J86249A, B, AND C RECTIFIERS
AND
J86249E L3 ELECTRONIC CONTROL
OPERATING METHODS

CONTENTS PAGE

1. GENERAL

1.01 The J86249A, B, and C regulated metallic-type rectifiers, in conjunction with the J86249E L3 saturable reactor electronic control, are used to float and charge storage batteries of the 302A power plant.

1.02 This section is reissued to:

(a) Change the title.

(b) Omit the information under the headings "How the Rectifier Works," "Regulation," and "Manual Control."

(c) Revise the routine checks.

(d) Bring the section generally up to date.

Since this is a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 The rectifiers are designed to provide regulated dc power from an ac power service. The rectifiers are available in ratings as follows: J86249A, 44 to 65 volts, 100 amperes dc; J86249B, 22 to 33 volts, 100 amperes dc; J86249C, 22 to 33 volts, 200 amperes dc. The input power requirement is 210 volts ±8 percent, 3-phase, 3-wire, 60-Hz ±2 percent ac. However with transformers, they may be connected to nominal 230- or 250-volt power service. They are self-regulating within ±0.5 percent and are suitable for use in room temperatures from 50 to 104°F (10 to 40°C).

Caution: Voltages inside the rectifier case are over 150 volts to ground. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time, as destructive or dangerous short circuits may occur. The door switches, when open, disconnect the 3-phase power from the transformers, but leave the incoming terminals of the AC contactor connected. They also disconnect battery from the main rectifier elements, but leave the CHARGE fuse and certain other equipment connected. Battery voltage will be present on the terminals of the OUTPUT (S3) rotary switch and elsewhere in the rectifier when CHARGE fuse is removed. The door switches are provided for the protection of personnel and should not be made inoperative. The dc windings 3-4 of L1, L2, L3, and L6 saturable reactors may have ac voltages of over 1000 volts under trouble conditions.

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

1.05 Keeping the ventilating passages and rectifier cells clean is especially important to prevent excessive heating. Care should be taken when soldering above stacks to prevent solder splashes from shorting cells in a rectifier stack.

1.06 Routine checks are intended to detect defects, particularly in infrequently operated parts

of the equipment and, insofar as possible, to guard against circuit failures that are liable to interfere with service. Checks and adjustments, other than those required by trouble conditions, should be made during a period when they will cause the least unfavorable reaction to service.

1.07 The instructions are based on drawing SD-81129-01, Fig. 1 and 4. For detailed description of the operation, see the corresponding circuit description.

1.08 More detailed information on the operation and maintenance of individual pieces of apparatus, such as instruments and switches, is given in other sections and the attendant should be familiar with them. All apparatus should be adjusted in accordance with these sections and with the circuit requirement table or the circuit description associated with the circuit drawing.

1.09 Battery voltage readings may be made with the plant voltmeter or a KS-8039 volt-milliammeter, provided that the instrument is connected at the battery and has been calibrated at float voltage.

2. LIST OF TOOLS, GAUGES, MATERIALS, AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch C Screwdriver
GAUGES	
R-1032, Detail 1	Thermometer
MATERIALS	
—	Felt Pad
TEST APPARATUS	
—	35-Type Test Set
KS-8039	Volt-Milliammeter — DC
KS-14510	Volt-Ohm-Milliammeter
—	Voltmeter, AC, Weston Model 904, 300/150-Volt

3. OPERATION

3.01 The rectifier is completely automatic in the regulation of float voltage and should require no day-to-day routine adjustments. The rectifier should start and build up its output in less than one minute unless the associated plant causes a greater delay. It is started and stopped by the operation of the NOR-OFF key. If the load exceeds the safe capacity of the rectifier, the regulating circuit switches to constant current regulation. As the load diminishes, the rectifier brings the voltage to the float value and returns to voltage regulation. The voltage at which the rectifier will regulate is adjustable by two potentiometers, COARSE ADJ VOLTS and ADJ VOLTS. Higher voltage for charging the battery may be obtained, without disturbing the float voltage adjustment, by externally removing a short circuit from the CHG potentiometer. The amount of current in the regulating coils of the reactors is indicated on the SAT CURRENT ammeter. The output voltage and current of the rectifier will be indicated on the OUT VOLTS voltmeter and OUTPUT CURRENT ammeter relay. The CON CUR TST millivoltmeter monitors the load current with the (CON CUR) NOR-TST switch in the NOR position. See Fig. 1 and 2.

3.02 The CHG-FLOAT switch will normally be in the FLOAT position. Usually a boost charge of the battery can be made with the switch in the FLOAT position. The CHG position is required when the battery and emergency cells are charged in series. The switch should be operated to the desired position while the rectifier is shut down.

3.03 The OUTPUT (S3) rotary switch is a three position switch. In the OPEN position (horizontal position to the right), the switch disconnects the rectifier from the batteries. In the vertical up position, the OUTPUT switch connects the rectifier output to the normal office batteries, and in the vertical down position it usually connects the rectifier to the normal office batteries and emergency end cells which are in series with each other.

Caution: Never operate the OUTPUT (S3) rotary switch to OPEN while the rectifier is carrying load. If this caution is not observed, the rectifying cells may be punctured and fail.

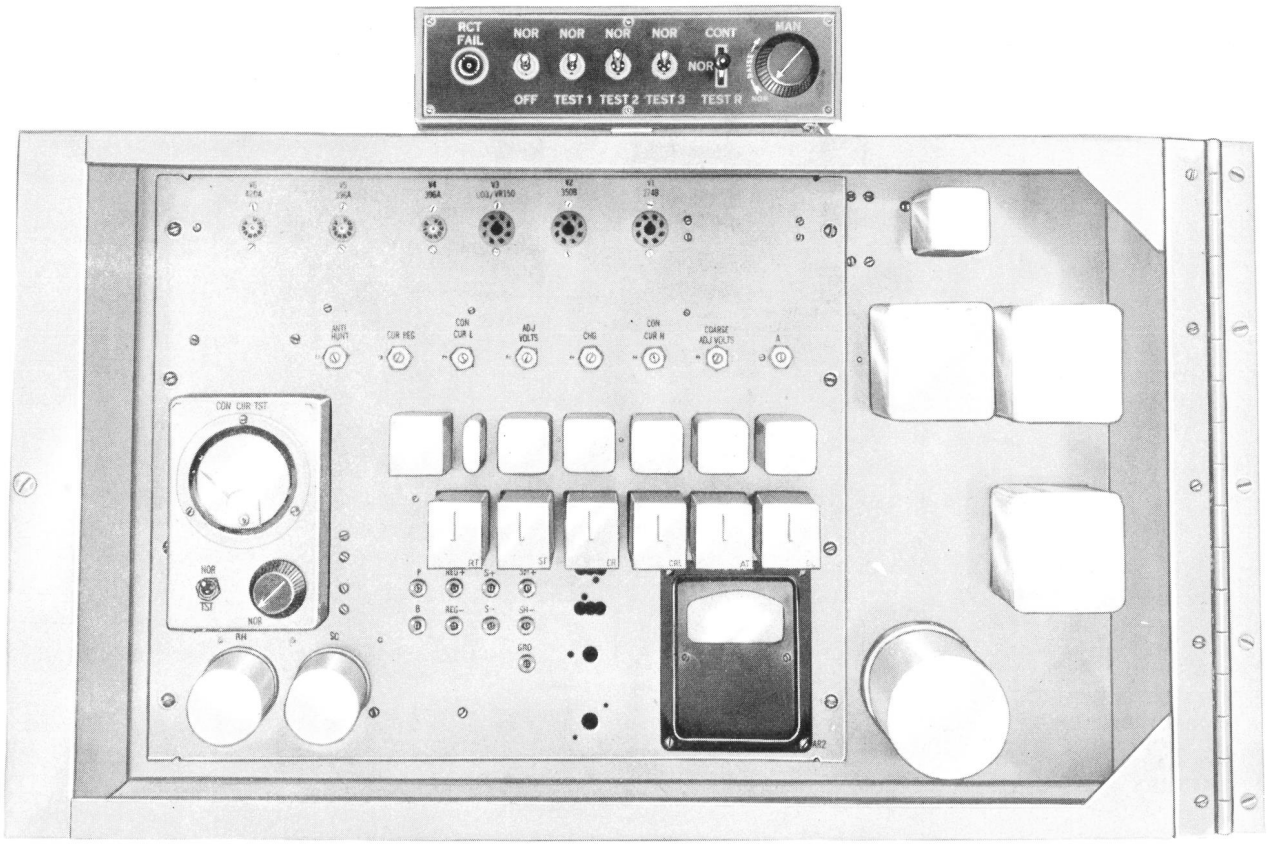


Fig. 1—J86249E L3 Electronic Control Panel

PREPARING TO START

3.04 When putting the rectifier into service, check that:

(a) The NOR-OFF key is in the OFF position (see Fig. 1 or 2).

