150B (J86871) BATTERY POWER PLANT
+ OR −24 VOLTS, 600 AMPERES
OPERATING METHODS

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NOTICE

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1. GENERAL

1.01 This section describes the physical and functional characteristics, acceptance and trouble-shooting procedures, and general operation of the 150B power plant.

1.02 The reasons for reissuing this section are listed below. Revision arrows have been used to denote the significant changes. The Equipment Test List is affected.

(a) To add the KS-20491 (Lorain) rectifier

(b) To add the KS-20491 (ITT-North) rectifier

(c) To add the WC2 circuit pack as an optional replacement for the WC1 circuit pack

(d) To add the J87122 battery string as an option

(e) To add the CP SP2B circuit pack as a mandatory replacement for the CP SP2 circuit pack in the J87436A rectifier

(f) To add the CP SP2B circuit pack as an optional replacement for the CP SP2 circuit pack in the J87438A rectifier.

1.03 The 150B power plant is a 24-volt, positive or negative ground, 100- through 600-ampere

plant which provides float and recharge capability. The operation of the plant is fully automatic. Normally all rectifiers are operated from commercial power to supply the office load and float the battery. After a commercial power failure has occurred and power is restored, the rectifiers will automatically recharge the battery and then will resume normal float regulation. Alarms are given when a plant fuse or circuit breaker operates, a rectifier fails, or the plant output voltage goes out of prescribed limits. Also, the plant is designed to turn off any rectifier for which the output voltage is too high and attempts to restart any rectifier which fails.

1.04 ▶The 150B power plant can be equipped for single-phase or 3-phase operation to provide a minimum ampere capacity of 100 amperes. The minimum capacity basic plant consists of one initial bay, equipped with a plant control unit, discharge circuit breaker panels, or discharge fuse panels, and two 100-ampere rectifiers (options given in Table A).◀

1.05 For plant capacities greater than 100 amperes, either supplementary bays or 200-ampere rectifiers can be provided. The J87438A, L1 or L2, 200-ampere rectifiers may be used either in place of or in combination with supplementary bays to increase plant capacity. The 200-ampere rectifiers may also be used exclusively in the plant (the 100-ampere rectifier in the initial bay is omitted in this case). A maximum capacity of 600 amperes (plus a 100-ampere recharge capacity) may be obtained with a fully equipped plant (see Fig. 1).

▶***Note:*** The J87438A 200-ampere rectifiers may be used only with 3-phase ac input voltage.◀

1.06 Battery equipment is furnished in accordance with J87122A or J87123A, B to meet the desired ampere-hour reserve considerations.

1.07 This issue of the section is based on the following schematic drawings (SDs):

- ▶SD-81997-02, Issue 7B—Power Systems, Rectifier Circuit, 208/240 or 480 Volts 60-Hz Input, ±24 Volts 100 Amperes Output, Auto-

▶**TABLE A**◀

RECTIFIER OPTIONS FOR BASIC 100-AMPERE PLANT

RECTIFIER TYPE	LIST NO.	NUMBER OF RECTIFIERS REQUIRED	AC INPUT	DC OUTPUT
J-87436A	L1 and L3	2	208/240 Volts (3-phase)	± 24 Volts
J-87436A	L2 and L3	2	480 Volts (3-phase)	± 24 Volts
KS-20491*	L21 and L105	2	208/240 Volts (single-phase)	— 24 Volts
KS-20491*	L22 and L105	2	480 Volts (single-phase)	— 24 Volts
KS-20491*	L23 and L105	2	208/240 Volts (single-phase)	+ 24 Volts
KS-20491*	L24 and L105	2	480 Volts (single phase)	+ 24 Volts

* Only the updated version of the KS-20491 rectifiers, based on SD-81997-02 (Lorain Products Corp) or SD-82462-02 (ITT-North Electric Co), are approved for use in the 150B power plants.

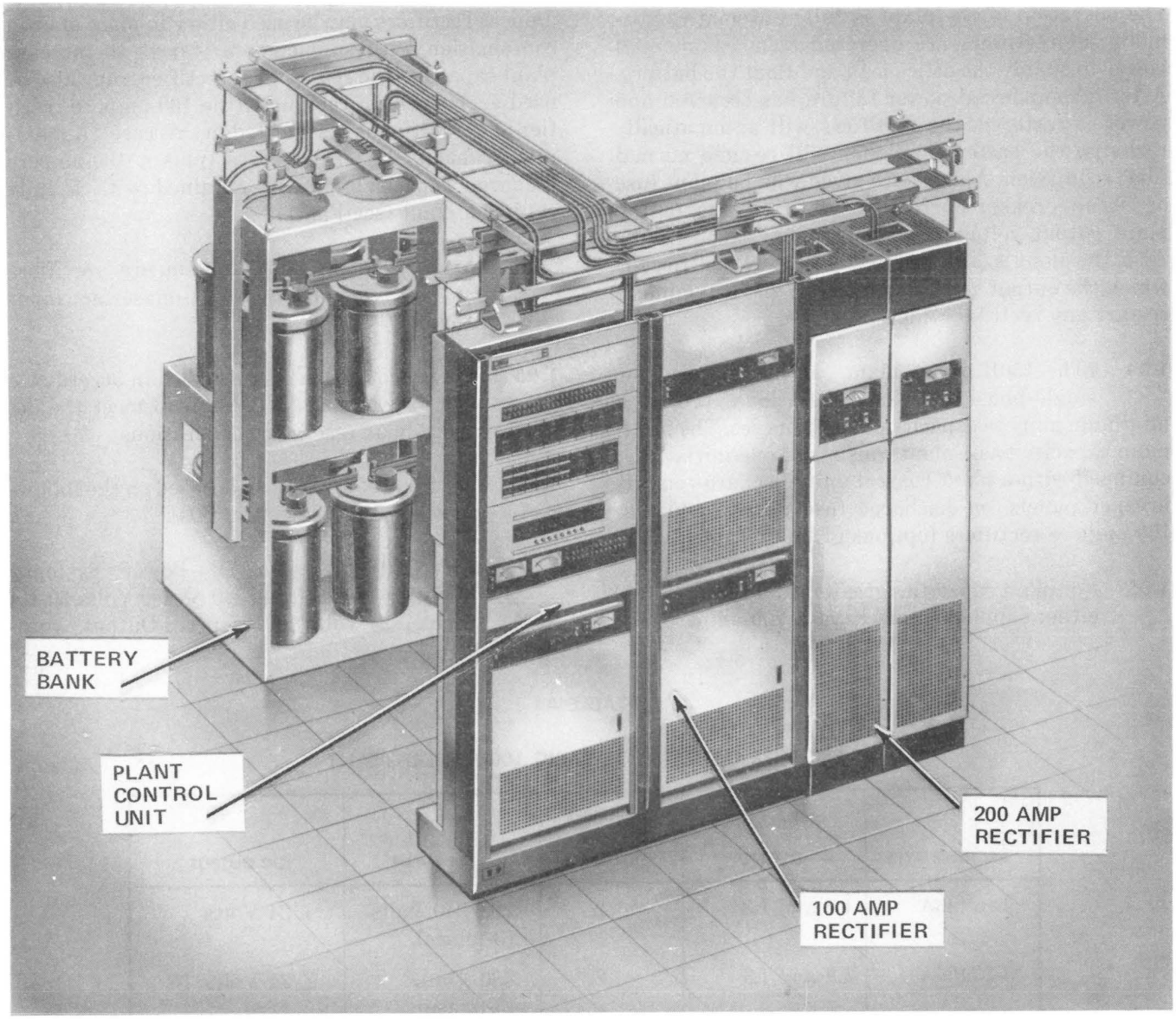

Fig. 1—150B Power Plant

matic Regulation (KS-20491—Lorain Products Corp)◀

- SD-82397-01, Issue 1—Power System, Rectifier, 208/240 or 480 Volts 60-Hz Input, ±24 Volts 100 Amperes Output (J87436A)

- SD-82399-01, Issue 4B—Power Systems, Rectifier, 208/240, 220/240, or 480 Volts 60-Hz Input, ±24 Volts 200 Amperes Output (J87438A)

- SD-82446-01, Issue 2A—Power Systems, 24-Volt Control Circuit for the Charge Discharge Circuits

- SD-82448-01, Issue 2B—Power System, Charge and Discharge Circuit, 12 Cells—150B Power Plant

- ◗SD-82462-02, Issue 2B—Power Systems, Rectifier Circuit 208/240 or 480 Volts 60-Hz Input, ±24 Volts 100 Ampere Output, Automatic Regulation (KS-20491—ITT-North Electric Co)◖

If this section is to be used with equipment or apparatus reflecting an earlier or later issue of the SD, reference should be made to the SDs and the corresponding circuit descriptions (CDs) to determine the extent of the changes and the manner in which the section may be affected.

1.08 ***Abbreviations and Acronyms:*** Refer to Table B for a list of abbreviations and acronyms with applicable terms used in this section.

TABLE B

ABBREVIATIONS AND ACRONYMS

ABBREVIATION	TERM
BAT	Battery
CCW	Counterclockwise
CHG	Charge
CP	Circuit Pack
CW	Clockwise
DISCHG	Discharge
DMM	Digital Multimeter
FAJ	Fuse Alarm Major
FAN	Fuse Alarm Minor
GRD	Ground
HLV	High-Low Voltage
HV	High Voltage
Hz	Hertz
LED	Light Emitting Diode
LV	Low Voltage
PWR FRM	Power Frame
RECT	Rectifier
REG	Regulation
RFA	Rectifier Failure Alarm
RSR	Restart Rectifier
SNS	Sense

2. PHYSICAL DESCRIPTION

INTRODUCTION

2.01 The initial bay, the supplementary bay, and the 200-ampere rectifier are each a single bay framework (Fig. 1).

The plant contains the following equipment:

- Plant Control Unit (J85516A, L1 and L3)
- Discharge Circuit Breaker Panel
- Discharge Fuse Panel
- Rectifier (J87436A, L1 and L3, or L2 and L3; J87438A, L1 or L2)
- ◗Rectifier (KS-20491, L21 and L105, L22 and L105, L23 and L105, or L24 and L105).◖

DESCRIPTION

A. Plant Control Unit (J85516A, L1 and L3)

2.02 The plant control unit mounts in the initial bay between the rectifier and the circuit breaker panel (Fig. 1). On the front panel of the control unit are the plant ammeter, the plant voltmeter, the alarm indicator LEDs, and a control fuse panel using 70-type fuses (Fig. 2). Table C gives a complete list of controls, indicators, and fuses on the control unit. Located inside the control unit are the plant voltage monitor and plant alarm circuits mounted on a printed wiring board (WC1 or ◗WC2◖ circuit pack). The board plugs into a printed wiring motherboard which provides a terminal field for rectifier control and plant alarm connections.

B. Rectifier (J87436A, L1 and L3, or L2 and L3; J87438A, L1 or L2)

2.03 The J87436A, 100-ampere rectifier mounts in a standard equipment bay (Fig. 1). The J87438A, 200-ampere rectifier is a self-contained bay (Fig. 1). Both rectifiers are designed to be serviced and maintained exclusively from the front.

2.04 The rectifier control panel holds the ON-OFF and test switches, the output voltage adjust potentiometer, the internal sense lead fuses (+V and -V), and the output ammeter (Fig. 3 and 4). The panel

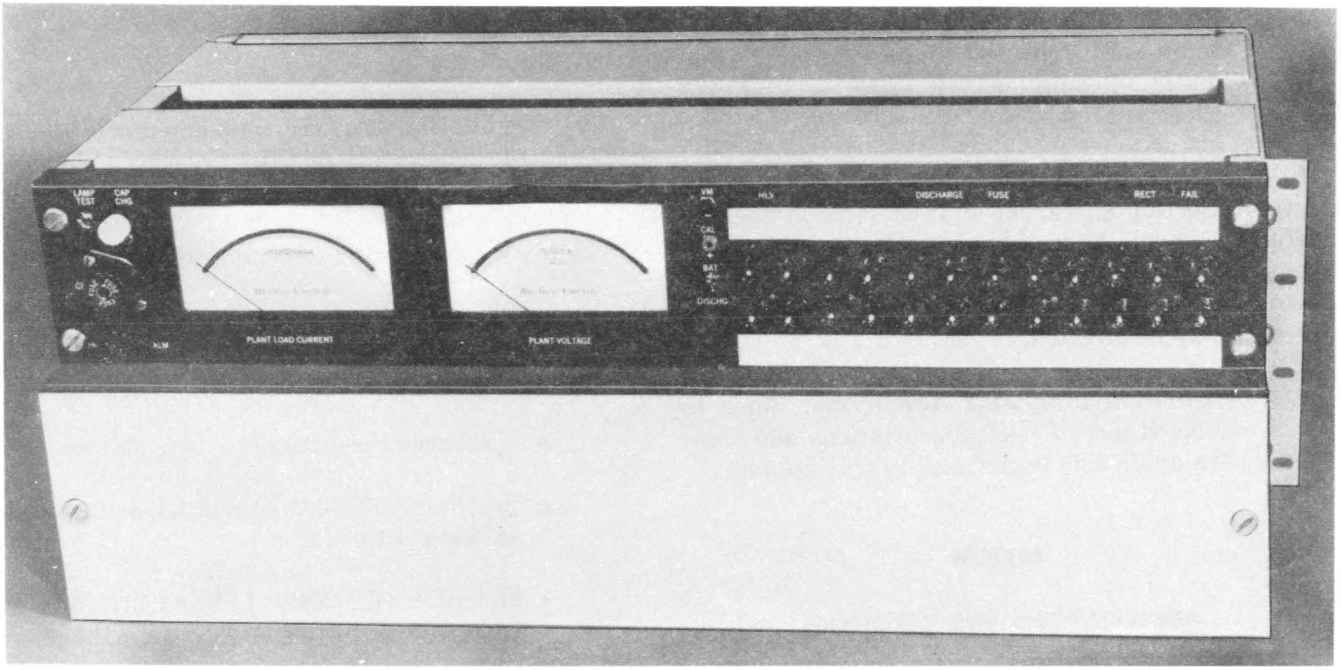

Fig. 2—J85516A, L1 and L3, Plant Control Unit

is removeable for access when service is required. See Table C for a complete list of controls, indicators, and fuses on the rectifier.

