POWER PLANTS
110A (J86572) AND 110B (J86455)
OPERATING METHODS

CONTENTS PAGE

1. GENERAL

1.01 The 110A (J86572) power plant (Fig. 1) has a capacity of 10 to 120 amperes at 22 to 26 volts, or 10 to 400 amperes at 44 to 50 or 44 to 52 volts. This power plant may be used with any system where the capacities and voltage ranges are suitable. The 110B (J86455) power plant has a capacity of 5 to 80 amperes at 24 volts. This power plant was primarily intended for use with the submarine cable system. However, it may also be used with any system where the capacities and voltage range are suitable. The 24-volt plant utilizes 30-ampere rectifiers and the 48-volt plant utilizes 30- and/or 100-ampere rectifiers as the charging medium. The 30-ampere rectifiers operate from a single-phase, 210- to 250-volt, 60-hertz, commercial ac power service. The 100-ampere rectifiers operate from a 3-phase, 210-volt, 60-hertz, ac power service and, with an additional autotransformer provided, will also operate from 230-, 250-, or 460-volt ac service.

1.02 This section is reissued to incorporate the use of the 48-volt semiconductor-type rectifiers. The J87233A rectifier is used for 30-ampere application and the J87223C and J87223D rectifiers are used for 100-ampere application. This section also includes operational procedure revisions. Since this reissue is a general revision, arrows ordinarily used to indicate changes have been omitted.

> ***Caution: Voltages inside of the rectifier case are over 150 volts to ground and between terminals. The precautions outlined in the operating section on the rectifiers should be observed.***

1.03 Various types of rectifiers are available for each 24- or 48-volt plant. The J86207P and J86207S rectifiers employ the use of electron tubes except where they have been modified for metallic rectifier stacks. The J86263A, J86263B, J86249A, and J86249B rectifiers are furnished with metallic rectifier stacks. The 30-ampere rectifiers are of the single-phase, full-wave type and use electron tubes or selenium rectifier stacks. The type of regulation used for these rectifiers is termed booster control and involves equipment for changing the voltage applied to the rectifier. This equipment consists of a motor-driven, continuously tapped autotransformer and an insulating booster transformer. The operation of the motor-driven autotransformer, by manual or automatic control, raises or lowers the plate voltage or rectifying element voltage to obtain the desired output. The 100-ampere rectifiers are of the 3-phase, full-wave type using selenium rectifier stacks and is termed saturable reactor control with ac buck-boost. Similar to the 30-ampere rectifiers, the control varies the voltage applied to the rectifier stack. Instead of using a motor-driven autotransformer, saturable reactors in series with the primary transformers control the primary voltages. By varying the saturating current in

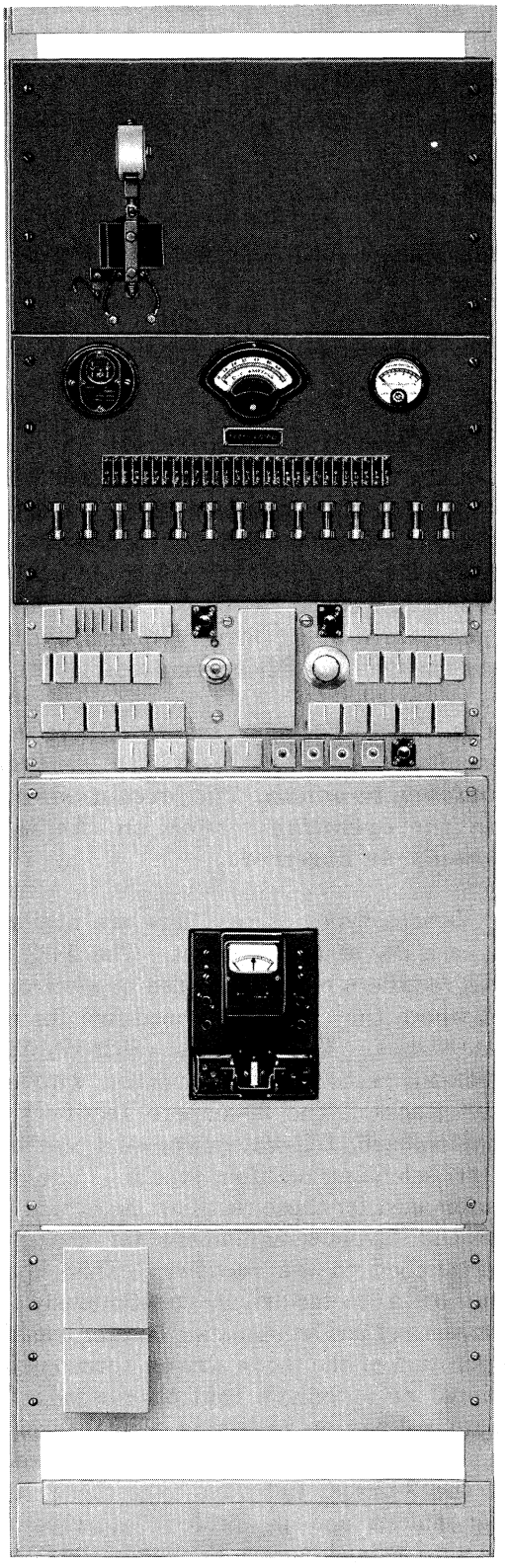

Fig. 1—Typical Charge Bay For 110A 48-Volt Plants

the saturable reactors, the voltage impressed on the rectifier stacks is varied to obtain the desired output.

1.04 The semiconductor-type rectifiers consist essentially of transformers, with taps for line voltage compensation, connected to a single-phase, full-wave bridge for the J87233A rectifier or a 3-phase, full-wave bridge for the J87223C and J87223D rectifiers. The rectified voltage is blocked by PNPN semiconductor devices in either the positive or negative output load, providing a positive or negative supply. The PNPN devices are fired by a blocking oscillator which, in turn, is controlled by a transistor error detector. The error detector senses voltage differences, and provides automatic regulation of the voltage and current. The current is filtered by inductors and then supplied to the load.