(b) NOR-TEST 1, NOR-TEST 2, and NOR-TEST 3 switches are in their NOR positions.

(c) The CONT key and (CON CUR) NOR-TST switch are in the NOR positions.

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

(e) Correct tubes are in the sockets.

(f) The correct CHARGE and VM fuses are in place.

(g) The correct AC CONTROL fuses are in place in the rectifier and the supply fuses are in the supply panel.

(h) The CHG-FLOAT switch is operated to the desired position (see 3.02).

(i) The OUTPUT (S3) rotary switch is operated to the battery position (see 3.03).

(j) Covers and doors are tightly closed so the door switches, S1 and S8, are operated.

(k) Circuit breakers, CONT and CHG ALM, are closed.

(l) There is available sufficient office load to fully load the rectifier, or a variable load of adequate capacity.

(m) The rectifier terminals are strapped in accordance with the application drawing for the particular office.

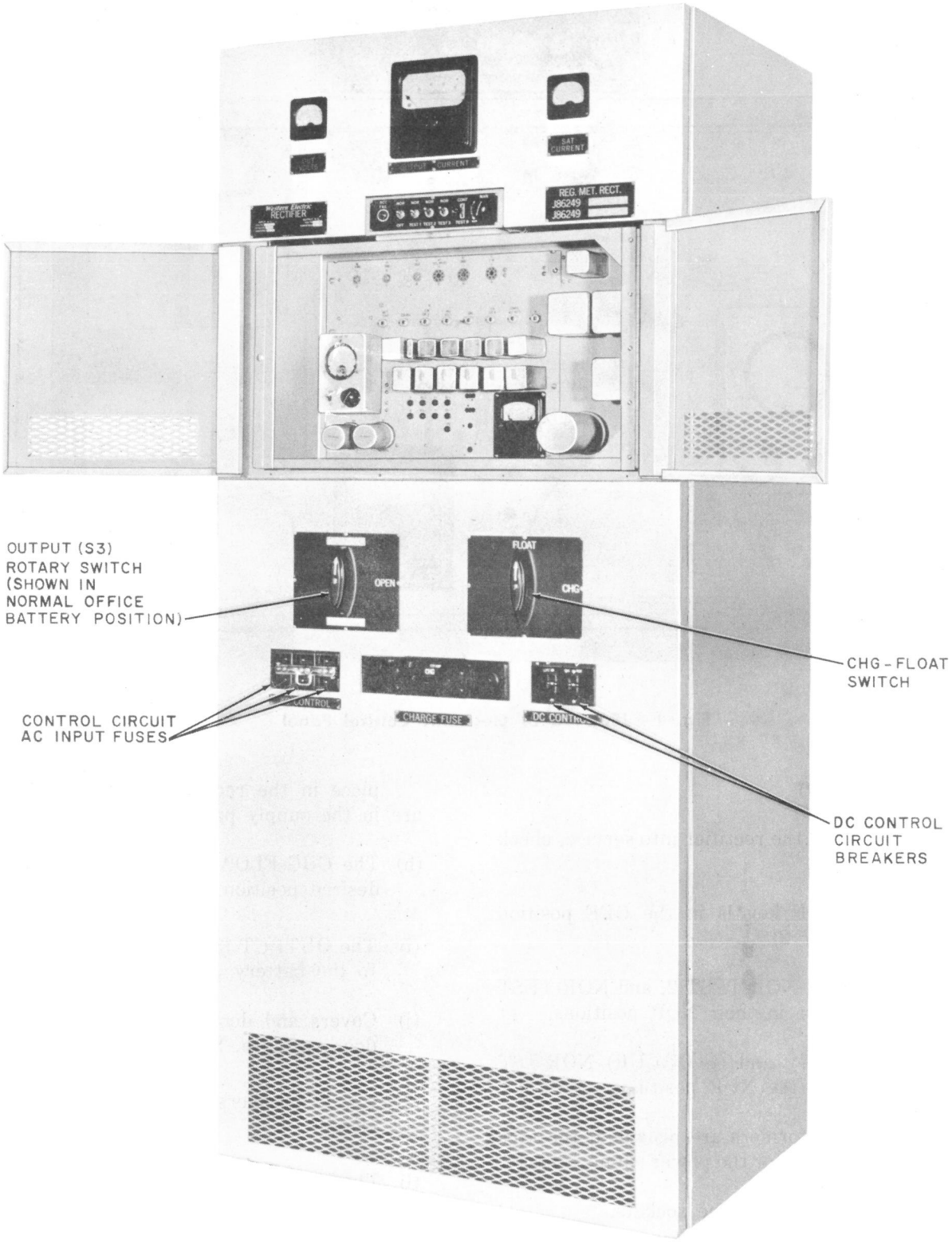


Fig. 2—J86249 Rectifier With J86249E L3 Electronic Control Panel

(n) The high and low contacts of the OUTPUT CURRENT (AR) ammeter relay are set as follows:

(1) The high contact is set at 90 amperes for the 100-ampere rectifiers or 180 amperes for the 200-ampere rectifiers.

(2) The low contact is set at 5 amperes for the 100-ampere rectifiers or 10 amperes for the 200-ampere rectifiers.

Note: If the office load is less than 5 percent of rated rectifier load, set the low ammeter relay contact lower (minimum of 2 percent) to prevent a false rectifier failure alarm from coming in.

(o) The high and low contacts of the AR2 ammeter relay are set as follows:

(1) The high contact is set at 75 percent of rated load.

(2) The low contact is set at 25 percent of rated load.

Note: If the settings in (n) and (o) differ from plant requirements, the plant requirements take precedence.

STARTING

3.05 ***Float Voltage:*** To adjust for float voltage, observe the directions in 3.04 and proceed as follows (see 3.02).

(1) Operate the CHG-FLOAT switch to FLOAT.

(2) Operate the NOR-TEST 1 switch to TEST 1.

(3) Operate the NOR-OFF switch to NOR.

Note: The RECT FAIL lamp is lighted.

(4) Operate the CONT key to TEST R.

(5) Allow approximately one minute for the tubes to heat.

(6) Rotate the MAN potentiometer slowly cw until the RECT FAIL lamp is extinguished.

(7) Quickly rotate the MAN potentiometer to the NOR position (maximum ccw).

(8) Operate NOR-TEST 1 switch to NOR.

(9) Rotate the COARSE ADJ VOLTS potentiometer cw, with the battery at float voltage, until the rectifier is carrying its share of the load or, if there are no other rectifiers operating in parallel with it, until it is carrying the entire load on the battery.

Note: Observe the OUT VOLTS voltmeter and the SAT CURRENT ammeter. The rectifier output current should be between 25 and 75 percent of rated full load.

(10) Connect the KS-8039 volt-milliammeter, set to the 75 or 30 VOLTS range, to the REG+ and REG- pin jacks.

(11) Adjust the load to the rectifier for approximately 50 percent of rated full load.

