KS-20491, L21, L22, L23, L24, RECTIFIERS

(SD-81997-02)

24 VOLTS 100 AMPERES

LORAIN PRODUCTS CORPORATION

TROUBLE-LOCATING INFORMATION

CONTENTS PAGE

1. GENERAL

1.01 The KS-20491 rectifier (Fig. 1) provides regulated dc power from a single-phase ac source normally for use in charging and floating a 12-cell battery plant.

1.02 The Equipment Test List is not affected.

1.03 The KS-20491 rectifier is arranged for single-phase, 60 ±3 Hz, ac input and is suitable for use with battery power plants where 3-phase service is not available. The output voltage is regulated within ±0.5 percent of 23.87 to 28.40 volts for any load current from no load to full load. For any load current from no load to 80 percent of full load, within the range of 28.40 to 32.80 volts, regulation is within ±0.5 percent.

1.04 The rectifier (SD-81997-02) is equipped with three circuit packs (CP1, CP2, and CP3). Circuit pack CP1 functions as voltage and current control circuitry, while CP2 contains control relays and alarm circuitry interfacing. Circuit pack CP3 (referred to as a display circuit pack) is a mounting base for the following components:

- OUTPUT VOLTS ADJ potentiometer
- RECT FAIL Light Emitting Diode (LED)
- OUTPUT VOLTS jacks.

1.05 Circuit packs CP1 and CP2 are readily accessible for testing if the front cover of the rectifier is removed. Circuit pack CP3 is mounted behind and attached to the control panel so that the RECT FAIL LED, the OUTPUT VOLTS ADJ potentiometer shaft,

