KS-20618 REGULATOR
FOR SINGLE-PHASE RECTIFIERS
TEST PROCEDURES

CONTENTS PAGE

1. GENERAL

1.01 The KS-20618 regulator is intended for the control of dc output power and to provide alarm functions for rectifiers using thyristors or a triac-ferroresonant transformer combination. The regulator consists of five separate printed circuit boards, four functional boards, and one extender. The functional boards regulate the output voltage at a preset level, provide current limiting, accept control signals from the plant, and send alarm signals to the plant. The extender board permits extending any of the four functional circuits for testing purposes.

1.02 The reasons for reissuing this section are listed below. Since this reissue is a general revision, no revision arrows have been used to denote signigicant changes. The Equipment Test List is not affected.

1. To rate the KS-20618 L6 and L8 printed circuit boards (Y option) Manufacture Discontinued (Mfr Disc.)
2. To add the KS-20618 L11 and L13 printed circuit boards (X option)
3. To add new Fig. 12
4. To add new paragraph 1.07.

1.03 The KS-20618 regulator is designed for use in rectifiers—such as the KS-20491, KS-20493, J87348, or J87349 rectifiers—to regulate respective output requirements. The KS-20618 regulator may be used wherever the capacity and regulation characteristics meet the specific requirement of equipment with which it will be associated.

1.04 The KS-20618 regulator operates from single-phase, 2-wire ac voltage, 57 to 63 Hz. The variation from any ac input voltage is +5 and -10 percent. The output voltage regulation of a rectifier for combined line and load variation is ±0.5 percent steady state when the rectifier is designed to use the KS-20618 regulator.

1.05 Two of the four printed circuit boards in the KS-20618 regulator perform the functions for voltage and current control; the third contains the alarm and plant control functions; the fourth furnishes the power for the first three boards; and the fifth board permits testing the other four boards when installed in a rectifier.

1.06 The Y option of the KS-20618 regulator is a direct replacement for the Z option. The Y option incorporates design features that add stability to the KS-20618 regulator when two rectifiers are used in parallel.

1.07 The X option of the KS-20618 regulator is a direct replacement for the Y option. If a thyristor replacement is required on a rectifier equipped with the old CP1 pulse circuits and improper thyristor turnon occurs, replace the old

CP1 per KS-20618 L1 or L6 with CP 1 per KS-20618 L11 (X option). To incorporate the alarm inhibiting feature on existing rectifiers requires replacement of the old CP3 per KS-20618 L2 or L8 with CP3 per KS-20618 L13 (X option) and some minor wiring changes. Refer to SD-81997-01 (for KS-20491 rectifiers) and SD-81999-01 (for KS-20493 rectifiers) for retrofit information.

1.08 This issue of the section is based on drawing SD-82030-01, Issue 5. If this section is to be used with equipment or apparatus reflecting later issue(s) of the drawing(s), 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.

1.09 Refer to the appropriate section in Division 032 for additional information for testing, replacing, and handling of circuit packs and semiconductor devices.

2. APPARATUS

2.01 *List of Tools and Test Apparatus*

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-inch C screwdriver
TEST APPARATUS	
KS-14510	Volt-ohm-milliammeter
—	Oscilloscope, Tektronix* Model 545 with dual-trace vertical preamplifier (or equivalent)
—	Digital multimeter, John Fluke Manufacturing Company, Model 8100A, ac and dc volts (or equivalent)

*Registered trademark of Tektronix, Inc.

3. OPERATION

A. General Description

3.01 ***CP1 PULSE CIRCUITS:*** The CP1 circuit board, PULSE CIRCUITS, provides pulses for application to gates of thyristors or triacs at some time during the interval of 0 to 180 degrees of the ac sine wave being controlled and/or rectified. A second gate signal is provided during the interval of 180 to 360 degrees of the ac sine wave. The delay angle is controlled by a voltage signal from the VOLTAGE REGULATION AND CURRENT LIMIT CIRCUITS (CP2). Pulses are generated in CP1 by a blocking oscillator which is controlled by the outputs of two voltage comparators, one for each half-cycle. The outputs of the comparator circuit depend on the relative magnitudes of an error signal from CP2 and the changes of the reference waveform which changes with supply voltage and load conditions.

CP1 per KS-20618 L1 (Z option) (Mfr Disc.)
CP1 per KS-20618 L6 (Y option) (Mfr Disc.)
CP1 per KS-20618 L11 (X option)

3.02 ***CP2 VOLTAGE REGULATION AND CURRENT LIMIT CIRCUITS:*** The CP2 circuit board compares the associated rectifier output voltage with a reference voltage which provides the PULSE CIRCUITS (CP1) with an error signal representing the polarity and magnitude of the difference. The CP2 also provides a circuit to limit the output current of the associated rectifier to an adjustable value between 50 percent and full load. A circuit is also provided which will limit the rate at which the rectifier will accept load when started. The circuit is designed to work with either positive or negative output rectifiers by making simple wiring options in the external wiring to the circuit packs.

CP2 per KS-20618 L2 (Z option) (Mfr Disc.)
CP2 per KS-20618 L7 (Y option)

3.03 ***CP3 ALARM CIRCUITS:*** The CP3 circuit board, provides circuits for controlling the associated rectifier from the plant circuit, sensing trouble conditions, and automatically shutting down the rectifier under alarm conditions. The circuit will automatically restart the rectifier when the proper voltage level is restored or when the trouble condition has been corrected.

CP3 per KS-20618 L3 (Z option) (Mfr Disc.)
CP3 per KS-20618 L8 (Y option) (Mfr Disc.)
CP3 per KS-20618 L13 (X option)

3.04 ***CP4 POWER SUPPLY CIRCUIT:*** The CP4 circuit board provides various dc

voltages for the CP1, CP2, and CP3 circuit boards. A voltage monitor circuit is provided to prevent the associated rectifier from operating unless power supply voltages are above a preset minimum.

CP4 per KS-20618 L4 (Z option) (Mfr Disc.)
CP4 per KS-20618 L9 (Y option)

3.05 ***CP5 EXTENDER CIRCUIT:*** The CP5 circuit board provides an extension of the CP1 through CP4 circuits for testing. A field of test points provide access to the circuitry of a functional board when plugged into the extender. The KS-20618 L10 extender has polarizing key slots to ensure the functional boards are inserted properly into the connector. The L10 extender will not accept the ***Z option*** boards. The KS-20618 L5 extender does not have key slots and, therefore, will accept all functional boards upside down. The word UP and ***arrows*** are stamped on the extender to show the position of the board before inserting into the connector.

CP5 per KS-20618 L5 (Z option) (Mfr Disc.)
CP5 per KS-20618 L10 (Y option)

B. Rectifier Operation

3.06 ***Normal Operation:*** Normally a rectifier circuit will remain energized and connected to the battery. In addition to manual starting and stopping, the rectifier may be stopped and restarted by signals from the power plant and will shut down automatically upon occurrence of certain trouble conditions.

Starting

3.07 In normal operation with the rectifier output terminals BAT and GRD connected to the battery, the power plant control connected to the rectifier, and the external rectifier POWER ON-POWER OFF switch in the OFF position, the ac line voltage is applied to the DC POWER SUPPLY CIRCUIT (CP4) through fuses. The DC POWER SUPPLY CIRCUIT (CP4) furnishes internal control power to the various control circuits. The voltage regulator circuit (CP2) is connected to the "RG" and "RB" remote sensing leads.

3.08 ***To start the rectifier,*** the rectifier POWER ON-POWER OFF switch is depressed and released. Provided the voltage monitor circuit on (CP4) senses that sufficient internal regulator voltage is available, the external ac input contactor operates to connect ac input power to the rectifier and the POWER ON lamp lights. Simultaneously, the regulator walk-in circuit is activated so the rectifier output current starts out low and increases linearly toward full load. After the walk-in cycle is complete, the walk-in circuit has no further effect on the current limiting circuit.

Normal Shutdown

3.09 ***To shut down the rectifier,*** the POWER ON-POWER OFF switch is depressed and released and the POWER OFF lamp is lighted. In power plant operation, the power plant may shut down the rectifier by a ground signal on the plant "TR" lead, releasing the ST1 relay, and in turn releasing the ac input contactor. The rectifier then restarts when the ground is removed from the plant "TR" lead.

Trouble Shutdown

3.10 ***Battery Voltage Shutdown:*** If the battery voltage should exceed a maximum limit, the power plant will apply ground to the "HV" lead. If, at that time, the rectifier is carrying 5 amperes or more of current, the rectifier is shut down and locked out. The RECT FAIL lamp lights, and a ground signal is sent to the power plant circuit over the "RFA" lead.

3.11 ***Blown Charge Fuse:*** If a rectifier fault should occur to short the rectifier output terminals, the external CHARGE fuse will operate blowing its associated alarm fuse. The rectifier will shut down and lock out. The RECT FAIL lamp will light, and a ground signal is sent to the power plant circuit over the "RFA" lead.

3.12 ***Voltage Monitor Shutdown (CP4):*** If for any reason the +15 and/or -15 volt supplies in the DC POWER SUPPLY CIRCUIT (CP4) fall below a preset value (for instance, if the external ac input fuses should operate), the ST1 relay is released which releases the ac input contactor, shutting down the rectifier but not locking it out. When the voltage is restored, the rectifier will restart automatically.

3.13 ***False High-Voltage Shutdown (CP3):*** If two rectifiers are operating in parallel and one of the rectifiers is manually turned off, this action precipitates a false high-voltage shutdown

signal on the "HV" lead of the remaining rectifier causing it to shut down and lock out. The CP3 (of the KS-20618 regulator) per KS-20618 L3 (Z option) should be replaced with the CP3 per KS-20618 L13 (X option). The Z and Y options have been rated Mfr Disc.

3.14 ***Rectifier Instability (CP2):*** In the case of parallel operation of rectifiers if unstable operation occurs, replace the CP2 (of the KS-20618 regulator) per KS-20618 L2 (Z option) with the CP2 per KS-20618 L7 (Y option). The Z option has been rated Mfr Disc.

3.15 ***Removal of Circuit Packs:*** Removal of either CP1, CP2, CP3, or CP4 from its socket inhibits the start or shuts down the rectifier. Reinserting the circuit packs in their proper sockets restores normal operation.

Restart After Trouble Shutdown

3.16 ***If either of the trouble conditions in 3.10 or 3.11 should occur, the rectifier is restarted after the trouble is corrected by operating the POWER ON-POWER OFF switch to the OFF position, then to the ON position.***

C. Rectifier Testing

3.17 In order to perform tests and adjustments on the rectifier independently of the battery load, proceed as follows.

(a) Disconnect the PLANT QUICK DISCONNECT connector.

(b) Remove the charge alarm fuse and the CHARGE fuse from the output of the rectifier.

This prevents alarms from being sent to the plant while testing. The "RG" and "RB" leads are opened and the SNS relay is released, transferring the sensing for CP2 to the rectifier output terminals. The rectifier local SNS lamp lights. The output voltage may be set, and current functions may be adjusted and tested independent of battery load.

4. TROUBLESHOOTING PROCEDURES

4.01 The troubleshooting procedures have been arranged (Fig. 1 through 15) to check the most probable cause of rectifier failure. The test procedure should start with a visual inspection, voltage measurements with the voltmeter, and finally tracing with an oscilloscope.