(12) Rotate the ADJ VOLTS potentiometer until the rectifier voltage, as indicated on the KS-8039 volt-milliammeter, is as follows:

49.9 volts for 23 cells

26.1 volts for 12 cells

23.9 volts for 11 cells

Note: The values shown in (12) are based on a float value of 2.17 volts per cell.

(13) Disconnect the KS-8039 volt-milliammeter.

(14) Adjust the load to the rectifier for the normal office load.

3.06 ***Charge Voltage:*** To adjust for charge voltage, observe the directions in 3.04 (see 3.02) and proceed as follows:

(1) Operate the CHG-FLOAT switch to CHG.

Note: Remove the short across the CHG potentiometer.

(2) Connect the KS-8039 volt-milliammeter, set to the 75 or 30 VOLTS range, to the REG+ and REG- pin jacks.

(3) Operate the NOR-OFF switch to NOR.

(4) Adjust the CHG potentiometer until the battery voltage, as indicated on the KS-8039 volt-milliammeter, increases to the following values:

50.6 volts for 23 cells

26.4 volts for 12 cells

24.2 volts for 11 cells

Note: These values are based on a charge value of 2.2 volts per cell. If plant requirements differ, the plant requirements take precedence.

(5) After this adjustment has been completed, reduce the rectifier output to zero.

Note: Decrease the load to the battery or increase the output of the other rectifiers supplying it, as necessary, to prevent service reaction.

(6) Operate the NOR-OFF switch to OFF.

(7) Disconnect the KS-8039 volt-milliammeter.

Note: Restore the short across the CHG potentiometer.

(8) Operate the CHG-FLOAT switch to FLOAT.

(9) Restore the rectifier to normal operation, as covered in 3.05.

Note: Increase the load to the battery or reduce the output of the other rectifiers supplying it, as necessary, to prevent service reaction.

3.07 When the rectifier is to be placed in service initially or if the rectifier has been out of service for an extended period of time, it is recommended that the routine checks in 4.05 and 4.06 be performed.

3.08 Measure the input voltage, with a Weston Model 904 voltmeter or equivalent, across each phase of the rectifier stacks when the rectifier stacks are new and when the rectifier is operating at rated current, voltage, and normal line input. Record these readings and place them on the rectifier for future reference. See 5.09.

4. ROUTINE CHECKS

4.01 As often as local experience demands, the relays should be inspected for adjustment and condition of contacts to make sure they are in accordance with the circuit requirements and Bell System Practices which apply.

4.02 Periodically operate the CONT key to the TEST R position and note that the rectifier begins or continues to operate. Return the CONT key to the NOR position.

4.03 Periodically, operate the NOR-TEST switches to check the rectifier operation as follows.

Note: Do not shut the rectifier down in the process of this test.

(1) Verify that the MAN potentiometer is rotated fully ccw.

(2) Operate the NOR-TEST 1 switch to TEST 1.

(3) Rotate the MAN potentiometer cw.

Requirement: The saturating current and rectifier output voltage shall increase as the potentiometer is rotated cw.

(4) Rotate the MAN potentiometer ccw to NOR.

(5) Operate the NOR-TEST 1 switch to NOR.

(6) Operate and hold the NOR-TEST 2 switch to TEST 2.

(7) Rotate the MAN potentiometer cw.

Requirement: The saturating current and rectifier output voltage shall increase as the potentiometer is rotated cw.

(8) Rotate the MAN potentiometer ccw to NOR.

(9) Operate the NOR-TEST 2 switch to NOR.

(10) Operate and hold the NOR-TEST 3 to TEST 3.

(11) Rotate the COARSE ADJ VOLTS potentiometer three-fourths cw.

(12) Rotate the MAN potentiometer cw.

Requirement: The saturating current and rectifier output voltage will increase. A point will be reached where further rotation of the MAN potentiometer has no effect. This point is where the regulating circuit switches over from constant voltage to constant current regulation as selected by the setting of the CON CUR H or CON CUR L potentiometer (see 4.06).

4.04 The accuracy of the CON CUR TST millivoltmeter and the OUTPUT CURRENT (AR) ammeter relay, at any load, can be verified by using the following equation:

CON CUR TST millivolts = (250 x load) ÷ rectifier rating

The load is the reading obtained from the OUTPUT CURRENT (AR) ammeter relay. The rectifier rating is in amperes (see nameplate). Compare the calculated CON CUR TST millivolts with the actual reading on the CON CUR TST millivoltmeter. They should agree within ±10 percent. If the observed and calculated voltages are not within these limits, the meters should be tested in accordance with 4.05.

4.05 ***OUTPUT CURRENT (AR) Ammeter Relay and CON CUR TST Millivoltmeter:*** Periodically check the calibration of the OUTPUT CURRENT (AR) ammeter relay and CON CUR TST millivoltmeter as follows:

(1) Connect the KS-8039 volt-milliammeter, using the 1.5 VOLTS range, to the SH+ and SH- test jacks.

(2) Adjust the load to the rectifier until the KS-8039 volt-milliammeter indicates 225 millivolts (0.225 volts).

Requirement 1: The OUTPUT CURRENT (AR) ammeter relay indicates 90 ±3 amperes for the 100-ampere rectifiers or 180 ±6 amperes for the 200-ampere rectifiers.

Requirement 2: The CON CUR TST millivoltmeter indicates 225 ±6 millivolts.

Note: If the above requirements are not met, the ammeter and/or voltmeter are out of calibration and should be calibrated before proceeding with the following routine checks.

4.06 ***Constant Current (CON CUR) Circuit and OL Relay Adjustment:*** Periodically check the setting of the CON CUR H, CON CUR L, ANTI-HUNT, CUR REG, and A potentiometers as follows:

(1) Verify that there is sufficient office load to fully load the rectifier or a variable load of adequate capacity.

(2) On the OUTPUT CURRENT (AR) and the AR2 ammeter relays, adjust the high contacts to the extreme right and the low contacts to the extreme left.

CON CUR TST Circuit

(3) Connect the KS-8039 volt-milliammeter, set to the 75 or 30 VOLTS range, to the REG+ and REG- jacks.

(4) Verify that the CON CUR TST and the MAN potentiometers are rotated fully ccw.

(5) Operate the (CON CUR) NOR-TST switch to TST. Note the indication of the KS-8039 volt-milliammeter.

(6) Rotate the CON CUR TST potentiometer cw until the indication of the KS-8039 volt-milliammeter decreases 2 volts below the voltage noted in (5). This indicates satisfactory performance of the CON CUR TST circuit.

(6) Rotate the CON CUR TST potentiometer fully ccw.

(7) Operate the (CON CUR) NOR-TST switch to NOR.

(8) Adjust the load to the rectifier to obtain a full scale indication on the OUTPUT CURRENT (AR) ammeter relay.

(9) Adjust the zero setting of the CON CUR TST millivoltmeter to obtain an indication of 250 millivolts.

Caution: The CON CUR TST millivoltmeter may not be on zero with no voltage across it. This condition is normal as a result of the foregoing adjustment at full load. Do not change the zero setting.

CON CUR H Potentiometer

(10) Decrease the load to the rectifier to zero.

Note: Decrease the load to the battery or increase the output of the other rectifiers supplying it, as necessary, to prevent service reaction.

(11) Operate the NOR-OFF switch to OFF.

(12) Operate the OUTPUT switch to OPEN.

(13) Operate the CONT key to TEST R.

(14) Verify that the (CON CUR) NOR-TST switch is operated to NOR.

(15) Verify that the CON CUR TST potentiometer is rotated fully ccw.

(16) Verify that the CHG-FLOAT switch is operated to FLOAT.

(17) Operate the NOR-OFF key to NOR.

(18) Note that the rectifier output voltage as indicated on the OUT VOLTS voltmeter is float voltage ±2 or ±4 for 24- or 48-volt plants, respectively (see 3.05).

