

708A POWER PLANT OPERATING METHODS

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1. GENERAL

1.01 The 708A power plant is used to provide a positive or negative 130-volt, 0- to 1000-ampere power supply for central offices. The plant includes charging equipment and its control, batteries, and emergency cells with their control, distribution equipment, and alarms.

Caution 1: This power plant includes automatically controlled equipment; care must be exercised to prevent accidental starting of parts of the plant on which maintenance work is to be done. Before starting work, prevent automatic starting of equipment by removing fuses, blocking relays, opening switches, etc, as necessary. When maintenance work has been completed, make sure the circuit has been restored to normal.

Caution 2: Voltages inside the rectifier units may exceed 150 volts to ground and between terminals. Also, battery voltages exist within the rectifier with the rectifier turned off.

1.02 This section is reissued to include test procedures and connections for plants which do not have test links, and to include caution notes to cover blocking relays and operating switches. This reissue does affect the Equipment Test List.

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

1.04 The instructions are based on schematic drawing SD-81696-01. For a detailed description of how the circuit operates, refer to the corresponding circuit description. The circuit will function with the following circuits:

- (a) SD-81061-01— } Power Audible
SD-81472-01— } Alarm Circuit
- (b) SD-81593-01—J87224 Regulated Rectifier
- (c) SD-81750-01—J87275 Rectifier

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

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2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
265C	Contact Burnisher Holder
266C	Wire Burnisher
361B	Relay Winding Connector
365	Clip (2 reqd)
—	3-Inch C Screwdriver
—	Fuse Puller, 7-1/2 Inches, Ideal Industries, Cat. No. 34-002
—	Blocking and Insulating Tools as required. (Use and apply as covered in Section 069-020-801.)
—	Plug Tip (.080 inch tip)
TEST APPARATUS	
KS-8039	Volt-Milliammeter
KS-14510	Volt-Ohm-Milliammeter
W1AF	Cord
W1AY	Cord
2W17A	Cord (W2W cord equipped with one No. 310 plug and two No. 360 tools)
411B	Test Pick (2 reqd)
35-Type	Test Set

3. OPERATION

3.01 Description: The 708A power plant (one control bay, one or more discharge bays, and from one to six charge/discharge bays) provides -130 volt power (option X) or +130 volt power (option Y) for systems requiring up to 1000 amperes. (See Fig. 1 and 2.) The charging units, two to twelve 100-ampere J87224A or B voltage-regulated rectifiers connected in parallel, operate continuously to maintain the main battery (normally 61 cells) at float voltage (2.17 volts per cell) and to supply the plant load. Operation of the OVER CHG switch to the CHG position will increase the output of the rectifiers from a float to an overcharge voltage (2.2 volts per cell) for boost charging. Equal load sharing between rectifiers is not necessary since each rectifier will limit its output current to its

full load rating and is capable of an output from zero to full load at float voltage.

Note: The J87224A rectifier requires a 3-phase, 60-Hz, 208- to 230-volt ac input while the J87224B rectifier operates on a 460-volt, 3-phase, 60-Hz ac input.

3.02 Two groups of emergency cells, EMC GR1 and EMC GR2, consisting of four cells each, are provided for use during commercial power failure to supplement the main battery. They are automatically cut into the load circuit when required, automatically disconnected after ac power is restored, and automatically recharged. The charge on the emergency cells is maintained by a J87275 L1 or L2 9-volt, 100-ampere emergency cell rectifier.

Note: The J87275 L1 and L2 rectifiers require the same ac inputs as the J87224A and B rectifiers, respectively.

3.03 The operation of the emergency cell switch may be controlled manually by operating the MAN-AUTO and RAISE or LOWER switches. Operating the MAN-AUTO switch to the MAN position and operating the RAISE switch adds emergency cells to increase the discharge voltage. Operating the LOWER switch disconnects the emergency cells to reduce the discharge voltage. In addition, the emergency cell switch has provision for manual rotation in the event of a motor or control relay failure.

3.04 Alarms are provided to indicate such conditions as abnormal float voltage, high or low voltage, failure of a charging unit, and fuse failure. Since the control bay will be located in the power room away from other office equipment, provisions are made for interconnecting the alarms associated with the plant to either the power audible alarm circuit or the office alarm system. Therefore, when a power alarm operates, an audible and a visual alarm will be given in other parts of the building as well as in the power room.

