RECTIFIERS
J87436A, LISTS 1, 2, AND 3
+ OR -24 VOLTS, 100 AMPERES
OPERATING METHODS

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1. GENERAL

1.01 The J87436A rectifiers are designed for use in 111A, 303A, 326A, 326B, 110A, 301C, 302A, 302B, and ▶150B◀ power plants. The J87436A, List 1, rectifier operates from 208/240 volts, 3-phase, 60 ±3 Hz input. The J87436A, List 2, rectifier operates from 480 volts, 3-phase, 60 ±3 Hz input. ▶The J87436A, List 3, rectifier consists of components and wiring to modify List 1 and List 2 rectifiers for output circuit breaker capability. If an output circuit breaker is required, order List 3, with List 1 or List 2. End-cell charging capability is also available with the J87436A rectifier as an additional option. The end-cell application is designated as Option Q. List 1 and List 2 rectifiers provide positive or negative 24 volts direct current at 100 amperes output.◀

1.02 The reasons for reissuing this section are listed below. Revision arrows are used to emphasize the more significant changes.

(a) The addition of end-cell charging capability

(b) To add Option Q and Option N

(c) To update the section in general.

This reissue does not affect the Equipment Test List.

1.03 This section is based on drawing SD-82397-01, Issue 1 and CD-82397-01, Issue 1. If this section is to be used with equipment or apparatus that is associated with a later issue of the drawing, reference should be made to the SD and CD to determine the extent of the changes and the manner in which the section may be affected.

1.04 The output polarity of the rectifiers is determined by the wiring Options Y and Z. Option Z is required for those applications in which the positive side of the battery is grounded. Option Y is required in those applications in which the negative side is grounded.

1.05 Regulation is obtained by the use of a controlled ferroresonant regulator, consisting of a ferroresonant transformer and an electronic control circuit. The control circuit acts upon the transformer to provide output voltage regulation against input voltage, frequency, and load current variations.

1.06 The rectifier has the following electronic features: electronic current limiting, inherent current limiting (if the output is shorted), and gradual increase in output (whenever the input contactor is operated). The rectifier also has automatic crossover to internal sense should external sense leads open. ▶The rectifier is capable of floating lead-acid cells at 2.17 volts per cell plus a 2-volt maximum battery feed loop drop (if List 3 is supplied, this restriction does not apply) between the rectifier and point of regulation. Manual adjustment of output volts, visual indication of

rectifier failure, test jacks for reading output volts at the point of regulation, and an output current ammeter are provided. The rectifier can be manually started by depressing the ON-OFF switch. Automatic shutdown controls are provided for selective high-voltage, internal high-voltage, fuse failure, and remote shutdown. The rectifier can be restarted from a remote location. A phase monitor circuit and alarm and a rectifier failure alarm are provided.

1.07 The J87436A rectifiers have EM Cell charging capability ordered as an option. The option is designated as Option Q. Rectifiers without EM Cell charging capability are designated as Option N.◀

1.08 The rectifiers, 31 inches high, 12 inches deep, and 21.25 inches wide, are made for mounting in a 23-inch relay rack. Multiple units may be stacked two per rack.

1.09 To simplify maintenance, the circuits associated with alarm, power control, voltage regulation, current limiting, voltage walk-in, and restart are mounted on replaceable circuit packs CPS SP1 and CPS SP2.

1.10 Input and output power connections, filter capacitors, ac contactor, dc breaker, and printed circuit packs are accessible through a door in the front of the cabinet.

1.11 On initial charge for new battery installations, the output voltage of the rectifier may be increased to 30 volts as described in paragraph 3.03.

1.12 Keep ventilating passages of the rectifier unobstructed to ensure adequate cooling during operation.

1.13 If the rectifier is held in stock or otherwise is out of service for a period exceeding 30 months, the polarized electrolytic capacitors should be checked and serviced in accordance with Section 032-110-701.

