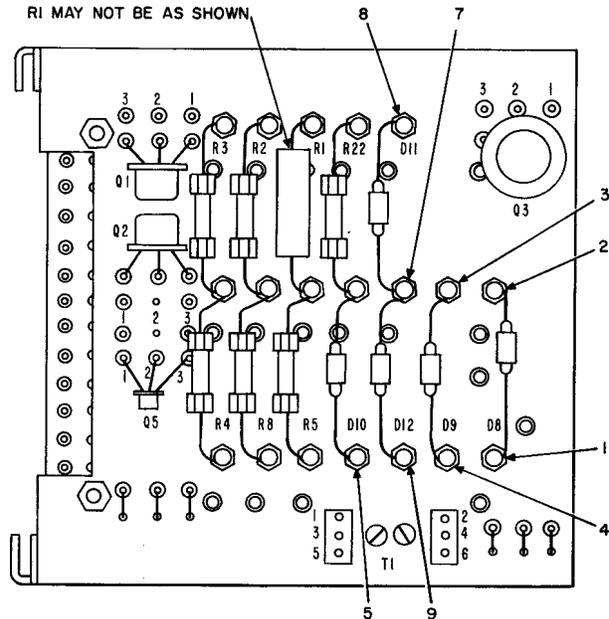
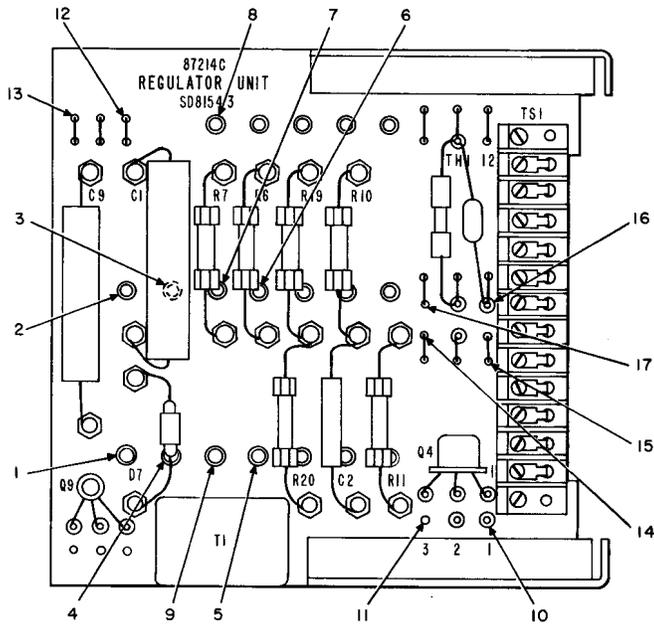
Fig. 5, 6, 7, and 8

TABLE A

NO DC OUTPUT CURRENT (POWER STAGES)

TROUBLE CONDITION	CHECK OUT PROCEDURE	CORRECTIVE ACTION REQUIRED
Rectifier will not restart after the ON-OFF switch is turned OFF, then ON.		Reverse any two of the three input leads.
Rectifiers tend to float the batteries at an improper voltage level.	Slowly rotate VOLTS ADJ (R14) potentiometer to see if charging current can be varied.	Set VOLTS ADJ (R14) potentiometer to proper float value.
No ac input.	Measure ac voltages across terminals L1-L2, L2-L3, and L1-L3 of ac contactor.	If there is no voltage at these points, replace ac input fuses.
AC contactor not operating.	Operate the ON-OFF switch to ON. Check for battery voltage across the output filter capacitors, observing proper polarity. Check contactor fuse which is located on the front panel of the rectifier to see if it has failed.	Make sure that the TR relay and RFA relay are not operated. Also, check to see that contact springs are seated properly in their holders. Replace fuse. Verify that the ON/OFF switch is in the OFF position when the fuse is being replaced.
AC contactor will not remain operated after the rectifier is turned on.	This may be due to an operated RFA1 relay. The RFA1 relay is also operated by placing ground on the HV lead. Check to see if ground potential is present at the HV lead.	If the battery float voltage is incorrect, rotate VOLTS ADJ (R14) potentiometer of the rectifier until proper voltage setting is reached. If ground still appears on the HV lead, check wiring to charge and discharge circuit; also consult the Bell System Practice for associated power plant.
Rectifier does not show any indication of dc output current.	After checking for failed ac input fuses, check to see if the CHG B (F1) fuse has failed.	Replace the F1 fuse. Do not replace the CHG alarm fuse until the main dc output fuse is replaced.
	<ul style="list-style-type: none"> ◆ Blown output filter capacitor fuse (option YF only) F7 (FL) and F6 (FL ALM) due to: <ul style="list-style-type: none"> (a) Open thyristor or diode in rectifier stack. 	Check thyristor and diode and replace defective stack change taps on input transformers.