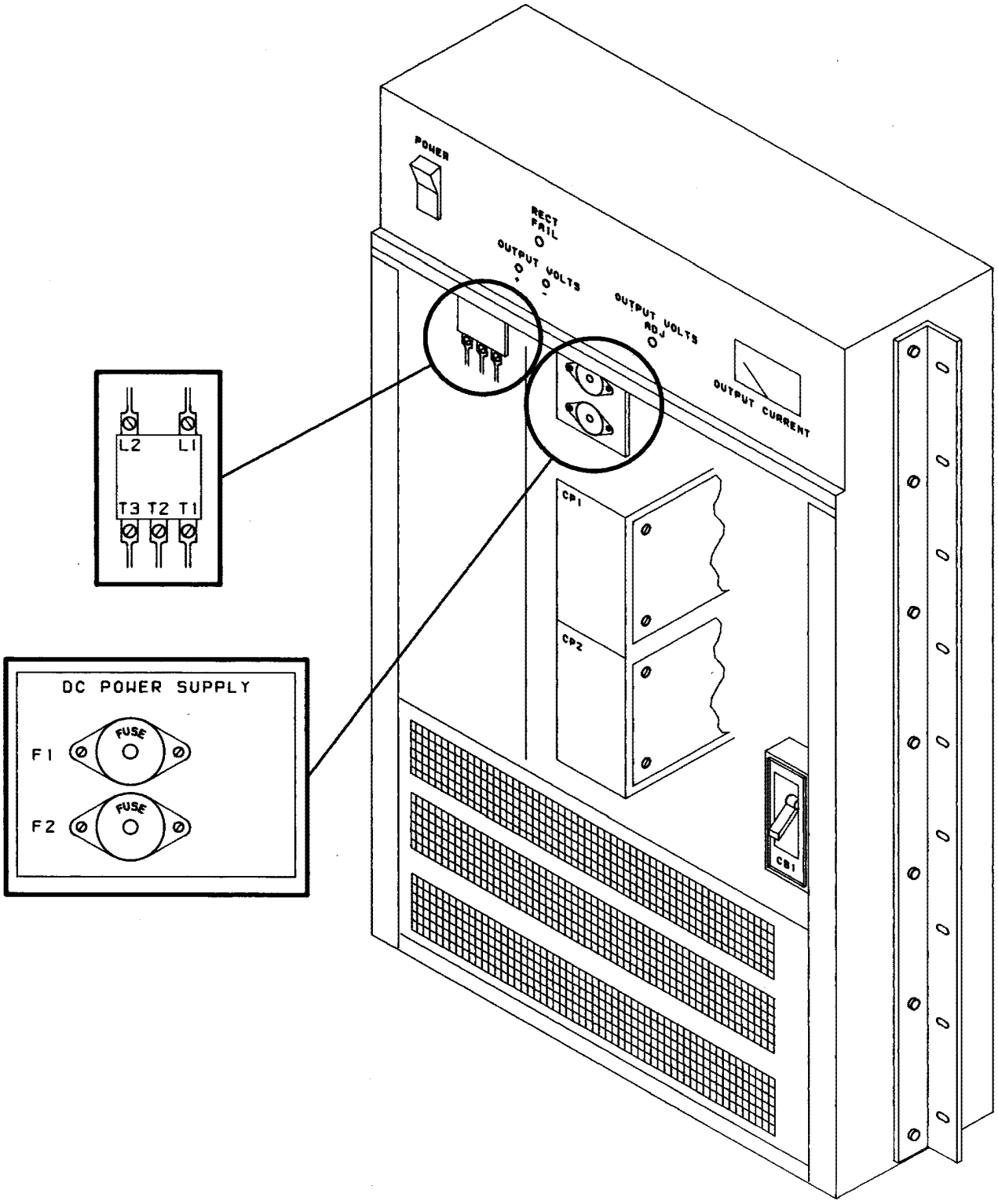


Fig. 1—KS-20491 Rectifier (SD-81997-02)—Cover Partially Removed

and the REG + and REG − test jacks all protrude through the panel and are accessible even when the front cover is in place.

1.06 To facilitate testing of CP1 and CP2, each board is provided with test points located along the edge to allow access to the required circuitry without removing the boards.

1.07 This issue is based on SD-81997-02, Issue 1, and CD-81997-02, Issue 1. For more information on the operation of the KS-20491 rectifier manufactured by Lorain Products Corporation, refer to Section 167-743-301, Issue 5. Prior issues of Section 167-743-301 contained no reference to SD-81997-02. If this section is to be used with equipment or apparatus that is associated with earlier or later issues of the drawings, reference should be made to the SDs and CDs to determine the extent of the changes and the manner in which the section may be affected.

2. APPARATUS

2.01 ***List of Tools and Test Apparatus:*** The following tools and test apparatus are used in this section.

TOOLS	DESCRIPTION
—	3-Inch C Screwdriver
TEST APPARATUS	
KS-8039	Volt-Milliammeter (or equivalent)
KS-20538	Volt-Ohm-Milliammeter (or equivalent)
—	Digital Multimeter, John Fluke Mfg. Co. Model 8100A AC and DC Volts (or equivalent)
—	Oscilloscope, Tektronix Model 545 with Type W Differential Input Preamplifier (or equivalent)

3. OPERATION

3.01 Three separate phases which constitute the normal operation of the rectifier are as follows:

(1) The rectifier is started and allowed (through electronic circuitry) to stabilize at a desired output value.

(2) The rectifier provides power to a load.

(3) The rectifier is shut down manually or automatically (due to a trouble condition).

3.02 To provide power for control purposes, an auxiliary power supply circuit derives its input from the ac line voltage in parallel with the input to the primary of the power transformer. In this configuration, the auxiliary power supply monitors the ac input to the rectifier, and causes the rectifier to shut down if the commercial line voltage is too low. The shutdown is affected by control relays which depends upon the auxiliary power supply for their operating voltages.

3.03 ***Shutdown of Rectifier:*** The rectifier may be shut down by either of the following:

(a) ***Normal Shutdown:*** By depressing the POWER switch to OFF, the rectifier may be shut down without sending an alarm.

(b) ***Trouble Shutdown:*** The rectifier will automatically shut down if the line voltage is too low for proper operation of the rectifier, or if a high-voltage condition exists at the rectifier output. In either case, the RECT FAIL LED is lighted on the control panel of both the plant and rectifier, and a minor alarm is sent.

(c) ***Remote Shutdown:*** The rectifier may be remotely shut down by applying ground to the TR lead of the plant control circuit.