3.05 Preparing to Start: When putting the plant into service, check that:

- CHG-NOR and ON-OFF keys are in the NOR or OFF positions.
- Emergency cell MAN-AUTO key is in the AUTO position.

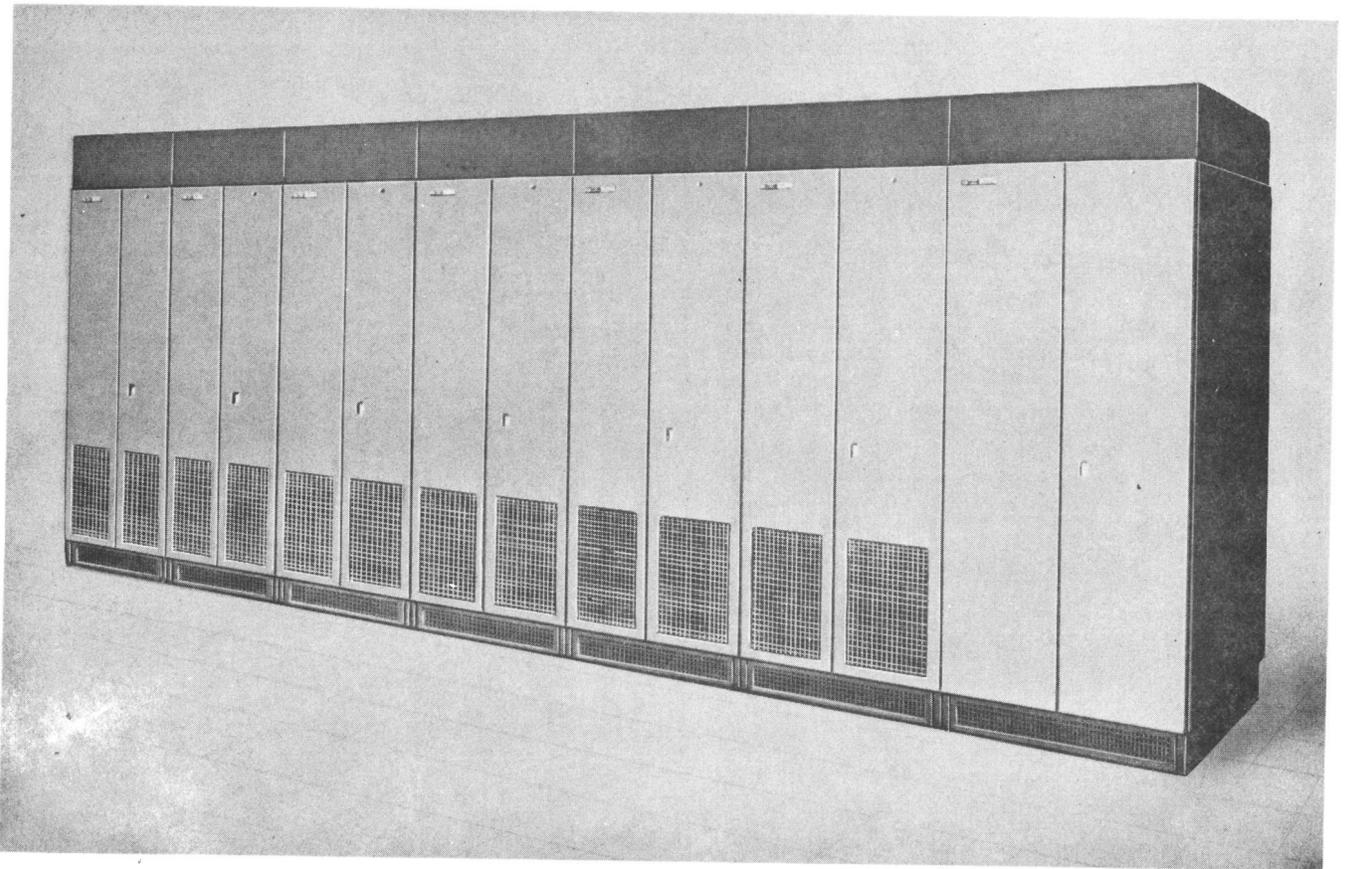


Fig. 1—708A Plant—Charge/Discharge Bays with Control Bay

- (c) Procedures for preparing to start in the rectifier section have been observed.
- (d) Correct size fuses are in place.
- (e) All external connections are made in accordance with the SD- drawings covering the associated circuits.