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TERMINAL	APPROX. READING	POSSIBLE CAUSE FOR INCORRECT READING
3 - 4 5 - 6 7 - 8 9 - 7	5.5 - 6.6 VOLTS - DC	DEFECTIVE D9 DEFECTIVE D10 DEFECTIVE D11 DEFECTIVE D12
10 - 11	0.5 - 13 VOLTS - DC	REMOVE THE CHG. FUSE AND TURN THE VOLTS ADJ. POT CW. THE VOLTAGE ACROSS 10 - 11 SHOULD GO FROM 13 VOLTS TO A LOWER VALUE. IF THIS DOES NOT HAPPEN AND THE VOLTAGE AT 10 - 11 IS ZERO AND THE RECTIFIERS OUTPUT VOLTAGE IS EXTREMELY HIGH, Q3 AND/OR Q4.
12 - 13	25 VOLTS - DC	IF LOWER THAN 20 VOLTS, REPLACE Q5.
14 - 15	12 - 24 VOLTS - DC	THIS VOLTAGE SHOULD GO FROM 24 VOLTS TO 12 VOLTS AS THE VOLT ADJ. POT IS TURNED CW. IF THIS DOES NOT HAPPEN, REPLACE Q3 AND Q9.
16 - 17	0 - 18 VOLTS - DC * 0 - 12 VOLTS - DC **	THIS VOLTAGE SHOULD VARY WITH THE VOLTS ADJ. POT. AS THE POT IS TURNED CW, THE VOLTAGE SHOULD DECREASE. IF THIS DOES NOT HAPPEN, REPLACE Q2.

NOTE:

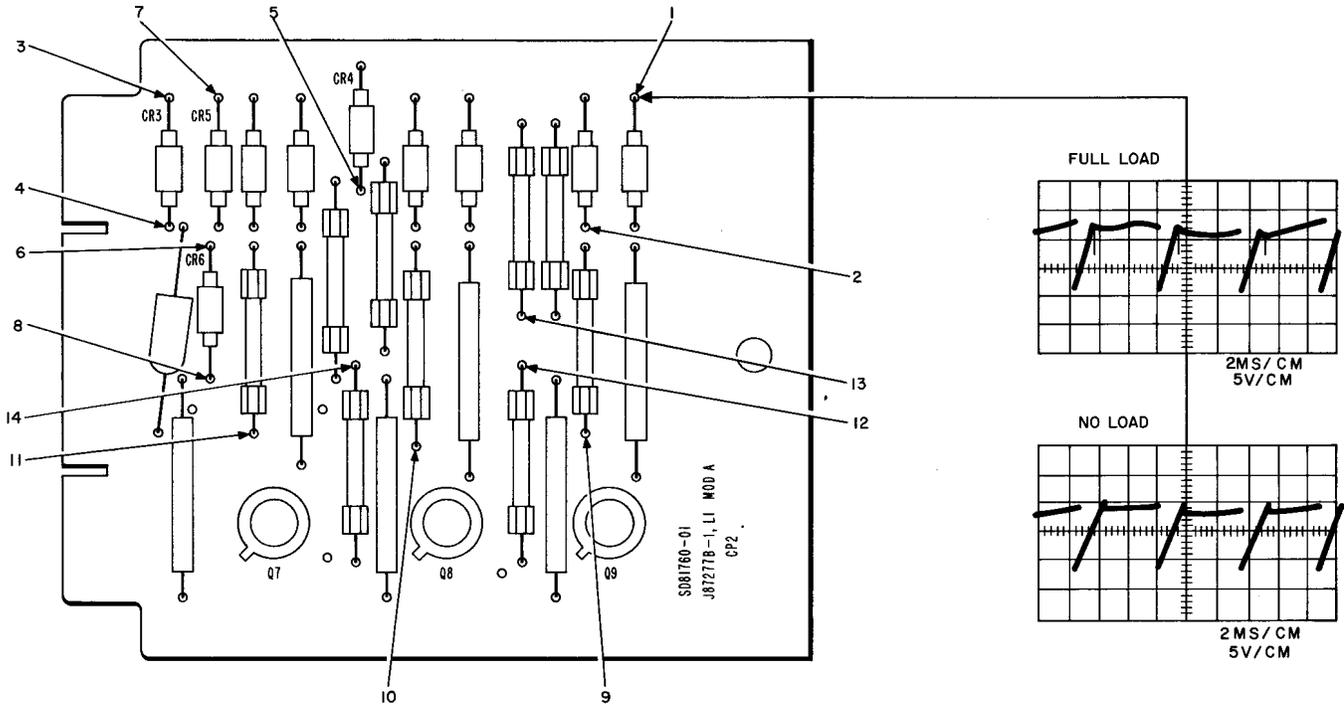
THE WESTERN ELECTRIC 420A DIODE CAN BE REPLACED WITH THE WESTERN ELECTRIC 446B.