(19) Allow the rectifier to operate 10 minutes to stabilize tube V6.

(20) Rotate CON CUR H potentiometer fully cw.

(21) Operate (CON CUR) NOR-TST switch to TST.

(22) Rotate CON CUR TST potentiometer cw until the CON CUR TST millivoltmeter indicates 275 ±2 millivolts.

(23) Rotate CON CUR H potentiometer ccw until the rectifier output voltage, as indicated on the OUT VOLTS voltmeter, decreases 1 volt for 24-volt rectifiers or 2 volts for 48-volt rectifiers from the voltage noted in (18).

Note: Some adjustment of both the CON CUR H potentiometer and CON CUR TST potentiometer will be necessary because of interaction.

(24) Rotate the CON CUR TST potentiometer fully ccw.

(25) Operate the (CON CUR) NOR-TST switch to NOR.

(26) Operate the NOR-OFF switch to OFF.

CON CUR L Potentiometer

(27) Block the CRL relay operated.

(28) Operate the NOR-OFF switch to NOR.

(29) Note the rectifier output voltage, as indicated on the OUT VOLTS voltmeter, is float voltage ±2 or ±4 for 24-volt or 48-volt plants, respectively (see 3.05).

(30) Allow the rectifier to operate 10 minutes to stabilize tube V6.

(31) Rotate CON CUR L potentiometer fully cw.

(32) Operate the (CON CUR) NOR-TST switch to TST.

(33) Rotate the CON CUR TST potentiometer cw until the CON CUR TST millivoltmeter indicates 200 ±2 millivolts.

(34) Rotate CON CUR L potentiometer ccw until the rectifier output voltage, as indicated on the OUT VOLTS voltmeter, decreases 1 volt for 24-volt rectifiers and 2 volts for 48-volt rectifiers.

(35) Rotate the CON CUR TST potentiometer fully ccw.

(36) Operate the (CON CUR) NOR-TST switch to NOR.

ANTI-HUNT Potentiometer

(37) If a periodic increase and decrease of the indication of the OUTPUT CURRENT ammeter is observed while performing the routine checks or in normal operation, adjust the ANTI-HUNT potentiometer slowly until the swings decrease to a minimum.

Note: In general, it will be found that the ANTI-HUNT potentiometer will work most satisfactorily when left in the midrange for lead-calcium battery loads and in the three-fourths cw position for the lead-antimony battery loads. If the ANTI-HUNT is incapable of eliminating cyclic hunting of rectifier output, use "A" option (if provided) shown in SD-81129-01, Fig. 4.

Overload Relay

(38) Verify that the rectifier output voltage as indicated on the OUT VOLTS voltmeter, is at float voltage ±2 volts for 24-volt rectifiers or ±4 volts for 48-volt rectifiers.

(39) Rotate the A potentiometer fully cw.

(40) Operate the (CON CUR) NOR-TST switch to TST and hold only while making adjustments.

(41) Using the CON CUR TST potentiometer, maintain the indication of the CON CUR TST millivoltmeter at 300 millivolts.

(42) Adjust the A potentiometer until the OL relay releases with a CON CUR TST millivoltmeter indication of 300 millivolts (120 percent of rectifier rating).

(43) Rotate the CON CUR TST potentiometer fully ccw.

(44) Operate the (CON CUR) NOR-TST switch to NOR.

(45) Operate the NOR-OFF switch to OFF.

(46) Operate the CONT key to NOR.

(47) Operate the OUTPUT switch to the position for normal office load.

(48) Restore the rectifier to normal service.

(49) Restore the settings of the high and low contacts of the OUTPUT CURRENT (AR) and the (AR2) ammeter relays as covered in 3.04 (n) and (o).

CUR REG Potentiometer

(50) Adjust the CUR REG potentiometer until the rectifier is carrying approximately 50 percent of rated load.

Note: The CUR REG potentiometer is unshorted and controlling the rectifier during the warm-up time interval of approximately one minute when the rectifier is first placed in service.

5. TROUBLES

5.01 This rectifier consists of a main power circuit controlled through an electronic regulating circuit whose input is the output voltage of the main unit. In addition, the drop in voltage across the output ammeter relay shunt is introduced into the regulating circuit for the purpose of current limitation. The output of the regulating circuit is introduced into the main power circuit to effect the desired corrections in the power output. In the maintenance of intricate equipment, trouble must be localized in an orderly way. This is difficult in the case of a circuit having this feedback or loop arrangement because trouble anywhere in the loop will give faulty operation of other parts of the loop which may be trouble free. In this rectifier, provision has been made for opening the loop by means of switches which permit checking the performance of each major subdivision of the equipment until the trouble is located. See 4.03.

Caution: The MAN potentiometer should always be rotated completely ccw before operating a test switch to avoid excessive voltage and current.

5.02 Although it may vary widely with extreme conditions, the saturating current 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. The output of the regulating circuit controls the input to the main power rectifying circuit. If increasing the amount of saturating current increases the rectifier output and decreasing the saturating current decreases the rectifier output, the saturating current supply circuit and main power circuit are generally performing satisfactorily. 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. Three test switches provide for the application of a

manually adjustable potential from the MAN potentiometer in the grid-to-cathode circuits (see Fig. 3) of certain tubes as follows:

NOR-TEST 1 Switch—Tube V2

NOR-TEST 2 Switch—Tube V4 (6-7-8 half)

NOR-TEST 3 Switch—Tube V6 (6-7-8 half)

By their separate operation to their TEST positions (in each instance the other two switches remaining on NOR) the series tube, the final amplifier, and the second current control amplifier may be tested.

5.03 When any kind of trouble is encountered, it is necessary to decide whether to locate the trouble with the equipment operating or de-energized. This rectifier has been designed to make some parts accessible for testing with the power connected. The jacks are mounted in the face of the panel which is accessible when the front doors are open. All parts over 150 volts to ground have been covered. 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 of quickly shutting down the rectifier at any time until the trouble is localized and cleared.

5.04 In general, the only items likely to become defective with use are the electron tubes which are subject to aging but should have long useful lives. Check the tubes in any available electron tube test set in accordance with its associated instructions, one at a time, or mark the tubes, as interchanging tubes may spoil adjustments. Tubes which test low may still be satisfactory. Certain typical defects such as grid emission or cathode-to-grid shorts may not be detected on the test set as they might occur only after the tube has heated for some time.

Note: Where routine replacements of all tubes is practiced as a preventative maintenance measure, do not include the V6 (420A) electron tube, since this is a long-life tube and should be replaced only if defective.

If the performance of the V6 (420A) electron tube is in doubt and a check by substitution is made, restore the 420A tube to its original position if no improvement is noticed. See 5.05.

5.05 Following the installation of a new V6 (420A) electron tube, the constant current adjustments should be made daily for several days. See 4.06. Subsequent readjustments should be made approximately every two weeks for several months, or as required.

5.06 The control potentiometers, the KS-5716 switches, and the KS-5649 door switches should be replaced if they become defective in any respect.

5.07 Varistors or rectifier stacks will age with use, and after a period of years may require changing the connection from the NEW to the AGED tap, where this arrangement is available. In other cases, the RV1 or SR13 varistor must be replaced. See 5.08 or 5.11. Since some of the rectifier stacks are arranged to form a bridge circuit, these should all be aged equally. If replacement is necessary due to aging, replace all stacks. If, however, a single stack opens or shorts when the others are comparatively new, the single stack may be replaced with one of the same code. Do not combine stacks from different manufacturers.

5.08 Aging taps are provided on T1 to T3 transformers for use when the main rectifier element has aged, usually after a long period of use. The connections should not be changed from taps 3 to taps 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 troubles. If rated output can be obtained with manual control, it will indicate that the transformer taps do not need to be changed.

