RECTIFIERS

KS-21520

48 VOLTS, 400 AMPERES

LORAIN PRODUCTS CORPORATION

TROUBLE LOCATING

CONTENTS PAGE

1 GENERAL

1.01 The KS-21520 semiconductor-type rectifiers provide regulated dc power from an ac power source for floating and charging central office 48-volt storage batteries. The L11 and L12 rectifiers are primarily intended for use in the 301C, 302A, and 302B power plants, while the L21 and L22 rectifiers are intended for use in the 111A, 303A, 326A, and 326B power plants.

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph. This issue does not affect the Equipment Test List.

Danger 1: The voltages inside this unit 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 or destructive and dangerous short circuits may occur. Disconnect ac supply before working on rectifier except when necessary to make tests.

Danger 2: Inductors and transformers of these rectifiers have class H insulation, and the temperatures of the inner windings may be approximately 170° C (338° F). The outside temperatures will be proportionately high. Heat sinks and studs of semiconductor power devices may be approximately 90° C (194° F). Contact with these components must be avoided to prevent burns.

Warning: Do not operate the S1 switch to either BAT or EC position without first charging the output filter capacitors in accordance with Section 169-748-301.

1.03 This issue of the section is based on drawing SD-82409-01, Issue 1. If this section is to be used with equipment or apparatus that is associated with an earlier or later issue of the drawing, 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.

1.04 For more detailed information on the operation of the KS-21520 rectifiers, refer to Section 169-748-301. Procedures for maintaining the dc output switch of the KS-21520 rectifier are contained in Section 169-748-501.

1.05 Electrolytic capacitors should be maintained in accordance with Section 032-110-701.

1.06 Semiconductor devices and printed circuit assemblies should be maintained in accordance with Section 032-173-301.

2. LIST OF TEST APPARATUS

TEST APPARATUS

KS-14510	Volt-Ohm-Milliammeter
KS-20599 L4	Digital Multimeter (or equivalent) (see warning)
—	Oscilloscope—Tektronix 545B or equivalent
—	100-ohm, 10 watt resistor
—	Extender board—Lorain furnished part 4233—302
—	Ground Fault Circuit Interrupter Hubbell No. GFP 115 or equivalent
—	Isolation Plug, Hubbell No. BL-12-767 or equivalent

3. OPERATION

3.01 ***Normal operation of the KS-21520*** rectifier shall be in accordance with Section 169-748-301. In the event of a trouble condition, the rectifier should be removed from service in accordance with Section 169-748-301.

3.02 ***Restoring the Rectifier to Service After a Trouble Condition:*** Under all trouble conditions, before placing the rectifier back in service, check the rectifier regulation, current limit, and alarm circuits for proper operation per Part 4 of Section 169-748-301.

3.03 Following is a list of the six plug-in circuit packs and the functions they perform.

1. The CP1 (Pulse Circuits) circuit pack contains the pulse circuits, one for each of the six phases.

2. The CP2 (REG VC0 and Limit Circuit) circuit pack contains the regular voltage controlled oscillator and limit circuit.

3. The CP3 (REF VCO Circuit) circuit pack provides an isolated 3-phase square wave reference signal locked to the ac input voltage in both frequency and phase.

4. The CP4 (Voltage and Current Regulator Circuit) circuit pack contains the voltage and current regulator circuits.

5. The CP5 (Alarm Electronics) circuit pack contains the ripple current monitor, the sense lead monitor, and the internal high voltage shutdown monitor.

6. The CP6 (Relay and Alarm Circuits) circuit pack contains the ac input voltage monitor circuit.

4. TROUBLE LOCATING PROCEDURES

4.01 Failure of the KS-21520 rectifiers will usually be characterized by one of the following conditions:

- Operated fuses and consequent loss of output
- Loss of ac input due to external fuse or circuit breaker operation
- Loss of output without operation of fuses
- Undesired output, either voltage or current or both.

The trouble flow chart in Fig. 1 is designed to analyze troubles in the rectifier from the standpoint of these four general symptoms. The output of the rectifier should be checked and the appropriate category of the flow chart should be consulted to isolate the trouble. For example, if initial inspection of a faulty rectifier reveals an operated fuse, refer to the indicated trouble chart.

4.02 The following precautions should be observed prior to and during the interval of detecting and clearing troubles in the rectifier.

Danger 1: Do not apply AC power to the rectifier except when checking voltages, currents, or waveforms. To completely isolate the rectifier from the AC line, the AC switch at the bus plug-in unit or power service must be operated to OFF.