3.06 Automatic Operation: With the MAN-AUTO switch in the AUTO position, the OVER CHG switch in the NOR position, and the rectifier ON-OFF keys in the ON position, enough rectifiers should be in operation to float the battery. However, if a boost charge is to be given using automatic regulation, the OVER CHG switch should be operated to the CHG position.

Note: The emergency cell switch can be controlled manually by operating the MAN-AUTO switch to MAN and then operating the RAISE

switch to add emergency cells, or the LOWER switch to disconnect emergency cells.

3.07 Removing J87224 Rectifier from Service:

Removing one rectifier will not affect normal operation of the plant. To remove a rectifier from service, operate the AC ON-OFF switch to OFF. Since at least one spare rectifier is furnished, the load dropped by the disconnected rectifier will be assumed by the connected idling spare.

3.08 Restoring J87224 Rectifier to Service: If

the rectifier is to be returned to service, operate the AC ON-OFF switch to ON. If the rectifier assumes full load, no load, or if in assuming partial load it raises the plant float voltage, check rectifier adjustment in accordance with 4.14 through 4.17.

3.09 Boost Charging Batteries: To boost charge the battery, operate the OVER CHG switch

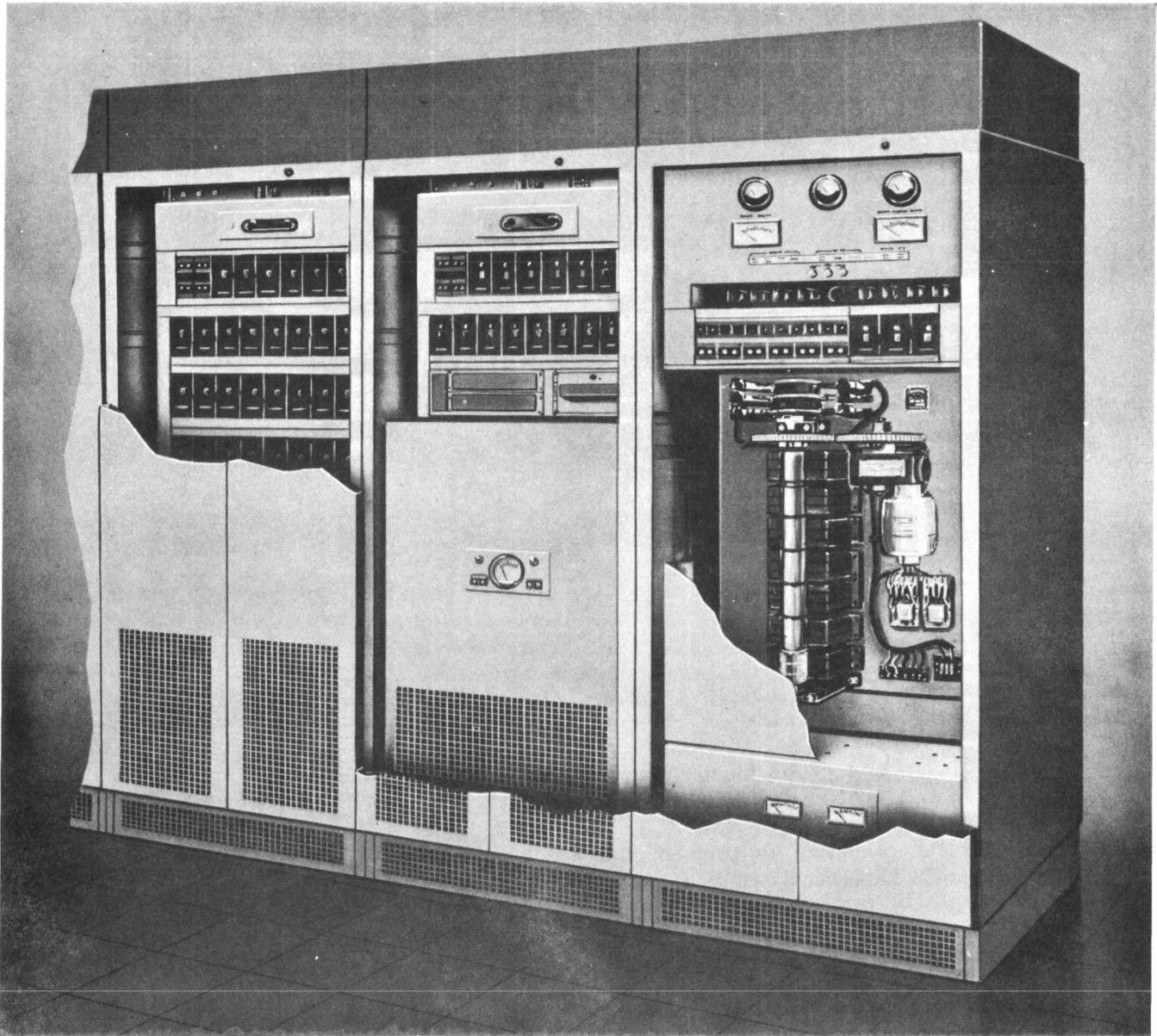


Fig. 2—Typical Discharge Bay, Charge/Discharge Bay, and Control Bay (with Cutaway Doors)

to the CHG position. This causes the rectifiers to maintain the battery at approximately 2.2 volts per cell.

3.10 Recharging After Power Failure: When a power failure occurs, the emergency cells and load will be switched through the sequences shown in Fig. 3. The 708A plant is arranged to supply the load and begin the recharge of the series-connected main and emergency cells upon restoration of ac power. As the charge progresses,

the emergency cell switch will automatically switch the emergency cells from the B to the A2 and A1 positions (from a series to parallel connection) as shown in Fig. 3, while still supplying the load. Prior to switching back to normal operation (NOR position), the main cell rectifiers will supply the load and main cell charge current through the parallel-connected emergency cells to provide a "charge-by-load" feature. The emergency cell rectifier will also charge the emergency cells, and this mode of operation will continue until these

cells are fully charged. At this time the emergency cell switch will return to its normal position where the emergency cell rectifier and the main cell rectifiers will float their respective batteries.