1.05 The J-coded rectifiers available by ratings for the 110A and 110B power plants are listed as follows.

RECTIFIER	VOLTAGE	AMPERES
J86207P	22 to 33	30
J86207S	44 to 65	30
J86263A	44 to 65	30
J86263B	22 to 33	30
J86249A	44 to 65	100
J86249B	22 to 33	100
J87223C	44 to 65	100
J87223D	44 to 65	100
J87233A	44 to 65	30

1.06 Keys are provided as a part of the rectifier for manual control of the output. A voltage control unit, consisting of an amplifier and a bridge, is used for automatic control of the rectifier output to maintain the float voltage of the battery. Only one control unit is required for a 24- or a 48-volt plant (Fig. 2, 3, and 4). From one to twelve rectifiers may be used in the 110A 48-volt plant (Fig. 5), and one to seven rectifiers in the 110A 24-volt plant. From one to four rectifiers are usually used in the 110B 24-volt plant (Fig. 6). On constant load plants, rectifiers in excess of those required to supply the load are available to charge the battery. On variable load plant, additional rectifiers will not be normally required, as charging of the battery can be done during light-load periods.

1.07 The battery equipment consists of single- and 3-cell enclosed jar units of 12 regular cells and 2 CEMF cells or resistor units for 24-volt plants and 24 regular cells with one CEMF cell for 48-volt plants. The 24-volt plant provides a

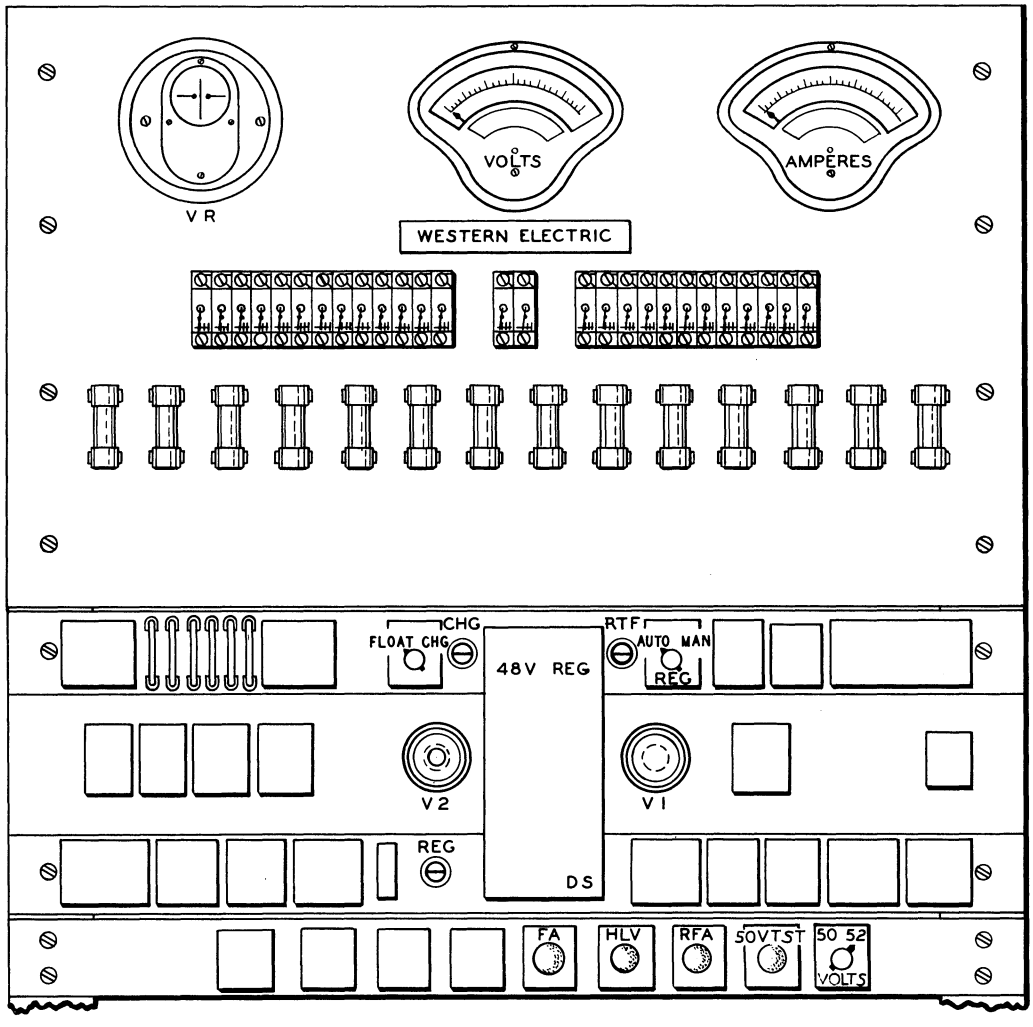

Fig. 2—110A 48-Volt Plant Controls

two-step arrangement with automatic control for switching the CEMF cells or resistor units in or out of the discharge circuit.

1.08 The 110A 48-volt plant has a 24-cell battery. It provides either 50- or 52-volt discharge voltage under control of the 50-52 VOLT key. When nominal 50-volt discharge voltage is selected, the CEMF cell is automatically switched into the circuit to maintain the discharge voltage at 50 volts while floating the battery at 52 volts. When nominal 52-volt discharge voltage is selected, the CEMF cell is only in the circuit during overcharge or when the 52-volt discharge voltage is returned to 50 volts for test purposes. The battery equipment of the 110B 24-volt plant consists of 12 regular cells with no provisions for CEMF cells.

1.09 The KS-19481 L1 grid battery eliminator replaces the KS-7105 grid battery. The output of the KS-19481 L1 is rated at 22.5 volts direct current when the input leads (white) are connected to a 5-volt ac source. The output leads (red and black) are connected with the red lead (+) to (C+) and the black lead (-) to (C-). (See 4.02.)

1.10 Instructions are based on the following drawings. For a detailed description of the operation of the individual circuits, see the corresponding circuit descriptions.