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

5.10 An alternate method for determining if rectifier stacks are approaching the end of their useful life is to measure the ac input voltage to each phase of the rectifier stacks, when the

rectifier is operating under the same conditions as outlined in 3.08, with a Weston Model 904 voltmeter or an equivalent 0.5 percent meter. Compare these values with those obtained in 3.08. If the stack ac input voltage increases 2 volts above the values obtained when the stacks were new, refer the matter to the supervisor as the rectifier stacks may have to be replaced.

5.11 There is no provision for aging taps for the SR13 varistor in the magnetic amplifier. To determine if the varistor needs to be replaced, proceed as follows with the rectifier connected to the battery. Operate the NOR-TEST 1 switch to the TEST 1 position. Rotate the MAN potentiometer to the maximum cw position momentarily and note that the SAT CURRENT ammeter indicates three-fourths of full-scale reading.

Caution: Do not keep the MAN potentiometer in the maximum cw position longer than is necessary to determine the SAT CURRENT ammeter reading because the output voltage increases rapidly.

If the SAT CURRENT ammeter does not indicate three-fourths of full scale, check V1 and V2 electron tubes (see 5.04). If the tubes are found to be satisfactory, then the trouble is in the SR13 varistor which should be replaced. Operate the NOR-TEST 1 switch to NOR position.

5.12 The taps on the T14 transformer are factory-adjusted for a minimum rectifier output voltage not greater than 45 volts for J86249A rectifiers or not greater than 22 volts for J86249B and J86249C rectifiers. If any of the following parts, C17, C18, T14, L6, or SR13 are replaced during maintenance, the T14 transformer taps may have to be reselected to meet the minimum voltage requirement. A change (shown on SD-81129-01, Issue 6) in the normal connections of the T14 transformer was made to increase the adjustment range. Check the rectifier minimum voltage with the rectifier operating at no load (OUTPUT switch operated to OPEN), the NOR-TEST 1 switch in the TEST 1 position, the MAN potentiometer in NOR (maximum ccw) position and with the regulating circuit disabled (remove V1 tube). As the adjustable tap lead is moved over the tap range, the rectifier output voltage should decrease to a minimum and then rise. Connect to the tap causing minimum voltage. If the voltage decreases as numerically lower taps are used but does not meet the minimum voltage requirement when tap 6 is reached, try the following tap arrangement.

(a) Remove the strap between T14 transformer terminals 10 and 11 and connect a strap between terminals 6 and 13.

(b) Connect the adjustable tap to terminal 11 or 12 as required to meet the minimum voltage limit.

Caution: When changing taps, disconnect the rectifier from the power supply before touching the terminals.

5.13 Should any of the following troubles develop, it is suggested that the possible cause be checked in the order given. If the trouble is not found, look for loose 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 point-to-point voltage table fails to lead to the source of trouble, it is advisable to make resistance measurements with the circuit completely de-energized, comparing the measured values with the values shown on the circuit drawing.

TROUBLE	POSSIBLE CAUSES
No dc output current (no saturating current in automatic control)	Blown ac supply or control fuse.
	Weak tubes.
	CONT circuit breaker operated.
	Door switch open.
	COARSE ADJ VOLTS potentiometer out of adjustment.
	CON CUR H potentiometer out of adjustment.
	Tube failure, V1, V2, V3, V4, or V6.
	TD1 relay failure.
	AC contactor not operated.
No dc output current (high saturating current in automatic control)	CHG fuse blown.
	OUTPUT (S3) rotary switch in OPEN position — CONT key in NOR.
	REG fuse failure in plant.
	Aged rectifier stacks.
	Low line voltage.

TROUBLE	POSSIBLE CAUSES
Low dc output current (low saturating current in automatic control)	COARSE ADJ VOLTS potentiometer out of adjustment.
	CON CUR H potentiometer out of adjustment.
	V1, V2, V3, V4, or V6 tubes weak.
	Aged SR13 rectifier stacks.
	SC or RH relay failure.
Low dc output current (high saturating current in automatic control or manual control)	Aged main rectifier stacks.
	Excessive charging lead drop.
	Low line voltage.
High dc output current (high saturating current in automatic control)	High line voltage.
	CHG or CUR REG potentiometers not shorted out.
	Failure or low emission in V5.
	Excessive grid current in V2.
	REG leads open or fuse blown.
	COARSE ADJ VOLTS potentiometer out of adjustment.
	Rectifier in manual with MAN potentiometer not fully ccw.
Output excessively noisy	Filter capacitors defective.
	Faulty connection to filter capacitors.
	Unbalanced ac line voltage (more than 5 percent).
	Defective stack in main rectifier assembly.
Unstable output (hunting)	ANTI-HUNT potentiometer misadjusted.
	Faulty C7, C9, R38, or R39.
Output voltage surge during starts	TD1 relay not furnished.
	TD1 relay not properly adjusted.

TROUBLE	POSSIBLE CAUSE
Rated output current not obtainable with saturating current maximum under MAN control	Excessive drop in dc connection to load.
	Shorted C31 through C35.
	Main rectifier cells high resistance due to aging.
	CHG fuse blown.
	OUTPUT (S3) rotary switch OPEN.
Cannot reduce dc output current to zero with saturating current minimum under MAN control	R40 or RV failure.
	T14 misadjusted.
Rectifier shuts off after short interval of operation	OL relay not adjusted.
Poor regulation at battery	RT relay not operating.
	CON CUR H potentiometer not adjusted properly.
	Aged main or MAG AMP stacks.
	Excessive charging lead drop.

6. POINT-TO-POINT VOLTAGES

6.01 Point-to-point voltages are intended for use when unsatisfactory operation is encountered, in which case they may prove useful in locating the cause. They are not operating requirements to be checked in routine and are not needed while the rectifier is operating satisfactorily. As given in the tables, they are approximate and typical of a rectifier connected to normal power supply, adjusted to the float voltage of the battery, and at no load as indicated.

6.02 High voltages are present within the rectifier and every precaution should be observed to avoid any contact with exposed metal parts or terminals when the rectifier 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 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.

6.03 Readings should be made with a KS-14510 volt-ohm-milliammeter. The output of the rectifier will not be appreciably affected by connecting the voltmeter leads to the circuit elements. In general, door switches are not intended for use in disconnecting power. However for convenience, they may be so used during the infrequent taking of point-to-point voltages.

6.04 Viewed from the rear, the socket terminals, starting from the keyway or blank position, are numbered clockwise. Before taking the voltage readings, disconnect the rectifier from the plant in accordance with Section 167-621-301 and perform the following operations. (CON CUR H potentiometer must be in reasonable adjustment before point-to-point voltages can be taken.)

(a) Operate the NOR-OFF switch to OFF position.

(b) Operate the CONT key to TEST R position.

(c) Operate the NOR-TEST 1 switch to TEST 1 position.

(d) Operate the OUTPUT (S3) rotary switch to OPEN.

(e) Restore the NOR-TEST 1 switch to NOR position.

(f) Restore the NOR-OFF switch to NOR position.

Note: The voltage indicated on the output voltmeter at this time is slightly higher than the float voltage, since the voltmeter indicates float voltage, CUR REG potentiometer voltage, and REG lead voltage. This condition is satisfactory since the point-to-point voltages are approximate.

Caution: Point-to-point voltages should be taken only after the rectifier has been operating for at least 10 minutes and tube V6 has stabilized.