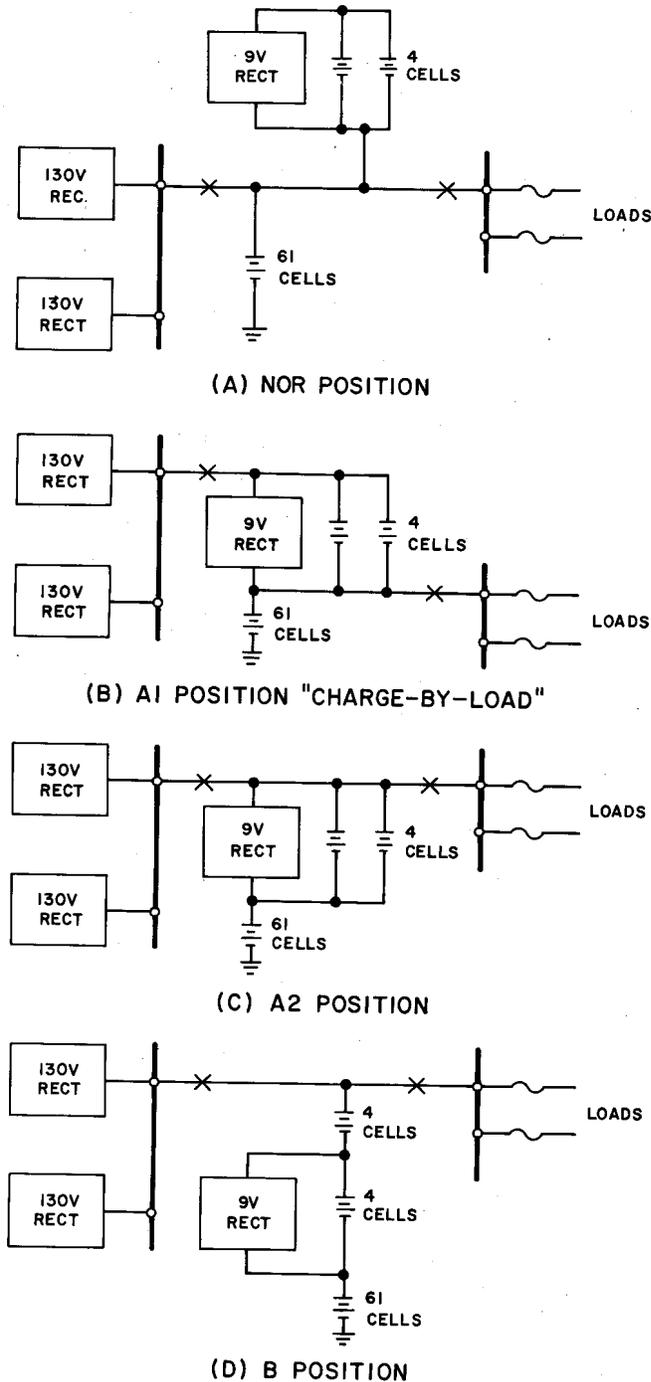


Fig. 3—Emergency Cell Switching Schematic

4. ROUTINE CHECKS

4.01 **General:** The purpose of making routine checks on this plant is to determine whether

or not all the features, indications, and alarms are in proper operating condition. The checking time and testing intervals should be based on local conditions and past experience.

4.02 **Battery:** The battery should be maintained and routined in accordance with Section 157-601-301. To ensure proper float voltage, the accuracy of the plant voltmeter should be periodically checked.

4.03 **Fuses and Alarms:** Check all fuse failure alarms and indicators periodically as covered in Table A. Before applying the test voltage or test ground, the operator should ascertain whether the test would shut down essential equipment. If such is the case it may be desirable to postpone these tests until a lighter load period.

Caution: Before applying test voltage or test ground, block relays; remove fuses; open switches; etc, as required, to prevent automatic plant operation or shutdown of rectifiers.

4.04 **Emergency Cell Switch:** The emergency cell switch should be maintained and routined in accordance with Section 030-786-701. The operation of this switch should be periodically checked with plant control features to ensure proper functioning. These checks should be made when they will cause the least service reaction.

4.05 With sufficient office or test load, switching off the ac power to the rectifiers should decrease the battery voltage to a value that will cause the emergency cell switch to cut in the parallel-connected emergency cells for the first corrective step. The test can be terminated at this point by restoring ac power to the rectifiers. The switch will return to its normal position when the emergency cells have been recharged. It should be noted that the switching occurs at the voltage values specified in the circuit data tables.

4.06 Complete switch operation, if it is desired, may be checked by maintaining the load (office and/or test) until the battery voltage decreases to a value to again cause the emergency cell switch to operate for the second corrective step. Again, the restoration of ac power to the rectifiers will start the sequencing process to return the plant to normal operation.