2.05 The front panel of the J87436A rectifier swings open to allow access to components inside (Fig. 5). On the J87438A rectifier there are two front panels—an upper panel and a lower panel—which swing open independently (Fig. 6). The rectifier contains three ferroresonant transformers, one for each ac input phase. A large heat sink holding the rectifying diodes is mounted over the transformers. The regulation, control, and alarm circuits are contained on two printed wiring boards (CP SP1 and CP SP2 or ◗CP SP2B◖) which plug into connectors inside the rectifier. Other rectifier components include triac heat sink assemblies, ac capacitors, iron-core inductors, and dc output capacitors and bus bars.

C. ◗Rectifier (KS-20491, L21 and L105, L22 and L105, L23 and L105, or L24 and L105)

2.06 The KS-20491 rectifier is designed for single-phase, 60 ±3 Hz, ac input and is suitable for use in battery power plants where 3-phase service is not available. When the rectifier is operating in an ambient temperature range of 10 to 50°C, the output voltage regulation for combined line and load variation is ±1 percent steady state.

2.07 The KS-20491 rectifier is available from two manufacturers; Lorain Products Corporation (Fig. 7) and ITT-North Electric Company (Fig. 8). There are significant differences in the internal design of each rectifier, but the equipment features and the output ratings are the same. The only models approved for use in the 150B plant are the versions based on SD-82462-02 (ITT-North) or SD-81997-02 (Lorain). The KS-20491, L105, circuit breaker kit (Option S) is also required when used in the plant.

Warning: The earlier models of the KS-20491 rectifier, based on SD-82462-01 or SD-81997-01, are not approved for use in the 150B power plant.

2.08 The rectifier utilizes back-to-back thyristors and a regulation circuit to electronically control a ferroresonant transformer for control of the output voltage and current. The output voltage is protected by the dc output circuit breaker (Option S) and by the current limit feature.

TABLE C

CONTROLS, INDICATORS, AND FUSES

NAME	EQUIP LOCATION	CONTROL INDICATOR	TYPE	FUNCTION
Plant Control Unit (J85516A, L1 and L3)	24V PWR FRM	HLV	LED (red)	Lights when a low- or high-voltage condition exists on the battery bus.
		DISCHARGE FUSE	LED (red)	Lights when the CHG, VM2, or BAT fuse blows, a load fuse blows, or a load circuit breaker trips.
		RECT FAIL	LED (red)	Lights when the HLV or VM fuse blows, an RB fuse blows, a rectifier output circuit breaker trips, a rectifier shuts down, or an ac power phase is lost.
		PLANT VOLTMETER	Meter	Indicates discharge bus voltage or battery bus voltage.
		PLANT LOAD CURRENT	Meter	Indicates total plant load current.
		VM CAL	Tests Jacks	Used to calibrate plant voltmeter.
		BAT-DISCHG	Switch	Selects sense points for plant voltmeter.
		CAP CHG	Lamp (white)	Lights to indicate load capacitors are charging.
		LAMP TEST	Switch	Used to test load capacitor charge circuit.
		CHG	Fuse	Protects load capacitor charge circuit.
		CHG ALM	Fuse	Provides alarm when CHG fuse blows.
		R	Fuse	Protects high-low voltage monitor, RFA relay, and alarm LEDs.
		HLV	Fuse	Protects high-low voltage monitor.
		VM	Fuse	Protects plant voltmeter.
		VM2	Fuse	Protects plant voltmeter.
		RB	Fuse	Protects rectifier regulator circuits.
		BAT	Fuse	Protects rectifier control circuit.

♦TABLE C (Contd)♦

CONTROLS, INDICATORS, AND FUSES

NAME	EQUIP LOCATION	CONTROL INDICATOR	TYPE	FUNCTION
Rectifier (J87438A, L1 or L2) or (J87436A, L1 and L3 or L2 and L3)	24V PWR FRM	OUTPUT CURRENT	Meter	Indicates rectifier output load current or simulated load current.
		ON-OFF	Switch	Manual power switch used to turn on and turn off rectifier.
		DC OUTPUT	Switch	Connects rectifier output to the plant charge bus.
		RECT FAIL	LED (red)	Indicates rectifier is shut down.
		NL/FL	Switch	Used to test rectifier for regulation.
		OUTPUT VOLTS ADJ	Potentiometer	Used to adjust rectifier output voltage.
		REG+ and REG-	Test Jacks	Used to measure rectifier output voltage.
		RELAY AND ALARM (+V and -V)	Fuses	Protects internal voltage sense leads
Rectifier KS-20491 L21, L22, L23 or L24 (ITT-North)	24V PWR FRM	OUTPUT CURRENT	Meter	Indicates rectifier output load current or simulated load current.
		ON-OFF	Switch	Manual power switch used to turn on and turn off rectifier.
		DC OUTPUT (CB2)	Circuit Breaker	Connects rectifier output to the plant charge bus.
		RECT FAIL	LED (red)	Indicates rectifier is shut down.
		OUTPUT VOLTS ADJ	Potentiometer	Used to adjust rectifier output voltage.
		REG+ and REG-	Test Jacks	Used to measure rectifier output voltage.
		24V BIAS SUPPLY (F1 and F2)	Fuses	Protects (T2) transformer primary in case of short circuit or overload.
		OUTPUT VOLTS (F3)	Fuse	Protects REG+ and REG- test jacks from fault condition.

TABLE C (Contd)

CONTROLS, INDICATORS, AND FUSES

NAME	EQUIP LOCATION	CONTROL INDICATOR	TYPE	FUNCTION
Rectifier KS-20491 L21, L22, L23, or L24 (Lorain)	24V PWR FRM	SIMULATED OUTPUT CURRENT	Pushbutton	Provides simulated adjustable load up to 125 percent of rated output of rectifier.
		CABLE ALARM (F9)	Fuse	Protects the dc cable assembly from short to ground.
		CB1	Pushbutton Switch	Protects (T1) transformer and auxiliary supply circuits.
		OUTPUT CURRENT	Meter	Indicates rectifier output load current or simulated load current.
		ON-OFF (S1)	Switch	Manual power switch used to turn on and turn off rectifier.
		DC OUTPUT (CB1)	Circuit Breaker	Connects rectifier output to the plant charge bus.
		RECT FAIL	LED (red)	Indicates rectifier is shut down.
		OUTPUT VOLTS ADJ	Potentiometer	Used to adjust rectifier output voltage.
		REG+ and REG-	Tests Jacks	Used to measure rectifier output voltage.
		F1 and F2	Fuses	Protects control transformer T2 and power circuit supply CP1.
		SIMULATED OUTPUT CURRENT (S2)	Switch	Connects simulated current circuit to ammeter and regulator circuits.

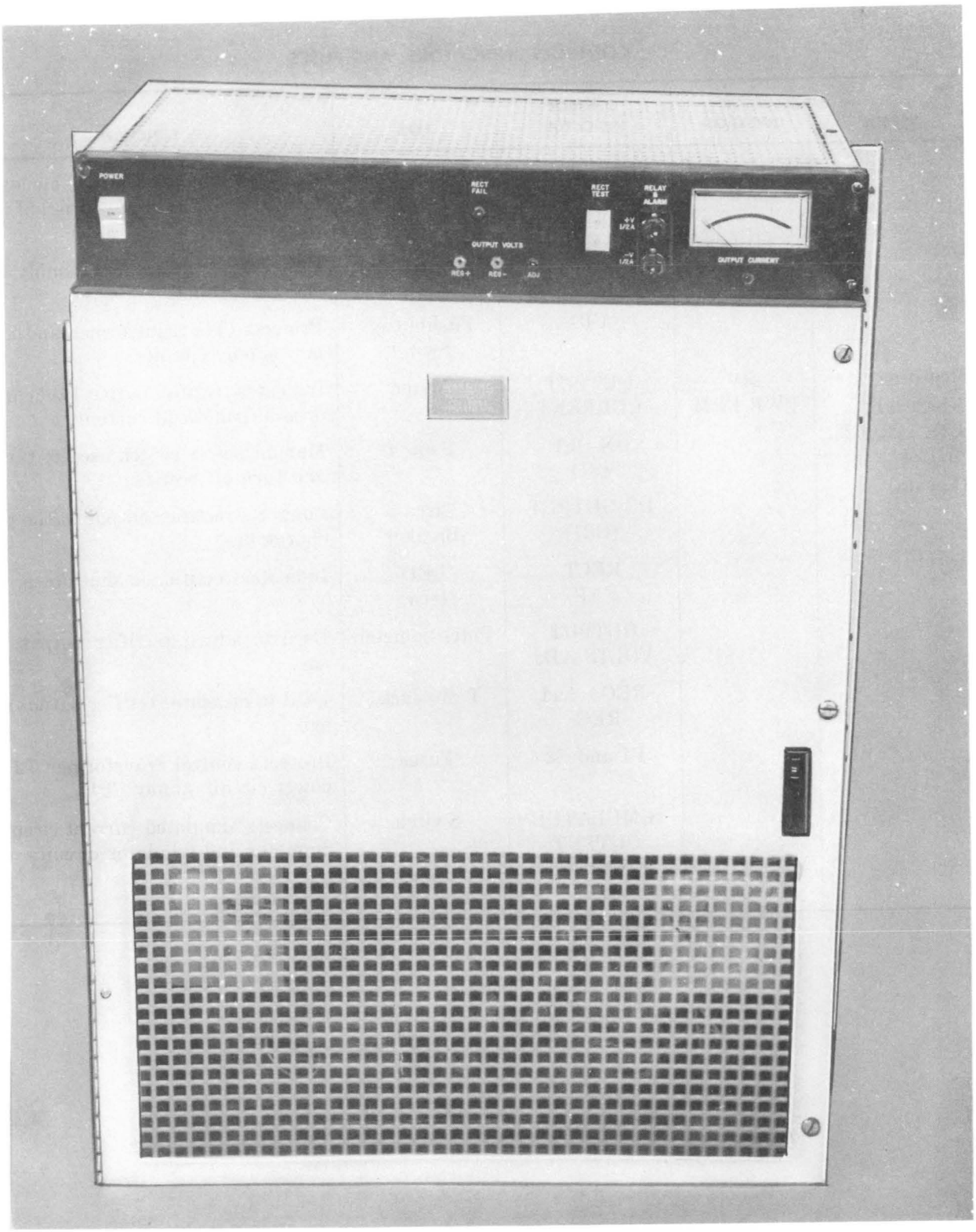

Fig. 3—J87436A, L1 and L3, or L2 and L3, Rectifier

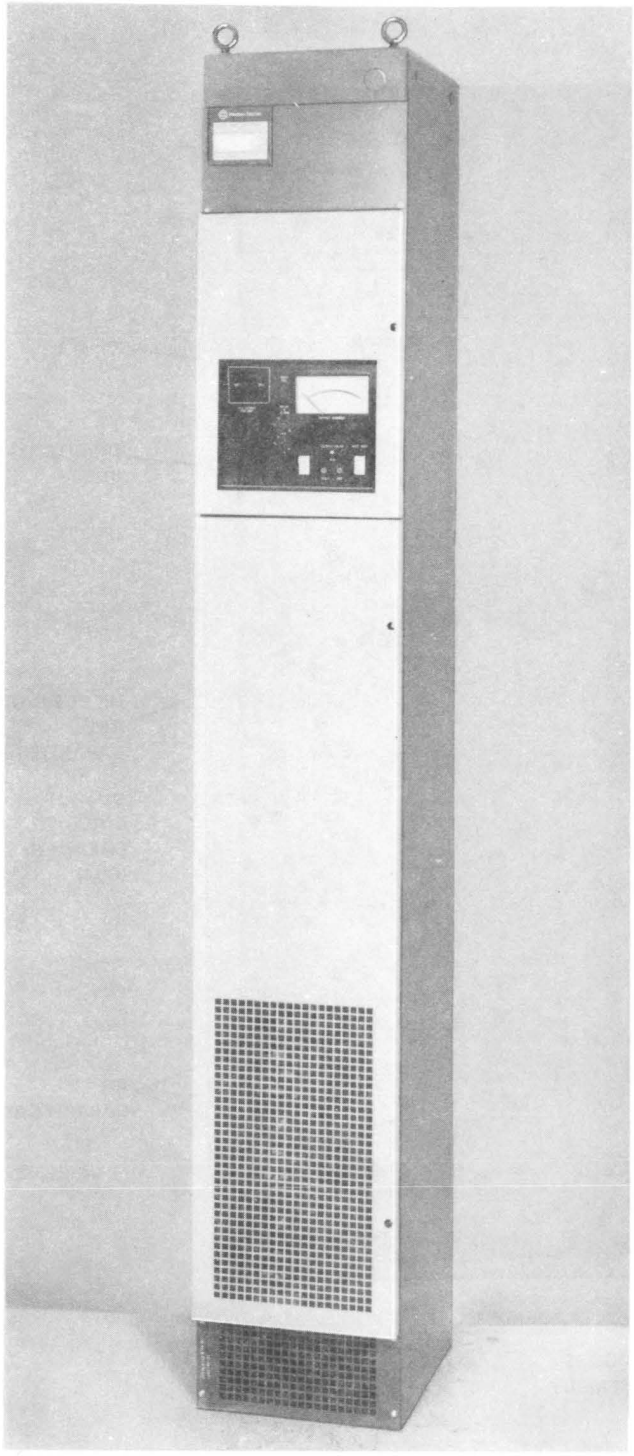

Fig. 4—J87438A, L1 or L2, Rectifier

2.09 This rectifier is designed to mount on a 23-inch relay rack framework or in a cabinet with similar mounting arrangements and can be serviced and maintained from the front only. All electrical connections can be made with the front cover removed. The meter, controls, and fuses are mounted on a hinged panel for access, maintenance, or replacement. See Table C for a complete list of controls, indicators, and fuses on the rectifier.◀

D. Discharge Circuit Breaker Panel

2.10 The discharge circuit breaker panel provides overload protected outputs from the discharge bus to the office loads. The panel is mounted in the initial bay and is equipped with circuit breakers as required by the load. Three panel sizes are available to accommodate different sizes and configurations of circuit breakers. Circuit breakers with capacities ranging from 15 amperes to 200 amperes may be used.

▶***Note:*** No maintenance is required on the dc distribution circuit breakers.◀

E. Discharge Fuse Panel

2.11 The discharge fuse panel, mounted in the initial bay, provides overload protected output connections from the discharge bus to individual office loads. The fuse panel is available in three sizes and is equipped with fuses ranging from 1/4 to 200 amperes as required by the loads.