110A Power Plant—

SD-80714-01 (Mfr. Disc)	Tube Rectifier Circuit, 30 Amperes, 48 Volts

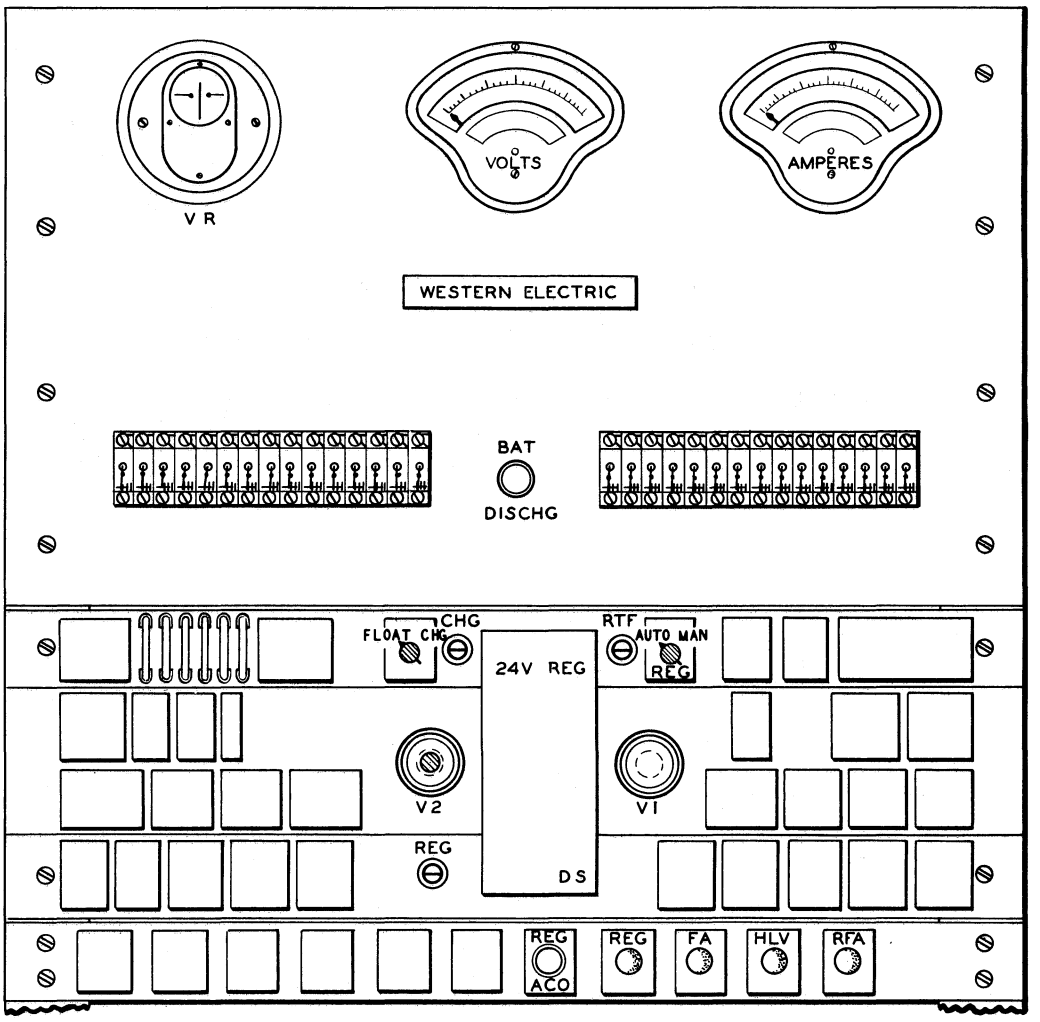

Fig. 3—110A 24-Volt Plant Controls

SD-80720-01 (Mfr. Disc)	Discharge Circuit, 44 to 50 Volts
SD-80720-02	Discharge Circuit, 44 to 50 Volts
SD-80722-01 (A&M Only)	Charge Circuit, 44 to 50 Volts
SD-80722-02	Charge Circuit, 44 to 50 Volts
SD-80753-01	Discharge Circuit, 22 to 26 Volts
SD-80755-01	Charge Circuit, 22 to 26 Volts
SD-80757-01 (Mfr. Disc)	Tube Rectifier Circuit, 30 Amperes, 24 Volts
SD-81129-01	Rectifier Circuit, 100 and 200 Amperes, 24 and 48 Volts
SD-81180-01	Metallic Rectifier Circuit, 30 Amperes, 48 Volts
SD-81181-01	Metallic Rectifier Circuit, 30 Amperes, 24 Volts
SD-81210-01	Resistors to Replace Countercells
SD-81270-01	Auxiliary Charge Circuit, 44 to 50 Volts
SD-81271-01	Auxiliary Discharge Circuit, 44 to 50 Volts