TABLE A
FUSES

FUSE LOCATION	FUSE DESIGNATION	TEST (SEE NOTE)	INDICATION				
			ALARMS	MULT LAMP		ALARM LAMP	SUPPLEMENTARY INDICATION
				CHG/DISCH	CONTROL		
DISCH BAY	—AMP	1	Major	X		DISCH FA	
180V RECT	CHG, A, B	1	Minor	X	X	RECT FAIL	Also RFA lamp on rectifier.
Control Panel	REG FUSE	2	None				Loss of rectifiers would bring in float alarm.
	REG 1 — REG 12	2	None				No output from rectifier.
	VM 1	2	None				Zero voltmeter reading on voltmeter in BAT position.
	VM 2	2	None				Zero voltmeter reading on voltmeter in DISCH position.
	FV	2	Minor		X	H-L FLOAT	
	CBS, VR, DRFA, ECM	1	Major		X	CONT FA	
	TST	2	None				No test voltage.
9V RECT	RG-EC, RB-EC	2	Minor		X	H-L FLOAT	No 9V rectifier operation; will give a low voltage signal for a float alarm.
	CHG A & B, PWR REL, SIG ALM	1	Minor		X	RECT FAIL	Also RFA lamp on rectifier.

Note 1: Connect 130V to alarm stud of fuse or its alarm fuse, if applicable.

Note 2: None; operated fuse indicated visually and by the symptom listed.

4.07 70-Type Fuse: Before testing fuse alarms on all 70-type fuses other than the CHG fuse, test for no-voltage and dead ground on the alarm lead using the KS-14510 volt-ohm-milliammeter. The resistance to ground should be at least 200 ohms. False grounding of the alarm circuit can cause severe arcing when checking a fuse alarm. Be careful not to insert the test prod past the metal collar just inside the fuse holder cap, as this may cross the battery connection on the top of the fuse with the alarm circuit. To test the alarm circuit of 70-type fuses mounted in an individual fuse block, insert the tip of the 411B test pick (attached to the W1AY cord) into the aperture of the fuse block cap and touch the exposed alarm test point. To test the alarm circuit of 70-type fuses mounted in a modular fuse block (such as the 22- or 23-type block), insert the tip of the 411B test pick into the aperture provided in the fuse block cover for the alarm to be tested and touch the alarm bar.