* 48 VOLT AND 130 VOLT RECTIFIERS ONLY.

** 24 VOLT RECTIFIERS ONLY.

Fig. 3—Regulator Unit, J87214C, CP1

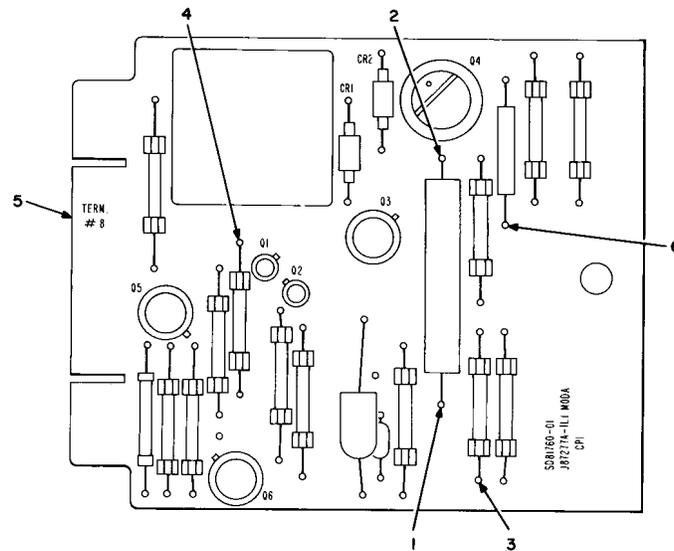
SECTION 169-648-301



TERMINAL	APPROX. READING	POSSIBLE CAUSE FOR INCORRECT READING
1 - 2	0.5 - 12 VOLTS - DC	THIS VOLTAGE WILL VARY DEPENDING ON THE LOAD. AS THE LOAD IS INCREASED, THIS VOLTAGE WILL DECREASE.*
3 - 4	5.5 - 6 VOLTS - DC	DEFECTIVE ZENER DIODE, CR3
5 - 3	5.5 - 6 VOLTS - DC	" " " " " CR4
6 - 7	5.5 - 6 VOLTS - DC	" " " " " CR5
8 - 6	5.5 - 6 VOLTS - DC	" " " " " CR6
8 - 9	4.5 VOLTS - DC	DEFECTIVE Q9
8 - 10	4.5 VOLTS - DC	" " Q8
8 - 11	4.5 VOLTS - DC	" " Q7
12 - 13	25 VOLTS - AC	NO SECONDARY VOLTAGE FROM TRANSFORMER/S OR OPEN LEAD FROM TRANSFORMER TO CARD.
12 - 14	25 VOLTS - AC	
13 - 14	25 VOLTS - AC	

* THIS IS NOT A TROUBLE CONDITION, IT IS NORMAL OPERATION.