2. LIST OF TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
KS-20599, L4	Digital Multimeter, or
KS-8039	Volt-Milliammeter
▶*KS-20538	Volt-Ohm-Milliammeter

*The KS-20538 meter should be used for measuring the input ac voltage on the J87436A, List 2, rectifiers.◀

3. OPERATION

3.01 ***Prepare the Rectifier for Service:*** When preparing to start the rectifier, proceed as follows. (See Fig. 1 for location of components.)

(1) Place the ON-OFF switch (S1) to OFF. Check that the plant connector J1 is removed from the circuit pack CPS SP1 and that the circuit breaker (CB1) is off.

Danger: Voltages inside the rectifier may exceed 150 volts to ground. Avoid all contact with terminals. Do not allow the test pick to touch two metal parts at the same time since destructive and dangerous short circuits may occur.

(2) Turn the OUTPUT VOLTS ADJ control fully counterclockwise (ccw).

(3) Apply power to the input terminals of the rectifier. Check to see that the associated input power fuses are installed in the ac power service cabinet.

▶***Warning: The KS-20599, L4, digital multimeter should not be used to measure the input ac voltage on the J87436A, L2, rectifier. The KS-20599, L4, digital multimeter only has a range to 500 volts ac.***◀

(4) Use the KS-20538 volt-ohm-milliammeter set to the 1000-volt ac scale, to measure the input ac voltage to the rectifier at the input terminals located inside the upper compartment.