3. FUNCTIONAL DESCRIPTION

INTRODUCTION

3.01 The function of the 150B power plant is to supply up to 600 amperes of regulated, 24-volt dc power. The plant is used to power the office load, float the battery bank, and recharge the battery bank after a commercial power failure has occurred. The functional units of the 150B power plant are as follows:

- Rectifier
- Plant Alarm and Control Circuit
- Battery Bank.

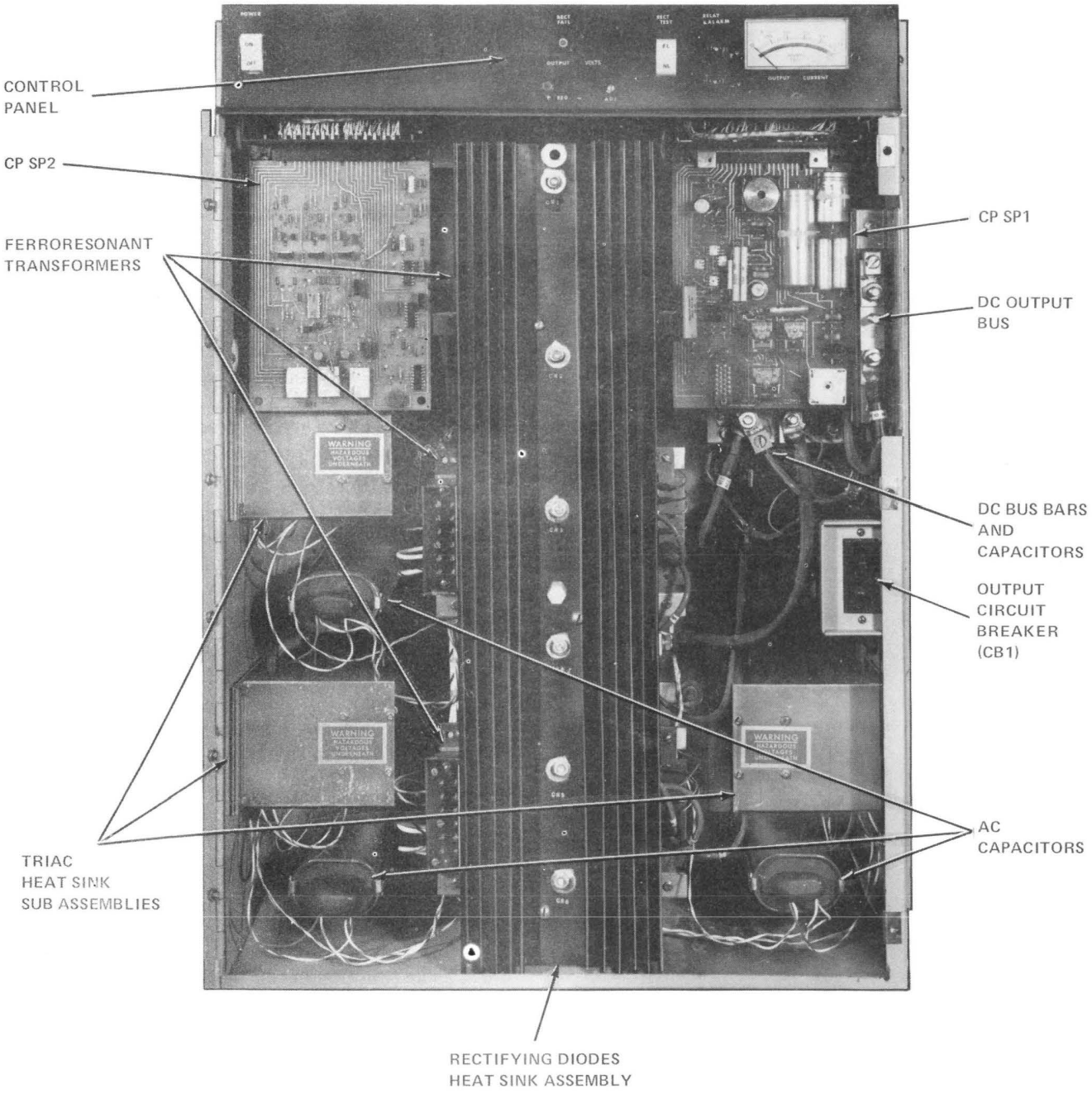

Fig. 5—J87436A, L1 and L3, or L2 and L3, Rectifier—Front Panel Open

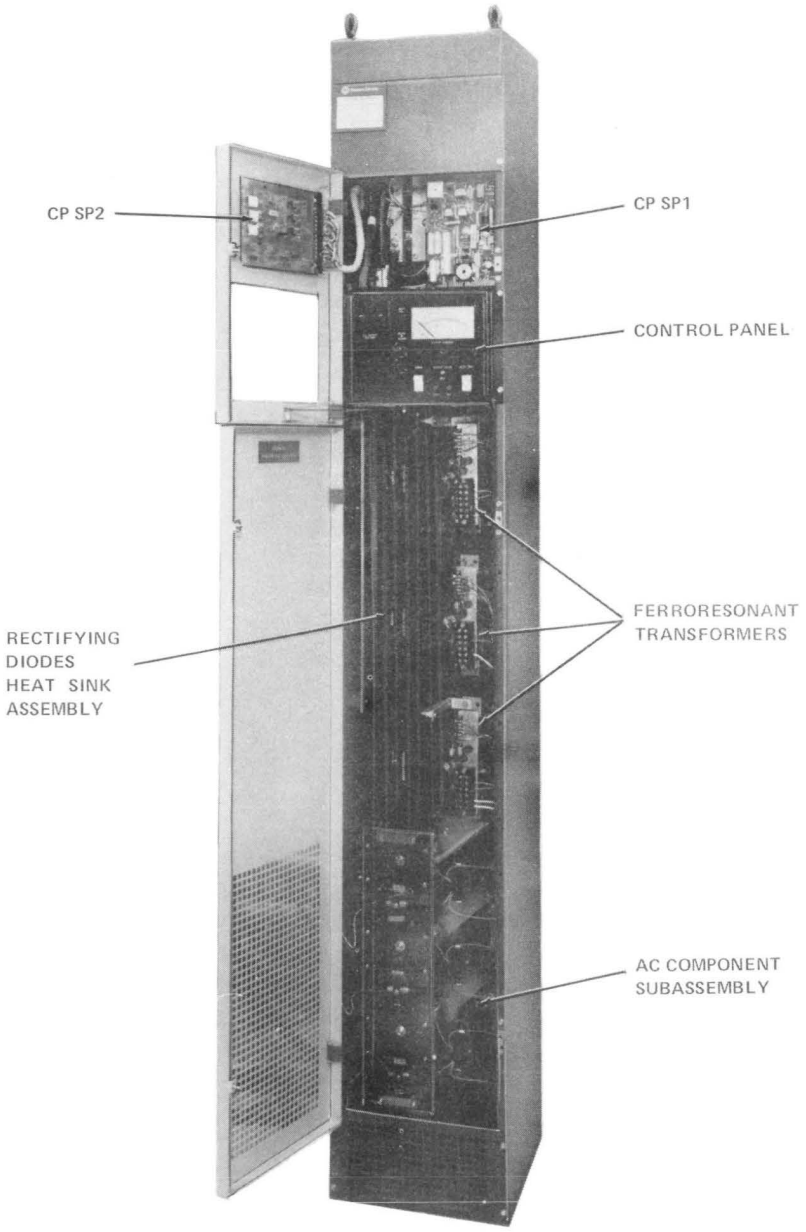

Fig. 6—J87438A, L1 or L2, Rectifier—Front Panels Open

DESCRIPTION

A. J87436A and J87438A Rectifiers

3.02 The J87436A, L1 and L3, and the J87438A, L1, rectifiers operate from a 208/240-volt, 3-phase, 60 ±3 Hz ac input. The J87436A, L2 and L3, and J87438A, L2, rectifiers operate from a 480-volt, 3-phase, 60 ±3 Hz ac input. When used in the power plant, the rectifier supplies current to a common charge battery bus. The voltage level of the charge battery bus is set to the voltage level requirement of the batteries. The functional units of the rectifier are the power circuit and the regulator and control circuit.

3.03 The rectifier power circuit converts the ac input to a regulated 24-volt dc output. The

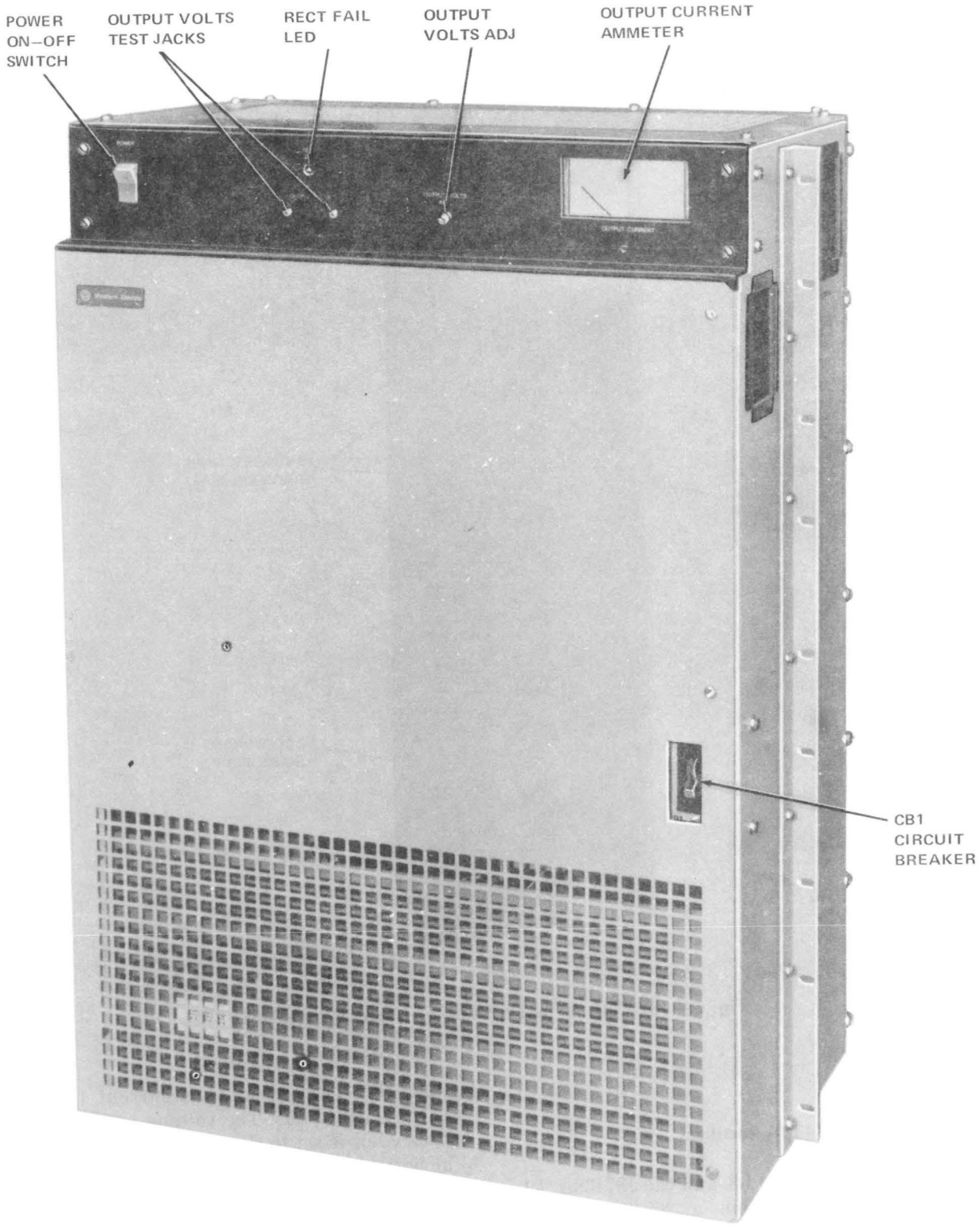

Fig. 7—KS-20491, L21, L22, L23, or L24 (Lorain) Rectifier

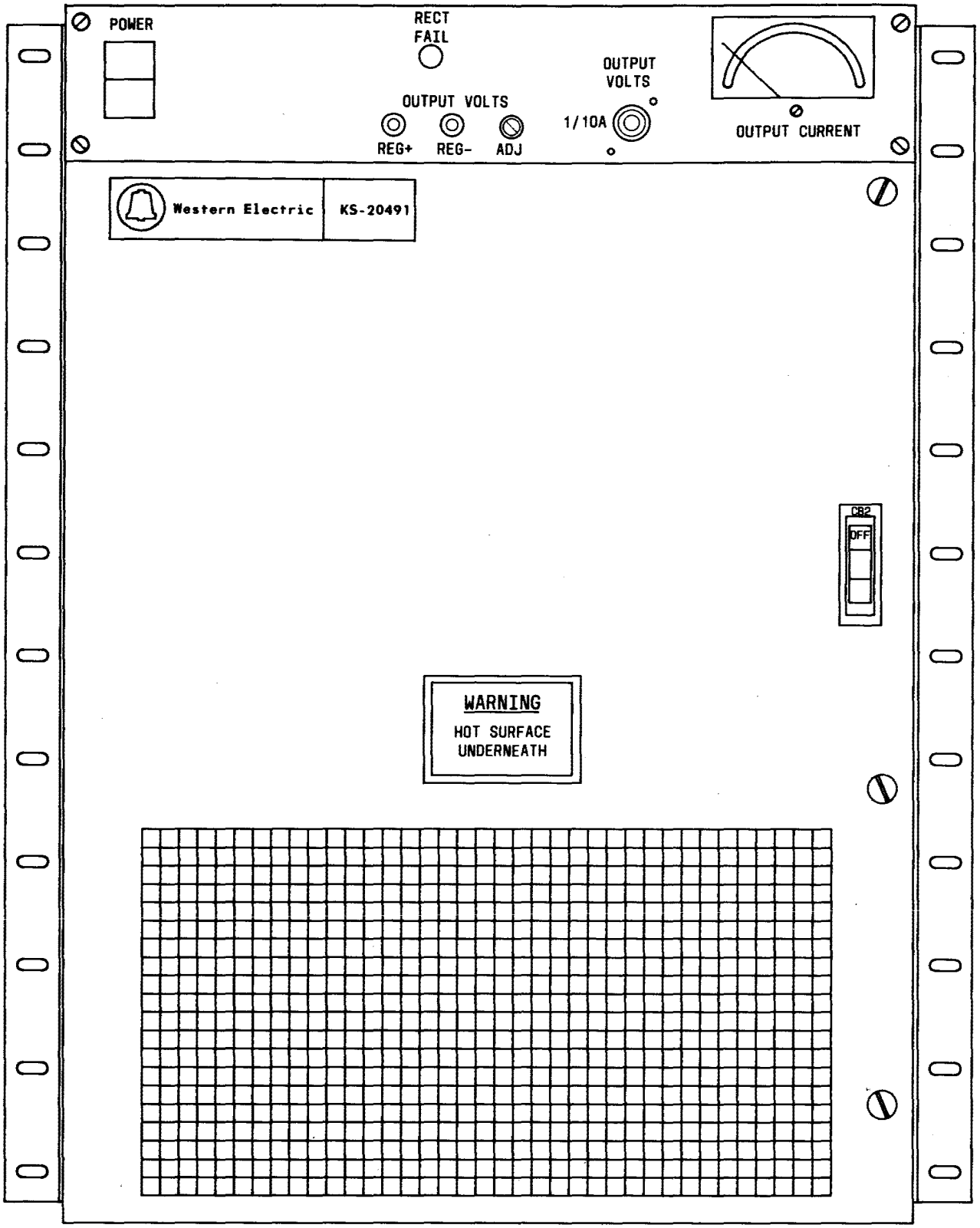

Fig. 8—KS-20491, L21, L22, L23, or L24 (ITT North) Rectifier

basic power conversion unit is a triac controlled, ferroresonant transformer circuit. In this circuit the magnetic saturation of a ferroresonant transformer is controlled by a triac to regulate the output voltage. Rectifying diodes convert the ac from the transformer to dc, which is filtered by an inductor and a capacitor bank. Three separate transformer circuits, one for each phase, are connected in parallel to supply the output.