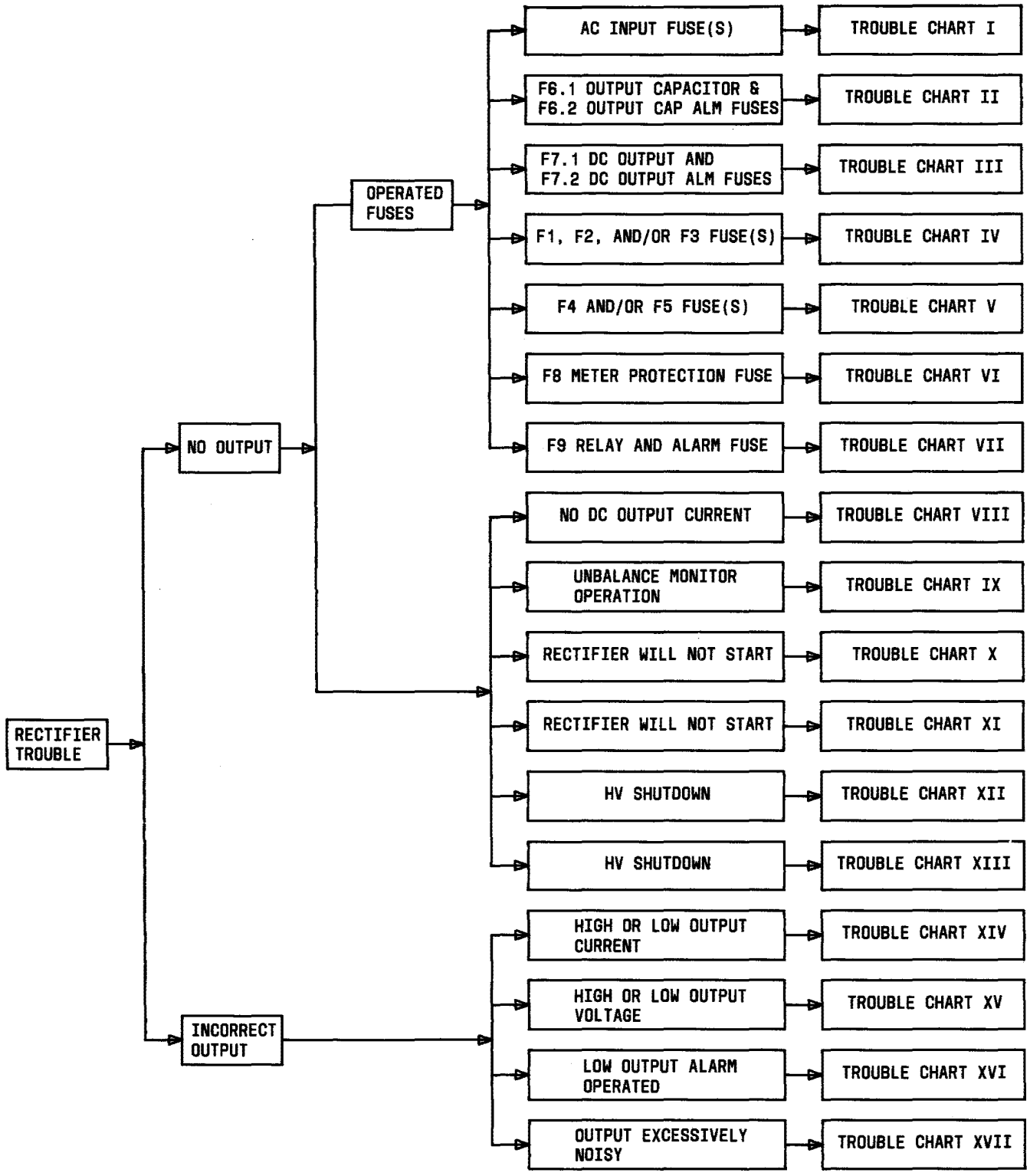

Fig. 1—Trouble Chart

Danger 2: Use care when working with wrenches and test leads to prevent shorting the DC circuit. Always disconnect the rectifier from battery and the AC service before performing repairs.

Note: In order to avoid the danger inherent in using isolated ac operated instruments, use the following procedure.

(1) Connect the ground fault circuit interrupter, Hubbell No. GFP 115 or equivalent, to a 115-volt source.

(2) Insert the isolation plug, Hubbell No. BL-12-767 or equivalent, into the ground fault circuit interrupter.

(3) Connect the ac operated instrument to the isolation plug.

Warning 1: When using an oscilloscope or any other test equipment powered from the AC line which has one probe connected to the chassis, that probe must always be connected to ground potential when troubleshooting the rectifier.

Warning 2: Under no circumstances should fuses of higher rating than those specified be used.