Fig. 5—Regulator Unit, J87277B, CP2



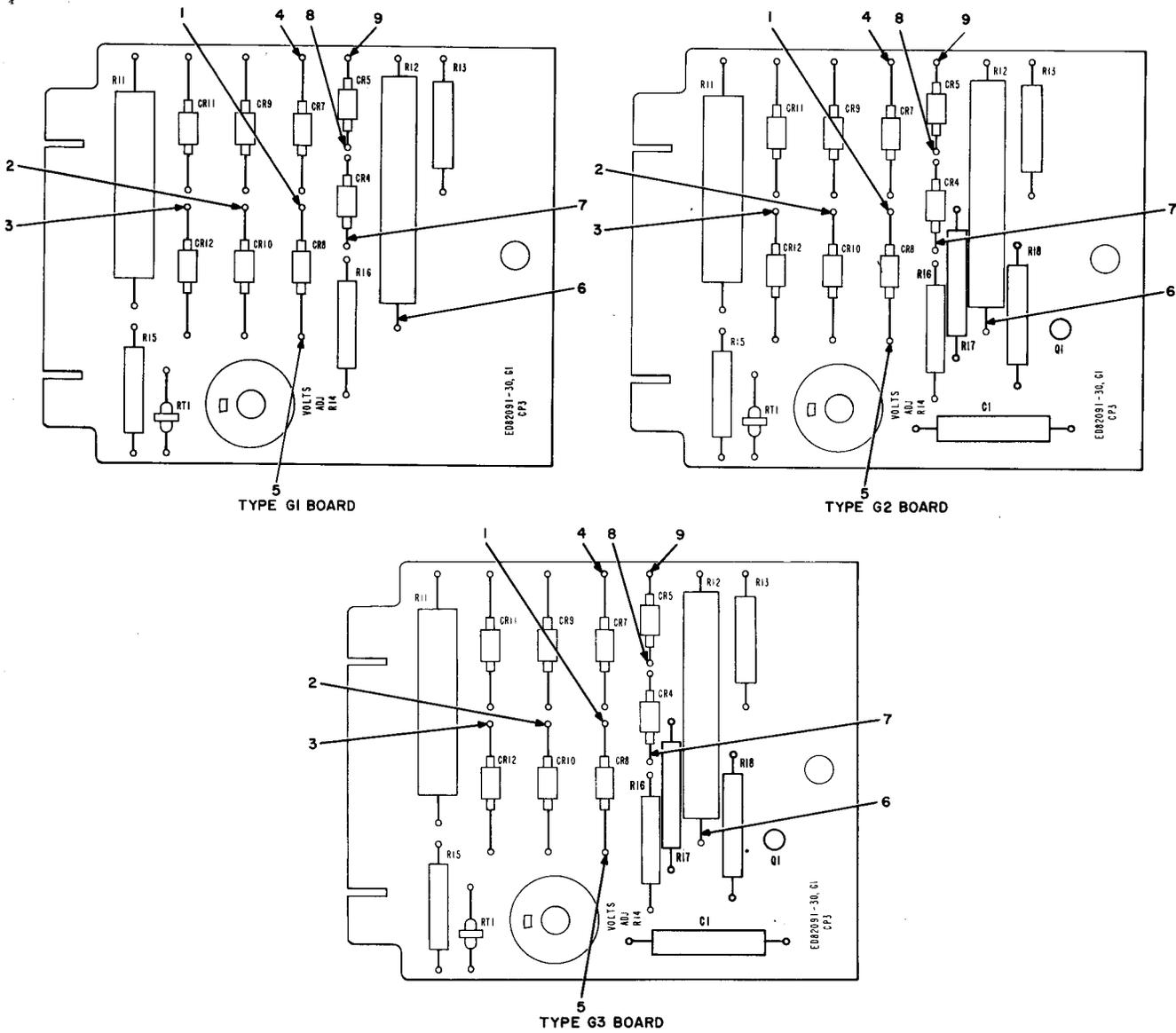
TERMINAL	APPROX. READING	POSSIBLE CAUSE FOR INCORRECT READING
1 - 2	25 VOLTS - DC	IF LOWER THEN 20 VOLTS, THEN Q4 IS DEFECTIVE.
3 - 4	0 - VOLTS - DC	AS THE VOLTS ADJ. POTENTIOMETER IS TURNED FROM THE MAXIMUM CW POSITION TO THE MAXIMUM CCW POSITION, THIS VOLTAGE SHOULD GO FROM ZERO TO APPROX. 10 VOLTS. IF NOT, THEN Q1 AND/OR Q2 IS/ARE DEFECTIVE.
5 - 6	0 - 8 VOLTS - DC	AS THE VOLTS ADJ. POTENTIOMETER IS TURNED FROM THE CW POSITION TO THE CCW POSITION, THE VOLTAGE SHOULD GO FROM ZERO TO APPROX. 8 VOLTS. IF NOT, Q3 IS DEFECTIVE.