Caution: Avoid shock by firmly attaching the cap to the tool holder barrel and holding the cap only.

4.08 Fuse Alarms—Alarm-Type Fuse Shunting a Larger Fuse: Remove the alarm-type fuse associated with a large fuse. Using the W1AF cord, connect first one and then the other alarm fuse terminal to the fuse alarm stud or bar. Note that the alarm operates each time the cord is connected. Replace the alarm-type fuse.

4.09 Fuse Alarms—Circuits Supplied Through an Alarm-Type Fuse: Connect the tip of one 411B test pick on the W1AF cord to the terminal at the side of the fuse which is covered by the alarm under test. Momentarily connect the tip of the other 411B test pick on the cord to the associated alarm stud or alarm bar. Note that the alarm operates while the cord is connected.

4.10 Discharge Fuse Alarm: Check the discharge fuse alarm circuits, using the W1AF cord equipped with one 411B test pick and a plug tip, as follows. Insert the plug tip into the REL TEST battery supply jack and then carefully insert the test pick through the aperture in the front of the fuse holder, adjacent to the colored bead, until contact is made with the alarm surface of the fuse cap. This should cause the MULT ALM lamp in the charge/discharge bay or discharge bay, and

the DISCH FA lamp in the control bay to light and a major alarm to sound.

4.11 Rectifier Failure Alarm: To check the RECT FAIL alarm circuit, apply ground, using a W1AY cord equipped with a 365 clip and a plug tip, by connecting terminal 8 of terminal strip 1 on the alarm panel in the charge/discharge bay to the ground terminal of the REL TEST block. The MULT ALM lamps in both the charge/discharge and control bays should light. The RECT FAIL lamp in the control bay should also light and a minor alarm sound. Operating the CUT OFF switch will silence the audible alarm but the visual alarms will be maintained. Removing the ground jumper will extinguish the visual alarms.

4.12 Float Alarm: Operate the MAN-AUTO switch to the MAN position and verify that the OVER CHG switch is in the NOR position. To check the operation of the float alarm circuit, use a W1AY cord with two clips to connect the output terminals of the VM1 and FV fuses. Remove the FV fuse and operate the OVER CHG switch to the CHG position. The battery voltage should rise and cause the FV relay to make its high contact. The MULT ALM and H-L FLOAT lamps in the control bay should light and a minor alarm should sound. Operating the CUT OFF switch will silence the audible alarm leaving the visual alarms. Operating the OVER CHG switch to the NOR position will extinguish the visual alarms. Insert the FV fuse; remove the jumper cord; and operate the MAN-AUTO switch to AUTO to restore the plant to its normal operating condition.

4.13 To check low-voltage operation of the FV relay, turn off sufficient rectifiers to decrease the battery voltage enough to cause the FV relay to make its low contact. The H-L FLOAT and MULT ALM lamps in the control bay should light and a minor alarm should sound. Operating the CUT OFF switch will silence the audible alarm but the visual alarms will be maintained. Restoring the rectifiers to operation will increase the battery voltage to normal float voltage thereby extinguishing the visual alarms.

4.14 Routine Checks on J87224 Rectifiers: Assuming the current limit adjustment at full load for all rectifiers, a rectifier at partial load determines the plant float voltage. It may be assumed that any rectifier at full load has a voltage adjustment higher than plant voltage and that a

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rectifier at no load is adjusted for a voltage lower than the plant voltage. Current limit may be checked by attempting to raise the rectifier voltage. After the check is completed, readjust the rectifier to its original setting.

4.15 The voltage adjustment for the no-load rectifiers may be determined by turning off the rectifier which is at partial load. By this action the load is transferred to one of the no-load rectifiers. As one of the no-load rectifiers assumes the load formerly carried by the shut-off rectifier, the plant voltage represents the setting of the rectifier now at partial load. By continuing to shut down partially loaded rectifiers, the adjustment point and possible need for readjustment of each no-load rectifier may be determined. If these tests are made when the office load is at its minimum value, all rectifiers which control plant float may be checked by ON-OFF switch operation.