4.03 As a general troubleshooting procedure, check for faulty connections and broken, burned, or shorted wires. Inspect the harness wiring and leads from all components for possible breaks and shorts. Check that no adjacent terminals or lugs touch each other. Check that all solder and pressure points make good electrical contact, using a volt-ohmmeter. Inspect for evidence of poor connections at switch and bus joints.

4.04 Before attempting any trouble-shooting, refer to the testing information contained in 4.06 through 4.16 as well as the voltage table and waveform diagrams.

4.05 Determine that the input taps of input inductor L1 and main transformer T1 and power supply transformer T3-T6 (T6 on L11, L21 only) have been properly chosen in accordance with Section 169-748-301, Operating Methods.

4.06 All testing is to be performed with the rectifier in the test mode of operation unless otherwise specified.

4.07 Whenever a circuit pack (CP1 through CP6) is identified as a probable cause of a trouble condition, it is recommended that a known good circuit pack be substituted before investigating the other probable causes listed in the trouble charts.

4.08 Do not attempt to repair defective printed circuit assemblies unless personnel are trained and equipped to repair printed circuit assemblies. Return the defective printed circuit assembly to the authorized repair facility in accordance with local instructions.

4.09 Substitution of circuit packs may be performed without putting the rectifier in the test mode of operation, however the external AC input to the rectifier should be turned off before replacing or removing any circuit packs.

4.10 If substitution of circuit packs fails to correct the problem, the power supply voltages to the circuit packs may be incorrect or a failure may have occurred in more than one circuit pack.

Note: To check the input voltage to the circuit packs or systematically check the outputs of circuit packs, refer to the voltage tables and waveform charts which follow.

4.11 The input voltages to circuit packs CP1 through CP6 may be checked by using the extender board in conjunction with circuit packs CP5 and CP4. Mounting CP5 and CP4 in turn on the extender board and measuring the voltages at test points indicated in Table A will confirm that proper voltages are applied to circuit packs CP1 through CP6.

Note: Circuit packs CP1 through CP6 are accessible from the front of the meter panel.

4.12 If the voltages to the circuit packs are correct, the output of the main electronic control circuit packs CP1 through CP3 may be checked.

Requirement 1: The waveforms should be checked in figure number order.

TABLE A

MODEL	CIRCUIT PACK	MEASURE VOLTAGE ON TEST POINT INDICATED ON EXTENDER BOARD*	VOLTAGE
KS21520 L11 KS31520 L12 KS21520 L21 KS21520 L22	CP5	TP1 TP2 TP4 TP5 TP7 TP8	+12VDC −12VDC −24VDC +24VDC −6VDC +6VDC
	CP4	TP2	−12VDC
	Measure the voltage between the collector of transistor Q1 and the output volts (+) jack. Voltage should be −24VDC.		

*Voltages at test points listed below are taken with respect to test point TP3 (common) on the extender board.

Requirement 2: It is important that the waveforms be in the proper phase relationships as shown in Fig. 2 through 5 during the 2-cycle time duration shown.

4.13 The cards to be checked should be installed in the extender board and the extender board plugged into the appropriate socket. The signals are then monitored by connecting the oscilloscope between the test points indicated adjacent to the waveform.

Note: The test points listed are located on the extender board unless otherwise indicated.

4.14 The main transformer T1 waveforms are taken at the following points.

(a) The T1A lead J connection can be made where the J lead connects to power diode CR1.

(b) The T1B lead H connection can be made where the H lead connects to power diode CR2.

(c) The T1C lead G connection can be made where the G lead connects to power diode CR3.

(d) All the terminal 4 connections can be made to the bar connected to the (+) lead below the transformer.

4.15 Before proceeding to the trouble chart, all the obvious trouble possibilities which may be caused by the input voltage should be eliminated. The following checks should be made to eliminate ac input troubles.

(a) The ac input should be checked for proper phase rotation.

(b) The phase-to-phase input voltage should be checked for proper input voltage levels.

(c) When the rectifier has multiple input voltage taps, the tap settings should be checked to be sure the tap settings correspond to the ac input voltage being applied.

Note: Refer to note 105 of SD-82409-01 for proper phase connections, ac input voltage limits, and transformer tap connections.

4.16 If the ac line has been checked and the rectifier still will not start and no alarms are present, check the following:

(a) Be sure the capacitor charging switch, CAP CHG, located on the DC OUTPUT switch assembly, is ***not*** in the ON position.