3.04 The regulator and control circuit of the J87436A and the J87438A rectifiers consist of the following printed wiring circuit packs:

- Alarm and Power Circuits—CP SP1
- Voltage Regulation and Current Limit Circuits—CP SP2 or ⧫CP SP2B.⧫

3.05 The alarm and power circuits, CP SP1 circuit pack, furnishes power to the regulator circuits and provides high voltage shutdown, remote shutdown and restart, and fuse alarms. The CP SP1 also monitors the presence of the ac input power phases and provides a simulated no load/full load test feature.

3.06 The voltage regulation and current limit circuits, CP SP2 or ⧫CP SP2B⧫ circuit pack, maintains the output voltage at the desired level, senses the value of output current, and provides current limiting and current walk-in.

B. ⧫KS-20491 Rectifiers

3.07 The KS-20491, L21 through L24, rectifiers operate from a single-phase, 60-Hz ac input. Table A lists rectifier input and output options. When used in the power plant, the rectifier supplies current to a common charge battery bus. The voltage level of the battery bus is set to the voltage requirement of the batteries. The functional units of the rectifier are the power circuit and the regulator and control circuit.

3.08 The rectifier power circuit converts the ac input to a regulated 24-volt dc output. The basic power conversion unit is a triac or thyristor controlled ferroresonant circuit. The ac output from the power transformer is converted to dc by a full-wave rectifier and filtered by a capacitor and inductor bank.

3.09 The regulator and control circuits of the KS-20491 rectifiers differ in some respects due to different manufacturers. The circuits perform the same basic functions, but the type and number of circuit packs is different, as described in the following paragraphs.

3.10 The regulator and control circuit of the KS-20491 rectifier manufactured by ITT-North (Fig. 9) consist of the following printed wiring circuit packs:

- DC Auxiliary Power Supplies, AC Monitor, and Simulated Output Current—CP1
- Voltage and Current Regulation and Current Limit—CP2
- Alarm Circuits—CP3
- Extender Board for trouble locating—CP4.

Warning: Circuit packs used in the earlier model KS-20491 rectifiers (−01 version) should not be substituted for circuit packs in the later model (−02 version) or damage to the rectifier will occur.

3.11 The auxiliary power supply and monitor circuit pack (CP1) contains circuitry to perform rectification and filtering, to convert auxiliary ac voltages to dc bias supply voltages. The CP1 also contains current monitoring circuitry to provide logic for selective high voltage shutdown and lockout, ac monitoring, load current sensing for ammeter simulated output current test, and suppress any surge current into the batteries.

3.12 The voltage regulator and current limit circuit pack (CP2) contains a voltage regulator circuit in conjunction with the pulse generator which controls the dc output by varying the firing angle of the power triac. The CP2 also contains the current limiting circuitry which switches the rectifier from voltage regulation to current regulation, and a walk-in circuit which causes the rectifier to assume the load at a preset rate.

3.13 The alarm control circuit pack (CP3) transmits and receives remote alarm and control signals to and from the plant. The CP3 contains the overvoltage shutdown circuit, the remote restart circuit, and shutdown and lockout circuit for internal rectifier trouble.

3.14 Circuit pack CP4 is an extender board which is used for troubleshooting the three functional circuit packs (CP1, CP2, and CP3).

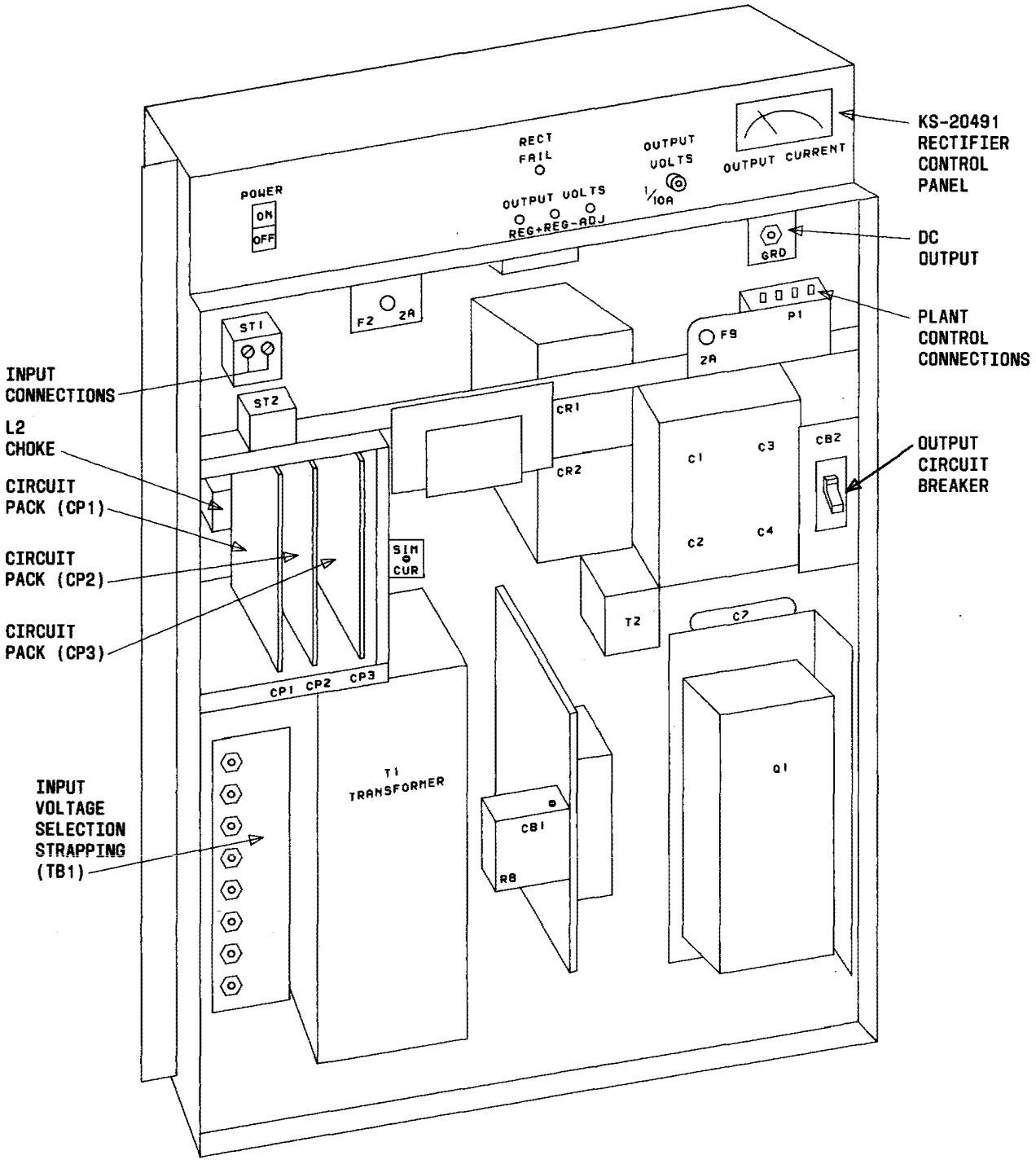

Fig. 9—KS-20491, L21, L22, L23, or L24 (ITT-North) Rectifier—Front Panel Removed

3.15 The regulator and control circuit of the KS-20491 rectifier manufactured by Lorain (Fig. 10) consists of the following printed wiring circuit packs:

- Voltage and Control Circuit—CP1
- Relay and Alarm Circuit—CP2
- Display Circuit—CP3.

Warning: Circuit packs used in the earlier model KS-20491 rectifiers (-01 version) should not be substituted for circuit packs in the later model (-02 version) or damage to the rectifier will occur.

3.16 The voltage and control circuit pack (CP1) contains circuitry to perform voltage regulation amplification and low current amplification. The CP1 also contains the pulse control circuit, the simulated output current circuit, the walk-in circuit, and the auxiliary power supply circuit.

3.17 The relay and alarm circuit pack (CP2) contains the overvoltage shutdown circuit, the rectifier fail circuit, the restart circuit, and current sensing circuits. CP2 also contains the remote shutdown and restart circuits.

3.18 The display circuit pack (CP3) contains circuitry for the output volts adjust, the output voltage test jacks, and the rectifier fail lamp. The circuit pack is located on the back of the rectifier control panel.

C. Plant Control and Alarm Circuit

3.19 The plant control and alarm circuit monitors the plant output bus and each individual rectifier, and is able to shut down and restart rectifiers during certain failure conditions. The functional units of the plant control and alarm circuit are as follows:

- High-Low Voltage Monitors
- Alarm Relays
- Alarm LEDs
- Rectifier Restart Circuit
- REG Circuit
- Discharge Circuit
- Capacitor Charge Circuit
- Meter Circuit.

3.20 The plant high-low voltage monitor circuit monitors the voltage level of the battery bus at the REG bus (Table D). The high-low voltage monitor consists of the following:

- High-Voltage Shutdown — HV
- Low-Voltage Alarm— LV1
- Very Low-Voltage Alarm— LV2.

Note: If control unit fuse HLV or R is open, all high-low voltage alarms are given and a shutdown signal is sent to the rectifiers.

3.21 The high-voltage shutdown (HV) lights the HLV LED and provides major alarm contact closures and a shutdown signal to the faulty rectifier(s). The HV signals and major alarms are given when the REG bus voltage increases to 26.75 volts.

3.22 The low-voltage alarm (LV1) provides minor alarm contact closures and lights the HLV LED when the REG bus voltage drops to 25.50 volts dc.

3.23 The very low-voltage alarm (LV2) provides major alarm contact closures and lights the HLV LED when the REG bus voltage drops to 24.00 volts dc.

3.24 The plant alarm relays provide alarm contact closures which light a plant alarm LED and initiate local and remote alarms (Table E). The plant alarm relays are identified as follows:

- ***FAN Relay***—Provides minor alarm contact closures and lights the RECT FAIL LED when the HLV or VM fuse blows, or an RB fuse blows.
- ***FAJ Relay***—Provides major alarm contact closures and lights the DISCHARGE FUSE LED when the CHG, VM2, or BAT fuse blows, a load fuse blows, or a load circuit breaker trips.

Note: The FAJ relay provides major alarm contact closures but does not light the DISCHARGE FUSE LED when the R fuse blows.

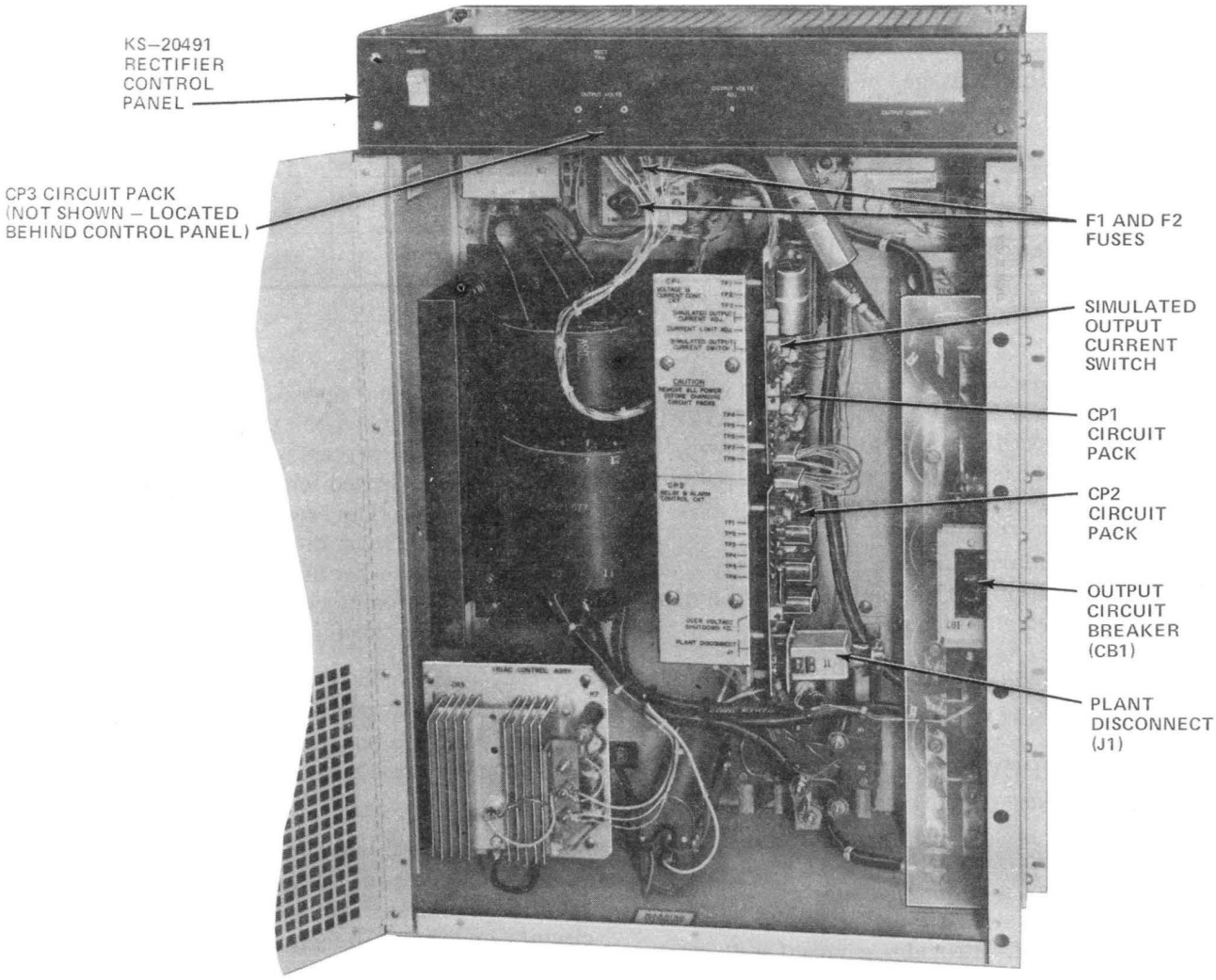

Fig. 10—KS-20491, L21, L22, L23, or L24 (Lorain) Rectifier—Front Panel Open

TABLE D

HIGH-LOW VOLTAGE ALARMS

VOLTAGE ALARM	PLANT VOLTAGE	PLANT ALARM LED LIGHTED	PLANT ALARM GIVEN
High Voltage	26.75 Volts or above	HLV, RECT FAIL (when rectifiers are shut down)	Major
Low Voltage	25.50 Volts	HLV	Minor
Very Low Voltage	24.00 Volts or below	HLV	Major

- ***RFA Relay***—Provides minor alarm contact closures and lights the RECT FAIL LED when a rectifier fails and shuts down, a power phase is lost, or a rectifier output circuit breaker trips.