4.16 The voltage setting of a rectifier at full load may only be determined by lowering its voltage adjustment until it is at partial load, at which time the plant voltage represents its setting.

4.17 Where the minimum office load requires some rectifiers to operate continuously at full load, those rectifiers do not contribute to the day-to-day float value, but should be checked occasionally since an excessively high setting could cause a plant high voltage in the rare case of a blown discharge fuse or other loss of normal constant load.

4.18 Voltage Control Alarms: As often as local experience demands, the voltage alarm circuits should be tested with a 35-type test set.

- (a) Position the keys and switch of the 35-type test set as follows.

KEY	POSITION
BAT & GRD CO	Operated
REV	Normal
VM	Normal
SWITCH	
G	Open

Using a 2W17A cord, connect dry cells to the test BAT & GRD jack of the test set as required (estimate 1-1/2 volts per cell) to operate the voltmeter relay to its high contact (see circuit requirements table), connecting the positive terminal of the dry cells to the tip lead of the cord and the negative terminal to the ring lead of the cord. The locking levers of No. 1 through 4 keys should be open and all resistance sliders should be in their extreme right positions. Close the locking lever of the No. 1 key and move the No. 1 resistor sliders to their extreme left position. Operate all knife switches in the test set in such a way as to cut out all fixed resistance. Under these conditions, the test set has its least resistance and the dry cells are out of the circuit.

- (b) Block nonoperated the HV relay in the plant.

4.19 High-Low Voltage Alarms: Test the low-voltage and high-voltage contacts of the HLV, FV, or EM CELL relays in the following manner.

- (a) **Float Voltage Alarm:** Using the 2W17A cord, connect the T & R jack of the test set to the test battery supply and the FV voltmeter relay as follows. In positive plants, connect the ring lead of the cord to the positive (+) terminal of the FV relay and the tip lead to the test battery supply. In negative plants, connect the tip lead of the cord to the (-) terminal of the FV relay and the ring lead to the test battery supply. Using the 300-volt scale, connect the KS-8039 volt-milliammeter across the positive (+) and negative (-) terminals of the relay. Then remove the FV fuse from the plant control panel and proceed as covered in (c) and (d).

- (b) **EM-CELL and High-Low Voltage Alarm Circuits:** Operate the MAN-AUTO key on the main control board to MAN. Insulate the No. 10 contact on the HVA relay. Using the 2W17A cord, connect the T & R jack of the test set to the HLV voltmeter relay as follows. In positive plants, connect the ring lead of the cord to the positive (+) terminal of the HLV relay and the tip lead to the test battery supply. In negative plants, connect the tip lead of the cord to the negative (-) terminal of the HLV relay and the ring lead to the test battery supply.

Using the 300-volt scale, connect the KS-8039 volt-milliammeter across the positive (+) and negative (-) terminals of the relay. Then remove the VR fuse from the plant control panel and proceed as covered in (c) and (d).

(c) **Low-Voltage Test:** Gradually move the No. 1 resistor sliders of the test set to the right, thus introducing resistance and lowering the voltage across the voltmeter relay. When checking the float alarm, note that, at the approximate voltage where the FV voltmeter relay should close its low contact (see circuit requirements table), the HL FLOAT lamp lights and the minor alarm sounds. Operate the ACO key to silence the alarm. The HL FLOAT lamp will remain lighted until the voltage is raised. When checking the EM-CELL switch alarm and high- and low-voltage alarm circuit, note that, at the approximate voltage where the EM-CELL and HLV voltmeter relays should close their low-voltage contact (see circuit requirements table), the RC and LV relays operate and, after an interval of approximately 20 seconds, the EM CELL SW lamp lights and the major alarm sounds. Move the No. 1 resistor sliders to the extreme left positions to shut off the alarm and release the relays.

(d) **High-Voltage Test:**

- (1) Gradually move the No. 1 resistor sliders on the test set to the right, thus introducing resistance and reducing the voltage through the voltmeter relay sufficiently to permit the introduction of the dry cells without causing the high contact of the relay to make (see circuit requirements table). Then restore the BAT & GRD CO key on the test set to normal.
- (2) Raise the voltage gradually by moving the No. 1 sliders toward the left to remove resistance from the circuit. When checking

the float alarm, note that, at the approximate voltage where the FV voltmeter relay should close its high contact (see circuit requirements table), the HL FLOAT lamp lights and the minor alarm sounds. Operate the ACO key to silence the alarm. When checking the high- and low-voltage alarm circuit, note that, at the approximate voltage where the HLV relay should close its high contact, the HVA relay operates and the major alarm sounds. When checking the EM CELL SW alarm, note that, at the approximate voltage where the EM CELL relay should close its high contact, after an interval of approximately 20 seconds, the EM CELL SW lamp lights and the major alarm sounds.