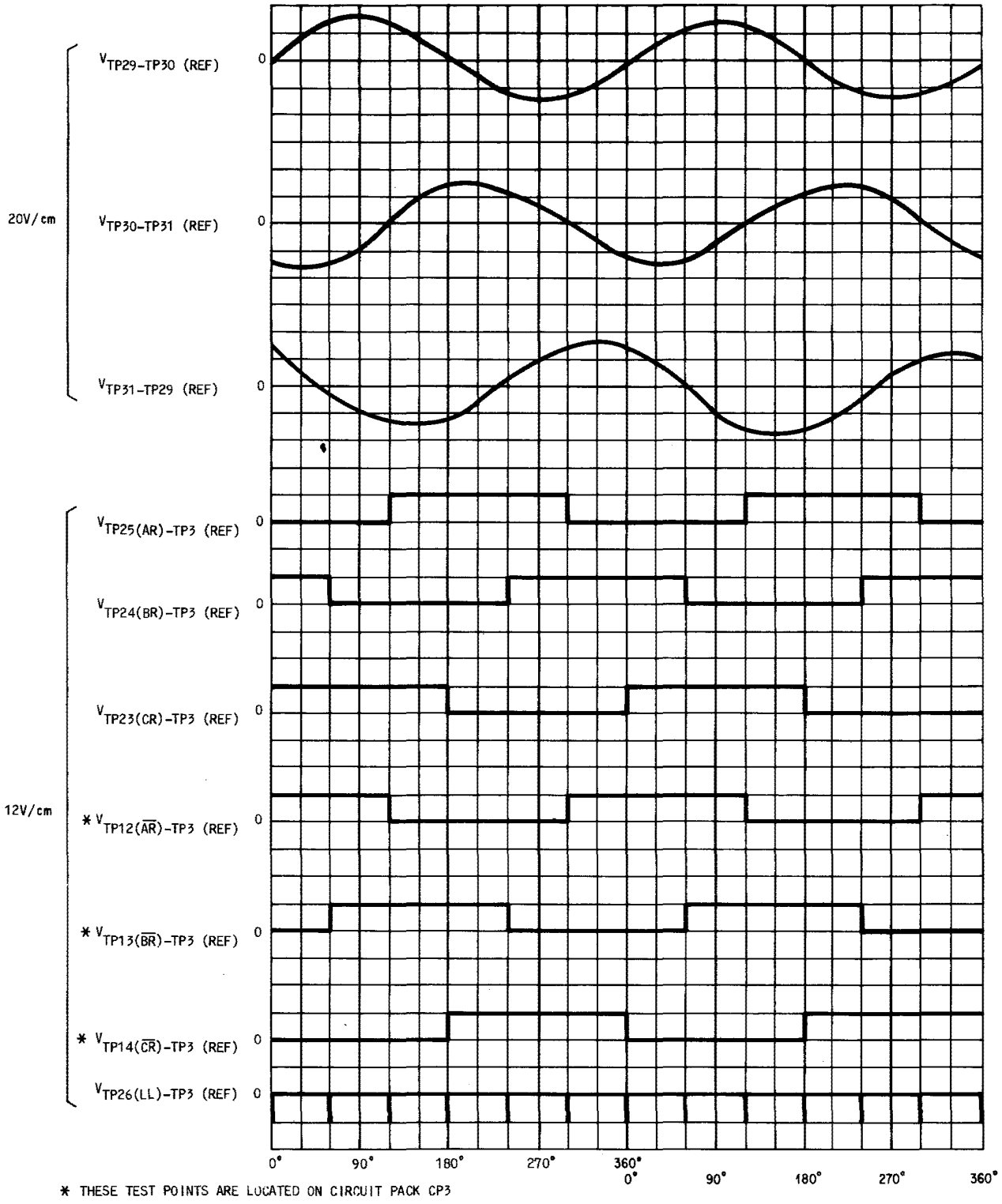

Fig. 2—Oscilloscope Waveforms of Circuit Pack CP3

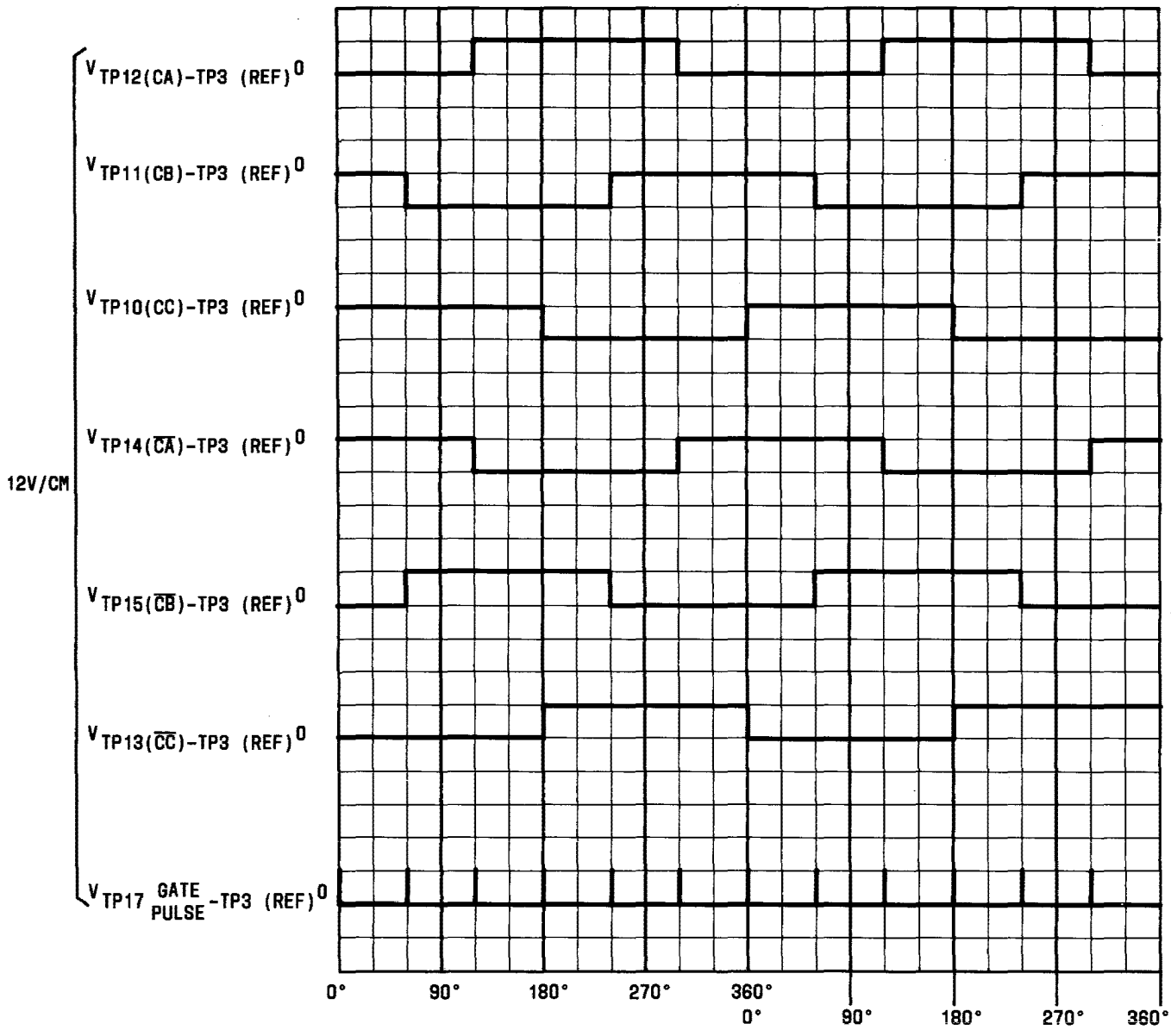

Fig. 3—Oscilloscope Waveforms of Circuit Pack CP2

(b) Check to be sure the DC OUTPUT switch is not in the BAT or EC position while the TEST switch is in the ON position.

Note: The TEST switch must be in the OFF position except when the rectifier is in the TEST mode of operation.

(c) Check to be sure the DC OUTPUT switch is not in the OPEN position. Follow closure instructions on the DC OUTPUT switch assembly.

4.17 The following danger and warnings should be observed while operating or performing maintenance on the rectifier.

Danger: Voltages inside the rectifiers are over 150 volts to ground. Avoid all contact with terminals.

Warning 1: Do not remove any printed circuit assembly while the rectifier is in operation. Remove