3.25 The plant alarm LEDs light to identify an alarm condition in the plant. The plant alarm LEDs are identified as follows:

- ***HLV***—Provides a visual indication of a high or low voltage condition

Note: The HLV LED will also light due to a blown HLV fuse on the control unit

- ***DISCHARGE FUSE***—Provides a visual indication of a major fuse alarm

- ***RECT FAIL***—Provides a visual indication of a failed rectifier or a minor fuse alarm.

Note: When the R fuse on the control unit is blown, none of the plant alarm LEDs will be able to light.

3.26 The rectifier restart circuit attempts to restart plant rectifiers that have failed and shut down. A rectifier failure activates the RFA relay which in turn operates relay RSR in the control unit after a delay of about 2 seconds. The RSR relay, when operated, provides a contact closure to all the rectifiers in the plant. This closure will cause any rectifier which has shut down to make one attempt to restart. If a shutdown was caused by a transient condition, the failed rectifier(s) will be restarted and the plant will resume normal operation. However, a rectifier will not restart when the trouble which caused the shutdown is still present. A delay circuit holds the restart contacts closed for approximately 5 minutes; then opens them. If any rectifier has shut down again or remains shut down, the restart contacts are closed again to make another attempt to restart the rectifier(s). Restart attempts will continue every 5 minutes until the trouble keeping the rectifier shutdown is corrected.

Note: The restart circuit is also activated by the loss of a power phase or a tripped rectifier output circuit breaker.

3.27 Voltage signals from the battery are supplied to the REG bus. The REG circuit supplies the voltage signals from the REG bus to the individual rectifier regulator circuits, the plant voltage monitor circuits, and the plant meter circuit. Regulation fuses RB( ) supply REG bus sense voltage to individual rectifier regulator circuits. The high-low voltage monitor senses the REG bus voltage through the HLV fuse. The PLANT VOLTAGE meter senses the REG bus voltage through the VM fuse.

3.28 The discharge circuit provides voltage signals and operating current from the discharge bus to the capacitor charge circuit, the high-low voltage monitor, the RFA relay, the alarm LEDs, the meter circuit, and the control circuits of the rectifiers. The capacitor charge circuit is supplied through the CHG fuse. The high-low voltage monitor, the RFA relay, and the alarm LEDs are supplied through the R fuse. The meter circuit senses the discharge bus voltage through the VM2 fuse. The rectifier control circuits are supplied through the BAT fuse.

TABLE E

FUSE AND CIRCUIT BREAKER ALARMS

FUSE OR CIRCUIT BREAKER	FUSE ALARM RELAY OPERATED	PLANT ALARM LED LIGHTED	OFFICE ALARM SIGNALS GIVEN
Plant control unit fuses RB1-RB16 (as required) HLV, VM	FAN	RECT FAIL	Minor
Plant control unit fuses CHG, R, VM2, BAT	FAJ	DISCHARGE FUSE (except R fuse)	Major
Plant discharge fuses and circuit breakers	FAJ	DISCHARGE FUSE	Major
Rectifier fuses RELAY and ALARM +V and -V (J87436A and J87438A only)	RFA	RECT FAIL	Minor
Rectifier circuit breaker CB1 (J87436A and J87438A only)	RFA	RECT FAIL	Minor
Rectifer fuses F1, F2, and F9 (KS-20491 ITT-North only)	RFA	RECT FAIL	Minor
Rectifier circuit breaker CB1 and CB2 (KS-20491 ITT-North only)	RFA	RECT FAIL	Minor
Rectifier fuses F1 and F2 (KS-20491 Lorain only)	RFA	RECT FAIL	Minor
Rectifier circuit breaker CB1 (KS-20491 Lorain only)	RFA	RECT FAIL	Minor

3.29 The capacitor charge circuit is used to precharge capacitors in the load circuits before the circuit breakers for the loads are operated to ON. The CAP CHG lamp lights to provide a visual indication that charging is taking place. The LAMP TEST switch is used to test the capacitor charge circuit by lighting the CAP CHG lamp if the circuit is functioning properly.

3.30 The meter circuit provides indications of plant voltage and load current. The PLANT VOLTAGE meter reads the voltage selected by the BAT-DISCHG switch, either the battery bus voltage (measured at the REG bus) or the discharge bus voltage. Test jacks VM CAL (+) and (-) are provided for connecting a test meter to read plant voltage and to calibrate the PLANT VOLTAGE meter. The PLANT LOAD CURRENT meter indicates load current supplied by the plant.

D. Battery Bank (J87122 or J87123A, B)

3.31 A 12-cell battery bank comprised of lead-acid cells is connected between the charge battery bus and the discharge bus. Normally the plant rectifiers supply current to the charge battery bus to float the batteries and power the office load through the discharge bus. When a commercial power failure occurs, the batteries supply current to the discharge bus to power the loads. After ac input power is restored, the rectifiers recharge the batteries through the charge battery bus.

4. APPARATUS

4.01 ***List of Tools and Test Equipment:*** The following tools and test equipment are used in this section.

TOOLS	DESCRIPTION
141	Cord Tip
411C	Test Pick
720A	Voltage Pickup Tool
W1AY	Test Cord
—	3-Inch C Screwdriver
—	5-Inch E Screwdriver

TEST EQUIPMENT

KS-20599, L4	Digital Multimeter (DMM) (or equivalent)

5. ACCEPTANCE TESTS

INTRODUCTION

5.01 In order to determine that the power plant is operating properly when first installed, the following acceptance tests should be performed. These tests should be performed in the order they are listed. If trouble is discovered during testing, first correct the problem; then return to the beginning of the test procedure where the trouble was found and start the test over.

TEST PROCEDURES

A. Test Plant Rectifiers

5.02 The procedures for testing the rectifiers in the plant are given in the following Bell System Practices which describes the operating methods of the rectifiers.

RECTIFIER	SECTION
J87436A	169-652-305
J87438A	169-652-307
▶KS-20491 (Lorain)	169-743-301
KS-20491 (ITT-North)	169-743-302◀

The following tests should be performed on each rectifier in the plant:

(1) Check output voltage adjustment

(2) Check voltage regulation (J87436A and J87438A only)

(3) ▶Check current limit (KS-20491 only)

(4) Check high voltage shutdown (KS-20491 only)

(5) Check TR shutdown (KS-20491 only)

(6) Check automatic restart (KS-20491 only).◀

B. Check and Adjust Battery Bus Voltage and Rectifier Output Current

5.03 To balance the output currents of the rectifiers and set the battery bus voltage, proceed as follows:

(1) Set the KS-20599, L1, digital multimeter (DMM) to measure approximately 100 volts dc. Connect the DMM across the VM CAL (+) and (-) test jacks on the plant control unit. (See Fig. 2.)

(2) Set the voltmeter selector switch on the plant control unit to BAT (Fig. 2).

Requirement: The OUTPUT CURRENT ammeter on each rectifier indicates some load current (see Note 1) and the DMM indicates the required charge voltages (see Note 2).

Note 1: The rectifiers are not required to share load current equally.

Note 2: Use 26.04 volts dc as the correct charge voltage (2.17 volts per cell for 12-cell battery).

Note 3: If the voltage and current requirements are met, go to (6). If the requirements are not met, continue with (3).

(3) On rectifiers with no current indication, rotate the OUTPUT VOLTS ADJ potentiometer

slowly cw, using the 3-inch C screwdriver, until the rectifier ammeter indicates some load current.

Requirement: The DMM indicates the correct charge voltage [see (2) and Note 2].

Note: If the voltage and current requirements are met, go to (6). If the requirements are not met, continue with (4)(a) or (b).

(4) To adjust plant voltage, proceed as follows:

(a) ***Bus Voltage High:*** If the actual battery bus voltage is higher than the required voltage, rotate the OUTPUT VOLTS ADJ potentiometer, using the 3-inch C screwdriver slightly ccw on rectifiers with the highest current indication.

(b) ***Bus Voltage Low:*** If the actual battery bus voltage is lower than the required voltage, rotate the OUTPUT VOLTS ADJ potentiometer, using the 3-inch C screwdriver, slightly cw on rectifers with the lowest current indication.

(5) Repeat the procedure from (3) until the battery bus voltage is set.

(6) Set the plant voltmeter selector switch to DISCHG (Fig. 2).

Requirement: The DMM indicates approximately the same value as the battery bus voltage.

(7) Set the voltmeter selector switch to BAT and disconnect the DMM from the VM CAL test jacks.

C. Calibrate Plant Voltmeter

5.04 To calibrate the plant voltmeter, proceed as follows:

(1) Set the DMM to measure approximately 100 volts dc. Connect the DMM across the VM CAL (+) and (-) test jacks. (See Fig. 2.)

Requirement: The PLANT VOLTAGE meter (Fig. 2) indicates within 0.25 volt of the DMM voltage indication.

Note: If the requirement is not met, use the 3-inch C screwdriver to adjust the calibration screw on the PLANT VOLTAGE meter until the indication on the PLANT VOLTAGE meter equals the indication on the DMM.

(2) Disconnect the DMM from the VM CAL test jacks.

D. Check Plant Fuse Alarms

5.05 To check the plant fuse alarms for proper operation, proceed as follows:

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

(1) Prepare a fuse alarm test cord per Fig. 11.

(2) At the plant control unit fuse panel, install the 720A voltage pickup tool at a suitable spare 70-type fuse position (Fig. 2).

(3) At the RB1 fuse, touch the tip of the 411C test pick to the exposed test point on the fuse cap (Fig. 12).

Requirement: The RECT FAIL LED lights (Fig. 2) and a minor alarm is given.

Note: If the alarm requirements are not met, remove the test pick from the fuse cap and refer to Part 8, Trouble Chart 3. If the requirements are met, continue with (4).

(4) Remove the test pick from the fuse cap.

Requirement: The RECT FAIL LED turns off and the alarm ceases.

(5) Repeat (3) and (4) for each additional RB fuse, the HLV fuse, and the VM fuse.

(6) At the BAT fuse, touch the tip of the 411C test pick to the exposed test point on the fuse cap.

Requirement: The DISCHARGE FUSE LED lights (Fig. 2) and a major alarm is given.

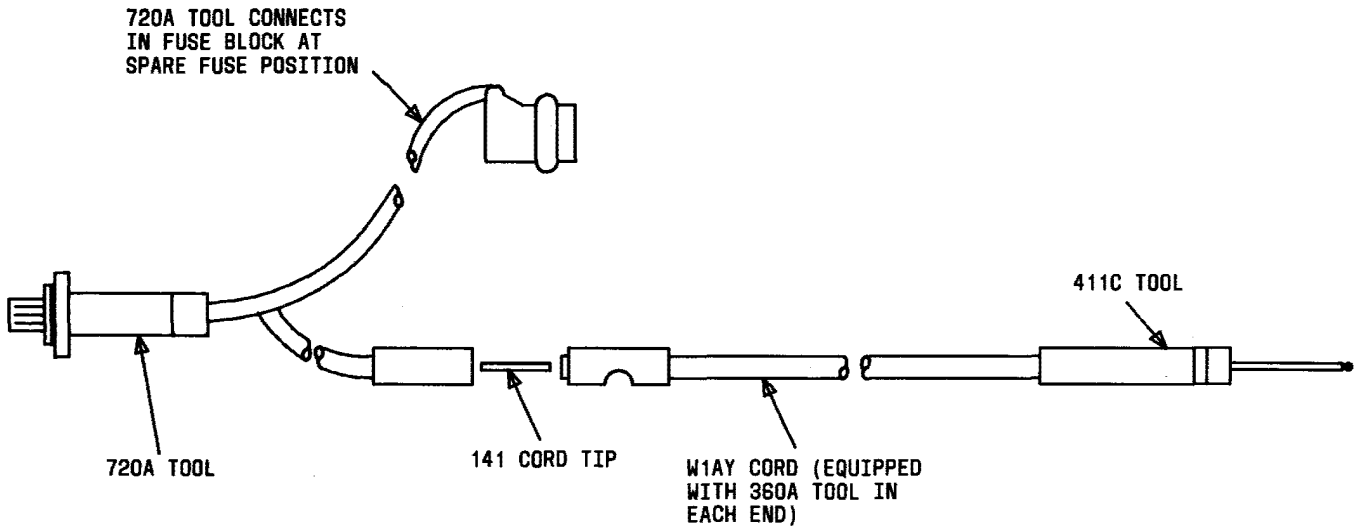

Fig. 11—Fuse Alarm Test Cord Assembly

Note: If the alarm requirements are not met, remove the test pick from the fuse cap and refer to Part 8, Trouble Chart 3. If the requirements are met, continue with (7).

(7) Remove the test pick from the fuse cap.