4.02 When signal tracing is necessary, select a properly grounded scope. Connect only one lead from the scope to the rectifier. Do not connect the ground lead of the oscilloscope to any part of the rectifier.

4.03 When desired to test circuit board CP1, CP2, CP3, or CP4, obtain access to board as follows.

(1) Remove board from connector on rectifier.

Warning: When using extender KS-20618 L5, ensure that the functional board is inserted right side up into extender connector to prevent electrical damage to the board. Finger number 1 on the functional board should always be in the up direction as indicated by the arrows and the word UP on the extender board.

(2) Insert board into connector on extender board CP5 (Fig. 16).

Note: Extender board CP5 is located on inside of cover on rectifiers KS-20491 and KS-20493.

(3) Insert extender into connector on rectifier. The entire circuit board is now exposed and may be accessed.

4.04 It is recommended that complete circuit boards be replaced rather than replacing components. Other associated circuit boards should be checked for possible damage before placing the rectifier back in service.

4.05 Reference should be made to the associated section for the rectifier. An analysis of the trouble indications will help determine which circuit pack should be checked. Reference should also be made to the associated rectifier SD and CD to assist in localizing trouble conditions.

Caution: Before performing any tests or troubleshooting procedures, remove the rectifier from service as covered in C. Rectifier Testing. This will prevent service reactions while performing tests on the rectifier.

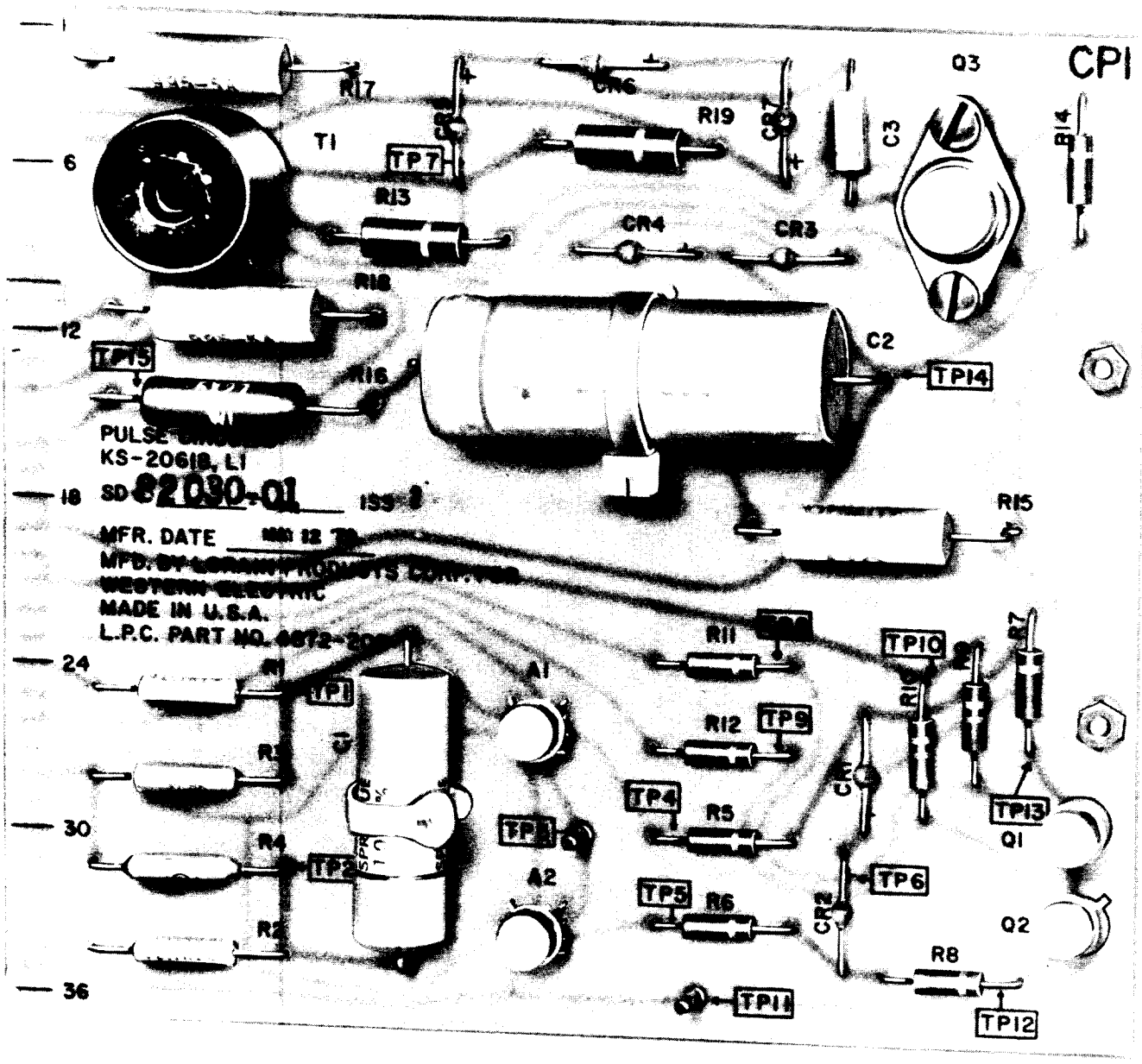


Fig. 1—KS-20618 L1 PULSE CIRCUITS CP1 (Mfr Disc.)

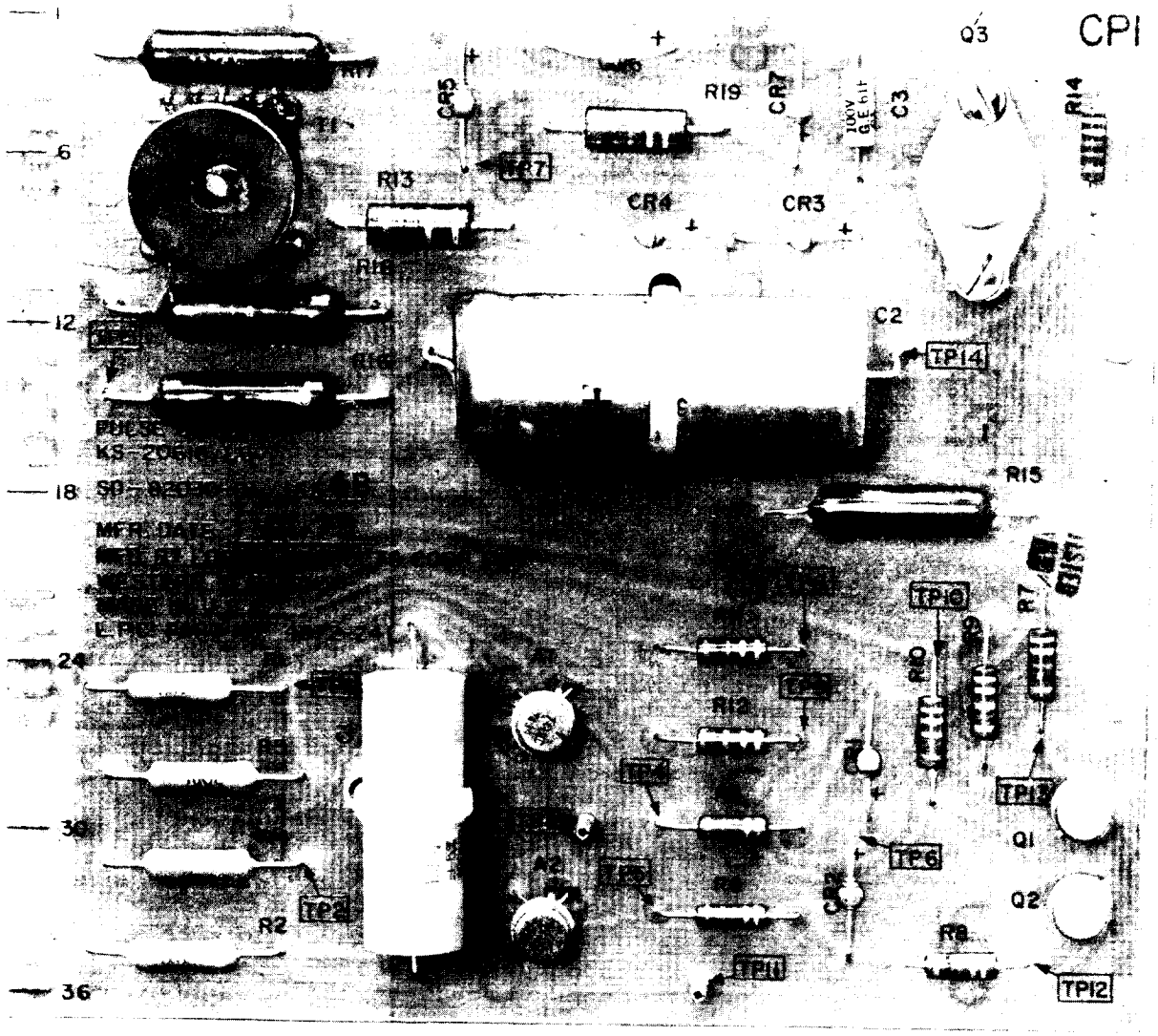
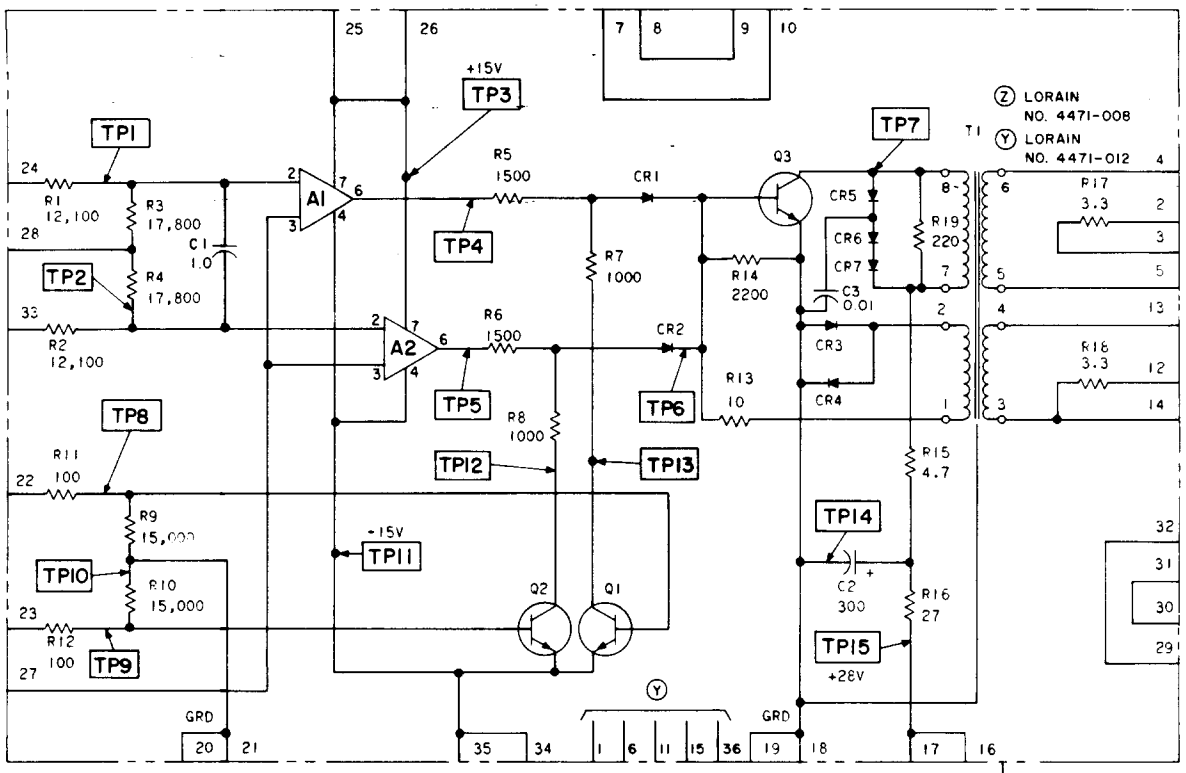


Fig. 2—KS-20618 L6 PULSE CIRCUITS CP1 (Mfr Disc.)