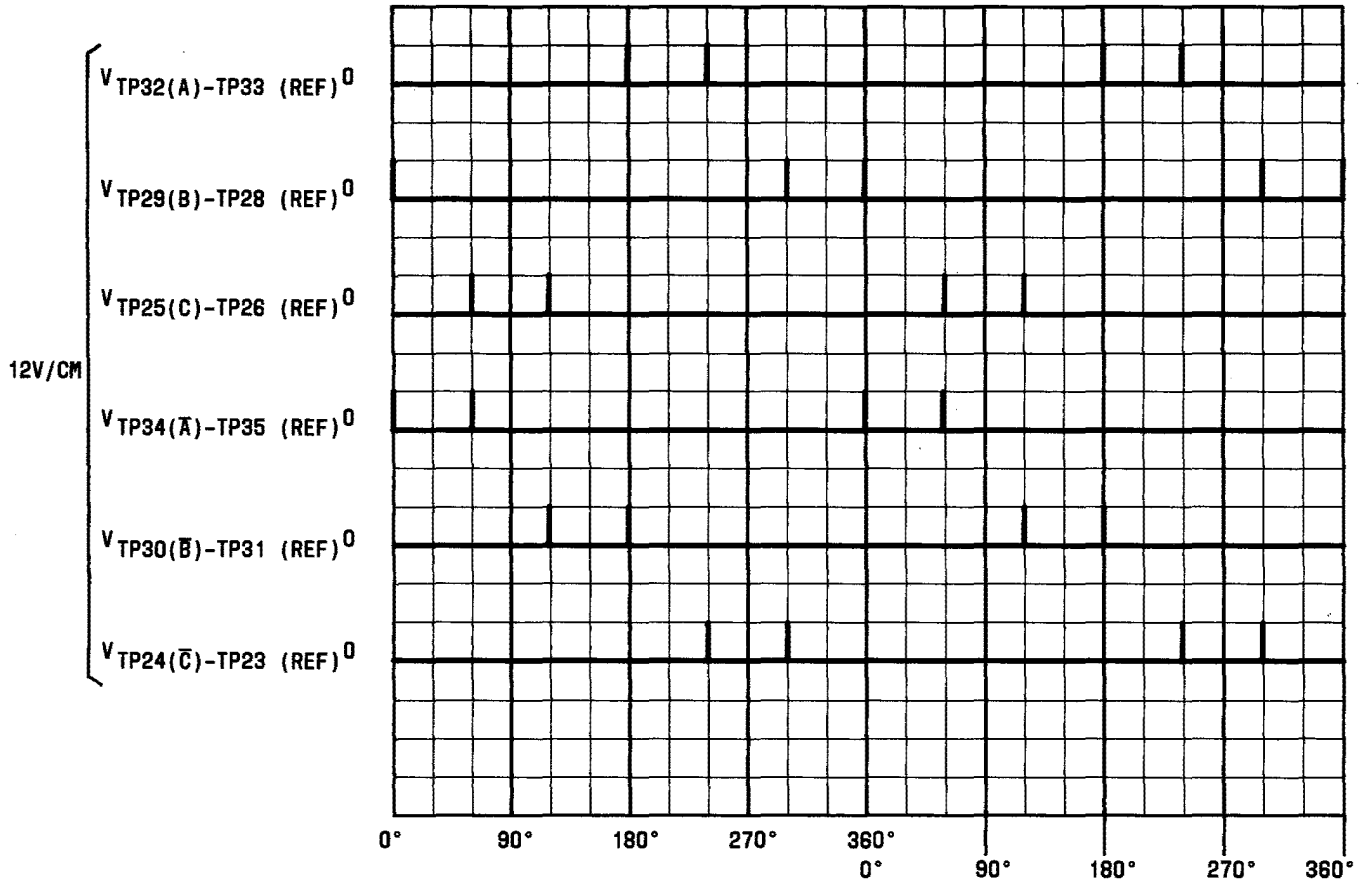

Fig. 4—Oscilloscope Waveforms of Circuit Pack CP1

power from the circuit before removing and replacing printed circuit assemblies (circuit packs).

Warning 2: Operation of the rectifier while a trouble exists may cause additional failures of some components. It is essential, while testing, to be alert to the need of quickly shutting down the rectifier until the trouble is localized and corrected.

4.18 ***Trouble Charts and Tests:*** Trouble Charts I through IX refer to operated fuses, Trouble Chart X refers to shutdown or rectifier failure in which no fuses are operated, and Trouble Charts XI through XVIII refer to an incorrect output.

4.19 ***Test Point Symbols:*** The test point symbols are stamped on circuit packs.

Note 1: Whenever a test procedure requires testing a circuit pack and components or test points are not accessible, the circuit pack board extender should be used.

Note 2: When checking the possible cause of a trouble, a (+) or (-) symbol after the component or test point indicates the polarity of the terminal. This should always be considered when connecting any test apparatus.

5. COMPONENT CHECKING PROCEDURES

5.01 The test procedures in 5.02 through 5.08 are given as an aid in determining defective components ***not mounted*** on a circuit card. In general, the components most likely to become defective with use are semiconductor devices and capacitors. These tests should be made with the rectifier disconnected from ac input power and battery potential.