Requirement: The DISCHARGE FUSE LED turns off and the alarm ceases.

(8) Repeat (6) and (7) for the R fuse, the VM2 fuse, and the CHG ALM fuse (located at the left side of the control unit).

(9) Remove the 720A voltage pickup tool from the fuse panel.

E. Check Plant Low Voltage (LV1 and LV2) Monitors

Note: The battery voltage must be at least float value when performing this check.

5.06 To check the low voltage (LV1 and LV2) monitors, proceed as follows:

(1) Remove the lower front panel on the plant control unit by loosening the screws on each end of the panel with the 5-inch E screwdriver and lifting the panel off (Fig. 2).

Note: The TST switch is a spring loaded, momentary contact switch.

(2) On the WC1 or WC2 circuit pack, operate the TST switch to the LV2 (upper) position.

Requirement: The HLV LED on the control unit lights and a major alarm is given.

Note: If the alarm requirement is not met, refer to Part 8, Trouble Chart 17.

(3) Release the TST switch.

Requirement: The HLV LED goes out and the major alarm stops.

Note: If the requirement is not met, refer to Part 8, Trouble Chart 17.

(4) Operate the TST switch to the LV1 (lower) position.

Requirement: The HLV LED lights and a minor alarm is given.

Note: If the alarm requirement is not met, refer to Part 8, Trouble Chart 17.

(5) Release the TST switch.

Requirement: The HLV LED goes out and the minor alarm stops.

Note: If the requirement is not met, refer to Part 8, Trouble Chart 17.

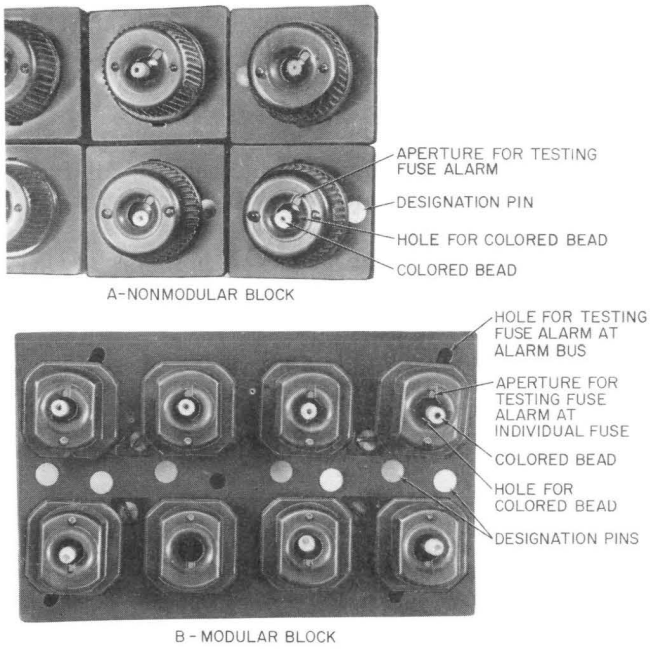

Fig. 12—Typical 70-Type Fuse Cap

(6) Replace the lower front panel of the control unit.

6. OPERATION

INTRODUCTION

6.01 The 150B power plant is completely automatic in maintaining the battery at float voltage and should require no day-to-day routine adjustments. Normally the plant is energized and connected to the office loads. However, should the plant need to be shut down or started up, refer to the following procedure which is applicable.

OPERATING PROCEDURES

A. Preparing to Start the Plant (Equipped With J87436A and/or J87438A Rectifiers)

6.02 When preparing to start the plant, proceed as follows:

(1) Verify that all discharge circuit breakers are set to OFF and all discharge fuses are removed.

(2) Verify that all fuses in the plant control unit are of the proper size and type and are installed in their respective fuse holders.

(3) Verify that the ac service fuses are installed.

(4) Verify that all rectifier ON-OFF switches and DC OUTPUT circuit breakers are set to OFF and the plant connectors are plugged into P1 of all the rectifiers (Fig. 5 or 6).

B. Starting the Plant (Equipped with J87436A and/or J87438A Rectifiers)

6.03 To start the plant, proceed as follows:

(1) Operate the ON-OFF switch of the first rectifier to be powered up to ON (Fig. 3 or 4).

Note: The rectifier may shut down immediately after the ON-OFF switch is operated to ON due to the filter capacitors charging. If this happens, operate the ON-OFF switch to OFF, then back to ON to restart the rectifier.

(2) Operate the DC OUTPUT circuit breaker of the first rectifier to be powered up to ON (Fig. 3 or 4).

(3) Repeat (1) and (2) for each additional rectifier in the plant.

(4) If the plant is ***not*** equipped with discharge circuit breakers having load charge pushbuttons, proceed to Step 9. If equipped with discharge circuit breakers having load charge pushbuttons, continue with Step 5.

Note: The LAMP TEST switch is a spring loaded momentary contact switch.

Warning: Hold the LAMP TEST switch only momentarily in the ON position. Holding the switch in the ON position for more than 2 or 3 seconds will cause the CAP CHG lamp to burn out.

(5) Operate the LAMP TEST switch on the plant control unit (Fig. 2) to the ON position; then release the switch.

Requirement: The CAP CHG lamp on the control unit (Fig. 2) is lighted when the LAMP TEST switch is in the ON position.

Note: If the requirement is not met, replace the CAP CHG lamp.

Warning: Do not hold a load charge pushbutton depressed for longer than 2 seconds if the CAP CHG lamp does not begin to dim.

(6) Depress and hold the load charge pushbutton on the first discharge circuit breaker to be switched on.

Requirement: The CAP CHG lamp on the control unit glows brightly initially and then dims out.

Note: If the requirement is not met, release the load charge pushbutton and check for troubles in the associated load circuit. If the CAP CHG lamp did not light, check for an open circuit or an open fuse in the input of the load. If the CAP CHG lamp lighted but did not dim, check for a short circuit across the input of the load.

(7) Release the load charge pushbutton and immediately operate the circuit breaker to ON.

(8) Repeat (6) and (7) for each additional discharge circuit breaker with a load charge pushbutton.

(9) Operate all remaining discharge circuit breakers without load charge pushbuttons to ON.

(10) Install all discharge fuses.

(11) Adjust the battery bus voltage and balance the rectifier output currents by following the procedure given in paragraph 5.03.

C. Stopping the Plant (Equipped With J87436A and/or J87438A Rectifiers)

6.04 To stop the power plant, proceed as follows:

(1) Operate the ON-OFF switch of the first rectifier to be shut down to OFF (Fig. 3 or 4).

(2) Operate the DC OUTPUT circuit breaker of the first rectifier to be shut down to OFF (Fig. 3 or 4).

(3) Repeat (1) and (2) for each additional rectifier in the plant.

(4) At the plant control unit, remove all fuses from the fuse panel (Fig. 2).

(5) Operate all discharge circuit breakers to OFF and remove all discharge fuses.

D. Preparing to Start the Plant (Equipped with KS-20491 Rectifiers)

6.05 When preparing to start the plant, proceed as follows:

(1) Verify that all plant discharge circuit breakers are set to OFF and all discharge fuses are removed.

(2) Verify that all fuses in the plant control unit are of the proper size and type and are installed in their respective fuse holders.

(3) On each rectifier, verify that the POWER ON/OFF (S1) switch is in the OFF position (Fig. 9 or 10).

(4) Verify that the plant control cable is connected to the rectifier.

(5) Verify that the ac service fuses are installed.

(6) On each rectifier, verify that the rectifier output circuit breaker is set to ON.

E. Starting the Plant (Equipped with KS-20491 Rectifiers)

6.06 To start the plant, proceed as follows:

(1) Operate the ON/OFF (S1) switch of the first rectifier to be powered up to the ON position (Fig. 9 or 10).

(2) Connect the KS-20599, L4, digital multimeter, set to the 100 volts dc scale, to the REG (+) and REG (−) test jacks.

(3) Loosen the locking device and slowly rotate the OUTPUT VOLTS ADJ potentiometer to read 26.04 volts. Tighten the locking device being careful not to disturb setting.

(4) Repeat Steps (1), (2), and (3) for each additional rectifier in the plant.

(5) If the plant is ***not*** equipped with discharge circuit breakers having load charge pushbuttons, proceed with Step 10. If equipped with discharge circuit breakers having load charge pushbuttons, continue with Step 6.

Note: The LAMP TEST switch is a spring loaded momentary contact switch.

Warning: Hold the LAMP TEST switch only momentarily in the ON position. Holding the switch in the ON position for more than 2 or 3 seconds will cause the CAP CHG lamp to burn out.

(6) Operate the LAMP TEST switch on the plant control unit (Fig. 2) to the ON position; then release the switch.

Requirement: The CAP CHG lamp on the control unit (Fig. 2) is lighted when the LAMP TEST switch is in the ON position.

Note: If the requirement is not met, replace the CAP CHG lamp.

Warning: Do not hold a load charge pushbutton depressed for longer than 2 seconds if the CAP CHG lamp does not begin to dim.

(7) Depress and hold the load charge pushbutton on the first plant discharge circuit breaker to be switched on.

Requirement: The CAP CHG lamp on the control unit glows brightly initially and then dims out.

Note: If the requirement is not met, release the load charge pushbutton and check for troubles in the associated load circuit. If the CAP CHG lamp did not light, check for an open circuit or an open fuse in the input of the load. If the CAP CHG lamp lighted but did not dim, check for a short circuit across the input of the load.

(8) Release the load charge pushbutton and immediately operate the discharge circuit breaker to ON.

(9) Repeat (7) and (8) for each additional discharge circuit breaker with a load charge pushbutton.

(10) Operate all remaining discharge circuit breakers without load charge pushbuttons to ON.

(11) Install all discharge fuses.

(12) Adjust the battery bus voltage and balance the rectifier output currents by following the procedure given in paragraph 5.03.

F. Stopping the Plant (Equipped with KS-20491 Rectifiers)

6.07 To stop the power plant, proceed as follows:

(1) Operate the POWER ON-OFF switch of the first rectifier to be shut down to OFF (Fig. 9 or 10).

(2) Operate the DC OUTPUT circuit breaker of the first rectifier to be shut down to OFF.

(3) Repeat (1) and (2) for each additional rectifier in the plant.

(4) At the plant control unit, remove all fuses from the fuse panel (Fig. 2).

(5) Operate all plant discharge circuit breakers to OFF and remove all discharge fuses.◀

7. ROUTINE CHECKS

INTRODUCTION

7.01 Routine checks are intended to determine whether or not the plant equipment, and infrequently operated parts in particular, are in proper operating condition. Routine checks also will help, insofar as possible, to guard against circuit failures which interfere with service. Checks and adjustments other than those required by trouble conditions should be performed ▶in accordance with the Equipment Test List◀ when there is a minimum interference to service.

▶***Note:*** No maintenance is required on the dc distribution circuit breakers.◀

CHECKS

7.02 The following checks should be performed periodically:

(a) Clean ventilating passages.

(b) Check rectifiers per paragraph 5.02.

(c) Check battery bus voltage and rectifier output current per paragraph 5.03.

(d) Calibrate plant voltmeter per paragraph 5.04.

(e) Check plant fuse alarms per paragraph 5.05.

(f) Check plant low voltage monitors per paragraph 5.06.

Note: Plant high voltage test is not required periodically since plant loads would be subjected to higher than normal voltage.

(g) Perform battery inspection and maintenance routines in accordance with the appropriate battery maintenance information.

8. TROUBLES

INTRODUCTION

8.01 This part gives procedures for locating and correcting the most common types of troubles that the plant may experience. The possible causes of a trouble and the actions to take for correcting the problem are listed in a trouble chart for each individual trouble condition. The trouble clearing procedures following the trouble charts are detailed repair procedures used in servicing the plant.

8.02 To assist in locating the correct trouble chart when an alarm has been given, the trouble flowcharts of Fig. 13 and Fig. 14 are provided. In general, equipment should be visually inspected for faulty connections, shorts, broken wires, and burned components. It is suggested that the probable causes of troubles listed in the trouble charts be checked in the order given. If the trouble cannot be located and corrected with the assistance of the trouble charts, then refer to the proper schematic diagrams and circuit descriptions for further information (see paragraph 1.07). After a repair has been made, the equipment repaired should be verified to be operating properly by following the appropriate test procedures in Part 5.

8.03 When a trouble is traced to a circuit pack, replace the circuit pack with the proper new or repaired circuit pack. Do not attempt to repair defective circuit packs unless personnel are equipped and trained to repair circuit packs. When it is necessary to replace a circuit pack, refer to Section 032-173-301, which covers Testing, Replacing, Handling, Storing, and Shipping Circuit Packs and Semiconductor Devices. Return defective circuit packs to an authorized repair facility in accordance with local instructions.

TROUBLE CHARTS

8.04 The following trouble charts cover troubles in the plant control unit, the plant rectifiers, and the charge discharge circuit.