TABLE A — POINT-TO-POINT VOLTAGES

J86249A Panel Meter Readings: SAT CURRENT = 0.070 Amp; OUTPUT VOLTS = 49.5 Volts; AMMETER (AR) = 0 Amp

J86249B Panel Meter Readings: SAT CURRENT = 0.090 Amp; OUTPUT VOLTS = 26 Volts

J86249C Panel Meter Readings: SAT CURRENT = 0.080 Amp; OUTPUT VOLTS = 27 Volts

METER CONNECTIONS		METER SCALE (VOLTS)	READING (VOLTS)		
TEST POINT	TEST POINT		J86249A	J86249B	J86249C
Contactor AC					
T1	T2	300AC	205	208	210
T2	T3	300AC	205	208	210
T1	T3	300AC	205	208	210
L1	L2	300AC	205	208	210
L2	L3	300AC	205	208	210
L1	L3	300AC	205	208	210
Control Circuit Fuses (Both sides)					
F1	F2	300AC	202	207	209
F2	F3	300AC	202	207	209
F1	F3	300AC	202	207	209
Rectifier Stack AC Supply					
Between	Between	60AC	37	20	20
each	each	60AC	37	20	20
phase	phase	60AC	37	20	20
Pin Jacks					
REG+	REG−	60DC	48.5	26	26
SH+	SH−	0.3DC	0	0	0
S+	S−	12DC	6.5*	5*	4.5*
P	GND	300DC	143**	152**	149**
B	GND	300DC	255***	252***	254***
P	B	300DC	113	113	109

*Output voltage may increase when taking this reading.
**This voltage may vary from 142 to 165 volts plus meter errors.
***This voltage will vary with the P to GND voltage.

TABLE A (Cont)

METER CONNECTIONS		METER SCALE (VOLTS)	READING (VOLTS)		
TEST POINT	TEST POINT		J86249A	J86249B	J86249C
Transformers					
T1—Term. 1	Term. 2	300AC	165	178	174
Term. 2	Term. 3	12AC	9.5	10	10.2
Term. 1	Term. 3	300AC	172	187	185
T2—Term. 1	Term. 2	300AC	162	177	177
Term. 2	Term. 3	12AC	9.4	10	10.3
Term. 1	Term. 3	300AC	170	186	188
T3—Term. 1	Term. 2	300AC	163	182	174
Term. 2	Term. 3	12AC	9.7	10.2	10.2
Term. 1	Term. 3	300AC	175	187	185
T4—Term. 1	Term. 2	300AC	70	60	60
Term. 2	Term. 3	60AC	34	30	30
Term. 1	Term. 3	300AC	108	90	90
T5—Term. 1	Term. 2	300AC	75	58	56
Term. 2	Term. 3	60AC	36.5	30	28
Term. 1	Term. 3	300AC	113	92	85
T6—Term. 1	Term. 2	300AC	68	50	63
Term. 2	Term. 3	60AC	33	26	31
Term. 1	Term. 3	300AC	100	80	93
T10—Term. 1	Term. 2	300AC	203	207	209
Term. 3	Term. 4	600AC	370	387	390
Term. 4	Term. 5	600AC	370	380	387
Term. 6	Term. 7	12AC	5	4.5	5
T11—Term. 1	Term. 2	300AC	205	208	208
Term. 3	Term. 4	300AC	105	109	110
Term. 5	Term. 6	12AC	6	6.2	6.2
Term. 7	Term. 8	12AC	6	6.2	6.2
T12—Term. 1	Term. 2	300AC	205	210	209
Term. 3	Term. 4	60AC	36	37	37
Term. 4	Term. 5	600AC	420	425	427
T13—Term. 1	Term. 6	300AC	105	130	114
Term. 8	Term. 12	12AC	6.3	6.2	6.3
Term. 7	Term. 12	12AC	6.9	7.4	6.9

TABLE A (Cont)

METER CONNECTIONS		METER SCALE (VOLTS)	READING (VOLTS)		
TEST POINT	TEST POINT		J86249A	J86249B	J86249C
Transformers (cont)					
T14—Term. 1	Term. 2	300AC	100	105	104
Term. 3	Term. 4	300AC	100	105	104
Term. 5	Term. 10	300AC	248	250	252
Term. 11	Term. 13	12AC	11.3	11	11.2
Term. 5	Term. 6	300AC	232	230	229
Inductors					
L1—Term. 1	Term. 2	300AC	265	255	264
Term. 3	Term. 4	3DC	2#	2.75#	2.25#
L2—Term. 1	Term. 2	300AC	272	256	260
Term. 3	Term. 4	3DC	2#	2.75#	2.25#
L3—Term. 1	Term. 2	300AC	268	250	266
Term. 3	Term. 4	3DC	2#	2.75#	2.25#
L6—Term. 1	Term. 2	300AC	102	95	106
Term. 5	Term. 6	300AC	102	93	107
Term. 3	Term. 4	12DC	6.2#	5#	4#
Rectifying Elements					
RV1—Term. 1	Term. 2	300DC	113	113	116
RV2—Term. 1	Term. 2	300AC	138	150	139
Term. 1	Term. 3	300DC	143	151	148
SR13—Term. AC	Term. AC	60AC	15	10.3	14
Term. +	Term. −	12DC	6	4.2	6.9
Potentiometers and Rheostats					
A—Term. 1	Term. 2	3DC	0	0	0
COARSE ADJ VOLTS (P1)—Term. 1	Term. 2	60DC	23.5	24	25.4
CUR REG (P8)—Term. 1	Term. 3	3DC	1	1.2	1
MAN (P3)—Term. 1	Term. 2	300DC	245	240	246
Term. 1	Term. 3	3DC	0	0	0
CHG (P5)—Term. 1	Term. 3	3DC	0	0	0

 # Caution: The dc windings 3-4 of saturable reactors L1, L2, L3, and L6 may have ac voltages of 100 to 200 volts normally and over 1000 volts under trouble conditions.

TABLE A (Cont)

METER CONNECTIONS		METER SCALE (VOLTS)	READING (VOLTS)		
TEST POINT	TEST POINT		J86249A	J86249B	J86249C
Resistors					
R1	(Each side	60DC	26	31	29
R2	of resistors)	3DC	0	0	0
R3		3DC	0	0	0
R4		60DC	38.3	49	49
R5		300DC	70	60	63
R6		300DC	133	150	157
R7		300DC	61	85	86
R8		3DC	0	0	0
R9		3DC	1.35	0.50	0.42
R11		12DC	7.5	7.6	7.2
R12		60DC	30.5	34	33.9
R13		60DC	16.5	18	18.8
R15		300DC	80	108	105
R16		60DC	46***	53***	46***
R17		12DC	7.2	9.3	8.6
R18		60DC	21	29	26.5
R19		3DC	0	0	0
R20		300DC	95***	92***	100***
R21		300DC	116†	92†	103†
R22		300DC	83†	50†	50†
R25		3DC	0	0	0
R26		600AC	322	340	334
R28		60DC	22	0	0
R29		300DC	105	—	182
R30		3DC	0	0	—
R32		12DC	6.5*	—	—
R33		60DC	15	0	—
R34		12DC	9.7	0	—
R35		300DC	78	0	—
R36		60DC	27.2	0	—
R38		3DC	0	0	—

†These voltages may vary considerably from those given.
*Output voltage may increase when taking this reading.
***This voltage will vary with the P to GND voltage.
—This part is not in the circuit.