(e) When the above tests have been completed, move the BAT & GRD CO of the test set to the operated position. Remount the FV or VR fuse. Then remove the test equipment and remove the blocking tool and insulation from the relays.

4.20 Alarm Multiple: The alarm multiple should be checked to be sure that major and minor power alarms in other parts of the building will operate in conjunction with corresponding audible alarms in the power room.

5. TROUBLES

5.01 Plant troubles listed are only those in connection with the charge control circuit which automatically connects or disconnects units of charging equipment and the control which automatically cuts emergency cells into or out of the discharge circuit. Troubles in main string and emergency cell rectifiers are covered in the appropriate Bell System Practices.

5.02 Table B lists the alarm lamps with their trouble indications.

TABLE B
ALARM LAMPS

MULT LAMP		ALARMS			ALARM LAMPS					TROUBLE
CONT BAY	CHG/DISCH BAY	MAJ	MIN	NONE	CONT FA	DISCH FA	EM CELL SW	H-L FLOAT	RECT FAIL	
	X	X				X				DISCH fuse operated
X	X		X						X	130-volt rectifier failure
X		X			X					Control fuse operated
X		X					X			EM CELL switch did not operate or EM cells are in series
X			X				X			High or low float voltage
X				X			X			MAN-AUTO switch in MAN position
X			X					X	X	9V rectifier failure

Caution: Where alarm fuses are in parallel with supply fuses, replace the operated supply fuse and then the alarm fuse.

5.03 Trouble Chart: The troubles and possible causes listed are not necessarily all-inclusive but are merely indicative of some of the problems that may be encountered when the 708A power plant is not operating normally. In the case of

visual alarms, the operator can tell the trouble location by designation of the lamp which is lighted on the CHG-DISCH bay, control bay, or rectifier panel. In the case of fuse alarms, Table A will assist the operator in locating the difficulty.

TROUBLE	POSSIBLE CAUSE	TROUBLE	POSSIBLE CAUSE
High float voltage	OVER CHG switch in CHG position for over-charge voltage. Rectifier voltage or current limit out of adjustment.	Low discharge voltage after power failure charge cycle	EM CELL switch will not cycle back to NOR position. No low current signal from the 9V rectifier.
Low float voltage	Rectifier voltage or current limit out of adjustment. Loss of ac power. Insufficient rectifier capacity. REG fuse operated or REG 1 — REG 12.	5.04 If the trouble is not located with the assistance of the indicators and trouble chart and a check shows no loose connections or short circuits due to foreign matter lying across wiring terminals, reference must be made to the schematic diagrams and circuit descriptions for individual components.	
Rectifiers not operating	Operated ac service fuse. CHG, A, or B fuse in rectifier operated. Plant REG fuse operated. Individual rectifier REG fuse operated. Rectifier voltage setting incorrect.	5.05 Individual components resistance measurements and continuity checks should be made with the power plant disconnected from input power and output load. Short the capacitors with a 1000-ohm 5-watt resistor to be certain that they are completely discharged. Any charge left on the capacitors will cause inaccuracy in resistance readings. Refer to the appropriate Bell System Practices for checking semiconductor devices, capacitors, transformers, and inductors.	
Low volt signal from EM CELL (9V) rectifier	Service fuse operated. CHG, A, B, PWR REL, or SIG ALM fuse operated. Rectifier out of adjustment.	<i>Caution: In making continuity checks, use the ohmmeter portion of the KS-14510 meter. Do not use the X10,000 position for testing transistors, as the higher voltage used may damage them.</i>	
Rectifiers shut down in "charge-by-load" operation	Diodes CR2 — CR4 not properly connected. Voltage too high — will operate HLV relay.	5.06 Before disconnecting leads, mark or record the connections.	
After power failure, EM CELL switch will not cycle back during recharge period	Diodes CR2 — CR4 not properly connected for sufficient voltage to operate the EM CELL relay.	5.07 Do not solder or unsolder connections to diodes before referring to Section 032-173-301.	