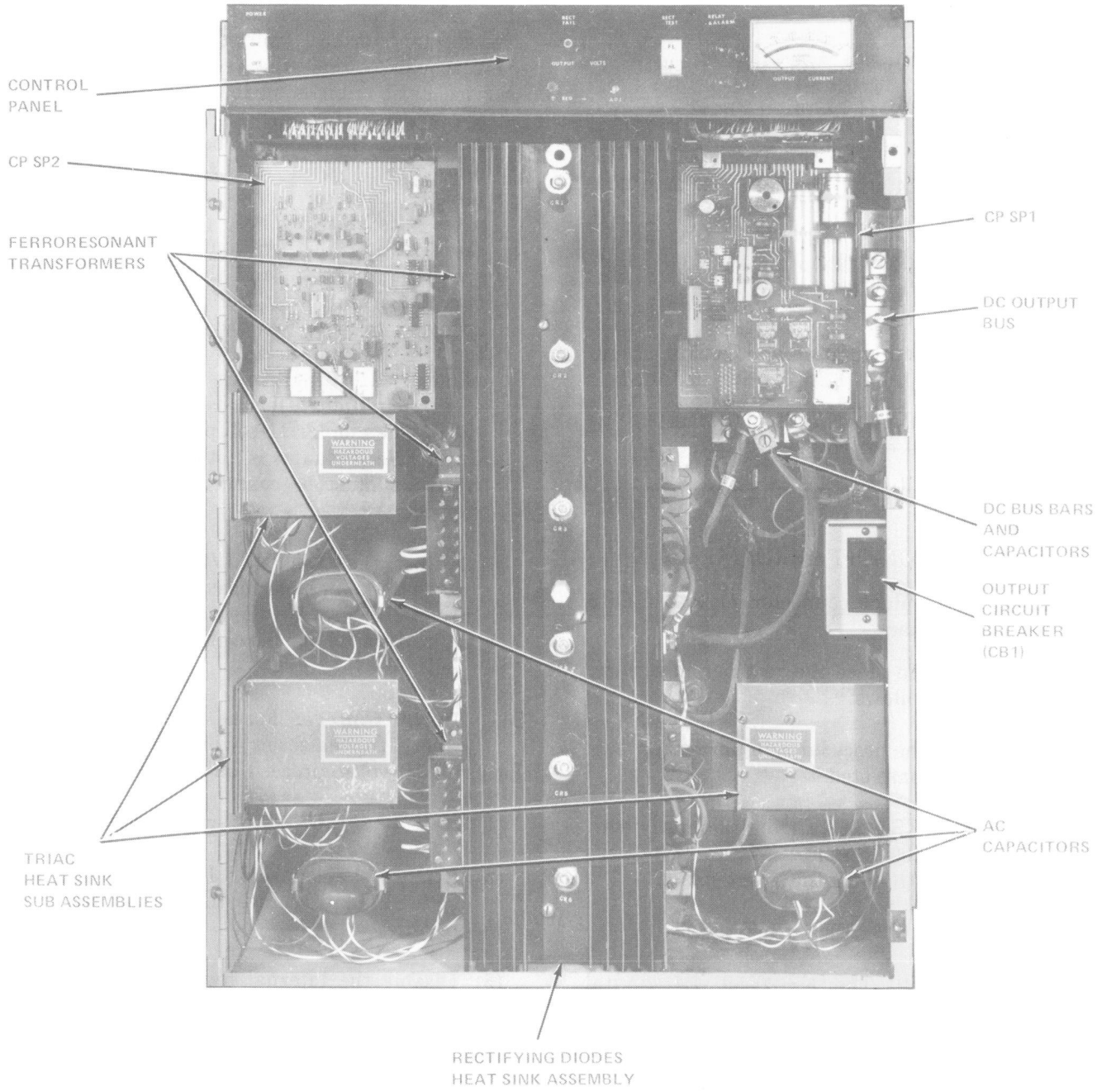

Fig. 1—J87436A Rectifier—Front View, Cover Removed

Requirement: The input ac voltage shall measure as follows:

RECTIFIER	NOMINAL VOLTAGE	LIMITS
J87436A List 1	208 (L1 Option S)	184 to 220
J87436A List 1	240 (L1 Option S)	212 to 254
J87436A List 2	480 (L2 Option T)	434 to 508

(5) Check that the regulation and control circuit fuses F1 (+V) and F2 (-V) are installed.

(6) Operate the ON-OFF switch (S1) to ON to precharge the electrolytic capacitors

(7) After 30 seconds, operate the circuit breaker (CB1) to ON.

(8) Operate the ON-OFF switch (S1) to OFF.

(9) Connect the plant connector J1 to the CPS SP1 circuit pack.

3.02 ***Starting:*** To place the rectifier in service, proceed as follows:

(1) Verify that the procedures in paragraph 3.01 have been completed.

(2) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to test jacks REG(+) and REG(-) on the front panel.

(3) Operate the ON-OFF switch to ON.

Requirement: The KS-20599, L4, digital multimeter should indicate less than ⧫23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants.⧫

Note: The rectifier has a walk-in feature that causes the output dc voltage to increase gradually. Wait at least 30 seconds after turn-on before measuring and adjusting the output voltage.

(4) Connect the KS-20599, L4, digital multimeter ⧫at the battery bus bars.⧫

(5) If the meter reads above ⧫23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants⧫ and there are other rectifiers on the line, adjust them down until ⧫23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants⧫ is reached. Adjust the rectifier being put in service until it picks up load.

Note: If the rectifier being adjusted goes into current limit and ⧫23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants⧫ is not reached, do not adjust the rectifier any further. Allow time for the batteries to charge and the rectifier to drop out of current limit before the rectifier is adjusted to pick up load at ⧫23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants.⧫ If the rectifier does not drop out of current limit after a reasonable time and ⧫23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants⧫ is not reached, additional rectifiers must be connected to the plant to support the load.

(6) Adjust the OUTPUT VOLTS ADJ control so that the voltage measured at the battery ⧫bus bars⧫ is ⧫23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants⧫ (2.17 volts per cell).

3.03 ***Initial Charge:*** For new battery installations where the batteries will receive an initial charge of 30 volts, proceed as follows:

(1) Operate the ON-OFF switch (S1) to OFF.

(2) Remove the connector J1 from circuit pack CPS SP1 and remove the circuit pack from the rectifier.