TABLE A (Cont)

METER CONNECTIONS		METER SCALE (VOLTS)	READING (VOLTS)		
TEST POINT	TEST POINT		J86249A	J86249B	J86249C
Resistors (cont)					
R39		3DC	0	0	0
R40		12DC	2.5	4.8	4
R41		300DC	60	71	70
R42		60DC	39	49	50
R44		60DC	45	36	36
R45		3DC	0[a]	0[a]	0[a]
R46		3DC	0[a]	0[a]	0[a]
R47A & 47B		3DC	0[a]	0[a]	0[a]
R48		3DC	0[b]	0[b]	0[b]
R49		300DC	110	105	103
R50		300DC	60	75	42
R51		60DC	60	26	66
R52		60DC	11		
R53		12DC	0.1	0.1	0.1
Capacitors					
C2		300DC	(See Jacks P & B)	(See Jacks P & B)	(See Jacks P & B)
C3		3DC	0.2	0.2	0.2
C4		0.3DC	0.03	0.2	0.2
C6		12DC	1.4	6.2	7.6
C7	R38 to R39 Side	60DC	35*	37*	40*
C7	ANTI - HUNT Potentiometer to R39 Side	60DC	40*	36*	40*
C8		300DC	143***	150***	147***
C9		60DC	40*	49*	55*
C10		60DC	23	35	50
C11		12DC	4.6	2.4	2.2
C12		60DC	35	48	55

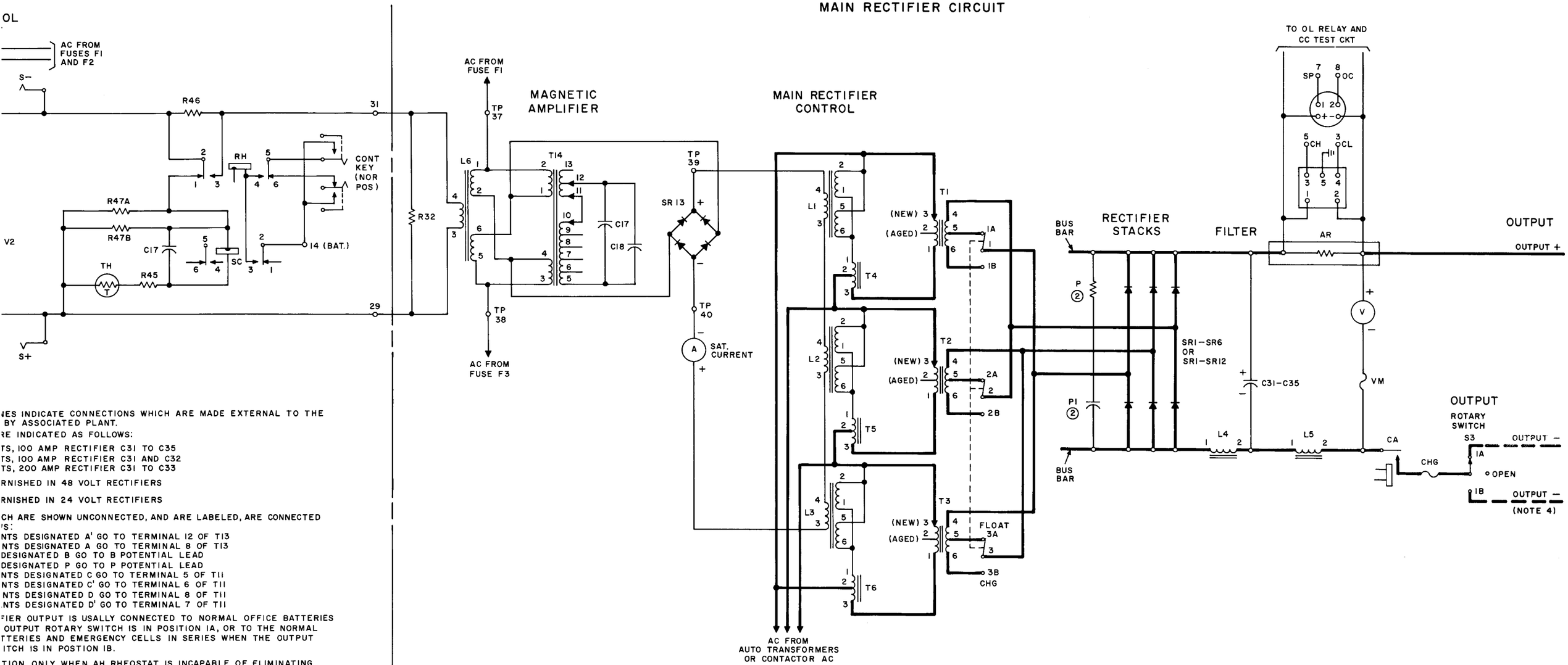
*Output voltage may increase when taking this reading.
***This voltage will vary with the P to GND voltage.
[a]No reading when RH relay operated.
[b]No reading with CON CUR TST key in NOR position.

TABLE A (Cont)

METER CONNECTIONS		METER SCALE (VOLTS)	READING (VOLTS)		
TEST POINT	TEST POINT		J86249A	J86249B	J86249C
Capacitors (cont)					
C13		12DC	2.9	5	4.6
C14		60DC	48.3	22	25
C15 & C16		60DC	48.2	22	25.1
C17 & C18 (Rectifier circuit)		300AC	255	266	252
C17 (Control circuit)		3DC	—	0	—
Tubes					
V1—Term. 2	Term. 8	12AC	4.9	5	5
Term. 2	Term. 4	600DC	332	350	373
Term. 2	Term. 6	600DC	332	350	379
V2—Term. 2	Term. 7	12AC	5.9	6.1	6
Term. 8	Term. 3	600DC	327	340	370
Term. 8	Term. 4	600DC	327	340	371
Term. 8	Term. 5	60DC	35	48	56
V3—Term. 2	Term. 5	300DC	143**	150**	148**
V4—Term. 1	Term. 9	12AC	6	6.2	6.2
Term. 8	Term. 7	12DC	1.4	6.3	7.8
Term. 2	Term. 3	12DC	2.9	5	4.6
Term. 2	Term. 4	300DC	115	147	145
V5—Term. 1	Term. 9	12AC	6	6.1	6.1
Term. 8	Term. 6	300DC	115	95	102
Term. 8	Term. 7	12DC	4.6	2.4	2.1
Term. 2	Term. 3	60DC	35	35	50
Term. 2	Term. 4	300DC	115	95	102
V6—Term. 2	Term. 3	3DC	0.05	0.05	0.21
Term. 2	Term. 4	60DC	35.3	35.3	35.3
RV3—Term. 1	Term. 2	300DC	67	67	75
Term. 2	Term. 3	300DC	77	77	64
Term. 1	Term. 3	300DC	147	147	141

**This voltage may vary from 142 to 165 volts plus meter errors.
—This part is not in the circuit.

MAIN RECTIFIER CIRCUIT



ES INDICATE CONNECTIONS WHICH ARE MADE EXTERNAL TO THE BY ASSOCIATED PLANT.

RE INDICATED AS FOLLOWS:

TS, 100 AMP RECTIFIER C31 TO C35
TS, 100 AMP RECTIFIER C31 AND C32
TS, 200 AMP RECTIFIER C31 TO C33

RNISHED IN 48 VOLT RECTIFIERS

RNISHED IN 24 VOLT RECTIFIERS

CH ARE SHOWN UNCONNECTED, AND ARE LABELED, ARE CONNECTED 'S:

NTS DESIGNATED A' GO TO TERMINAL 12 OF T13
NTS DESIGNATED A GO TO TERMINAL 8 OF T13
DESIGNATED B GO TO B POTENTIAL LEAD
DESIGNATED P GO TO P POTENTIAL LEAD
NTS DESIGNATED C GO TO TERMINAL 5 OF T11
NTS DESIGNATED C' GO TO TERMINAL 6 OF T11
NTS DESIGNATED D GO TO TERMINAL 8 OF T11
NTS DESIGNATED D' GO TO TERMINAL 7 OF T11