Z = KS-20618, L1

Y = KS-20618, L6

PRELIMINARY PROCEDURE:

1. TURN OFF RECTIFIER.
2. REMOVE CP1 AND INSERT EXTENDER BOARD IN JCP1.
3. INSERT CP1 INTO EXTENDER BOARD.

TESTING PROCEDURE:

1. TURN RECTIFIER ON.

   CAUTION: TURN OFF RECTIFIER IMMEDIATELY IF OUTPUT VOLTAGE IS ABNORMALLY HIGH.

   NOTE: IF THE OUTPUT VOLTAGE IS HIGH, THE POSSIBLE CAUSES ARE: DEFECTIVE TRANSISTOR Q3, SHORTED DIODE CR3 OR CR4, OR SHORTED CAPACITOR C1, C2, OR C3.

2. USING A DC OSCILLOSCOPE, SET AT APPROXIMATELY 3 MILLISECONDS PER DIVISION, CONNECT THE OSCILLOSCOPE TO THE TEST POINTS OR TERMINALS GIVEN IN FIG. 4, a THROUGH i. THE OPERATING CONDITION AND POSSIBLE CAUSES ARE GIVEN WITH EACH WAVEFORM.

NOTE: VOLTAGES SHOWN ARE TYPICAL WITH THE RECTIFIER AT 2 AMP LOAD.

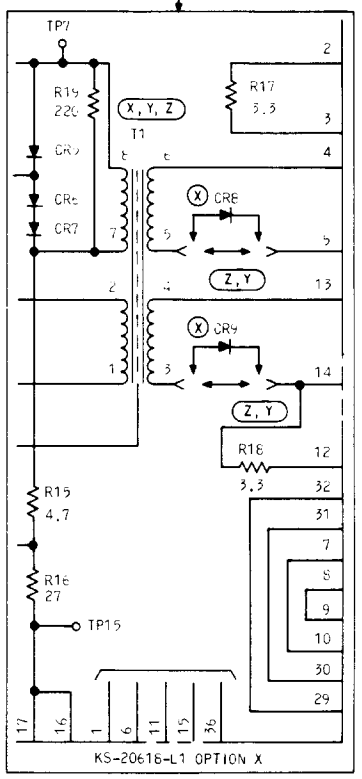
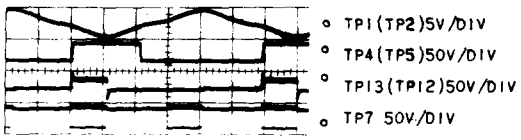
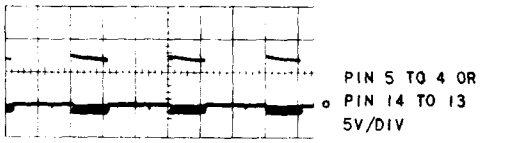


Fig. 3—Troubleshooting PULSE CIRCUITS CP1



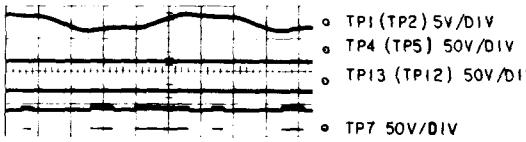
NORMAL OPERATION: (NOTE PHASE RELATIONSHIPS)
TP1(TP2) 5V(±1)
TP4(TP5) 24V(±4)
TP13(TP12) 15V(±1.5)
TP7 27V (±3)

FIG. 3a



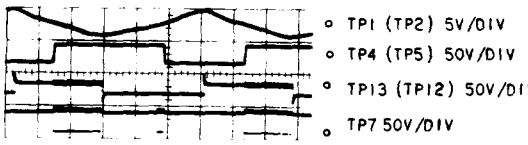
NORMAL GATE PULSES: 6.5V (±1)

FIG. 3b



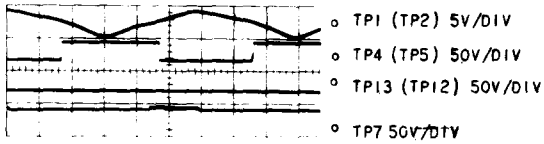
TROUBLE: NO SIGNAL AT TP4 (TP5)
POSSIBLE CAUSE: A1 (A2) DEFECTIVE

FIG. 3c



TROUBLE: INCORRECT PHASE RELATIONSHIP BETWEEN TP4 (TP5) AND TP13 (TP12)
POSSIBLE CAUSE: SHORTED CR1 (CR2)

FIG. 3d

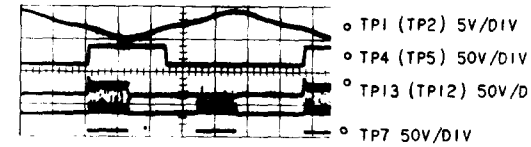


TROUBLE: NO SIGNAL AT TP13 (TP12), HALF WAVE CONTROL
POSSIBLE CAUSE: SHORTED Q1 (Q2)

FIG. 3e

TROUBLE: PHASE AT TP7 AND TP13(TP13)FOLLOWS TP4(TP5)
POSSIBLE CAUSE: OPEN Q1 (Q2) OR SHORT BASE-EMITTER Q1(Q2)

FIG. 3f

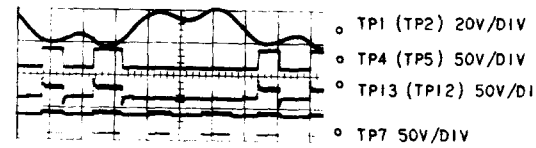


TROUBLE: HIGH AMPLITUDE REVERSE PULSES AT TP7
POSSIBLE CAUSE: OPEN CR3,CR4,CR5,CR6, OR CR7

FIG. 3g

TROUBLE: Q3 WILL NOT OSCILLATE, THYRISTORS MAY MISFIRE
POSSIBLE CAUSE: OPEN FEEDBACK WINDING OF T1, TERM. 1 AND 2

FIG. 3h



TROUBLE: INCORRECT WAVEFORM AT TP1 (TP2)
POSSIBLE CAUSE: OPEN C1

FIG. 3i

Fig. 4—Waveforms for PULSE CIRCUITS CP1

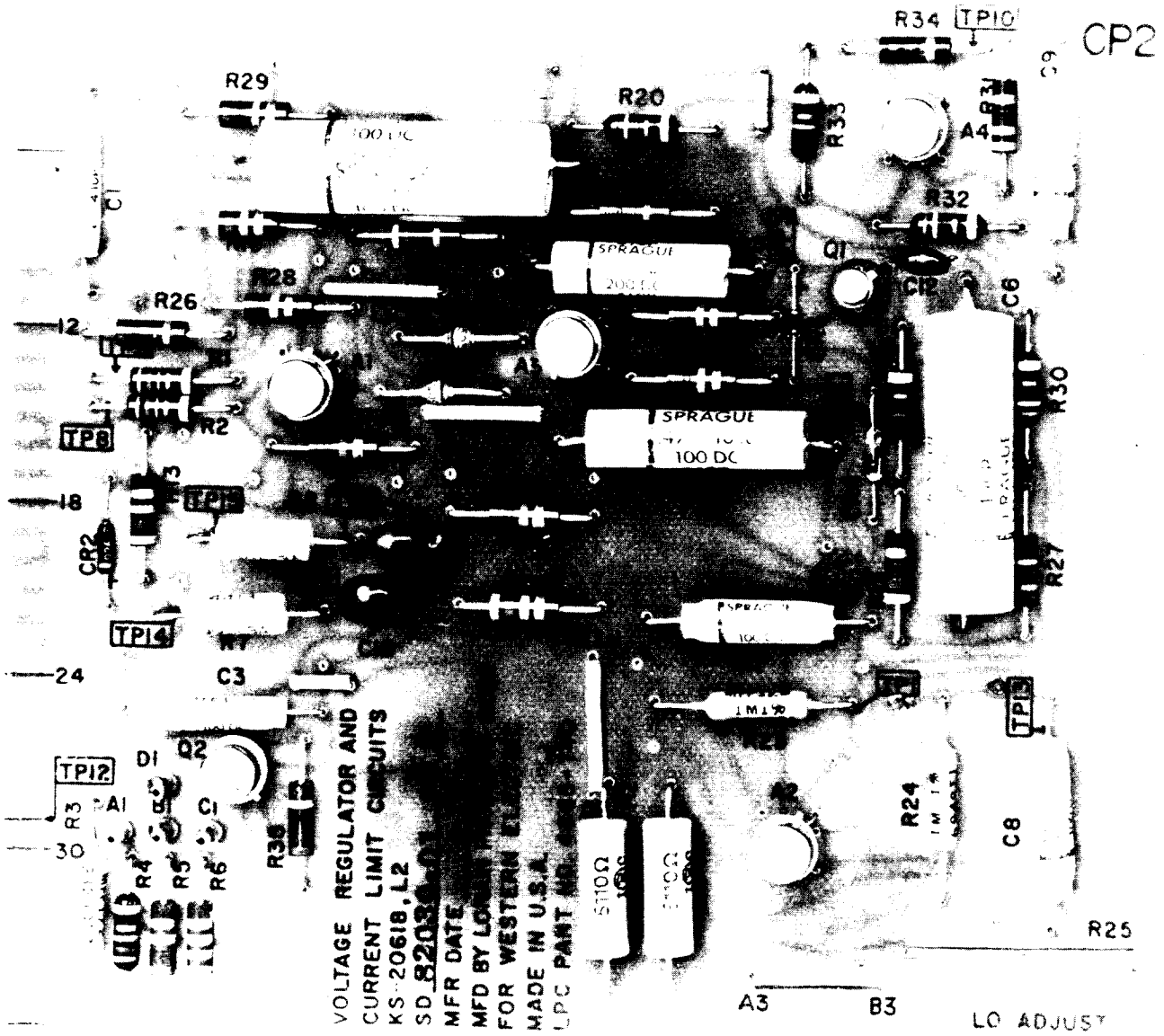


Fig. 5—KS-20618 L2 VOLTAGE REGULATOR AND CURRENT LIMIT CIRCUITS CP2 (Mfr Disc.)