4. TROUBLE-LOCATING PROCEDURES

4.01 When trouble occurs, as evidenced by visual and/or audible alarms, the status of the visual indicators should be checked. The visual indicators consist of the POWER switch (OFF and ON positions), the RECT FAIL LED and the output circuit breaker (ON and OFF positions). The deflection of the OUTPUT CURRENT meter may also indicate a problem if the indicated current level is other than expected.

Danger: AC input power and battery should be disconnected from the rectifier before attempting maintenance in the power sections of the rectifier. Use extreme care when touching any component, such as transformers, which may have heated during operation.

4.02 After checking the visual indicators, a physical inspection should be made. With all power disconnected, open the rectifier cover (see Fig. 1). Check for faulty connections, broken, burned or shorted wires. Inspect wiring harness and leads from all components for possible breaks and shorts. Check major components for discoloration which might indicate overheating.

4.03 Further trouble locating should not be attempted until circuit packs CP1, CP2, and CP3 have been found to operate properly.

4.04 When the trouble is traced to a circuit pack, replace it with a new or properly repaired circuit pack. Do not attempt to repair defective circuit packs unless personnel are equipped and trained to repair circuit packs. Handle the defective circuit pack in accordance with local instructions.

TROUBLE CHARTS

Danger: When using a portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the power should first be disconnected from equipment being tested or, if test picks are being used, they should be removed from the equipment under test.

4.05 Tables of trouble-locating information (Tables A, B, C, and D) are shown in Fig. 2. After selecting the table which most nearly describes the trouble being experienced, the user should follow, in order, the steps outlined in the table.