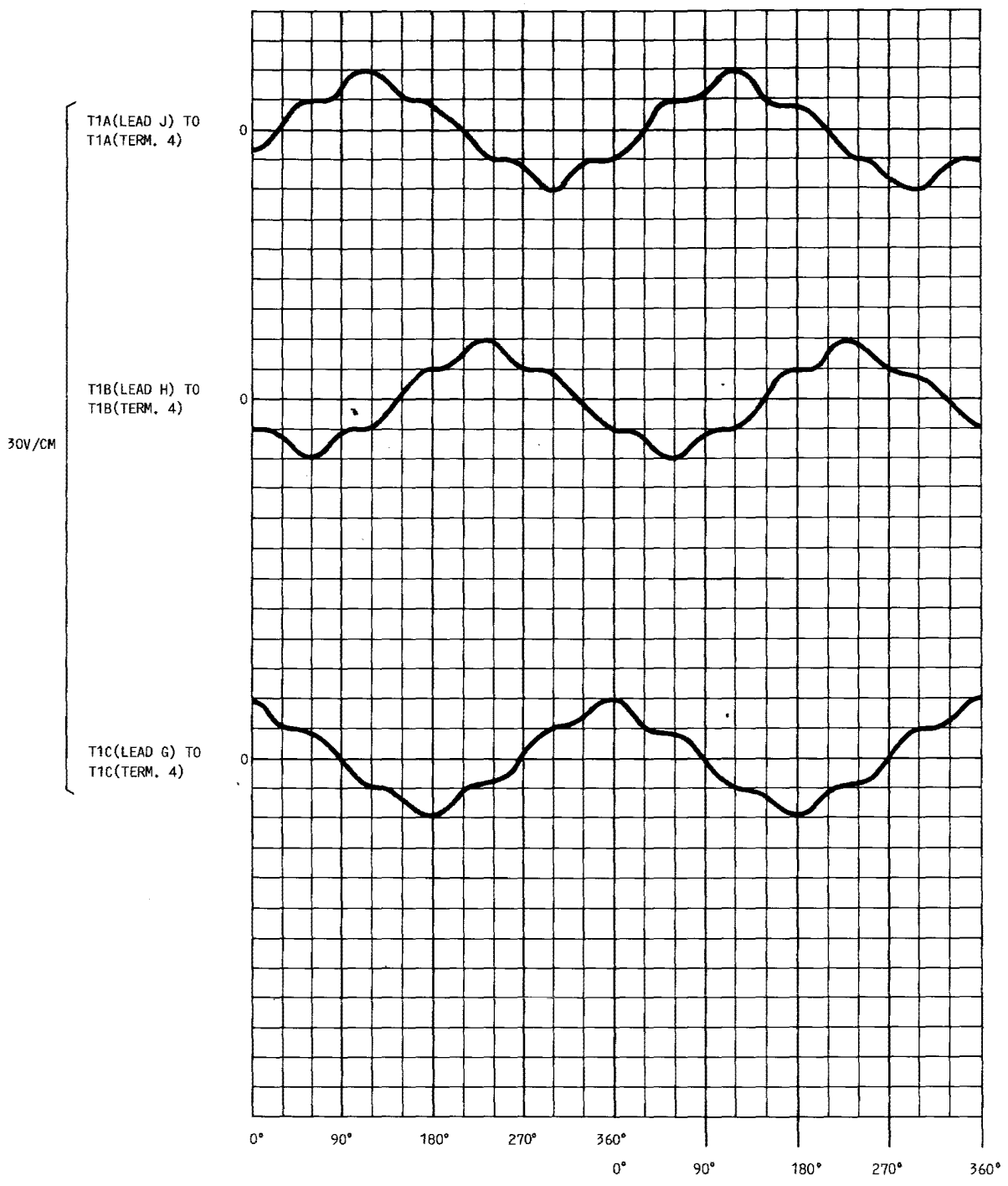

Fig. 5—Oscilloscope Waveforms of Transformer T1

Warning 1: When using an ohmmeter for checking semiconductors, use mid-range ohm scale (scales below RX10,000 and above RX10). The high scale ohmmeter voltage may damage the semiconductor device. A scale too low can force excessive current through some semiconductors. Refer to Section 032-173-301.

Warning 2: Before soldering or unsoldering leads of semiconductors,

refer to Section 032-173-301. Always use a heat sink when soldering leads on semiconductor devices.

Warning 3: Before checking circuits which contain electrolytic capacitors, reference should be made to Section 032-110-501.

5.02 ***Capacitors***

Warning: Prior to testing a capacitor, it should be completely discharged to ground.

When checking capacitors, determine if the capacitor can be checked safely in the circuit without disconnecting one lead from the capacitor. If either ac or dc voltage sources cannot be isolated from the capacitor under test, disconnect one lead from the capacitor terminal. Initially, the capacitor should be discharged by temporarily connecting a 100-ohm, 10-watt resistor across the capacitor terminals. When checking electrolytic capacitors, proper polarity of the test meter to the capacitor terminals must be observed. When using the KS-14510 meter, the black lead of the test meter must be connected to the (+) positive terminals of the capacitor and the red lead of the test meter is connected to the (-) negative capacitor terminal. When testing paper or mica capacitors, polarity of meter leads is not significant. To check a capacitor, proceed as follows.