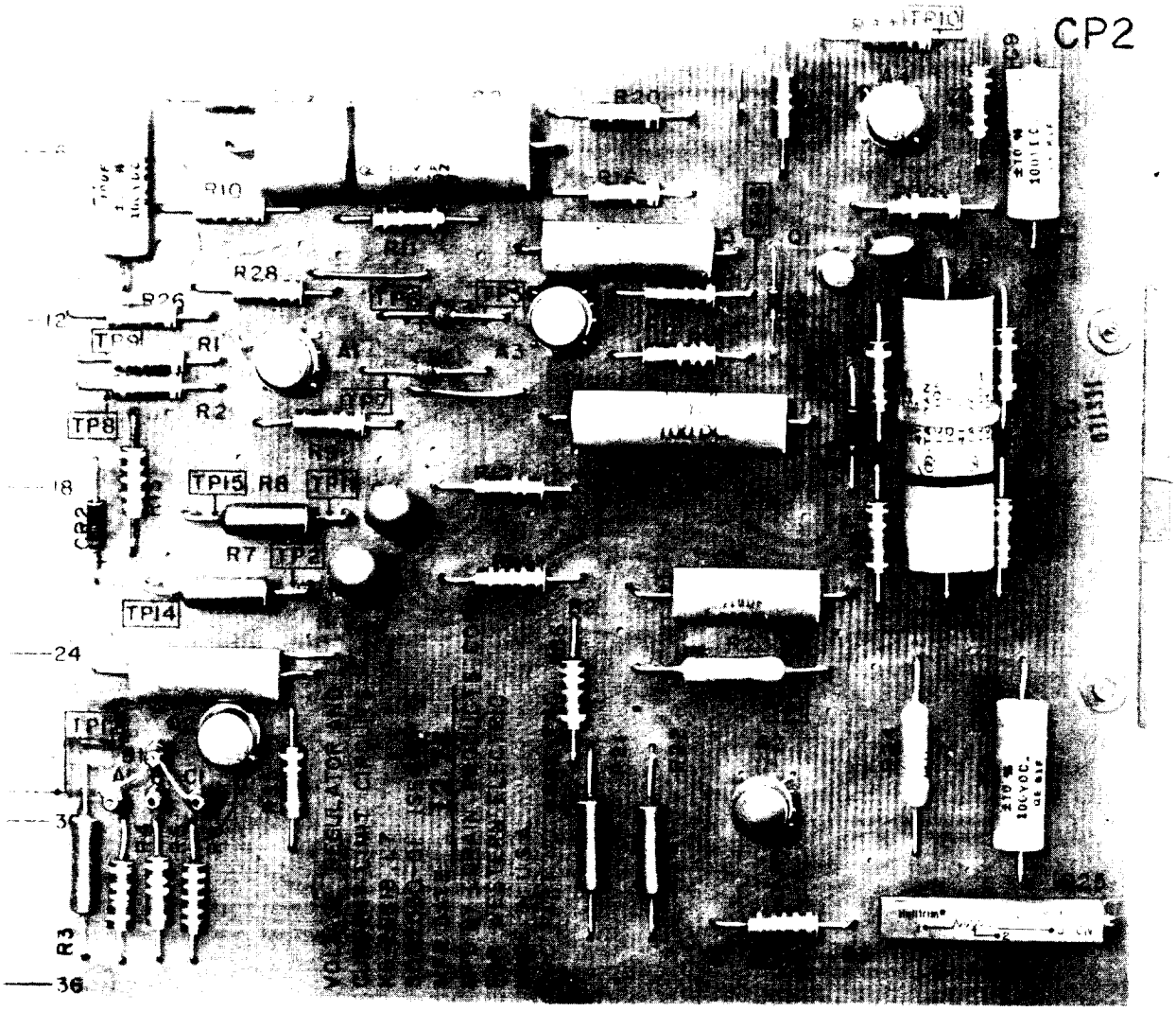
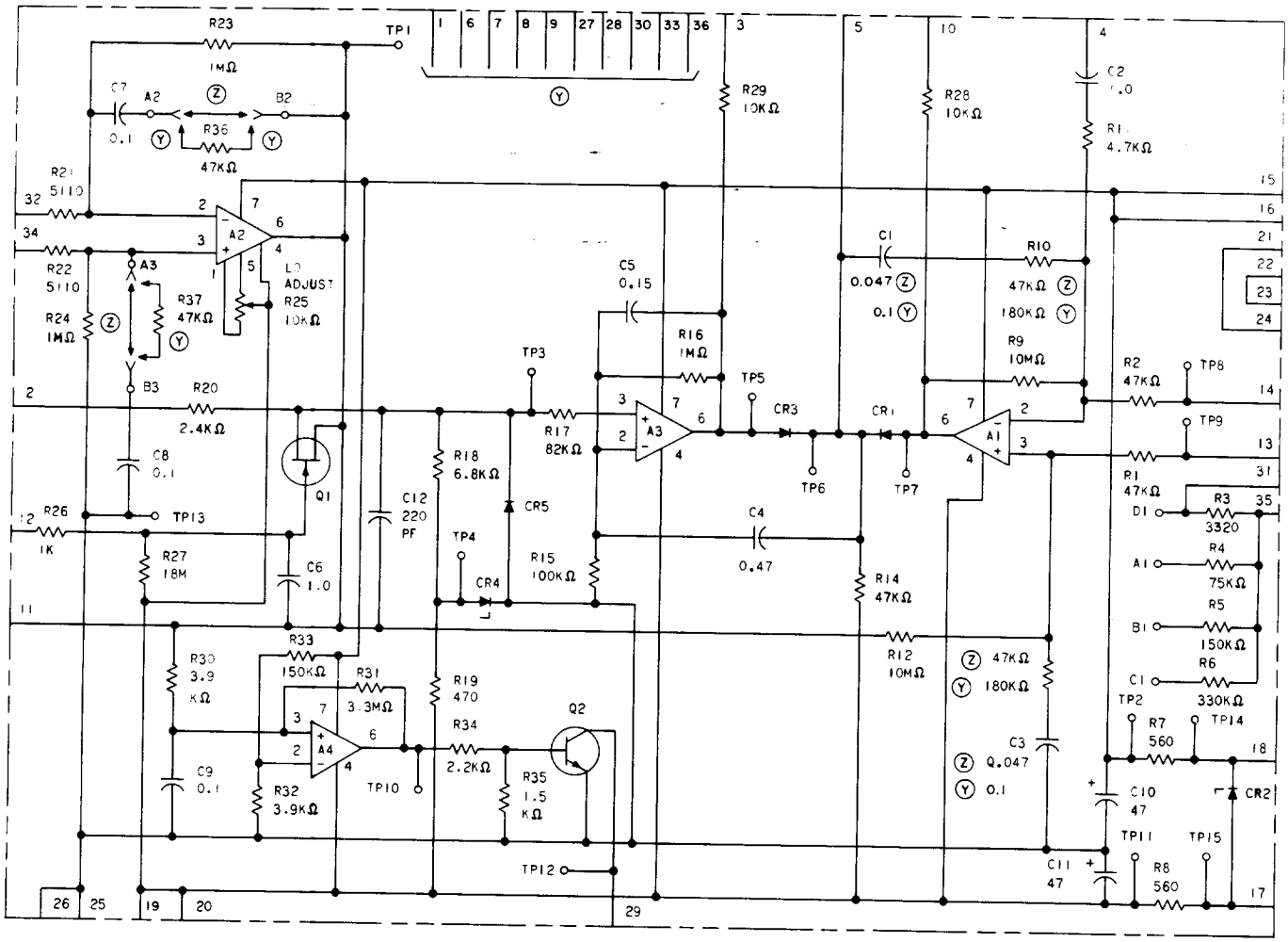


Fig. 6—KS-20618 L7 VOLTAGE REGULATOR AND CURRENT LIMIT CIRCUITS CP2



Ⓩ = KS-20618, L2

Ⓨ = KS-20618, L7

PRELIMINARY PROCEDURE:

1. TURN RECTIFIER OFF.
2. DISCONNECT LOAD FROM RECTIFIER.
3. REMOVE CP2 FROM JPC2.
4. INSTALL EXTENDER BOARD CP5 INTO JPC2.
5. INSTALL KNOWN GOOD CP2 INTO EXTENDER BOARD.
6. TURN RECTIFIER ON AND ADJUST FOR NORMAL BATTERY FLOAT VOLTAGE AT NO LOAD.
   CAUTION: TURN OFF RECTIFIER IMMEDIATELY IF OUTPUT VOLTAGE IS ABNORMALLY HIGH.
7. SET CURRENT LIMIT FOR CORRECT AMPERES IN ACCORDANCE WITH ASSOCIATED RECTIFIER BSP.
8. TURN RECTIFIER OFF.
9. REMOVE THE KNOWN GOOD CP2 FROM THE EXTENDER CARD.
10. INSTALL THE CP2 CARD TO BE TESTED INTO THE EXTENDER CARD.

TEST PROCEDURE:

NOTE: ALL TEST POINT VOLTAGES ARE WITH RESPECT TO GROUND AND UNLESS OUTPUT VOLTAGE IS ABNORMALLY HIGH, ALL TESTING IS DONE WITH THE RECTIFIER ON.

1. TURN RECTIFIER ON.
   CAUTION: TURN OFF RECTIFIER IMMEDIATELY IF OUTPUT VOLTAGE IS ABNORMALLY HIGH.
2. CHECK EACH RECTIFIER TROUBLE INDICATION AT THE TOP OF THE CHART IN FIG. 8 TO DETERMINE THE TESTS TO BE MADE ON CP2.
3. WITH THE RECTIFIER ON, CONNECT THE VOLTMETER, SET TO THE CORRECT RANGE, BETWEEN THE TEST POINT GIVEN AND GROUND.