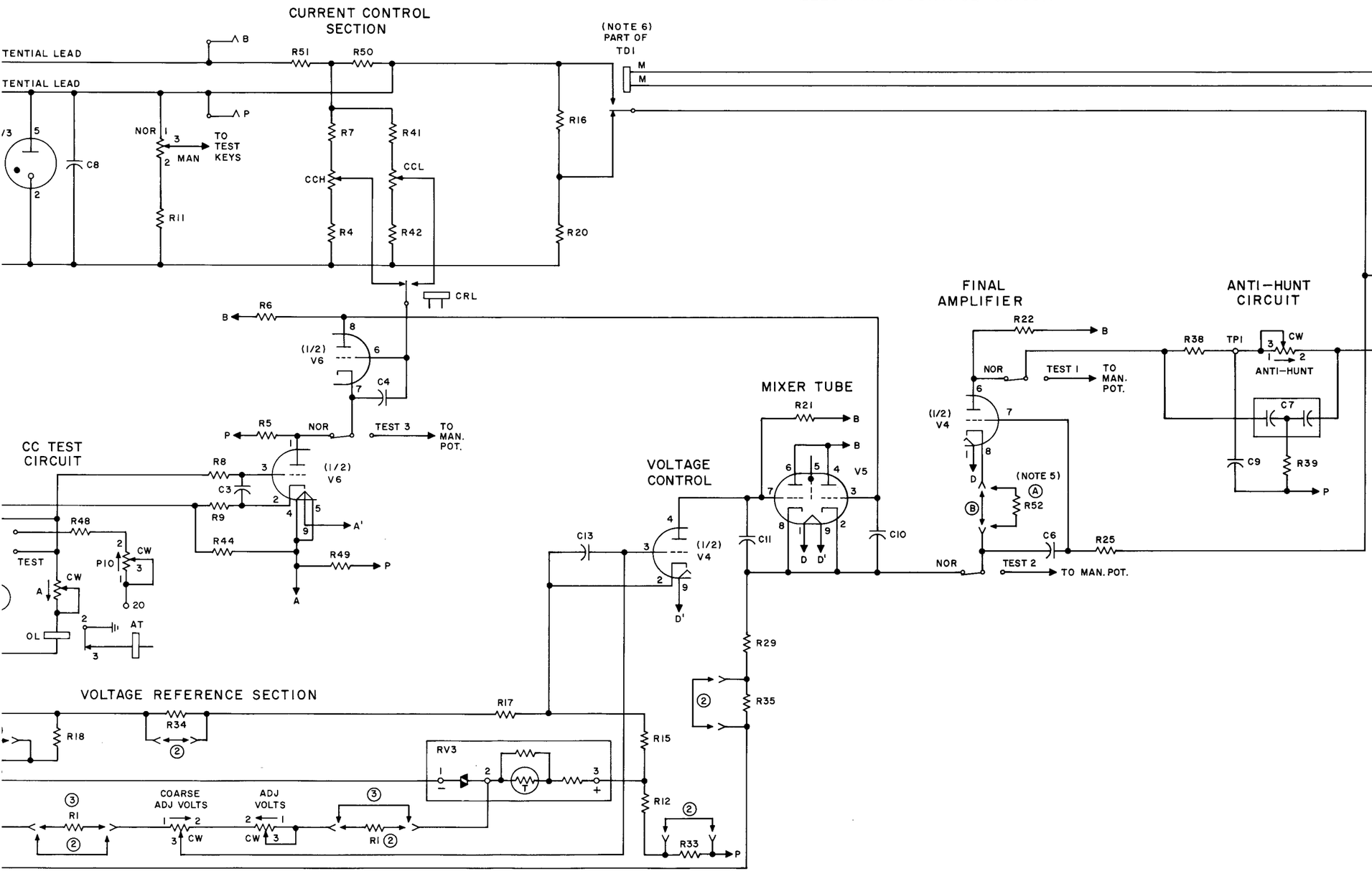
FIER OUTPUT IS USALLY CONNECTED TO NORMAL OFFICE BATTERIES OUTPUT ROTARY SWITCH IS IN POSITION 1A, OR TO THE NORMAL TTERIES AND EMERGENCY CELLS IN SERIES WHEN THE OUTPUT ITCH IS IN POSTION 1B.

TION ONLY WHEN AH RHEOSTAT IS INCAPABLE OF ELIMINATING NTING OF RECTIFIER OUTPUT.

) OPTION WERE NOT FURNISHED PRIOR TO ISS. 13 OF SD−81129.

Fig. 3 — Simplified Schematic Diagram of J86249 Rectifier With J86249E L3 Electronic Control

ELECTRONIC CONTROL CIRCUIT



NOTES:

1. DOTTED LINES INDICATE CONNECTIONS WHICH ARE MADE EXTE RECTIFIER BY ASSOCIATED PLANT.
2. OPTIONS ARE INDICATED AS FOLLOWS:
   - (1) 48 VOLTS, 100 AMP RECTIFIER C31 TO C35
     24 VOLTS, 100 AMP RECTIFIER C31 AND C32
     24 VOLTS, 200 AMP RECTIFIER C31 TO C33
   - (2) NOT FURNISHED IN 48 VOLT RECTIFIERS
   - (3) NOT FURNISHED IN 24 VOLT RECTIFIERS
3. LEADS WHICH ARE SHOWN UNCONNECTED, AND ARE LABELED, AR AS FOLLOWS:
   FILAMENTS DESIGNATED A' GO TO TERMINAL 12 OF T13
   FILAMENTS DESIGNATED A GO TO TERMINAL 8 OF T13
   LEADS DESIGNATED B GO TO B POTENTIAL LEAD
   LEADS DESIGNATED P GO TO P POTENTIAL LEAD
   FILAMENTS DESIGNATED C GO TO TERMINAL 5 OF T11
   FILAMENTS DESIGNATED C' GO TO TERMINAL 6 OF T11
   FILAMENTS DESIGNATED D GO TO TERMINAL 8 OF T11
   FILAMENTS DESIGNATED D' GO TO TERMINAL 7 OF T11
4. THE RECTIFIER OUTPUT IS USALLY CONNECTED TO NORMAL OFF WHEN THE OUTPUT ROTARY SWITCH IS IN POSITION 1A, OR TO OFFICE BATTERIES AND EMERGENCY CELLS IN SERIES WHEN T ROTARY SWITCH IS IN POSTION 1B.
5. USE (A) OPTION ONLY WHEN AH RHEOSTAT IS INCAPABLE OF E CYCLIC HUNTING OF RECTIFIER OUTPUT.
6. TDI AND (A) OPTION WERE NOT FURNISHED PRIOR TO ISS. 13 C

ELECTRONIC CONTROL CIRCUIT

PLATE SUPPLIES

CURRENT CONTROL SECTION

FINAL AMPLIFIER

ANTI-HUNT CIRCUIT

MIXER TUBE

CC TEST CIRCUIT

VOLTAGE CONTROL

VOLTAGE REFERENCE SECTION

T11 5 C
6 C'
34 2 4 R40 TP3 RV1 B POTENTIAL LEAD
33 1 3 C2 P POTENTIAL LEAD
8 D
7 PART OF TDI (NOTE 6) D'
AC FROM FUSES F2 AND F3
V3 5 2 C8
NOR 1 3 TO TEST KEYS 2 MAN
B P
R51 R50
R7 R41
CCH CCL
R4 R42
R11
(NOTE 6) PART OF TDI
M M
R16 R20
CRL
RV2 + 1 1 2 2 3 3
R26
T12 33 2 5 4 34 1 3
T13 7 1 8 A 2 9 10 4 6 11 12 A'
R6 B
(1/2) V6 8 6 7 C4
R5 NOR TEST 3 TO MAN. POT. P
R8 3 C3 R9 2 4 5 9 A'
(1/2) V6
R44 R49 P A
AR GRD SH- SH+
AMMETER RELAY SHUNT (PART OF RECTIFIER OUTPUT CIRCUIT)
NOR TEST CC TEST MV
R48 2 P10 CW 3 1 20
A CW 2 OL 3 AT
R22 B
NOR TEST 1 TO MAN. POT.
6 7 (1/2) V4 1 8 D
(NOTE 5) A B R52
C6 R25 NOR TEST 2 TO MAN. POT.
R38 TP1 3 CW 1 2 ANTI-HUNT
C7 C9 R39 P
R21 B B
6 5 4 V5 7 3 8 1 9 2 D D'
C11 C10
C13 3 4 (1/2) V4 2 9 D'
R29 R35
R17 R15 R12 R33 P
RV3 1 2 3 T
R34 R18 R36
RT CR 20 15 25 1 2 CW 3 CHG
CUR REG 2 1 3 CW
R13 R1 COARSE ADJ VOLTS ADJ VOLTS R1
REG
TI0 7
R2