(3) Disable the internal high-voltage shutdown by connecting a strap (clip lead) between the anode of diode CR7 and the ground junction between capacitors C2 and C4 on circuit pack CPS SP1.

(4) Install circuit pack CPS SP1 in the rectifier. Leave the connector J1 disconnected.

(5) Precharge the electrolytic capacitors by operating the circuit breaker (CB1) to OFF. Operate the ON-OFF switch S1 to ON. After 30 seconds, operate the circuit breaker (CB1) to ON.

(6) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to the battery ▶bus bars.◀

(7) Operate the ON-OFF switch (S1) to ON.

(8) Adjust the OUTPUT VOLTS ADJ for an output of 30 volts measured on the KS-20599, L4, digital multimeter.

(9) Continue the 30-volt initial charge for the required time. Operate the ON-OFF switch to OFF.

(10) Restore the internal high-voltage shutdown as follows:

(a) Remove circuit pack CPS SP1.

(b) Remove the clip lead installed in (3).

(c) Reinstall circuit pack CPS SP1.

(11) Reconnect the plant high-voltage shutdown by replacing connector J1 on CPS SP1.

(12) Rotate the OUTPUT VOLTS ADJ control ccw to the stop.

(13) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to the test jacks REG(-) and REG(+) on the front panel.

(14) Operate the ON-OFF switch to ON. Check that the output circuit breaker (CB1) is closed.

(15) Adjust the manual OUTPUT VOLTS ADJ to obtain ▶23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants◀ at the terminals of the battery.

(16) Disconnect the KS-20599, L4, digital multimeter.

3.04 ***Stopping:*** To stop the rectifier, operate the ON-OFF switch (S1) to OFF.

3.05 ***Taking the Rectifier Out of Service:*** To take the rectifier out of service, proceed as follows:

(1) Operate the ON-OFF switch (S1) to OFF.

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

Danger: Battery voltage is still present on the output terminals of the rectifier after the output circuit breaker has been opened, as long as the rectifier is connected to the dc bus bars of the plant and J1 connector is still plugged into circuit pack CPS SP1.

(3) Remove fuses F1 and F2.

(4) Disconnect the connector J1 from circuit pack CPS SP1.

(5) Remove the ac input fuses from the associated ac power service cabinet.

▶Danger: Battery voltage is present at heat sink for the negative ground option.◀

4. ROUTINE CHECKS AND ADJUSTMENTS

4.01 Routine checks and adjustments are intended to detect and correct defects and abnormal operating conditions that may cause service interruptions. Routine checks should be made when they will not interfere with service.

Danger: Voltage inside the rectifier may exceed 150 volts to ground. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time since destructive and dangerous short circuits may occur.

4.02 ***Output Voltage Adjustment:*** To adjust the output voltage, proceed as follows:

(1) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to the ▶rectifier output test jacks REG(-) and REG(+).◀

(2) Adjust the OUTPUT VOLTS ADJ for ▶23.87 volts dc for 11-cell plants or 26.04 volts dc for 12-cell plants◀ at the terminals of the battery.

Note: The output voltage will increase rapidly up to the terminal voltage of the battery as the OUTPUT VOLTS ADJ control is turned

cw. Above this level, the voltage increases only slightly and the current is a more sensitive indication of output.

(3) Disconnect the digital meter.

4.03 ***Voltage Regulation Check:*** To check the voltage regulation, proceed as follows:

(1) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to test jacks REG(-) and REG(+) on the front panel.

(2) Check that the ON-OFF switch (S1) is operated to ON and that the output circuit breaker (CB1) is closed.

(3) Operate the NL/FL test key (S2) to the NL position.

Requirement: The output dc current measured on the OUTPUT CURRENT meter (M1) should show a slight decrease. The output voltage measured on the KS-20599, L4, digital multimeter should show a decrease of only about one-fourth volt. ⏵This requirement may vary slightly if other rectifiers are operating in parallel.⏴

(4) Operate the NL/FL test key (S2) to the FL position.