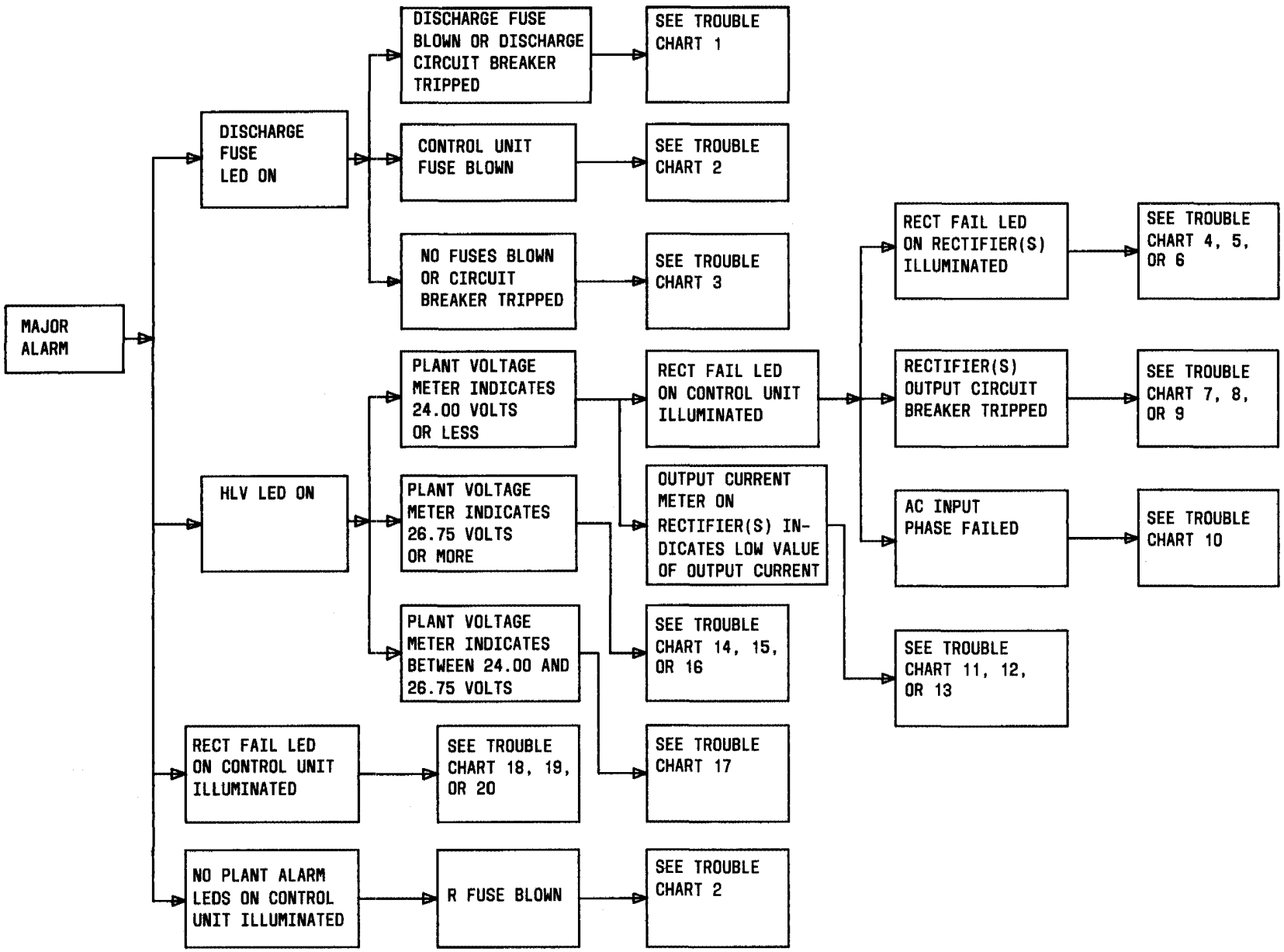

Fig. 13—Plant Trouble Flowchart—Major Alarm

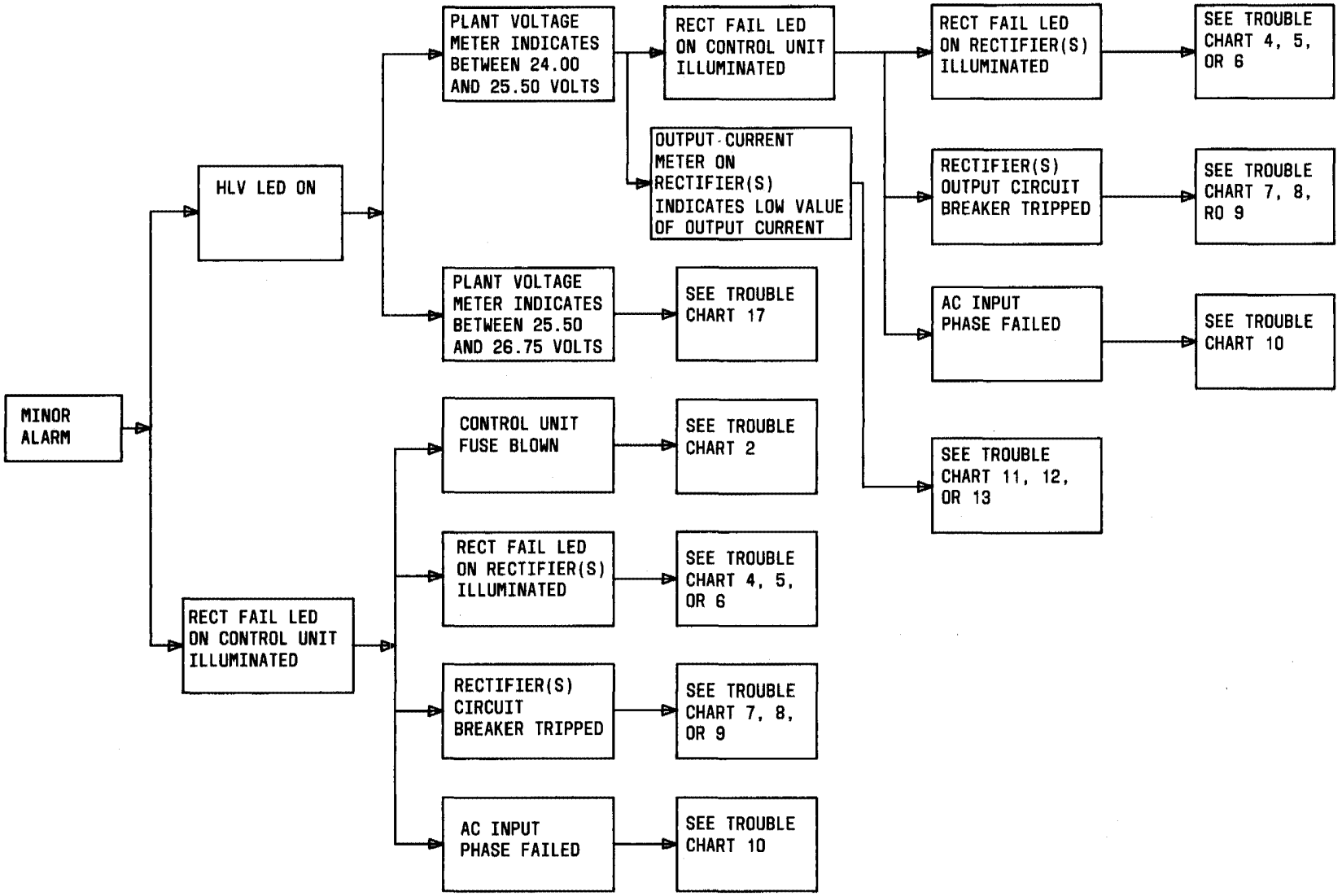

Fig. 14—Plant Trouble Flowchart—Minor alarm

TROUBLE CHART 1

DISCHARGE FUSE BLOWN OR DISCHARGE CIRCUIT BREAKER TRIPPED

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
DISCHARGE FUSE LED on	Replace blown fuse or reset tripped circuit breaker. If the fuse blows or the circuit breaker trips again, examine the probable cause	The load circuit associated with the blown fuse or tripped circuit breaker is drawing an excessive amount of current, or a short circuit is present across the input of the load	Check the load circuit for short circuits or other defects. Replace the blown fuse or reset the tripped circuit breaker.

▶TROUBLE CHART 2◀

CONTROL UNIT FUSE BLOWN

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
A. DISCHARGE FUSE LED on	Replace blown control fuse. If fuse blows again, proceed with the corrective action for the fuse that is blown	(1) CHG fuse blown, CHG ALM fuse blown (when capacitor charge push-button on circuit breaker is depressed to charge load capacitors)	Check load circuit for a short circuit at the input. Replace both CHG fuse and CHG ALM fuse.
		(2) VM2 fuse blown	Check for short to ground on the PLANT VOLTAGE meter leads.
		(3) BAT fuse blown	Shut down plant per paragraph 6.04 or 6.07, unplug all rectifier plant connectors, and replace BAT fuse. Reconnect plant connectors one at a time until the BAT fuse blows. In rectifier which caused fuse to blow, replace either CP SP1 (J87436A and J87438A), CP2 (KS-20491 Lorain) or CP3 (KS-20491 ITT-North) per paragraph 8.06 or 8.07. Replace BAT fuse and restart plant per paragraphs 6.02 and 6.03, or 6.05 and 6.06.
		(4) R fuse blown	Check LEDs, resistors R3, R4, and R5. Remove CP WC1 or CP WC2 and replace R fuse. If fuse does not blow with CP WC1 or CP WC2 removed, the board is defective. Replace CP WC1 or CP WC2.
B. RECT FAIL LED on	Remove CP WC1 or CP WC2. Replace control fuse. If fuse does not blow with board removed, board is defective.	CP WC1 or CP WC2	Replace CP WC1 or CP WC2 per paragraph 8.05.

◗TROUBLE CHART 3◖

PLANT ALARMS DO NOT OPERATE PROPERLY

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
DISCHARGE FUSE LED on, no trouble present	Test plant alarms by following the procedures given in paragraphs 5.05 and 5.06. If plant alarm requirements given in the procedures are not met, proceed with the corrective action	(1) Defective plant alarm circuit	Replace WC1 or WC2 circuit pack per paragraph 8.05.
		(2) Open wiring to LEDs	Check continuity to LEDs.
		(3) LEDs burned out	Replace LEDs.

▶TROUBLE CHART 4◀

J87436A OR J87438A RECTIFIER WILL NOT RESTART

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on rectifier is on and stays on	Wait approximately 6 minutes to allow the rectifier to restart automatically before examining probable causes	(1) Relay RFA (K2) in rectifier operated:	
		(a) RELAY and ALARM fuse +V or -V blown	Replace CP SP1 and/or CP SP2 or CP SP2B per paragraph 8.06 to correct trouble. Replace blown fuse.
		(b) Internal high voltage shutdown circuit in rectifier defective	Replace CP SP2 or CP SP2B per paragraph 8.06.
		(c) Defective external selective high voltage shutdown circuit in rectifier	Replace CP SP1 and/or CP SP2 or CP SP2B per paragraph 8.06.
		(2) Restart circuit in rectifier defective	Replace CP SP1 per paragraph 8.06.
		(3) Restart circuit in control unit defective	Replace WC1 or WC2 circuit pack per paragraph 8.05.

♦TROUBLE CHART 5♦

K-20491 (ITT-NORTH) RECTIFIER WILL NOT RESTART

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on rectifier is on and stays on	Wait approximately 6 minutes to allow the rectifier to restart automatically before examining probable causes.	(1) Relay RFA in rectifier operated:	
		(a) 24V BIAS supply fuses F1 or F2 blown	Replace CP1 per paragraph 8.07. Replace blown fuse.
		(b) OUTPUT VOLTS fuse F3 blown	Clear short at TP2 OUTPUT VOLTS test jack.
		(c) CABLE ALARM fuse F9 blown	Clear short in DC cable assembly.
		(d) Internal high voltage shutdown circuit in rectifier defective	Replace CP3 per paragraph 8.07.
		(e) Defective external selective high voltage shutdown circuit in rectifier	Replace CP3 per paragraph 8.07.
		(2) Restart circuit in rectifier defective	Replace CP3 per paragraph 8.07.
		(3) Restart circuit in control unit defective	Replace WC1 or WC2 circuit pack per paragraph 8.05.

♦TROUBLE CHART 6♦

KS-20491 (LORAIN) RECTIFIER WILL NOT RESTART

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on rectifier is on and stays on	Wait approximately 6 minutes to allow the rectifier to restart automatically before examining probable causes.	(1) Relay RFA (K2) in rectifier operated:	
		(a) F1 or F2 fuse blown	Replace CP1 per paragraph 8.07. Replace blown fuse.
		(b) Internal high voltage shutdown circuit in rectifier defective	Replace CP2 per paragraph 8.07.
		(2) Restart circuit in rectifier defective	Replace CP2 per paragraph 8.07.
		(3) Restart circuit in control unit defective	Replace WC1 or WC2 circuit pack per paragraph 8.05.

TROUBLE CHART 7

J87436A OR J87438A RECTIFIER OUTPUT CIRCUIT BREAKER (CB1) TRIPPED

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on control unit is on; OUTPUT CURRENT meter on rectifier indicates zero output current	Reset circuit breaker. If breaker trips again, examine probable causes	(1) R13 or R14 open (located at each end of OUTPUT CURRENT meter shunt R18)	Replace R13 or R14.
		(2) Defective current limiting circuit	Replace CP SP2 or CP SP2B per paragraph 8.06.

▶TROUBLE CHART 8◀

KS-20491 (ITT-NORTH) RECTIFIER OUTPUT CIRCUIT BREAKER (CB2) TRIPPED

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on control unit is on; OUTPUT CURRENT meter on rectifier indicates zero output current	Reset circuit breaker. If breaker trips again, examine probable causes	(1) R103 or R108 open (located at each end of OUTPUT CURRENT meter shunt R4)	Replace R103 or R108.
		(2) Defective current limiting circuit	Replace CP2 per paragraph 8.07.

▶TROUBLE CHART 9◀

KS-20491 (LORAIN) RECTIFIER OUTPUT CIRCUIT BREAKER (CB1) TRIPPED

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on control unit is on; OUTPUT CURRENT meter on rectifier indicates zero output current	Reset circuit breaker. If breaker trips again, examine probable causes	(1) R4.1 or R67 open (located at each end of OUTPUT CURRENT meter shunt R3)	Replace R4.1 or R67.
		(2) Defective current limiting circuit	Replace CP1 per paragraph 8.07.

♦TROUBLE CHART 10♦

AC INPUT PHASE FAILED

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on control unit is on		(1) Input fuse in power service cabinet blown	Locate and correct cause of blown fuse. Replace fuse.
		(2) AC power failure	Locate and correct fault in the ac distribution circuit.
		(3) Phase monitor circuit defective	
		(a) J87436A or J87438A rectifiers	Shut down plant per paragraph 6.04. Restart each rectifier per paragraph 6.03 one at a time until the RECT FAIL LED on the control unit lights. Replace CP SP1, per paragraph 8.06, of the rectifier which caused the RECT FAIL LED to light. Restart all remaining rectifiers.
		(b) KS-20491 rectifiers (Lorain and ITT-North)	Shut down plant per paragraph 6.07. Restart each rectifier per paragraph 6.06 one at a time until the RECT FAIL LED on the control unit lights. Replace CP1 per paragraph 8.07, of the rectifier which caused the RECT FAIL LED to light. Restart all remaining rectifiers.

TROUBLE CHART 11

J87436A OR J87438A RECTIFIERS OUTPUT VOLTAGE TOO LOW

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
OUTPUT CURRENT meter on rectifier(s) indicates low value of output current		(1) ADJ potentiometer out of adjustment	Adjust rectifier output voltage per paragraph 5.02. Adjust plant voltage and balance rectifier currents per paragraph 5.03.
		(2) Defective voltage regulation circuit or defective voltage walk-in circuit	Replace CP SP2 or CP SP2B per paragraph 8.06.
		(3) Triac Q1, Q2, or Q3 defective	Replace defective triac Q1, Q2, or Q3.
		(4) Loose connections on ferroresonant transformer T1, T2, or T3	Tighten loose connections.
		(5) RECT TEST switch held in NL position	Replace RECT TEST switch.