Fig. 7—Troubleshooting VOLTAGE REGULATOR AND CURRENT LIMIT CIRCUITS CP2

TROUBLE INDICATION CHART										
	RECTIFIER INDICATION						CP2 INDICATION			
APPROXIMATE OUTPUT VOLTS	NOTES	CURRENT LIMIT	CURRENT LIMIT ADJ.	SIMULATED CURRENT	WALK-IN	LO	TEST POINT	NORMAL INDICATION ZERO LOAD	NORMAL INDICATION SIMULATED CUR ON AT 50% LOAD	CAUSE FOR INCORRECT INDICATION
ZERO	RECTIFIER WILL NOT START.						TP2	+15 ±1.5 VDC		C10 SHORTED
							TP11	-15 ±1.5 VDC		C11 SHORTED
ABNORMALLY LOW	OUTPUT FULLY DEPRESSED.				NONE		TP3	-1.8 ±0.2 VDC	-1 ±0.4 VDC	A. Q1 SHORTED B. C12 SHORTED
	NO REGULATION OUTPUT DROPS WITH LOAD.						TP14	+9 ±0.5 VDC		CR2 SHORTED
							TP5	-12 ±2 VDC	-6 ±2 VDC	A3 DEFECTIVE
						NONE	TP1	0 ±0.05 VDC	+4 ±0.1 VDC	A2 DEFECTIVE
	NO REGULATION OUTPUT DROPS WITH LOAD				NONE		TP7	0 ±1 VDC		A1 DEFECTIVE
							TP3 TP4	-1.8 ±0.2 VDC -10 ±1 VDC	-1 ±0.4 VDC	A. CR4 SHORTED B. CR5 SHORTED
	OUTPUT DROPS WITH LOAD OR SIMULATED CUR.			DECREASES OUTPUT			TP3	-1.8 ±0.2 VDC	-1 ±0.4 VDC	C6 SHORTED
	OUTPUT AND REG ABNORMAL IN LOCAL SNS ONLY.						TP6	-0.5 ±1 VDC		C2 SHORTED
NORMAL	REGULATION NORMAL	NONE	NONE		NONE	NONE	TP1	0±0.05 VDC	+4 ±0.1 VDC	A2 DEFECTIVE
		NONE	NONE	NO EFFECT AT TP5	NONE		TP5	-12 ±2 VDC	-6 ±2 VDC	A3 DEFECTIVE
		NONE	NONE	NO EFFECT AT TP6	NONE		TP6	-0.5 ±1 VDC		CR3 OPEN
		NONE	NONE				TP5 (A3 HOT)	-12 ±2 VDC	-6 ±2 VDC	CR1 SHORTED
		NONE	NONE			NONE	TP1	0 ±0.05 VDC	+4 ±0.1 VDC	C7 SHORTED
					NONE					A. Q1 OPEN B. Q6 OPEN
					ERRATIC					C12 OPEN
				NO EFFECT AT TP1	NONE	NONE	TP1	0 ±0.05 VDC	+4 ±0.1 VDC	A2 DEFECTIVE
				NO EFFECT AT TP10		NONE	TP10	-12 ±2 VDC	+12 ±2 VDC	C9 SHORTENED
						NONE	TP10	-12 ±2 VDC	+12 ±2 VDC	A. A4 DEFECTIVE B. Q2 OPEN
						CONST	TP10	-12 ±2 VDC	+12 ±2 VDC	A4 DEFECTIVE
							TP12	+25 ±3 VDC	0.1 ±0.05 VDC	Q2 SHORTED
						NONE WITH LOAD, CONST WITH SIM.CUR.	TP1	0 ±0.05 VDC	+4 ±0.1 VDC	C8 SHORTED
		NORMAL	NARROW RANGE				TP4	-10 ±1 VDC		CR4 OPEN
							TP5	-12 ±2 VDC	-6 ±2 VDC	C5 OPEN
		OVERSHOOT AT SET PT.					TP6	-0.5 ±1 VDC		C4 OPEN
	OUTPUT DROPS WITH LOAD.				NORMAL		TP6	-0.5 ±1 VDC		C4 SHORTED
										C1 SHORTED
	OSCILLATES ON REMOTE SNS.									C1 OPEN
	OSCILLATES ON LOCAL SNS.									C2 OPEN
ABNORMALLY HIGH	WALKS IN TO HIGH VOLTAGE DO NOT LEAVE POWER ON						TP6	-0.5 ±1 VDC		CR1 OPEN
							TP7	0 ±1 VDC		A1 DEFECTIVE
							TP14	+9 ±0.5 VDC		CR2 OPEN

Fig. 8—Trouble Indication Chart for VOLTAGE REGULATOR AND CURRENT LIMIT CIRCUITS CP2

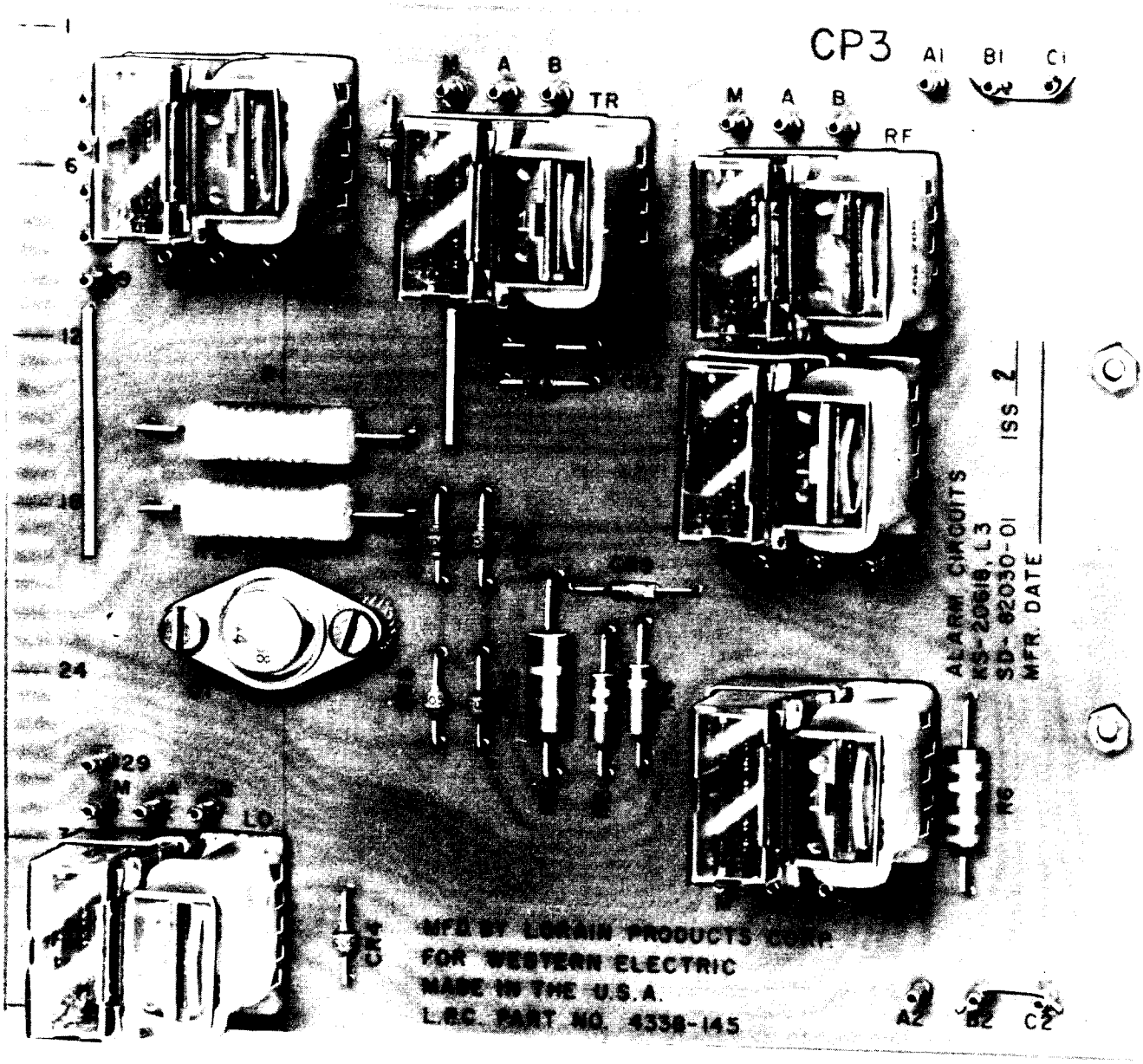


Fig. 9—KS-20618 L3 ALARM CIRCUITS CP3 (Mfr Disc.)

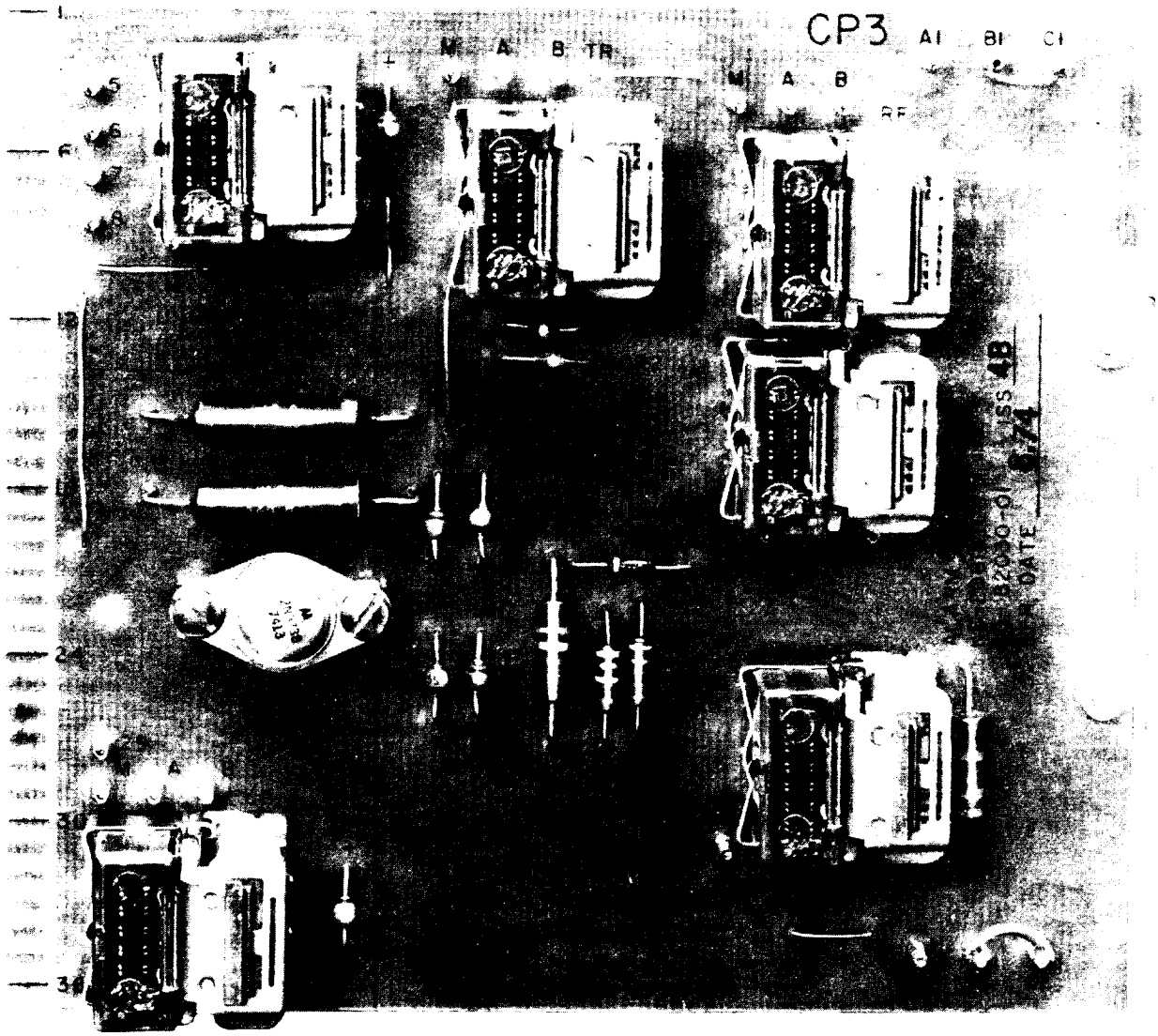
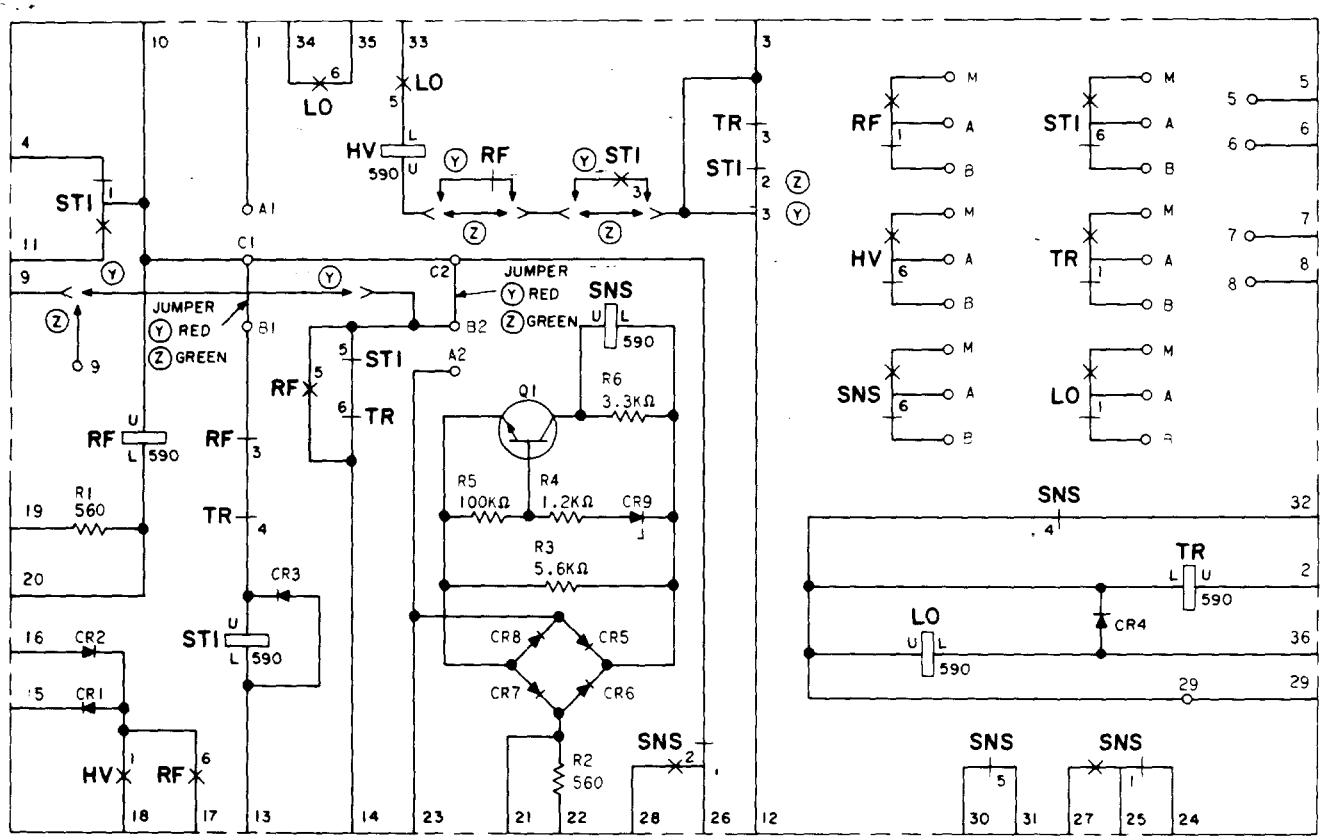