Requirement: The output dc current measured on the OUTPUT CURRENT meter (M1) should show a slight increase. The output voltage measured on the KS-20599, L4, digital multimeter should show an increase of only about one-fourth volt. ⏵This requirement may vary slightly if other rectifiers are operating in parallel.⏴

(5) Release the NL/FL test key.

(6) Disconnect the test meter from the test jacks REG(-) and REG(+).

5. TROUBLES

5.01 The possible causes of troubles in the rectifier and the corrective actions to be taken are given in the following chart. In addition to the action specified, check for loose or open connections and plugs. Check for short circuits due to foreign matter lying across wiring terminals.

5.02 If the trouble is not corrected by following the trouble charts, refer to the circuit schematic drawing for further information. Refer to Section 032-173-301 for testing, replacing, and storing circuit packs and semiconductor devices.

TROUBLE CHART

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
No output (RECT FAIL lamp illuminated)	(1) No input power. AC power failure	Locate and correct fault. Restore input power.
	(2) Input fuse blown in power service cabinet. (One open fuse operates phase monitor and PH (K1) relay contacts 1, 2, and 3 for use in external circuits)	Locate and correct cause of blown fuses. Replace fuses.
	(3) Input power relay ST1 does not close	Check relay ST2 contacts 5 and 7.
	(4) Relay ST2 does not close	
	(a) Diode CR7 shorted	Replace circuit pack CP SP1.
	(b) TR relay (K3) operated. Remote shutdown ground signal on terminal Y of P1 on CPS SP1	Remove unwanted ground signal.
	(5) Relay RFA (K2) operated.	
	(a) Internal high-voltage shutdown circuit actuated by excess output voltage (30 volts dc or more). Manual OUTPUT VOLTS ADJ set too high	Adjust manual OUTPUT VOLTS ADJ for output less than 30 volts dc. See paragraph 4.02.
	(b) External voltage sense leads disconnected from load.	Restore load voltage sense leads to REG(+) and REG(—) terminals.
	(c) Defective components in external selective high-voltage shutdown circuit: CR10, U3, C7, R20, Q6, R18, R19	Replace CPS SP1.
	(d) Other defective components in external high-voltage shutdown circuit: CR26, IC4, R30, R29	Replace CPS SP2.
	(e) Fuse F1 or F2 in internal voltage sensing leads open	Determine cause of fuse failure. Replace CPS SP1 or CPS SP2 to correct trouble. Replace fuse F1 or F2.
	(f) Output circuit breaker CB1 open	Close output circuit breaker CB1.
	(g) Transformer T4 defective	Replace transformer T4.
	(h) Failure of components on CPS SP1 [other than those listed in (c)]	Replace CPS SP1.

TROUBLE CHART (Contd)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
	(6) Output circuit breaker tripped open	Close output circuit breaker.
	(7) Rectifier/filter circuit components defective: diodes CR1 through CR6, L4, C7	Locate and replace defective components.
Output current low	(1) NL/FL switch in NL position	Release NL/FL switch. Check to see that NL/FL switch is not defective.
	(2) OUTPUT VOLTS ADJ (R11) potentiometer out of adjustment or shorted	Adjust OUTPUT VOLTS ADJ (R11) potentiometer or replace. See paragraph 4.02.
	(3) Defective IC1 or IC2 on CPS SP2	Replace CPS SP2.
	(4) One of three input power line phases open. (May be indicated by phase monitor relay PH (K1) closure.) May be caused by open input power fuse in power distribution frame	Locate and correct cause of blown fuse. Replace fuse.
	(5) Voltage walk-in circuit components defective on CPS SP2: C12, R36, R37, R56, CR8, CR21, C15, R36, CR25	Replace CPS SP2.
	(6) Triac Q1, Q2, or Q3 defective or shorted	Replace defective triac Q1, Q2, or Q3.
	(7) Loose connections on transformers T1, T2, or T3	Tighten loose connections.
Output current high	(1) NL/FL switch held in FL position	Release NL/FL switch. Check to see that NL/FL switch is not defective.
	(2) OUTPUT VOLTS ADJ ((11) potentiometer out of adjustment or open	Adjust OUTPUT VOLTS ADJ (R11) potentiometer, or replace.
	(3) External voltage sense lead open	Check external voltage sense leads and connections.
	(4) Current control circuit components defective: IC1, IC2	Replace CPS SP2.
	(5) Broken or open lead going to triac. (May be indicated by rectifier not turning on)	Locate and repair or replace triac.