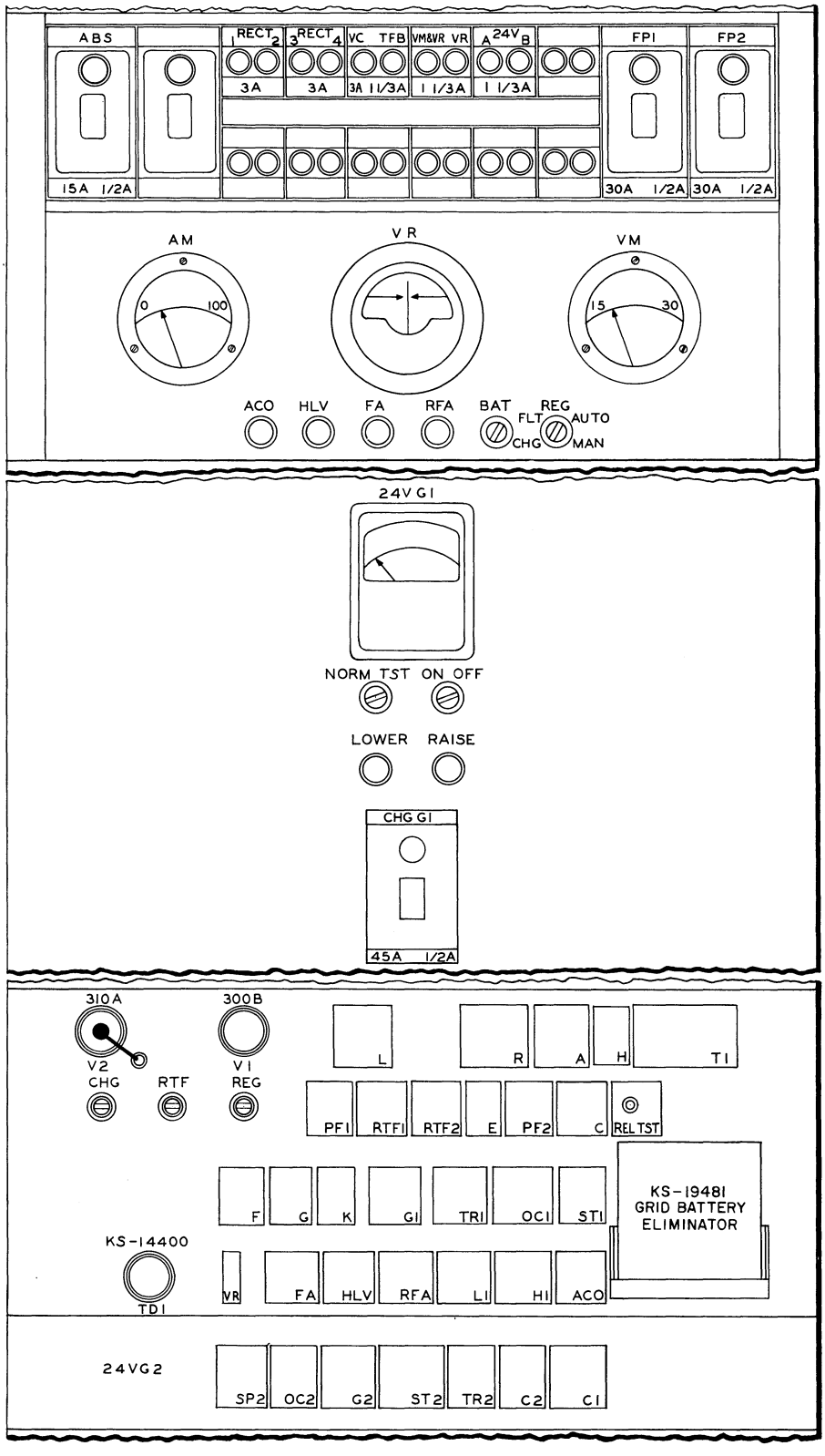

Fig. 4—110B Power Plant Controls and Rectifier

SD-81543-01	Regulated Rectifier Control Circuit
SD-81597-01	Rectifier Circuit, Semiconductor Type, 30 Amperes, 48 Volts
SD-81756-01	Rectifier Circuit, Semiconductor Type, 100 Amperes, 48 Volts
SD-81760-01	Regulator Circuit

110B Power Plant—

SD-81181-01	Rectifier Circuit, 30 Amperes, 24 Volts
SD-81211-01	Charge Circuit, 5 to 80 Amperes, 24 Volts
SD-81212-01	Discharge Circuit, 5 to 80 Amperes, 24 Volts

1.11 Additional information on the operation and maintenance of individual rectifiers and other apparatus, such as instruments, keys, and relays, is given in other sections and the attendant should be familiar with them. All relays, etc, should be adjusted in accordance with these sections and the circuit requirements tables on the circuit drawings. Refer also to the following sections.

026-305-701	Automatic Starting Compensators, Circuit Breakers, Contactors, Field Control Panels, Magnetic Switches, and Starters
028-706-701	Autotransformers—Continuously Tapped Type
032-110-701	Capacitors—Electrolytic-Aluminum Type
040-254-701	Relays—260- and 261-Type Weston Models 30, 534, and 546
040-632-701	Ammeter Relays
040-647-701	Relays—KS-7801 Through KS-7850
100-101-101	35-Type Test Sets
157-321-701	Countercells
157-601-301	Continuous Float Operation of Lead-Acid Type Batteries
157-601-701	Storage Batteries, Lead-Acid Type
169-255-301	Rectifier Circuit—J87223C and J87223D Operating Methods
169-261-301	Rectifier Circuit—J87233A Operating Methods
169-603-319	Regulated Rectifier, Booster Control—J86207P and J86207S
169-603-816	Modification of J86207S, J86263A and J86263B Rectifiers
169-618-301	Regulated Rectifier, Relay Control—J86249
169-620-301	J86263A, 48-Volt and J86263B, 24-Volt Regulated Metallic-Type Rectifier—30 Amperes