Fig. 10—KS-20618 L8 ALARM CIRCUITS CP3 (Mfr Disc.)



PRELIMINARY PROCEDURE:

Ⓨ KS-20618, L8
Ⓩ KS-20618, L3

1. TURN RECTIFIER OFF. DISCONNECT AC INPUT POWER.
2. REMOVE ALARM CIRCUITS CP3 FROM JPC3.

NOTES: 1. ALL TESTING WILL BE DONE WITH CP3 REMOVED FROM THE RECTIFIER.
2. THE PREFERRED POWER SOURCE FOR THE TEST PROCEDURE IS A BENCH POWER SUPPLY OF 28-VOLTS DC,5 AMPERES. HOWEVER,THE DC POWER SUPPLY CP4 IN THE RECTIFIER IS USED AS A POWER SOURCE IN THE TEST PROCEDURE.

TEST PROCEDURE:

A. MAKE A VISUAL INSPECTION OF CP3 BOARD FOR BROKEN OR CRACKED COMPONENTS OR PRINTED LEADS.
   1. CHECK FOR JUMPER WIRE BETWEEN PIN B1 AND C1.
   2. CHECK FOR JUMPER WIRE BETWEEN PIN B2 AND C2.

B. IF POWER SUPPLY CP4 IN THE RECTIFIER IS TO BE USED AS A POWER SOURCE,CONNECT TWO INSULATED CLIP CORDS TO THE -28 VOLT SUPPLY AT THE FILTER CAPACITOR,ONE TO PLUS SIDE (PIN 5 OF CP4) AND ONE TO MINUS SIDE (PIN 14 OF CP4).
   1. APPLY AC INPUT POWER TO THE INPUT CONTACTOR-RECTIFIER SHOULD BE OFF.
   2. USING THE VOLTMETER,CHECK -28 VOLT SUPPLY AT THE FILTER CAPACITOR.
   3. INSERT CP3 TO BE TESTED INTO CIRCUIT BOARD EXTENDER CARD-DO NOT INSERT CARDS INTO RECTIFIER.
   4. USING CLIP CORDS FROM THE -28 VOLT SUPPLY,FOLLOW THE TEST PROCEDURE IN TABLE 1.

C. IF NO TROUBLE WAS DISCOVERED,USE AN OHMMETER TO CHECK THE FOLLOWING:
   1. RESISTANCE BETWEEN PIN 19 AND PIN 20 SHOULD BE 560 OHMS ± 5%.
   2. RESISTANCE BETWEEN PIN 21 AND PIN 22 SHOULD BE 560 OHMS ± 5%.

D. USE AN OHMMETER TO CHECK THE FRONT TO BACK RATIO OF THE FOLLOWING:
   1. CR-2 CATHODE TO PIN 16.
   2. CR1-ANODE TO PIN 15.
   3. CR5,CR6,CR7 AND CR8-ANODE TO CATHODE.

E. FOLLOW THE PROCEDURE IN TABLE 2. TO OPERATE THE RELAYS MANUALLY, PRESS DOWN ON THE ARMATURE AT THE TOP OF THE RELAY.

Fig. 11—Troubleshooting ALARM CIRCUITS CP3 (Sheet 1 of 2)

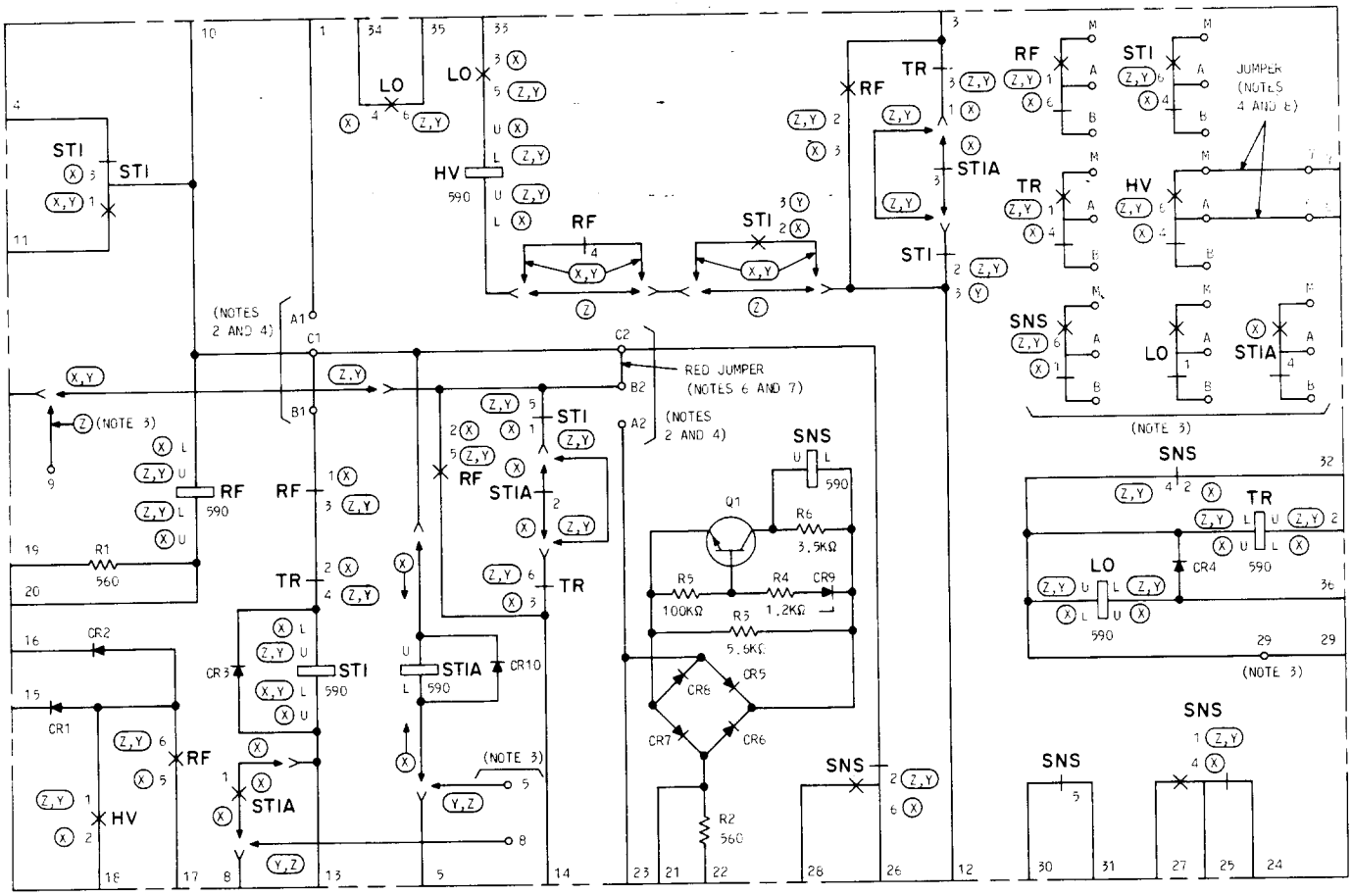
TABLE 1

CONNECT CLIP CORDS:		NORMAL INDICATION	REASON FOR INCORRECT INDICATION
GROUND TO PIN	-28V TO PIN		
10	13	OPERATE STI	A. STI COIL DEFECTIVE B. CR3 SHORTED C. TR RELAY CONTACT 4 OPEN D. RF RELAY CONTACT 3 OPEN E. JUMPER B1 TO C1 OPEN
10	20	OPERATE RF	RF COIL DEFECTIVE
29	2	OPERATE TR	TR COIL DEFECTIVE
29	36	OPERATE LO	A. LO COIL DEFECTIVE B. CR4 SHORTED
29 AND 12	36 AND 33	OPERATE LO AND HV	A. HV COIL DEFECTIVE B. LO RELAY CONTACT 5 OPEN
21	23	OPERATE SNS	A. SNS COIL DEFECTIVE B. Q1 DEFECTIVE C. CR9 OPEN D. R3 OPEN E. R4 OPEN

TABLE 2

RELAY	NOTES	CONNECT OHMMETER: PIN TO PIN		NORMAL INDICATION		REASON FOR INCORRECT INDICATION
				RELEASED	MANUALLY OPERATED	
STI		10	4	SHORT	OPEN	A. BENT, DIRTY OR CORRODED RELAY CONTACTS B. OPEN PRINTED CIRCUIT TRACES ON BOARD
		10	14	SHORT	OPEN	
		10	11	OPEN	SHORT	
		12	3	SHORT	OPEN	
TR	CONTACT 4 TESTED IN TABLE 1	12	3	SHORT	OPEN	
		10	14	SHORT	OPEN	
RF	CONTACT 3 TESTED	17	+CR2	OPEN	SHORT	
	MANUALLY OPERATE TR FOR THESE TESTS	3	12	OPEN	SHORT	
		10	14	OPEN	SHORT	
HV		18	+CR2	OPEN	SHORT	
SNS		10	26	SHORT	OPEN	
		24	25	SHORT	OPEN	
		30	31	SHORT	OPEN	
		32	29	SHORT	OPEN	
		26	28	OPEN	SHORT	
		25	27	OPEN	SHORT	
LO	CONTACT 5 TESTED	34	35	OPEN	SHORT	

Fig. 11—Troubleshooting ALARM CIRCUITS CP3 (Sheet 2 of 2)



PRELIMINARY PROCEDURE:

1. TURN RECTIFIER OFF. DISCONNECT AC INPUT POWER.
2. REMOVE ALARM CIRCUITS CP3 FROM JPC3.

NOTES: 1. ALL TESTING WILL BE DONE WITH CP3 REMOVED FROM THE RECTIFIER.
2. THE PREFERRED POWER SOURCE FOR THE TEST PROCEDURE IS A BENCH POWER SUPPLY OF 28-VOLTS DC, 5 AMPERES. HOWEVER, THE DC POWER SUPPLY CP4 IN THE RECTIFIER IS USED AS A POWER SOURCE IN THE TEST PROCEDURE.