TROUBLE CHART (Contd)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Output current not limited to 110 amperes	(1) R13 or R14 open. (located at each end of meter M1 shunt R18)	Replace R13 or R14.
	(2) Defective components in current limiting circuit: IC3, C11, R46, R47, R49	Replace CPS SP2.
Internal high-voltage shutdown circuit inoperative or operates at level other than 30 volts	(1) Defective components in internal high-voltage shutdown circuit on CPS SP1: R14, R15, C6, Q8, CR8, U4, RFA relay	Replace CPS SP1.
	(2) Internal high-voltage shutdown circuit disabled by test strap between CR7 and C4 (+) of CPS SP1 (see paragraph 3.03)	Remove test strap from CPS SP1.
Rectifier will not restart	(1) Restart circuit components defective: Q7, R10, R11, R12, RV1, C5, CR6, K2	Replace CPS SP1.
	(2) External restart leads disconnected or restart switch defective. No closure across terminals B and C of P1 or CPS SP1	Repair external restart closure circuit.
Selective high-voltage shutdown circuit with external sense inoperative	(1) Rectifier not delivering 10 amperes or more dc output	Operation is normal. Circuit is operable only when output current is 10 amperes or more.
	(2) External high-voltage shutdown signal (ground) not applied to CPS SP1. J1 terminal U	Check external high-voltage shutdown signal connections. Repair as required.
	(3) Components of output current monitoring circuit defective: IC4, CR26, R29, R30	Replace CPS SP2.
	(4) Components of high-voltage shutdown circuit defective: R6, U3 optoisolator, CR9, CR10, C7	Replace CPS SP1.
Rectifier remote shutdown inoperative	(1) External battery not connected to terminal X of CPS SP1	Connect battery to terminal X of CPS SP1.
	(2) On shutdown, ground closure not applied to terminal Y of CPS SP1	Repair shutdown closure circuit between terminal Y of CPS SP1 and ground.
	(3) Network Z1 shorted	Replace CPS SP1.
	(4) TR relay (K3) does not operate	Replace CPS SP1.

TROUBLE CHART (Contd)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Phase monitor circuit operates and indicates trouble	(1) Input power line phase one open. (May be caused by open input power fuse in power service cabinet	Locate and correct cause of blown of blown fuse. Replace fuse.
	(2) Phase monitor circuit components defective: L1 shorted, C8 open. (Input power fuses good)	Replace CPS SP1.
Phase monitor circuit inoperative	(1) Phase monitor circuit components defective: L1 open, C8 shorted, CR4 open. PH relay (K1) open, CR5 shorted	Replace CPS SP.
Walk-in circuit disabled. Output current appears suddenly when power is applied	(1) Walk-in circuit components defective: CR8, CR21, C15, R36, CR25, R37, C12, R36, R56	Replace CPS SP2.
NL/FL test switch does not cause change in output current when operated. No regulation	(1) Defective NL/FL switch	Replace NL/FL switch.
	(2) Defective R16 or R17 across NL/FL switch	Replace defective resistors R16 or R17.
	(3) Defective components of voltage regulator circuit on CPS SP2: IC1, IC2, C10, R38, R39, R40, R45, R49, R50, R53, R55, CR22, CR28	Replace CPS SP2.
	(4) R (+) or R (—) sense lead disconnected from load or from J1 of CPS SP1 terminals A and E	Check and reconnect sense leads.