1.12 Routine checks should be made during a period when they will cause the least unfavorable reactions.

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

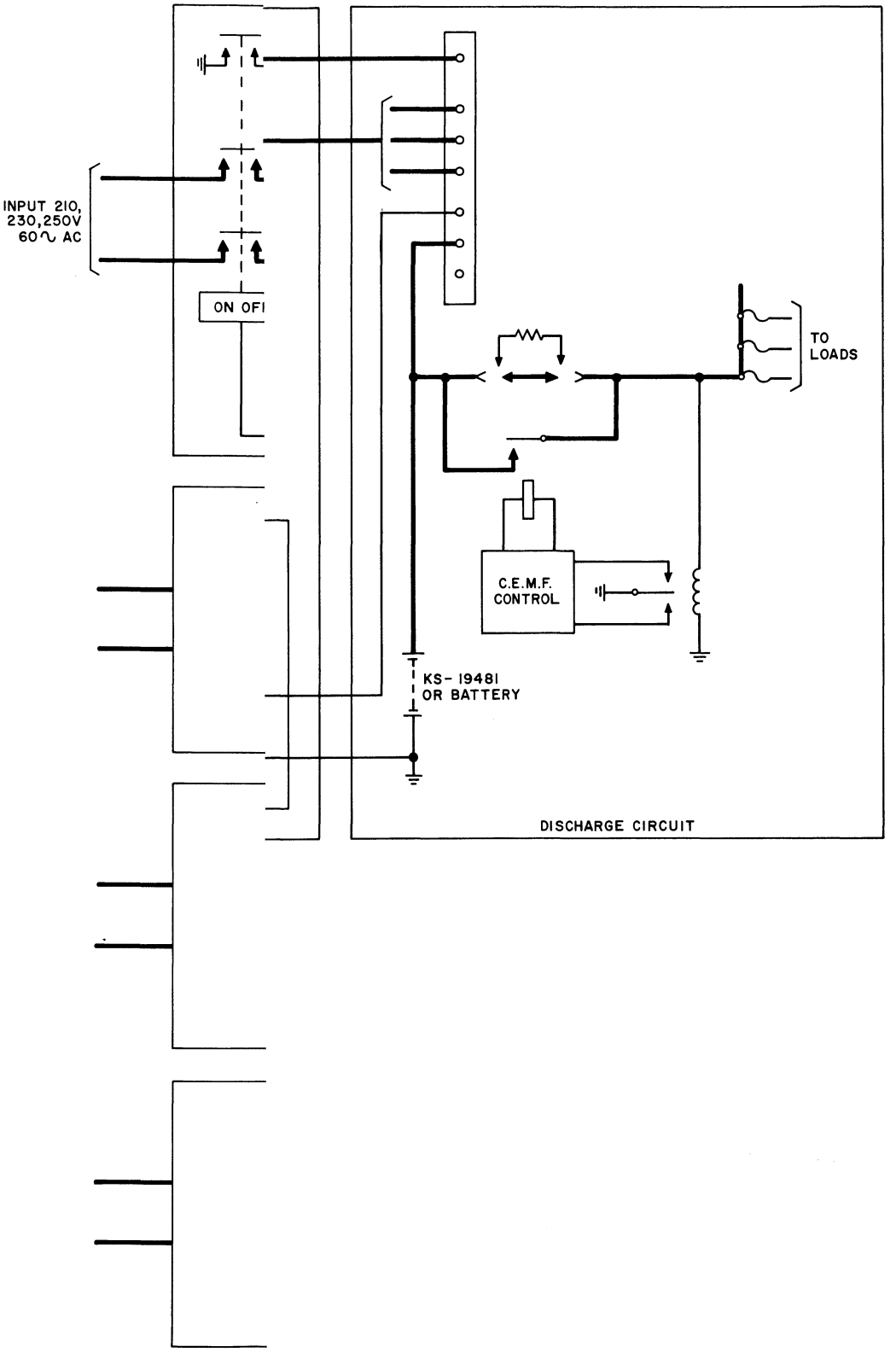

Fig. 5—Block Schematic of 24- and 48-Volt 110A Power Plant

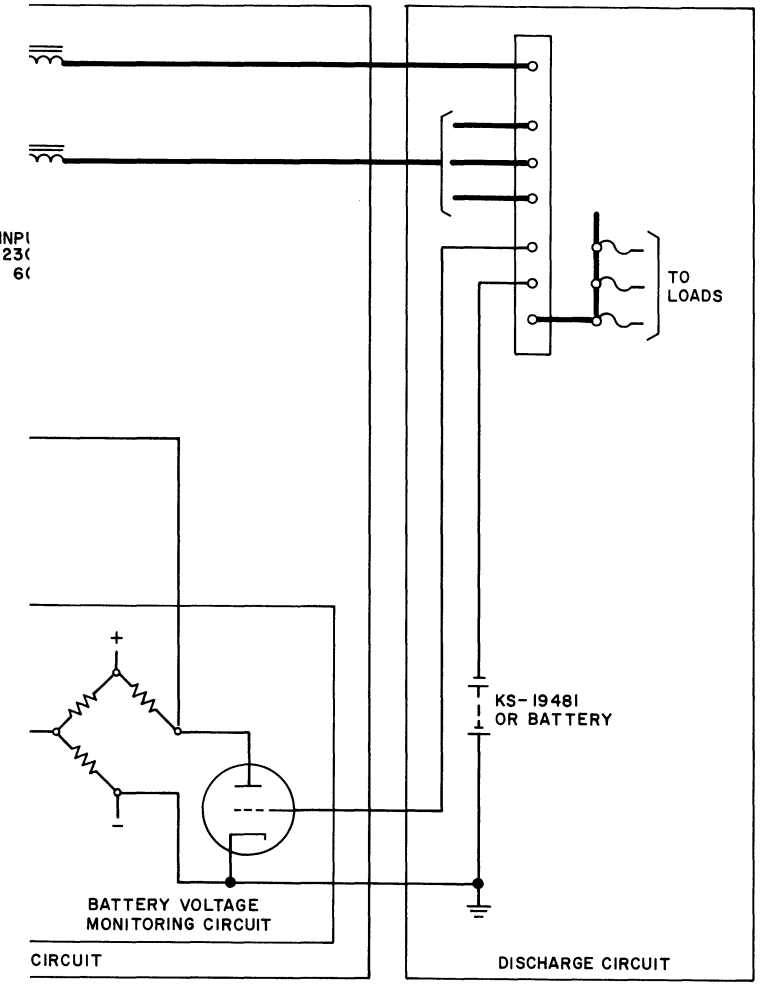

Fig. 6—Block Schematic of 24-Volt 110B Power Plant

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
265C	Contact Burnisher Holder
266C	Wire Burnisher
KS-6278 (2 reqd)	Connecting Clip
—	3-Inch C Screwdriver (or the replaced 3-inch cabinet screwdriver)
TEST APPARATUS	
KS-14510	Volt-Ohm-Milliammeter
—	Voltmeter, Weston Model 931, Ranges 300/150/75/30
—	Voltmeter, Weston Model 931, 0-3 Volt Scale
W1AF	Cord
35F	Test Set

3. OPERATION

3.01 ***Starting the J86207P, J86207S, J86263A, and J86263B Rectifiers:***

(1) Operate the regulator REG key to the AUTO position.

(2) Operate the regulator FLOAT-CHG key to the FLOAT position.

(3) Operate the rectifier ON-OFF key to the ON position.

(4) Operate the rectifier NOR-TST key to the NOR position.

3.02 ***Stopping the J86207P, J86207S, J86263A, and J86263B Rectifiers:***

(1) Operate the rectifier NOR-TST key to the TST position.

(2) Slowly reduce the load on the rectifier to zero by operating the rectifier LOWER key, allowing time for other rectifiers to assume the load.

(3) Operate the ON-OFF key to the OFF position. If the rectifier is to be left out of service, remove the ac fuses and the dc charge fuse.

Note: The RAISE and LOWER keys are self-restoring and have effect only while held in position manually. They should be used only when the NOR-TST key is in the TST position.

3.03 ***Starting the J86249A and J86249B Rectifiers:***

(1) Operate the CHG-FLOAT (S2) rotary switch to the FLOAT position.

(2) Operate the output (S3) rotary switch, designated OPEN, to the top position.

Note: The output (S3) switch is a 3-position rotary switch. The center position, OPEN, disconnects the negative charging lead from the battery. The other two positions are not marked on the rectifier, but the top position connects the rectifier negative lead to the battery. The bottom position is not required in the 110A or 110B power plant.

(3) Operate the ON-OFF key to the ON position. The rectifier will assume a share of the load and the output will be automatically adjusted by the control relays in response to signals from the connecting circuit.

3.04 ***Stopping the J86249A and J86249B Rectifiers:***

(1) Operate the MAN-TEST key to the TEST position.

(2) Operate the RAISE-LOWER key to the LOWER position and allow time for the other rectifiers to assume the load.

(3) Reduce the rectifier output to zero.

(4) Operate the ON-OFF key to the OFF position. If the rectifier is to be left out of service, remove the ac fuses and the dc charge fuse.

Caution: Do not start the rectifier with the output (S3) rotary switch in the OPEN position.

3.05 ***Starting the J87223C and J87223D Rectifiers:***

(1) Operate the regulator REG key to the AUTO position and the FLOAT-CHG key to the FLOAT position.

(2) Operate the POWER ON-OFF (S1) switch to the ON position.

(3) If the voltage output of the rectifier is not equal to the battery float requirements, momentarily operate the TST (S2) switch to the center position and rotate the VOLTS ADJ (R14) potentiometer as required to acquire the normal operating voltage.