TEST PROCEDURE:

A. MAKE A VISUAL INSPECTION OF CP3 BOARD FOR BROKEN OR CRACKED COMPONENTS OR PRINTED LEADS.
   1. CHECK FOR JUMPER WIRE BETWEEN PIN B1 AND C1.
   2. CHECK FOR JUMPER WIRE BETWEEN PIN B2 AND C2.

B. IF POWER SUPPLY CP4 IN THE RECTIFIER IS TO BE USED AS A POWER SOURCE, CONNECT TWO INSULATED CLIP CORDS TO THE -28 VOLT SUPPLY AT THE FILTER CAPACITOR, ONE TO PLUS SIDE (PIN 5 OF CP4) AND ONE TO MINUS SIDE (PIN 14 OF CP4).
   1. APPLY AC INPUT POWER TO THE INPUT CONTACTOR-RECTIFIER SHOULD BE OFF.
   2. USING THE VOLTMETER, CHECK -28 VOLT SUPPLY AT THE FILTER CAPACITOR.
   3. INSERT CP3 TO BE TESTED INTO CIRCUIT BOARD EXTENDER CARD-DO NOT INSERT CARDS INTO RECTIFIER.
   4. USING CLIP CORDS FROM THE -28 VOLT SUPPLY, FOLLOW THE TEST PROCEDURE IN TABLE 1.

C. IF NO TROUBLE WAS DISCOVERED, USE AN OHMMETER TO CHECK THE FOLLOWING:
   1. RESISTANCE BETWEEN PIN 19 AND PIN 20 SHOULD BE 560 OHMS ± 5%.
   2. RESISTANCE BETWEEN PIN 21 AND PIN 22 SHOULD BE 560 OHMS ± 5%.

D. USE AN OHMMETER TO CHECK THE FRONT TO BACK RATIO OF THE FOLLOWING:
   1. CR2-CATHODE TO PIN 16.
   2. CR1-ANODE TO PIN 15.
   3. CR5,CR6,CR7 AND CR8-ANODE TO CATHODE.

E. FOLLOW THE PROCEDURE IN TABLE 2. TO OPERATE THE RELAYS MANUALLY, PRESS DOWN ON THE ARMATURE AT THE TOP OF THE RELAY.

(X) KS-20618, L13
(Y) KS-20618, L8
(Z) KS-20618, L3

Fig. 12—Troubleshooting Alarm Circuits CP3 (X Option)

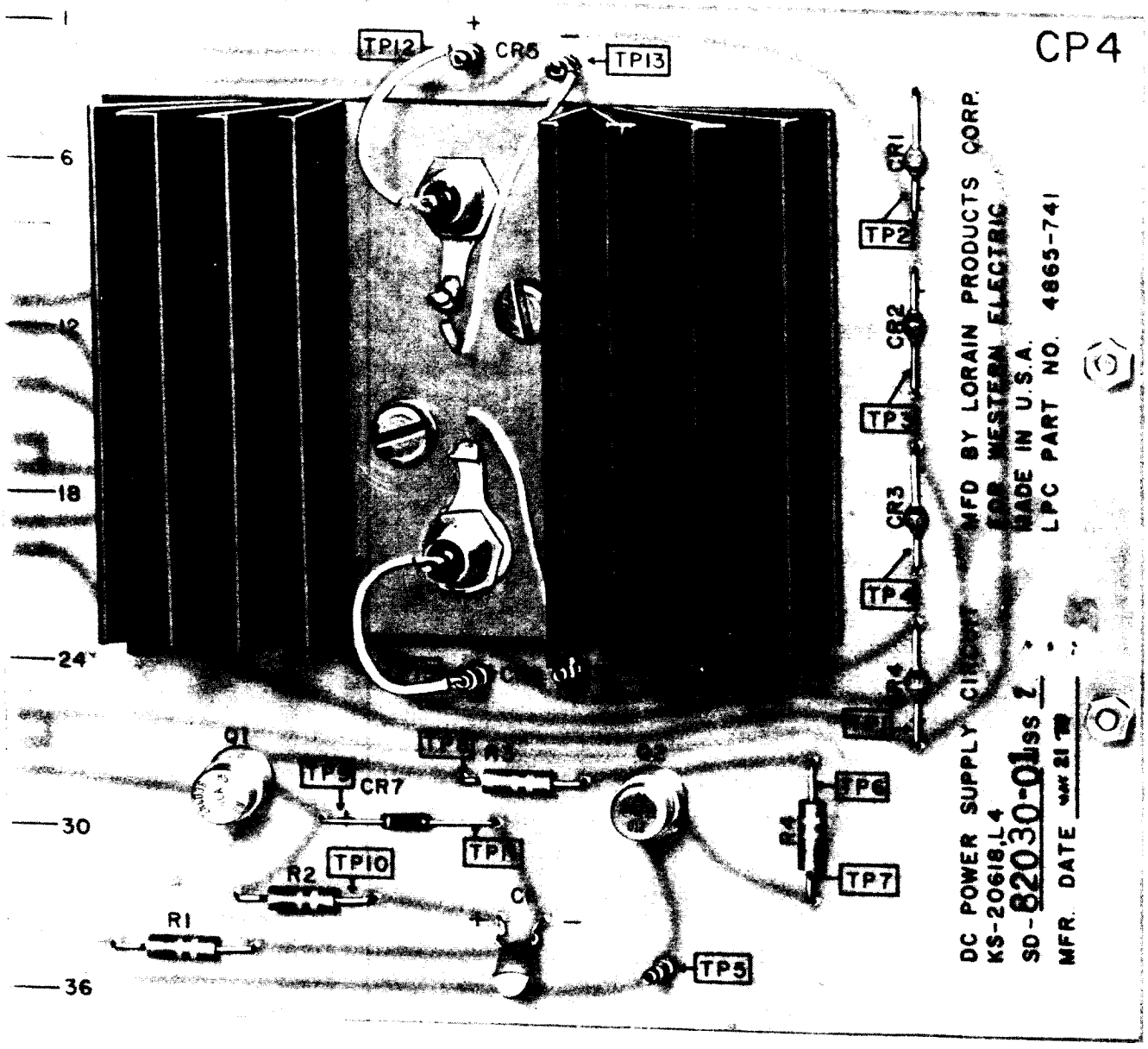


Fig. 13—KS-20618 L4 DC POWER SUPPLY CIRCUIT CP4 (Mfr Disc.)

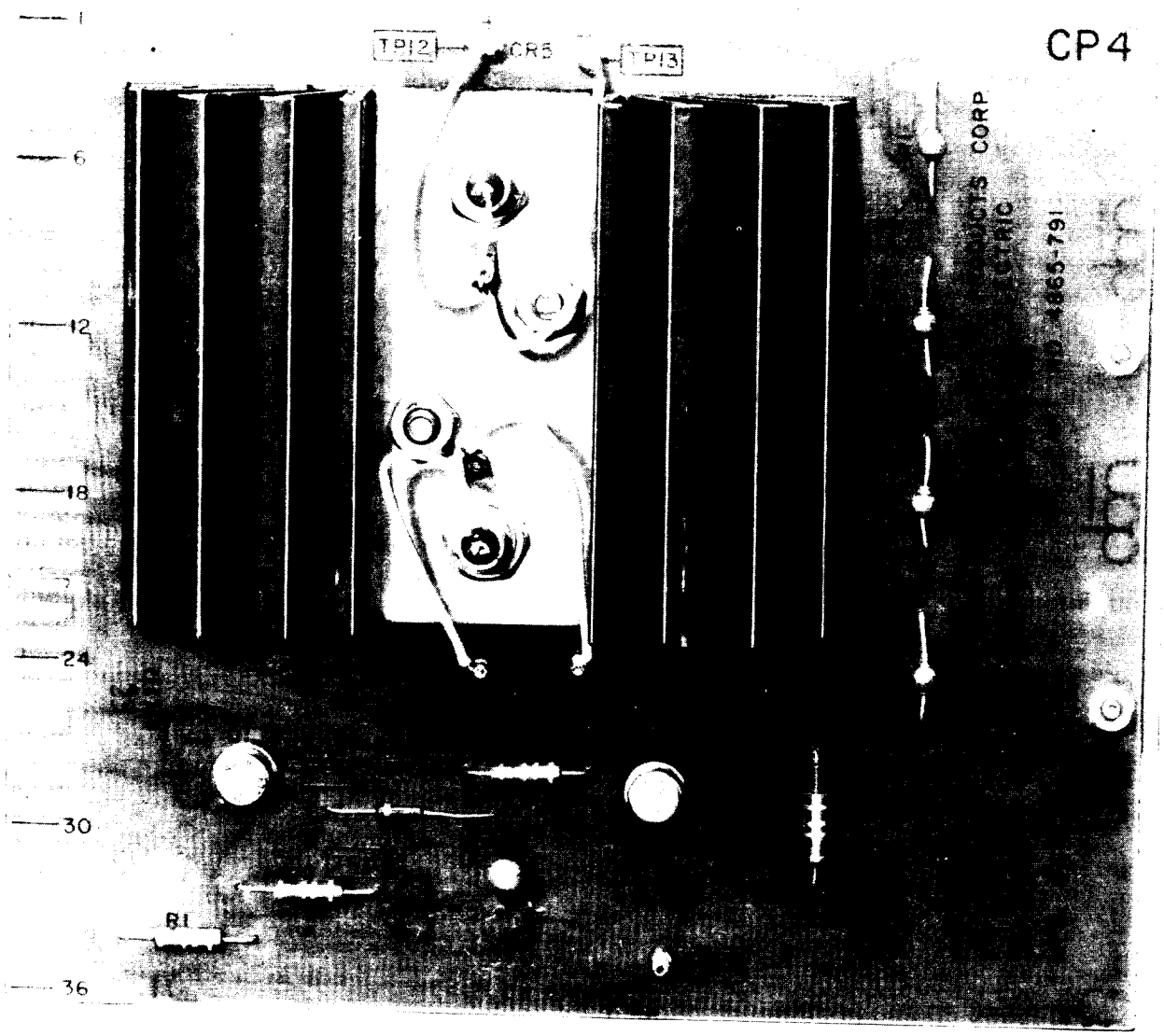
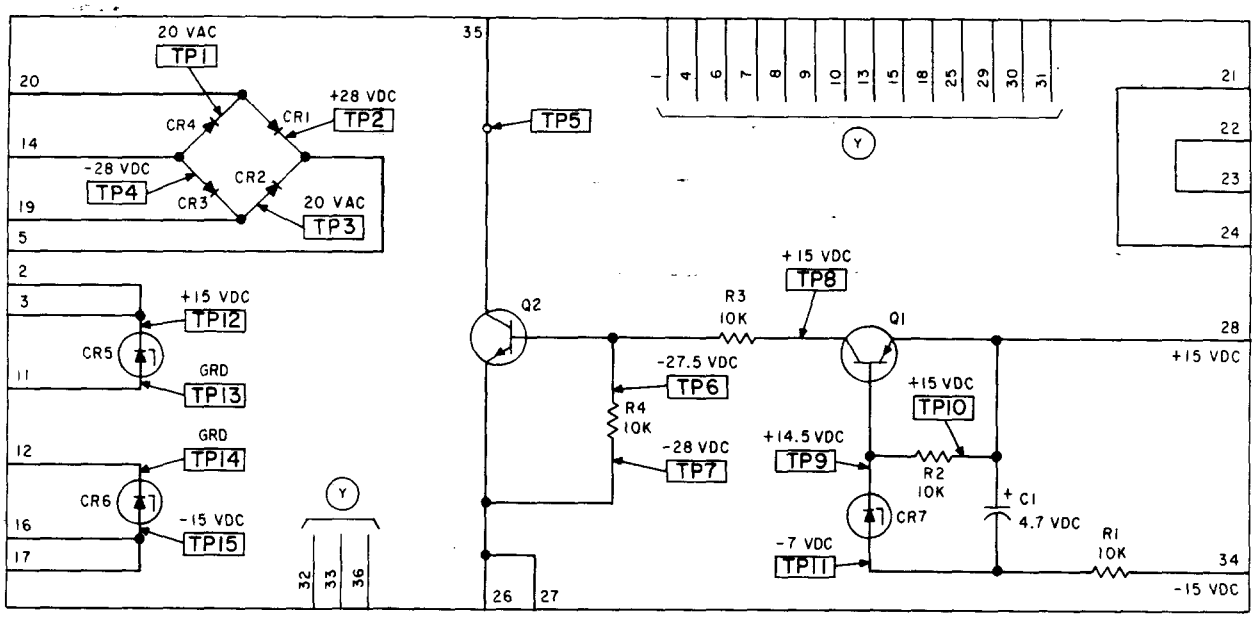