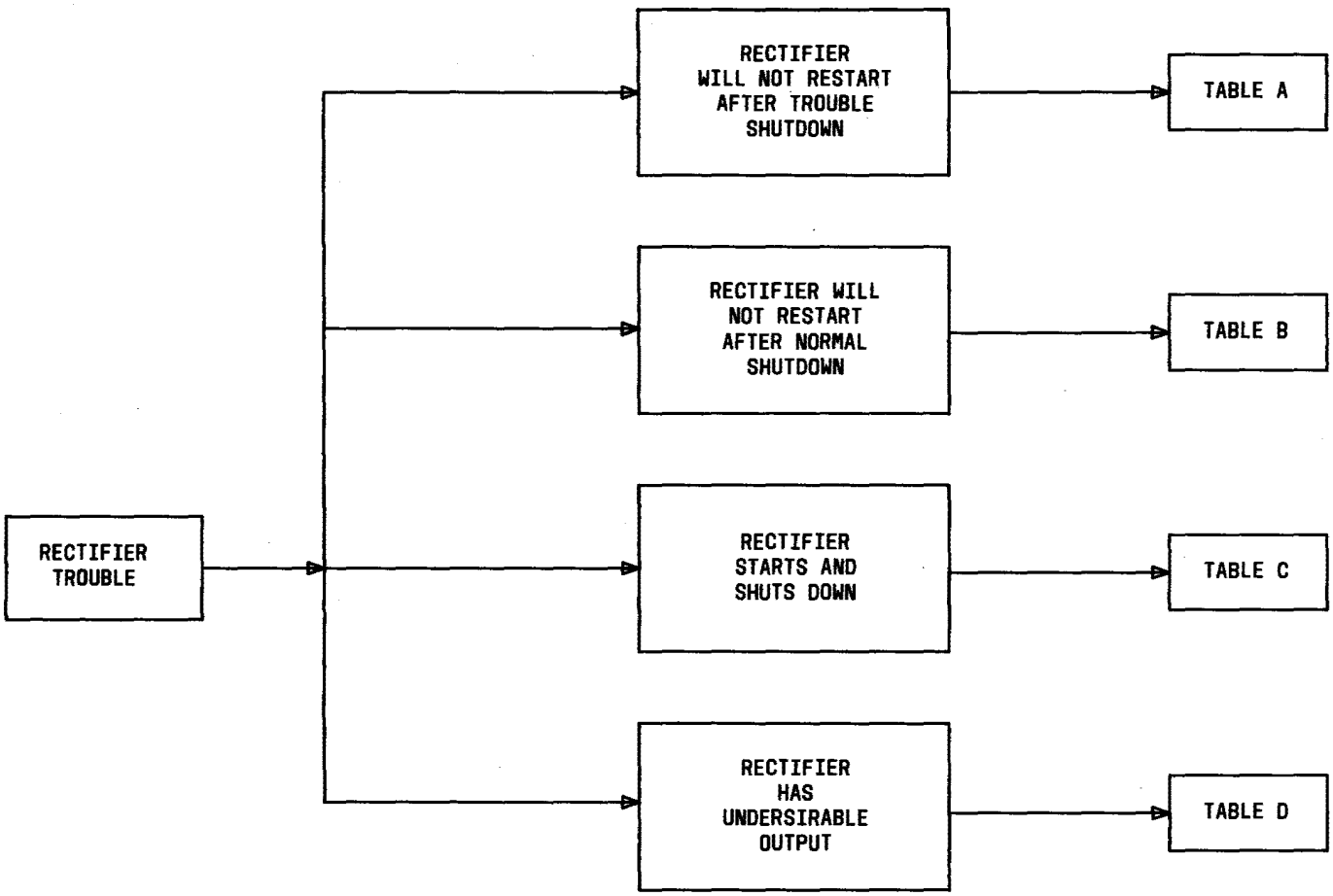


Fig. 2—Trouble Flowchart

TABLE A

RECTIFIER WILL NOT RESTART AFTER TROUBLE SHUTDOWN

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
RECT FAIL LED lighted	(1) CB1 Circuit breaker operated		Reset CB1. If CB1 trips again, see Possible Cause (10).
	(2) F1 or F2 fuse operated	Visually inspect fuses. If fuses not operated, see Possible Cause (6)	Replace operated fuses. If fuse operates again, see Possible Cause (2)(a), and (2)(b).
	(a) Shorted diode(s) in power supply circuit		Replace CP1.
	(b) Transformer T2 primary shorted	Check for excessive heat buildup	Replace defective transformer.
	(3) AC input fuses operated	Visually inspect fuses in bus duct or power service cabinet	Replace operated fuses. If fuse operates again, see Possible Cause (4), (5).
	(4) Transformer T1 primary winding shorted.	Check for excessive heat buildup	Replace defective transformer.
	(5) Low ac input voltage	Check ac input voltage between terminals L1 and L2 (SD-81997-02), and compare with requirements. (See Fig. 1)	If input voltage is lower than required (Option Y, 430V; Option Z, 186V) notify supervisor.
	(6) T2 transformer secondary open	On CP1 measure voltage at J6-9 and J6-8 with respect to J6-4. If 28V ac is not present, check T2 transformer secondary for an open circuit. If 28V ac is indicated, see Possible Cause (7)	Replace defective transformer.

TABLE A (Contd)

RECTIFIER WILL NOT RESTART AFTER TROUBLE SHUTDOWN

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
RECT FAIL LED lighted (Contd)	(7) Faulty power supply circuit	Check for 28 volts dc at J6-3 and J6-10 with respect to TP7 on CP1. If 28 volts are available, see Possible Cause (8)	Replace CP1.
	(8) Resistor R5 and/or R6 defective	Check resistors	Replace R5 and/or R6.
	(9) False ground on TR lead	Check wiring of TR lead to plant. Refer to schematic diagram of associated plant	Clear false ground.
	(10) Faulty Charge Fuse Alarm (CFA) circuit	On CP2, check that TP4 is high with respect to TP1. If TP4 is not high with respect to TP1, see Possible Cause (15)	Reset CB1, if tripped. If CB1 trips again, see Possible Cause (11), (12), (13), and (14). If CB1 is not tripped or does not trip when reset and rectifier will not start, replace CP2.
	(11) Faulty current limit circuit		Replace CP1.
	(12) Shorted power diode CR1 or CR2	Check diode	Replace defective diode.
	(13) Defective filter capacitor C2.1-C2.6	Check capacitor	Replace defective capacitor.
	(14) Misadjusted current limit control	Check adjustment. Refer to Section 167-743-301	Adjust as required.
	(15) Faulty start-logic circuit	On CP2, check that TP2 is high with respect to TP1. If TP2 is not high with respect to TP1, see Possible Cause (17), (18), and (19)	Replace CP2. If trouble is not cleared, see Possible Cause (16).