3.06 ***Stopping the J87223C and J87223D Rectifiers:*** Operate the POWER ON-OFF (S1) switch to the OFF position. If the rectifier is to be left out of service, remove the ac fuses and the dc charge fuse.

3.07 ***Starting the J87233A Rectifier:***

(1) Operate the regulator REG key to the AUTO position and the FLOAT-CHG key to the FLOAT position.

(2) Operate the OUTPUT (CB1) circuit breaker to the ON position.

(3) If the voltage output of the rectifier is not equal to the battery float requirements, rotate the ADJ VOLTS (R11) potentiometer as required to acquire the normal operating voltage.

3.08 ***Stopping the J87233A Rectifier:*** Operate the OUTPUT (CB1) circuit breaker to the OFF position. If the rectifier is to be left out of service, remove the ac fuses.

3.09 ***Starting a Rectifier After a Shutdown:***

(1) Replace all ac fuses and dc charge fuse.

(2) Start the rectifier as outlined in 3.01, 3.03, 3.05, or 3.07.

3.10 ***Equalizing or Boost Charges:*** To obtain boost charge voltage, operate the CHG-FLOAT key to the CHG position and open the countercell switch, CEMF GR2, during charge. For adjustment of regulator for charging voltage, refer to 4.05. After charge, restore the CHG-FLOAT key to the FLOAT position and then restore discharge circuit to normal by closing the countercell switch, CEMF GR2. If all rectifiers shut down at this point, momentarily operate the REG key to the MAN position and then back to the AUTO position.

3.11 ***Recharging After Power Failure:*** If, during an extended interval with emergency ac power, the emergency reserve engine does not have the capacity to operate sufficient charging units to maintain the battery at float voltage, the battery reserve may become insufficient for starting the plant after a deep discharge to below emergency volt limits. If this is the case, the following procedure should be employed.

(1) After it has been affirmed that the central office equipment is inoperative due to a low battery reserve, ***notify the supervisor and at his direction remove the discharge fuses.*** The removal of the office load generally allows the battery voltage to recover enough to start at least one charging unit.

(2) Using a portable voltmeter, check all of the batteries for a reversal of polarity in accordance with 157-601-301. (See note.)

(3) Replace discharge fuses when the plant appears to function normally and all charging units are available.

Note: If one or more cells in a series becomes fully discharged while the remainder of the cells are still discharging, there will be a reversal, that is, a change of polarity on the discharged cells with adverse effects on the plates.

4. ROUTINE CHECKS

4.01 The purpose of routine checks on this plant is to determine whether or not all the features, indications, and alarms are in proper operating condition. Basically, the objective of these checks is to cause all equipment to operate at periodic intervals without intentionally causing drastic or harmful situations. These checks should be made as often as previous experience indicates the need. The checks should be made during a period when they will cause the least amount of adverse service reaction.

4.02 The KS-7105 grid battery in the charge control circuit has an average value of 22.5 volts direct current. The voltage of the battery should not be measured with a voltmeter, but its condition can be determined by means of the REG potentiometer. When the battery is new, the REG potentiometer will be near its ccw end; when the REG potentiometer is in the maximum cw position and the float voltage cannot be obtained, the grid battery should be replaced with the KS-19481 grid battery eliminator. The REG potentiometer should be adjusted for the correct float voltage after placing the KS-19481 grid battery eliminator in service in the power plant.

ADJUSTMENTS OF VOLTAGE CONTROL EQUIPMENT

4.03 ***Panel Voltmeter Accuracy Check:***

(1) Connect the Weston model 931 voltmeter across the terminals of the panel voltmeter, using the 75-volt scale.

(2) Operate the rectifier NOR-TST key to the TST position.

(3) Depress the voltmeter 24- or 48-volt BAT key (if furnished).

(4) Manually adjust the first rectifier output by operating the RAISE or LOWER key until the battery voltage is maintained at 2.17 volts per cell (26 or 52 volts).

Note: If necessary, manually adjust additional rectifiers until float voltage is acquired.

(5) If the panel voltmeter reading is not within ±2 percent of its deflection as compared to the Weston model 931 voltmeter, adjust the panel voltmeter by turning the adjusting screw. Place a mask bearing the date and the legend ***Zero correct at (26*** or ***52) volts.*** over the adjusting screw.

(6) Disconnect the Weston model 931 voltmeter and restore the NOR-TST key to the NOR position.

4.04 ***Float Voltage Adjustment:***

(1) In the 48-volt plant, operate the 50-52 VOLTS key, if furnished, to the 50 VOLTS or 52 VOLTS position (see 1.08).

(2) Operate the regulator REG key to the MAN position and the FLOAT-CHG key to the FLOAT position.

(3) Operate the rectifier NOR-TST key to the TST position and the ON-OFF key to the ON position.

(4) With the voltage at float voltage (26 or 52 volts) as read on the panel voltmeter and maintained at that value by operating the rectifier RAISE or LOWER keys, rotate the REG rheostat cw until the L and R relays on the control panel are released.

(5) Verify that the regulator now maintains float voltage.

(6) If float voltage is not maintained, slowly rotate the REG rheostat cw to raise voltage or ccw to lower voltage. Allow time for the battery voltage to respond until both the L and R relays are released and the battery is at float value. The operation of the L and R relays will be indicated by the sound of the operation of the RL and RR relays of the last operating rectifier, providing that its output is between 5 and 25 amperes.

(7) Verify that the regulator now maintains float voltage.

(8) Operate the rectifier NOR-TST key to the NOR position.

(9) Operate the regulator REG key to the AUTO position.

Note: If the rectifier is not regulating at the proper voltage, check the KS-7105 grid battery or the KS-19481 grid battery eliminator (see 4.02).

4.05 ***Charge Voltage Adjustment:***

(1) First adjust for float voltage as outlined in 4.04.

(2) Operate the regulator FLOAT-CHG key to the CHG position and verify that REG key is in the AUTO position.

(3) Verify that the rectifier NOR-TST key is in the NOR position and the ON-OFF key is in the ON position.

48-Volt Plants—

(a) Rotate the CHG rheostat slowly cw, allowing time for the battery voltage to respond until it is at charge voltage.

- For plants where the J option (one countercell) is furnished, adjust the CHG rheostat for a voltage of 2.2 volts per cell or as close below this value as possible and still prevent the operation of the voltage alarm during charging.

- For plants where the K option (three countercells) is furnished in the discharge circuit, open the CEMF GR2 switch and adjust the CHG rheostat for 2.3 volts per cell.

(b) Verify that the regulator now maintains charge voltage. Readjust, if required.