NOTE:

IT IS RECOMMENDED THAT THIS ENTIRE CARD BE REPLACED RATHER THAN CHANGING INDIVIDUAL COMPONENTS. WHEN MEASURING TERMINALS 3 AND 4, 5 AND 6, REMOVE THE CHARGE FUSE.

Fig. 6—Regulator Unit, J87277B, CP1

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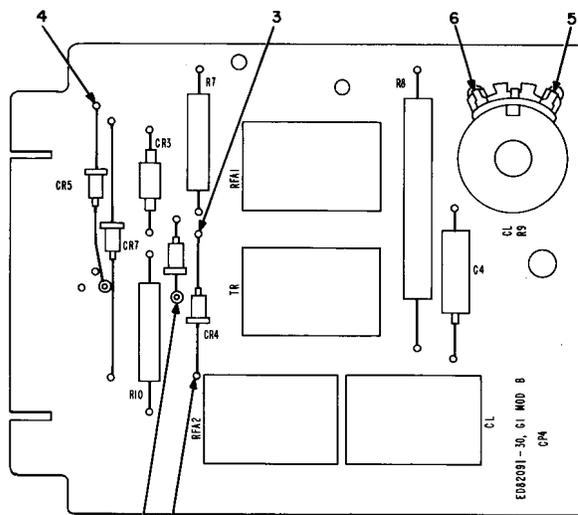


TERMINAL	APPROX. READING	POSSIBLE CAUSE FOR INCORRECT READING
1 - 2 2 - 3 1 - 3	30 VOLTS - AC $\pm 10\%$ 30 VOLTS - AC $\pm 10\%$ 30 VOLTS - AC $\pm 10\%$	NO SECONDARY VOLTAGE FROM ASSOCIATED TRANSFORMER OR BROKEN CONNECTION TO CARD.
4 - 5	44 VOLTS - DC $\pm 10\%$	DEFECTIVE CR7 - CR12 (IT COULD BE ONE DIODE OR ALL SIX).
6 - 7	BATTERY VOLTAGE	OPERATED REG. FUSE, BROKEN LEAD FROM TS1 (CHECK FOR BATTERY VOLTAGE AT TS1 TERMINALS 1 - 2).
8 - 7 9 - 8	5.5 - 6.6 VOLTS - DC 5.5 - 6.6 VOLTS - DC	DEFECTIVE DIODE CR4 DEFECTIVE DIODE CR5