TABLE A (Contd)

RECTIFIER WILL NOT RESTART AFTER TROUBLE SHUTDOWN

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
RED FAIL LED lighted (Contd)	(16) ST1 contactor coil open	Check coil	Replace defective contactor.
	(17) Faulty ±12V monitor circuit		Replace CP2.
	(18) Switch S1 defective	Check continuity of switch	Replace defective switch.
	(19) Printed circuit board not mating properly with connector	Remove CP1 and check for damage to edge of board for unburnished areas which would indicate poor mating of board with connector. Also check edge connector for crushed contacts. Reinstall CP1 and check CP2 and CP3 in same manner	Replace defective circuit pack or connector as required.

TABLE B

RECTIFIER WILL NOT RESTART AFTER NORMAL SHUTDOWN

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
RECT FAIL LED Not lighted	(1) ±12 volt monitor defective		Replace CP2.
	(2) Low ac input voltage	Check ac input voltage between terminals L1 and L2. See Fig. 1 and SD-81997-02	If ac input voltage is lower than required, (Option Y, 430V; Option Z, 186V), notify supervisor.
	(3) CP1 interlock defective	Remove CP1 from connector and check for continuity between J5-22 and J6-1	If open circuit exists, replace CP1 with good circuit pack.
	(4) Triac CR2 defective	Check triac	Replace defective triac.
	(5) Contactor ST1 coil open	Check contactor coil	Replace defective contactor.
	(6) POWER switch defective	Check continuity of switch	Replace defective switch.

TROUBLE CHART C

RECTIFIER STARTS AND SHUTS DOWN

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
RECT FAIL LED lighted, no output	(1) False ground on HV lead from plant	Put rectifier in test mode. Refer to Section 169-743-301	Check wiring of HV lead.
	(2) Operated external charge fuse or external charge circuit breaker		Reset circuit breaker or replace operated fuse. If rectifier still shuts down, see Possible Cause (3).
	(3) Overvoltage shutdown adjusted too low	Attempt to restart rectifier and monitor output voltage at time of shutdown	Adjust overvoltage shutdown. Refer to Section 169-743-301.
	(4) Overvoltage shutdown circuit faulty		Replace CP2.
	(5) Misadjusted OUTPUT VOLTS ADJ	Monitor output voltage at time of shutdown	Adjust output voltage. Refer to Section 169-743-301.
	(6) Faulty voltage and current control circuit		Replace CP1.
	(7) Faulty CP3		Replace CP3.
	(8) Faulty triac CR4	Check CR4	Replace CR4.
	(9) Faulty ac inductor L1	Check inductor	Replace faulty L1.

TABLE D

UNDESIRABLE OUTPUT

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
A. Output noisy, rectifier not oscillating	(1) Faulty voltage and current control circuit		Replace CP1.
	(2) Faulty triac CR4	Check CR4	Replace CR4.
	(3) Resistors R1, or R2 open	Check resistors	Replace defective resistors.
B. Output noisy, rectifier oscillating	(1) Open power diode CR1, or CR2	Check diodes	Replace defective diode.
	(2) Defective filter capacitor C2.1-C2.6	Check capacitor	Replace defective capacitor.
	(3) Faulty output inductor L2	Check inductor	Replace defective inductor.
C. Rectifier output current too high	(1) Misadjusted current limit control		Check and adjust current. Refer to Section 169-743-301.
	(2) Faulty current limit circuit		Replace CP1.
D. Rectifier output current too low	(1) Current limit set lower than full load current		Check and adjust current. Refer to Section 169-743-301.
	(2) Excessive charge lead drop or loose connection		Check rectifier output lugs and tighten if necessary.
	(3) Faulty current limit circuit		Replace CP1.
	(4) Low ac input voltage	Check ac input voltage between terminal L1 and L2 (SD-81997-02). See Fig. 1	If input voltage is lower than required, notify supervision.