24-Volt Plants—

(a) Rotate the CHG rheostat slowly cw, allowing time for the battery voltage to respond until both the L and R relays release at the charge value of 2.3 volts per cell for 110A plants and 2.2 volts per cell for 110B plants. The operation of the L and R relays will be indicated by the sound of the operation of the RL and RR relays of the last operating rectifier, providing its output is between 5 and 25 amperes.

(b) Verify that the regulator now maintains charge voltage. Readjust, if required.

Restoring Rectifier to Service—

- Operate the regulator FLOAT-CHG key to the FLOAT position.

REGULATION CONTROL CIRCUIT CHECK

4.06 ***Rectifier Transfer Check:*** There must be at least one operating and one idle rectifier.

(1) Verify that the regulator FLOAT-CHG key is in the FLOAT position and the REG key is in the AUTO position.

(2) Operate the rectifier NOR-TST key to the TST position and the ON-OFF key of the first rectifier is in the ON position.

(3) Reduce the output of the first rectifier slowly to zero using the LOWER key. Allow time for the second rectifier to assume the load. Where electron tube-type rectifiers are used, there is a 3- to 5-minute delay in starting.

(4) Restore the NOR-TST key to the NOR position. The first rectifier will reclaim the load from the second rectifier.

(5) Repeat (1) through (4) on all successive rectifiers, except the last one.

4.07 ***Regulation Tube Failure Check:***

(1) Verify that the regulator FLOAT-CHG key is in the FLOAT position and the REG key is in the AUTO position.

(2) Verify that the rectifier NOR-TST key is in the NOR position and the ON-OFF key is in the ON position.

(3) Adjust the RTF rheostat so that the RTF1 relay operates at trip value in accordance with the circuit requirements tables.

(4) Remove the ***regulator*** electron tube V2. When the discharge circuit voltage reaches trip value, all rectifiers will shut down. The trip value as read on the plant voltmeter (voltmeter BAT key released) shall be 26.5 volts for 110A 24-volt power plants, 27.5 volts for 110B 24-volt power plants, and 54 volts for 110A 48-volt power plants.

(5) Operate the REG key to the MAN position.

(6) Reinsert the regulator electron tube V2.

(7) Operate the REG key to the AUTO position. The regulator and rectifiers should function and connect to the load in the normal manner.

4.08 ***Power Failure Check:***

(1) With the rectifier operating normally, remove the regulator ac fuses. All rectifiers will stop and the TR autotransformer brushes should move to the minimum voltage position. The C1

contactor in the first rectifier will reoperate but there will be no output.

(2) Replace the regulator ac fuses. The regulator and rectifiers should function and connect to the load in the normal manner.

4.09 ***Rectifier Electron Tube Failure and/or Rectifier Stack Failure:***

(1) With the rectifier operating normally, insulate the bottom contacts 6-7 of the G relay.

(2) Manually operate the TF relay for electron tube-type rectifiers or the RF relay for metallic-type rectifiers. The TF or RF relay will lock operated, causing the G relay to operate and the rectifier will shut down.

(3) Operate the rectifier ON-OFF key to the OFF position, then to the ON position. If the rectifier is an electron tube the TF relay releases, the rectifier starts and assumes the load after a delay of 3 to 5 minutes.

(4) Remove the insulation from the contacts of the G relay. If the rectifier is a metallic-type, the RF relay releases, the rectifier starts and assumes the load immediately.

DISCHARGE CIRCUIT CHECKS

4.10 ***Nominal 50-Volt Discharge Voltage Check:***

(1) With the rectifiers operating normally, open the VR switch to release the CEMF GR1 relay. The discharge voltage will be the same as the battery voltage. The HLV lamp lights and an audible alarm sounds within 30 to 60 seconds.

(2) Close the VR switch to operate the GR1 relay. The discharge voltage is 2 volts lower than the battery voltage. The visual and audible alarms retire.

4.11 ***Nominal 52-Volt Discharge Voltage Check:***

(1) With the rectifiers operating normally, operate the 50-52 VOLTS key in the charge circuit to the 50 VOLTS position. The CEMF GR1 relay operates and the 50V TST lamp lights.

(2) Verify that the discharge voltage is 2 volts lower than the battery voltage.

(3) Operate the 50-52 VOLTS key to the 52 VOLTS position. The CEMF GR1 relay releases, and the 50V TST lamp is extinguished.

(4) Verify that the discharge voltage is the same as the battery voltage.

(5) Operate the regulator FLOAT-CHG key to the CHG position. The CEMF GR1 relay operates.

(6) Verify that the discharge voltage is 2 volts lower than the battery voltage.

(7) Operate the regulator FLOAT-CHG key to the FLOAT position.

4.12 ***Nominal 24-Volt Discharge Voltage Check:***

(1) With the rectifiers operating normally, close the BAT SW switch to operate the GR1 relay.

(2) Verify that the discharge voltage is 2 volts lower than the battery voltage.

(3) Operate the regulator FLOAT-CHG key to the CHG position.

(4) Verify that the discharge voltage is 4 volts lower than the battery voltage due to operation of the G2 relay after the high contact of the VR relay closes.

(5) Restore the regulator FLOAT-CHG key to the FLOAT position.

(6) Verify that the battery voltage drops, closing the low contact of the VR relay and releasing the G2 relay. Then verify that the discharge voltage is 2 volts below the battery voltage.

(7) Manually hold the H1 relay operated.

(8) Verify that the HLV lamp lights after a 30- to 60-second delay and that the audible alarm sounds.

Note: Where resistors are used in place of CEMF cells, it is necessary to change the link connections between the terminals and

the bus bar to compensate for load changes, as shown on the table of SD-81210-01.

ALARMS

Note: In 110B power plants where alarm sending equipment is provided, verify that the proper alarm is received in the distant office.

4.13 ***Rectifier Fuse Alarm:***

(1) Where 70-type fuses are installed, insert a blown fuse into the fuse holder of the fuse under test.

(2) Verify that the RFA or RECT FAIL lamp lights and the audible alarm sounds.

(3) Remove the blown fuse and insert a good fuse.

(4) Verify that the lamp extinguishes and the audible alarm retires.

(5) If 70-type fuses are not furnished, momentarily connect each alarm stud to the associated fuse with a W1AF test cord equipped with a KS-6278 connecting clip at each end.

(6) Verify that the RFA or RECT FAIL lamp lights and the audible alarm sounds.

Note: Where an alarm cut-off feature is provided, operate the ACO key and verify that the audible alarm retires.