Fig. 14—KS-20618 L9 DC POWER SUPPLY CIRCUIT CP4



NOTE:
VOLTAGES GIVEN ARE TYPICAL WITH RESPECT TO GROUND — RECTIFIER ON, NORMAL OPERATION

(Y) KS-20618, L9 ONLY

PRELIMINARY PROCEDURE:
(1) TURN RECTIFIER OFF
(2) REMOVE CP4 AND INSERT EXTENDER BOARD CP5 INTO JCP4.
(3) INSERT CP4 INTO EXTENDER BOARD.

TEST PROCEDURE:
(1) TURN RECTIFIER ON MOMENTARILY TO RECORD RECTIFIER OUTPUT VOLTAGE, THEN TURN RECTIFIER OFF.

CAUTION: TURN OFF RECTIFIER IMMEDIATELY IF OUTPUT VOLTAGE IS ABNORMALLY HIGH.

(2) IF RECTIFIER TURNED AND REMAINED ON IN (1), PROCEED AS IN TABLE 1, USING THE RECORDED RECTIFIER OUTPUT VOLTAGES. CONNECT THE VOLTMETER, SET TO THE CORRECT RANGE, BETWEEN THE TEST POINT SPECIFIED AND GROUND (TP13, TP14.) TURN RECTIFIER ON MOMENTARILY TO VERIFY APPROXIMATE TROUBLE VOLTAGE AT THE TEST POINT.

TABLE 1

OUTPUT VOLTAGE	POSSIBLE CAUSE	TEST POINT TO GRD	APPROXIMATE TROUBLE VOLTAGE	CAUSE FOR TROUBLE VOLTAGE
ABNORMALLY LOW	LOSS OF -15V SUPPLY PLUS DEFECTIVE VOLTAGE MONITOR	PIN 34	ZERO VOLTS	A. CIRCUIT PACK CP1 OR CP2 NOT IN PC SOCKET PROPERLY B. CR6 DEFECTIVE
		TP11	14.5 VOLTS	CR7 SHORTED
		TP8	ZERO VOLTS	Q1 OR Q2 SHORTED
ABNORMALLY HIGH	LOSS OF +15V SUPPLY PLUS DEFECTIVE VOLTAGE MONITOR	PIN 28	ZERO VOLTS	A. CIRCUIT PACK CP1 OR CP2 NOT IN PC SOCKET PROPERLY B. CR5 DEFECTIVE
		TP11	ZERO VOLTS	CR7 SHORTED
		TP8, TP10	ZERO VOLTS	Q1 OR Q2 SHORTED

(3) IF RECTIFIER REMAINS OFF WHEN RECTIFIER POWER SWITCH IS OPERATED, PROCEED AS IN TABLE 2. CONNECT THE VOLTMETER, SET TO THE CORRECT RANGE, BETWEEN TEST POINT SPECIFIED AND GROUND (TP13, TP14.) OPERATE THE RECTIFIER POWER SWITCH MOMENTARILY ON TO VERIFY VOLTAGES AT TEST POINT.

TABLE 2

NOTE (1) VOLTAGES GIVEN ARE TYPICAL WITH RESPECT TO GRD. NORMAL OPERATION.
NOTE (2) ALL TESTS ARE MADE WITH AC INPUT APPLIED, RECTIFIER POWER SWITCH MOMENTARILY ON.

TEST POINT TO GRD	APPROXIMATE VOLTS (NORMAL OPERATION)	IF INCORRECT, CHECK:	CAUSE FOR OPERATED FUSES
TP1	20(±2) VAC	DC POWER SUPPLY FUSES	CR1, 2, 3, OR 4 SHORTED
TP3	20(±2) VAC	DC POWER SUPPLY FUSES	CR1, 2, 3, OR 4 SHORTED
TP2	+25(±3) VDC	CR1 OR CR2 OPEN	
TP4	+25(±3) VDC	CR3 OR CR4 OPEN	
TP12	+15(±1.5) VDC	CR5 DEFECTIVE	
TP15	-15(±1.5) VDC	CR6 DEFECTIVE	
TP11	-7(±2) VDC	CR7 OR Q1 DEFECTIVE, C1 SHORTED, R1 OPEN	
TP8	+15(±1.5) VDC	CR7 OR Q1 DEFECTIVE, C1 SHORTED, R3 OPEN	
TP6	-25(±3) VDC	Q1 OR Q2 DEFECTIVE, R3 OPEN	

Fig. 15—Troubleshooting DC POWER SUPPLY CIRCUIT CP4

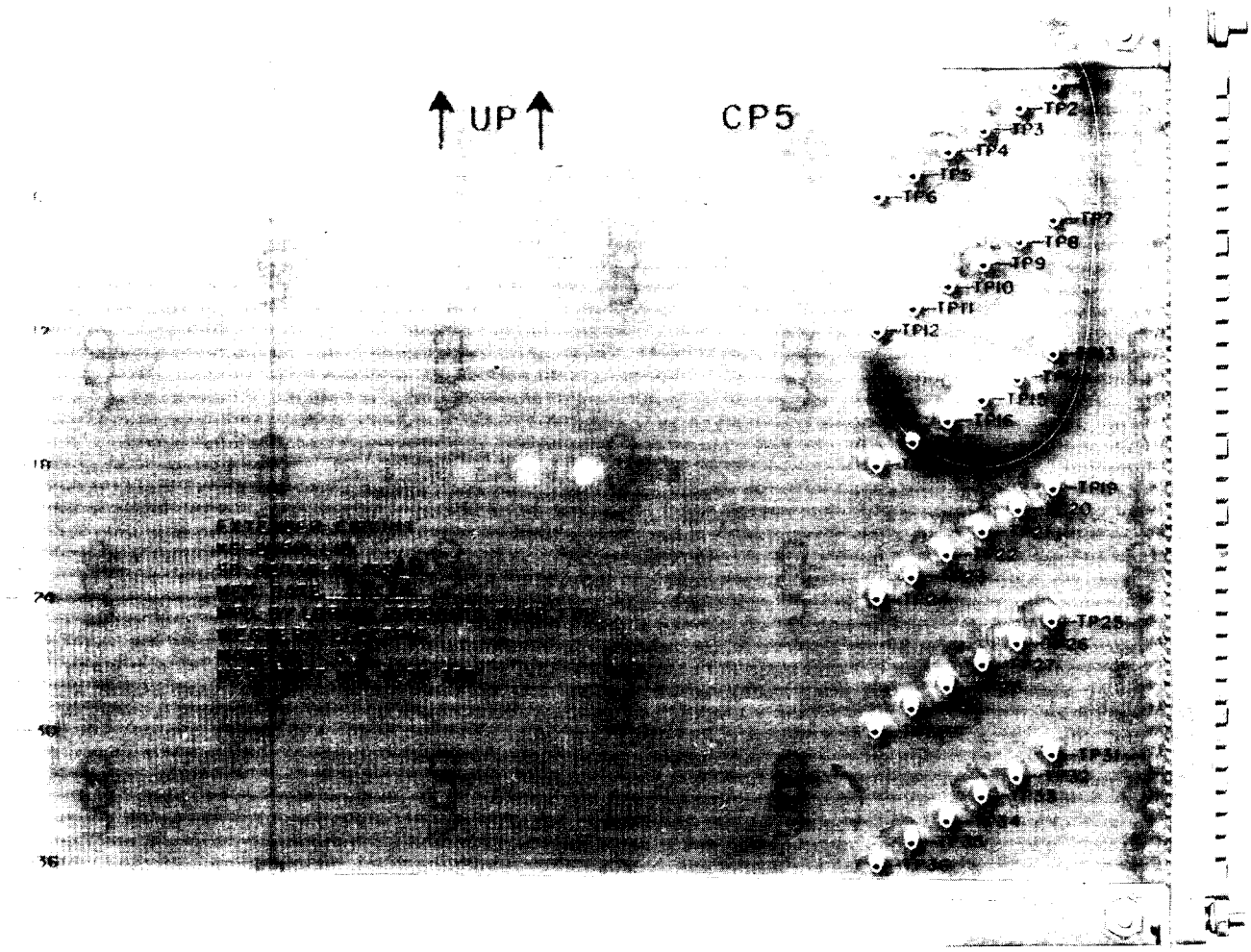


Fig. 16—KS-20618 L10 EXTENDER CIRCUIT CP5