TABLE D (Contd)

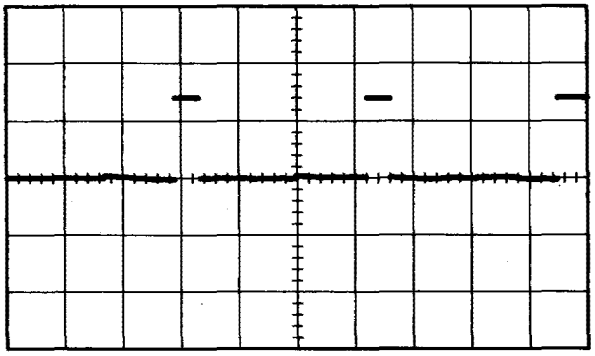
UNDESIRABLE OUTPUT

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
E. Voltage regulation poor	(1) Faulty voltage and current control circuit		Replace CP1.
	(2) Excessive charge lead drop or loose connection		Check rectifier output lugs for tightness and good condition.
	(3) Open battery sense leads		Check continuity of sense leads and repair as necessary.
	(4) Sense (SNS) relay coil open		Replace CP2.
F. No output current; output voltage less than battery voltage	(1) Misadjusted OUTPUT VOLTS ADJ	Put rectifier in test mode. Refer to Section 169-743-301	Check and adjust output voltage. Refer to Section 169-743-301.
	(2) Open battery sense leads		Check continuity of leads and repair as necessary. Also see Possible Cause E (4).
G. No output current; output voltage near zero	(1) Shorted power diode CR1 or CR2	Check diode	Replace defective diode.
	(2) Defective filter capacitor C2.1-C2.6, or main capacitor C1 shorted		Replace defective capacitor.
H. No output current; output voltage greater than zero	(1) T1 transformer secondary windings shorted	Check transformer for excessive heat buildup	Replace defective transformer.
	(2) Faulty voltage and current control circuit	On CP1, check that TP1 is near +12V with respect to TP7. If TP1 is near − 12V, see Possible Cause H (4)	Replace CP1.

TABLE D (Contd)

UNDESIRABLE OUTPUT

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
H. No output current; output voltage greater than zero (contd)	(3) Potentiometer R2 or resistor R3 faulty		Replace CP3.
	(4) Current control error signal out of limits	On CP1, check that TP5 is near +12V with respect to TP7. If TP is near −12V, see Possible Cause H (7)	Replace CP1.
	(5) Faulty current walk-in circuit		Replace CP1.
	(6) Faulty walk-in reset circuit		Replace CP2.
	(7) Faulty voltage and current control circuit	On CP1, check waveforms at TP2 and TP3. If waveforms correspond to Fig. 3, see Possible Cause H (8)	Replace CP1.



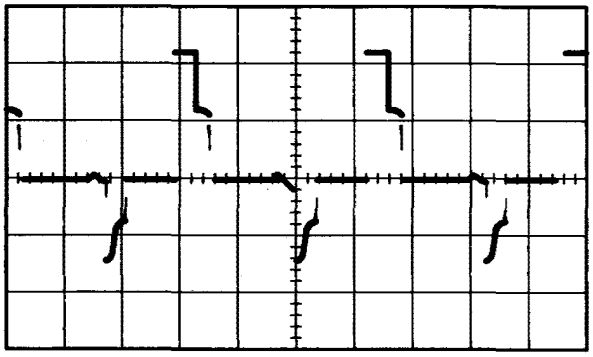
NOTE: The time base is 5 millisec/div and the amplitude is 2V/div. This waveform is AC coupled to the scope. For convenience, the bottom of the wave (−12V) was set at the "X" axis. The top of the wave is (−) 9V. Increasing the width of the bottom of the wave lowers the output voltage.

Fig. 3—Waveforms at TP2 or TP3 on CP1

TABLE D (Contd)

UNDESIRABLE OUTPUT

SYMPTOM	POSSIBLE CAUSE	INITIAL ACTION	CORRECTIVE ACTION
H. No output current; output voltage greater than zero (contd)	(8) Gate signal to triac CR4 abnormal	Check waveform at gate to MT1 of CR4. If waveforms correspond to Fig. 4, see Possible Cause H(9), H(10), and H(11)	Replace CP1.
	(9) Faulty triac CR4		Check and replace defective CR4.
	(10) Main capacitor C1 open		Check and replace defective capacitor.
	(11) T1 transformer secondary winding shorted		Check and replace defective transformer.



NOTE: The time base is 5 millisec/div and the amplitude is 0.5V/div.

Fig. 4—Waveforms at Gate to MT1 of CR4