4.14 ***Discharge Fuse Alarms:***

(1) Using a W1AF test cord equipped with a KS-6278 connecting clip at each end, momentarily connect each alarm stud to the associated fuse.

(2) Verify in each case that the FA lamp lights and the audible alarm sounds.

(3) Where 70-type fuses are furnished, use a blown fuse and insert it into the fuse holder of the fuse under test.

(4) Verify in each case that the FA lamp lights and the audible alarm sounds.

(5) Remove the blown fuse and insert a good one.

(6) Verify that the lamp extinguishes and that the audible alarm retires.

Note: In some cases the ABS alarm bar is wired directly to the alarm circuit and no FA lamp is furnished.

4.15 ***High-Low Voltage Alarm:***

(1) Manually operate and hold the H and L1 relay operated, each in turn, one at a time.

(2) Verify that after 30 to 60 seconds the HLV lamp lights and the audible alarm sounds.

(3) Release the operated relay. The lamp extinguishes and the audible alarm retires.

4.16 ***Regulation Alarm (110A 24-Volt Plant):***

(1) If a voltage alarm is furnished, manually block the A relay operated.

(2) Verify that in 6 to 14 minutes the VA2 and VA3 relay operate and the REG lamp lights.

(3) Remove the block from the A relay and observe that the REG lamp extinguishes.

4.17 ***Indicating Alarm (110B 24-Volt Plant):***

(1) Block the H1 relay operated.

(2) Verify that in 15 to 45 seconds the HLV lamp lights and the audible office alarm sounds.

(3) Remove the block from the H1 relay. Observe that the HLV lamp extinguishes and the audible office alarm retires.

(4) Repeat (1) through (3) using the L1 relay.

5. TROUBLES

5.01 A power service low-voltage condition or defective rectifiers will cause the rectifiers to increase powerstat output to maximum, operate the high-limit switches, and shut down. In either case, an RFA alarm sounds. Where this has occurred on several rectifiers, restart the rectifiers

by operating the ON-OFF key on all rectifiers to the OFF position. Then operate the ON-OFF keys of each rectifier to the ON position one at a time. If the ON-OFF key of each rectifier is operated to the OFF position and then to the ON position individually, the rectifiers may not restart due to locked-up relays in the plant.

5.02 If any rectifier does not seem to be carrying the load it should, operate the NOR-TST key to the TST position and attempt to change output with the RAISE and LOWER keys. Failure to respond could indicate that one or both ***rectifier*** tubes are defective or that there is a rectifier element failure, ac power failure, blown ac fuse, blown rectifier charge fuse, poorly adjusted relays (possibly RR or RL), or faulty motor capacitor. Incorrect position of keys would prevent a rectifier from assuming its load.

5.03 If all rectifiers show no load, proceed as follows.

(a) If the L relay is operated, replace ***regulator*** tube V1.

(b) If the R relay is operated, replace ***regulator*** tube V2.

5.04 When a rectifier alarm is given, locate the rectifier in trouble. Its output will be zero and its associated G relay will be operated. Check ac fuses, CHG and RC. Replace, if blown. If fuses are not blown and alarm still operates, replace both ***rectifier*** electron tubes, V1 and V2, on rectifier where so equipped. If this corrects the trouble, replace with the old electron tubes, one at a time, until the defective electron tube is located.

5.05 If all rectifiers show capacity output, either the V2 ***regulator*** electron tube has failed or the load is in excess of combined rectifier output.

5.06 If current of any 30- or 100-ampere rectifier is in excess of either 32 or 115 amperes, check adjustment of OL relay and associated A rheostat, and, where provided, RB relay and associated B rheostat. This may be checked using the KS-14510 volt-ohm-milliammeter (0.3-volt scale) across the associated ammeter shunt. The 32 amperes will correspond to 270 millivolts and 115 amperes to 290 millivolts.

5.07 If rectifiers are not regulating at proper voltage and whenever a KS-19481 grid battery eliminator or new regulator tube is installed, reset the regulator as covered in 4.04.

5.08 Checks of the vacuum tubes in the regulator can be made with any available tube tester.

5.09 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, if any. Defective rheostats whose construction does not allow cleaning should be replaced.

5.10 Additional information for the various types of rectifiers used in the 110A and 110B power plants will be found in the associated Bell System Practices (see 1.11).

TROUBLE CHART

5.11 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 or open connections or short circuits due to foreign matter lying across wiring terminals.

TROUBLE	POSSIBLE CAUSE
(a) No dc output current	Power failure.
	Blown ac supply or control fuse.
	Blown CHARGE fuse.
	Ammeter relay out of adjustment.
	Failure of V1 or V2 tube on rectifier.
	Plant voltage regulator out of adjustment.
	RL relay operated continuously.
(b) Low dc output current, low saturating current	Plant voltage regulator out of adjustment.
	Low line voltage. V2 tube failure.
	Defective KS-7105 grid battery or KS-19481 grid battery eliminator.
	Low emission or aged V1 or V2 tube on regulator.
	Aged rectifier stacks.
	RY relay break contact failing.
	RR relay make contact failing.
	Failure of any relay in starting chain (AR, OC, ST, VRC, and DS1).
(c) Limit switch operated	AC line voltage too high or too low.
	Charge fuse blown.
	Load too high.
	Failure of an electron tube (V1 or V2 on regulator).
(d) High dc output current, high saturating current	Plant voltage regulator out of adjustment.
	High line voltage.
	RR relay operated continuously.
	RL relay make contact failing.
	Incorrect strapping of CEMF resistors.
	Grid emission in V2 tube.
	Near zero grid voltage in V2 tube caused by failure of a component of the relay control circuit.
(e) Low dc output current, high saturating current	Unbalance in ac line voltages.
	The ac voltages applied to the rectifying element terminals differ by more than 5 percent.
	CHG-FLOAT switch on FLOAT when charging, especially emergency cells.
	Main selenium rectifier cells high resistance due to aging.
(f) Output excessively noisy	AC voltages applied to the rectifying element terminals differ by more than 5 percent.
	C1 and/or C2 filter capacitors aged or defective.
	Filter capacitor connections loose or open.
	Defective cells in one or more of the selenium rectifier stack assemblies constituting the main rectifying element.
	Defective diode in two or more silicon rectifier stack assemblies constituting the main rectifying element.
(g) Cannot reduce dc output current to zero with saturating current minimum under MAN control	CHG-FLOAT switch on CHG instead of FLOAT.
	High line voltage.
(h) Output voltage varying	L and R relays not properly adjusted or L and R network not properly wired.