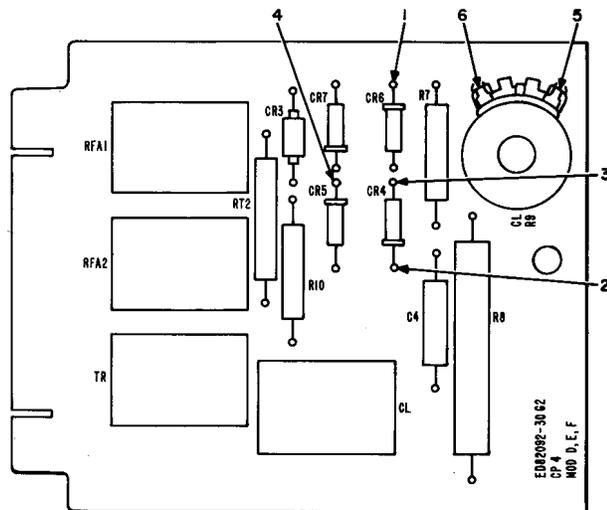
NOTE:

THE WESTERN ELECTRIC 420A DIODE CAN BE REPLACED WITH THE WESTERN ELECTRIC 446B.

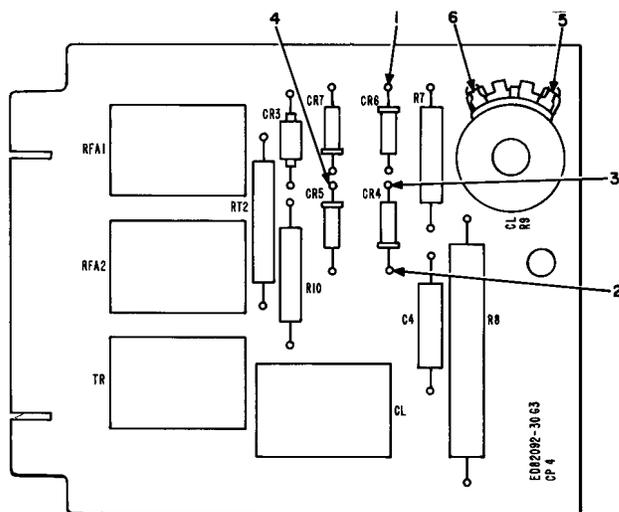
Fig. 7—Error Detector Circuit ED-82091-30, CP3



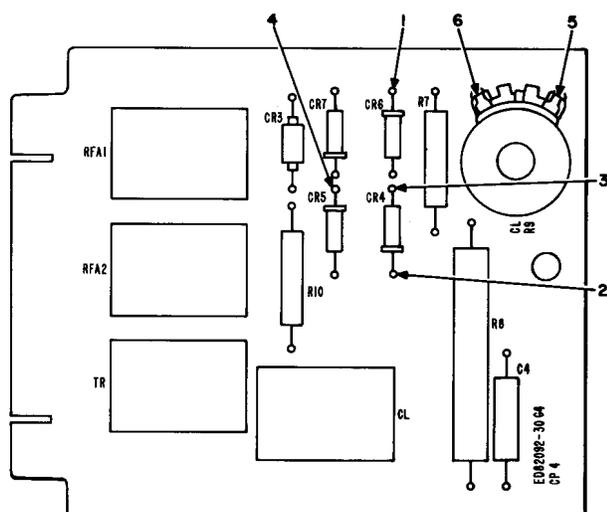
TYPE G1 BOARD



TYPE G2 BOARD



TYPE G3 BOARD



TYPE G4 BOARD

TERMINAL	APPROX. READING	POSSIBLE CAUSE FOR INCORRECT READING
1 - 2	75 VOLTS - AC / 100% LOAD 35 VOLTS - AC / 50% LOAD 6 VOLTS - AC / 10% LOAD	CHECK CONNECTIONS FROM CURRENT TRANSFORMER. CHECK CR4 - CR7 AS SHOWN BELOW.
3 - 4	85 VOLTS - DC / 100% LOAD 10 VOLTS - DC / 10% LOAD	DEFECTIVE DIODES CR4 - CR7.
5 - 6	CHECK WITH OHMMETER	REMOVE THE CARD FROM THE RECTIFIER. CHECK TO SEE THAT THE OHMIC VALUE OF THE POTENTIOMETER AGREES WITH THAT OF THE SCHEMATIC.

Fig. 8—Error Detector Circuit ED-82092-30, CP4