▶TROUBLE CHART 12◀

KS-20491 (ITT-NORTH) RECTIFIER OUTPUT VOLTAGE TOO LOW

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
OUTPUT CURRENT meter on rectifier(s) indicates low value of output current		(1) ADJ potentiometer out of adjustment	Adjust rectifier output voltage per paragraph 5.02. Adjust plant voltage and balance rectifier currents per paragraph 5.03.
		(2) Defective voltage regulation circuit or defective voltage walk-in circuit	Replace CP2 per paragraph 8.07.
		(3) Triac Q1, Q2, or Q3 defective	Replace defective triac Q1, Q2, or Q3.
		(4) Loose connections on ferroresonant transformer T1, T2, or T3	Tighten loose connections.
		(5) Defective SRS relay or C107 capacitor on CP1	Replace CP1 per paragraph 8.07.

▶TROUBLE CHART 13◀

KS-20491 (LORAIN) RECTIFIER OUTPUT VOLTAGE TOO LOW

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
OUTPUT CURRENT meter on rectifier(s) indicates low value of output current		(1) ADJ potentiometer out of adjustment	Adjust rectifier output voltage per paragraph 5.02. Adjust plant voltage and balance rectifier currents per paragraph 5.03.
		(2) Defective voltage regulation circuit or defective voltage walk-in circuit	Replace CP1 per paragraph 8.07.
		(3) Triac Q1, Q2, or Q3 defective	Replace defective triac Q1, Q2, or Q3.
		(4) Loose connections on ferroresonant transformer T1, T2, or T3	Tighten loose connections.

TROUBLE CHART 14

J87436A OR J87438A RECTIFIERS HV SHUTDOWN DOES NOT OPERATE

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
The PLANT VOLTAGE meter indicates 26.75 volts or more	Check for shutdown rectifiers	Selective high voltage shutdown circuit on rectifiers not shut down inoperative	
		(a) Rectifiers not delivering approximately 10 amperes or more	Operation is normal. Circuit is operative only when output current is approximately 5 percent or more of rated maximum output current. Readjust output voltage and current per paragraph 5.03.
		(b) Output current monitoring circuit defective	Replace CP SP2 or CP SP2B per paragraph 8.06.
		(c) High voltage shutdown circuit defective	Replace CP SP1 per paragraph 8.06.

▶TROUBLE CHART 15◀

KS-20491 (ITT-NORTH) RECTIFIER HV SHUTDOWN DOES NOT OPERATE

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
The PLANT VOLTAGE meter indicates 26.75 volts or more	Check for shut-down rectifiers	Selective high voltage shutdown circuit on rectifiers not shut down inoperative	
		(a) Rectifiers not delivering approximately 5 amperes or more	Operation is normal. Circuit is operative only when output current is approximately 5 percent or more of rated maximum output current. Readjust output voltage and current per paragraph 5.03.
		(b) High voltage shut-down circuit defective	Replace CP3 per paragraph 8.07.
		(c) Output current monitoring circuit defective	Replace CP1 or CP2 per paragraph 8.07.

TROUBLE CHART 16

KS-20491 (LORAIN) RECTIFIER HV SHUTDOWN DOES NOT OPERATE

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
The PLANT VOLTAGE meter indicates 26.75 volts or more	Check for shut-down rectifiers	Selective high voltage shutdown circuit on rectifiers not shut down inoperative	
		(a) Rectifiers not delivering approximately 5 amperes or more	Operation is normal. Circuit is operative only when output current is approximately 5 percent or more of rated maximum output current. Readjust output voltage and current per paragraph 5.03.
		(b) High voltage shut-down circuit defective	Replace CP2 per paragraph 8.07.

TROUBLE CHART 17

PLANT VOLTAGE MONITOR DOES NOT OPERATE PROPERLY

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
A. Low voltage relay (LV1) released at a plant voltage other than 25.50 volts dc	Test the low voltage alarm by following the procedure given in paragraph 5.06. If the requirements given in the procedure are not met, investigate the probable causes	(1) Defective low voltage alarm circuit	Replace WC1 or WC2 circuit pack per paragraph 8.05.
		(2) HLV fuse blown	Replace blown fuse. If fuse blows again, replace WC1 or WC2 circuit pack per paragraph 8.05.
B. Very low voltage relay (LV2) released at a plant voltage other than 24.00 volts dc	Test the very low voltage alarm by following the procedure given in paragraph 5.06. If the requirements given in the procedure are not met, investigate the probable causes	(1) Defective very low voltage alarm circuit	Replace WC1 or WC2 circuit pack per paragraph 8.05.
		(2) HLV fuse blown	Replace blown fuse. If fuse blows again, replace WC1 or WC2 circuit pack per paragraph 8.05.

▶TROUBLE CHART 18◀

J87436A OR J87438A RECTIFIER HIGH VOLTAGE SHUTDOWN OCCURRED

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on control unit illuminated	If a rectifier was shut down by the HV shutdown circuit, allow the restart circuit to restart the rectifier. Observe the OUTPUT CURRENT meter of the rectifier as the rectifier restarts. If the output current of the rectifier rises to a high value and the rectifier shuts down again, examine Probable Cause 1. If the rectifier shuts down again with a low value of output current and the plant voltage is less than 26.75 volts, examine Probable Cause 2	(1) Rectifier output voltage too high:	
		(a) ADJ potentiometer out of adjustment	Adjust rectifier output voltage per paragraph 5.02. Adjust plant voltage and balance rectifier currents per paragraph 5.03.
		(b) External voltage sense leads R+ or R– open	Check external voltage sense lead connections in rectifier and control unit. Correct fault.
		(c) Current control circuit defective	Replace CP SP2 or CP SP2B per paragraph 8.06.
		(d) RECT TEST switch held in FL position	Replace RECT TEST switch.
		(2) HV shutdown circuit defective	Replace WC1 or WC2 circuit pack per paragraph 8.05.
		(3) HLV, RB, or VM fuse blown	Replace blown fuse. If fuse blows again, replace WC1 or WC2 circuit pack per paragraph 8.05.

▶TROUBLE CHART 19◀

KS-20491 (ITT-NORTH) RECTIFIER HIGH VOLTAGE SHUTDOWN OCCURRED

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on control unit illuminated	If a rectifier was shut down by the HV shutdown circuit, allow the restart circuit to restart the rectifier. Observe the OUTPUT CURRENT meter of the rectifier as the rectifier restarts. If the output current of the rectifier rises to a high value and the rectifier shuts down again, examine Probable Cause 1. If the rectifier shuts down again with a low value of output current and the plant voltage is less than 26.75 volts, examine Probable Cause 2	(1) Rectifier output voltage too high:	
		(a) ADJ potentiometer out of adjustment	Adjust rectifier output voltage per paragraph 5.02. Adjust plant voltage and balance rectifier currents per paragraph 5.03.
		(b) External voltage sense leads R+ or R– open	Check external voltage sense lead connections in rectifier and control unit. Correct fault.
		(c) Current control circuit defective	Replace CP1 or CP2 per paragraph 8.07.
		(2) HV shutdown circuit defective	Replace WC1 or WC2 circuit pack per paragraph 8.05.
		(3) HLV, RB, or VM fuse blown	Replace blown fuse. If fuse blows again, replace WC1 or WC2 circuit pack per paragraph 8.05.

▶TROUBLE CHART 20◀

KS-20491 (LORAIN) RECTIFIER HIGH VOLTAGE SHUTDOWN OCCURRED

SYMPTOM	INITIAL ACTION	PROBABLE CAUSE	CORRECTIVE ACTION
RECT FAIL LED on control unit illuminated	If a rectifier was shut down by the HV shutdown circuit, allow the restart circuit to restart the rectifier. Observe the OUTPUT CURRENT meter of the rectifier as the rectifier restarts. If the output current of the rectifier rises to a high value and the rectifier shuts down again, examine Probable Cause 1. If the rectifier shuts down again with a low value of output current and the plant voltage is less than 26.75 volts, examine Probable Cause 2	(1) Rectifier output voltage too high:	
		(a) ADJ potentiometer out of adjustment	Adjust rectifier output voltage per paragraph 5.02. Adjust plant voltage and balance rectifier currents per paragraph 5.03.
		(b) External voltage sense leads R+ or R– open	Check external voltage sense lead connections in rectifier and control unit. Correct fault.
		(c) Current control circuit defective	Replace CP2 per paragraph 8.07.
		(2) HV shutdown circuit defective	Replace WC1 or WC2 circuit pack per paragraph 8.05.
		(3) HLV, RB, or VM fuse blown	Replace blown fuse. If fuse blows again, replace WC1 or WC2 circuit pack per paragraph 8.05.

TROUBLE CLEARING PROCEDURES

A. Replace WC1 or ▶WC2◀ Circuit Pack

8.05 To replace the WC1 or ▶WC2◀ circuit pack in the plant control unit, proceed as follows:

(1) Remove the HLV fuse and the R fuse from the control unit fuse panel (Fig. 2).

Note: When the HLV fuse or the R fuse is removed, both major and minor alarms are given and a shutdown signal is sent to the rectifiers.

(2) Using the 5-inch E screwdriver, loosen the screw at each side of the lower front panel and lift the panel off (Fig. 2).

Warning: High current potential exists on the terminals inside the control unit and on the back of the upper front panel. Avoid shorting any terminals together.

(3) Loosen the two screws on each side of the upper front panel with the 5-inch E screwdriver (Fig. 2). Lift the panel off and allow the panel to hang face down supported by its wiring.

(4) Grasp the WC1 or ▶WC2◀ circuit pack by the finger hole at the front edge of the board and pull the circuit pack ▶free of its connector. Turn the card on an angle and remove from unit.◀

(5) Insert the new circuit pack into the control unit. Make certain the circuit pack connector is aligned with the pins on the motherboard before the connector and pins are pushed together.

(6) Replace the upper front panel onto the control unit and secure the panel holding screws.

(7) Replace the lower front panel onto the control unit and secure the panel holding screws.

(8) Replace the R fuse and the HLV fuse into the control unit fuse panel.

Note: After both the R fuse and the HLV fuse are in place, a restart signal is sent to the rectifiers.

B. Replace CP SP1, CP SP2, or ▶CP SP2B◀ Circuit Pack in J87436A or J87438A Rectifiers

8.06 To replace the CP SP1, CP SP2, or ▶CP SP2B◀ circuit pack in a rectifier, proceed as follows:

(1) At the rectifier, operate the ON-OFF switch to OFF (Fig. 3 or 4).

(2) Operate the output circuit breaker (CB1) to OFF.

(3) Remove the rectifier ac input fuse for each phase from the power service cabinet.

Danger: Wait at least 3 minutes after operating the output circuit breaker to OFF before opening the front panel. This will give the filter capacitors time to discharge.

(4) On a 100-ampere rectifier, loosen the three screws on the right side of the front panel, using the 5-inch E screwdriver, and swing the panel open (Fig. 3). On a 200-ampere rectifier, loosen the screw on the right side of the upper front panel using the 5-inch E screwdriver and swing the panel open (Fig. 4).

(5) Unplug the plug connector from CP SP1 (Fig. 5 or 6) by turning the T-handle locking screws at the top and bottom of the connector ccw to release the connector. Alternate between turning the upper screw several turns and turning the lower screw several turns. The connector will then stay parallel to the board as it is being unplugged and will not bind.

(6) Unlock the card holder at each side of the circuit pack by moving each holder away from and slightly behind the circuit pack to free the locking tabs.

(7) Pull the circuit pack out of its connector.

(8) Insert the new circuit pack fully into the connector. Snap the locking tab on the card holder at each side of the circuit pack into the notch on the board.

(9) Plug the plant connector onto CP SP1. Alternate between turning the upper screw several

turns cw and turning the lower screw several turns cw until the screws are tight.

(10) Close the front panel and secure the panel locking screw(s).

(11) Replace the ac input fuses in the power service cabinet.

(12) At the plant control unit, remove the RB fuse associated with the rectifier being serviced.

(13) Set the KS-20599, L4, DMM to measure approximately 100 volts dc. Connect the meter to rectifier test jacks REG+ and REG−.

(14) Operate the rectifier ON-OFF switch to ON.

Note: The rectifier may shut down immediately after the ON-OFF switch is operated to ON due to the filter capacitors charging. If this happens, operate the ON-OFF switch to OFF, then back to ON to restart the rectifier.

(15) Using the 3-inch C screwdriver, adjust the rectifier ADJ potentiometer until the DMM indicates the required charge voltage.

Note: Use 26.04 volts dc as the correct charge voltage.

(16) Replace the RB fuse into the control unit fuse panel.

(17) Operate the rectifier output circuit breaker to ON.

(18) Check and adjust the battery bus voltage and the rectifier output current by following the procedure given in paragraph 5.03.

C. ▶Replace CP1, CP2, or CP3 Circuit Pack in KS-20491 ITT-North or Lorain Rectifier

8.07 To replace CP1, CP2, or CP3 circuit pack in a rectifier, proceed as follows:

(1) At the rectifier, operate the ON-OFF switch to OFF (Fig. 7 or 8).

(2) Operate the output circuit breaker (CB2) to OFF.

(3) Remove the ac input fuse from the power service cabinet.

Danger: Wait at least 3 minutes after operating the output circuit breaker to OFF before opening the front panel. This will give the filter capacitors time to discharge.

(4) Loosen the three screws on the right side of the front panel, using the 5-inch E screwdriver, and swing panel open (Fig. 9 or 10).

(5) Unlock the holding tabs and carefully remove the circuit pack from its connector.

(6) Insert the new circuit pack fully into the connector. Secure the locking tabs holding the circuit pack.

(7) Close the front panel and secure the panel locking screws.

(8) Reinstall the ac input fuses in the power service cabinet.

(9) Set the rectifier output circuit breaker (CB2) to ON.

(10) Set the rectifier ON/OFF switch (S1) to ON.

(11) Connect the KS-20599, L4, digital multimeter, set to 100 volts dc, to the REG (+) and REG (−) test jacks.

(12) Using the 3-inch C screwdriver, adjust the OUTPUT VOLTS ADJ potentiometer until the DMM indicates 26.04 volts dc.

(13) Check and adjust the battery bus voltage and rectifier output current by following the procedure given in paragraph 5.03.◀