(1) Set the KS-14510 meter on OHMS X 10,000 scale. (The ohmmeter battery voltage on the OHMS X 10,000 scale is 30 volts dc.)

(2) Connect the meter leads across the capacitor terminals (observing proper polarity for electrolytic capacitors).

Requirement: The ohmmeter indicates low resistance initially and then indicates an increase in resistance as the capacitor charges. Normal resistance readings are as follows:

(a) Paper or mica capacitors of less than 1 microfarad should read 100 megohms or more.

(b) Paper capacitors of more than 1 microfarad should read less than 100 megohms.

(c) Electrolytic capacitors should read greater than 100,000 ohms.

Note: For replacement and maintenance of aluminum type electrolytic capacitors, refer to Section 032-110-701.

5.03 ***Diodes:*** To check a diode, proceed as follows.

Danger: THe heat sinks of diodes CR7-CR12 are electrically connected to the main battery bus. Disconnect the rectifier from battery before performing any work operations on the equipment. Opening of the DC OUTPUT, S1, switch and removal of the F9, Relay and Alarm, fuse removes battery from the secondary of the rectifier and control circuits except at the following locations.

(a) ***Rear of the Relay and Alarm, F9, fuse block on back of the meter panel.***

(b) ***"F Bus" lead to resistors R16 and R17 (located upper left side of cabinet)***

(c) ***EC (L11 and L12 only) and BAT terminals of S6 PRE-CHG switch on S1, DC OUTPUT, switch assembly.***

(1) Set the KS-14510 meter on the OHMS X 1000 scale. (The OHMS X 1000 scale provides minimum current drain—0.075 milliamperes).

(2) Connect the meter leads across the diode leads. Then reserve the meter connections across the diode.

Requirement: The meter indicates high resistance in one direction and low resistance in the opposite direction.

Note 1: Low resistance or high resistance in both directions indicates a possibly defective diode. If the check indicates a defective diode, disconnect one lead of the diode from the circuit and repeat the resistance check.

Note 2: For additional information on the diode test, refer to Section 032-173-301.

5.04 ***Transistors:*** To check a transistor, proceed as follows.

(1) Set the KS-14510 meter on the OHMS X 10 scale (digital meter on 1000 OHMS).

(2) Connect the meter leads as follows.

(a) Connect meter between emitter and collector leads of the transistor. Then reverse the meter connections to the emitter and collector.

Requirement: The meter indicates high resistance in both directions.

Note: Low or zero resistance in either direction may indicate a defective transistor. If the check indicates a defective transistor, disconnect the emitter or collector lead from the circuit and repeat the resistance check.

(b) Connect the meter between the emitter and base leads of the transistor. Then reverse the meter connections to the emitter and base.

Requirement: The meter indicates low resistance in one direction and high resistance in the opposite direction.

Note: Zero resistance may indicate a shorted junction, infinite (∞) resistance indicates an open junction. If a short or open is indicated, disconnect the base or emitter lead from the circuit and repeat the resistance check.

(c) Connect the meter between the collector and base leads of the transistor. Then reverse the meter connections to the collector and base.

Requirement: The meter indicates low resistance in one direction and high resistance in the opposite direction.

Note: Zero resistance may indicate a shorted junction, infinite (∞) resistance indicates an open junction. If a short or open is indicated, disconnect the base or collector lead from the circuit and repeat the resistance check.

5.05 ***Transformers:*** If a trouble condition still exists after checking the possibility of defective circuit cards, semiconductor devices, and capacitors, check for a possible defective transformer as follows.

(1) Set the KS-14510 meter on OHMS X 1000 scale.

(2) Connect the meter leads across each winding of the transformers.

Requirement: The meter indicates continuity—low resistance.

Note: High or infinite (∞) resistance indicates a defective winding.

(3) Connect the meter leads between the case and one winding terminal of the transformer.

Requirement: The meter indicates an open—infinite (∞) resistance.

Note: Low or zero resistance indicates a defective transformer.

5.06 ***Silicon Controlled Rectifiers:*** To check for a defective silicon controlled rectifier, proceed as follows.

Danger: Heat sinks and studs of semiconductor power devices may be approximately 90° C (194° F). Contact with these components must be avoided to prevent burns.

Note: An open SCR may be indicated by cracks, burns, or scorched spots on the porcelain surface. Visually inspect SCRs before starting check.

(1) Connect an ohmmeter as shown in Fig. 6.

(a) Cathode to the negative voltage

(b) Anode to the positive voltage

(c) Switch S1 in OFF position between gate and anode.

(2) With the ohmmeter in the RX1 scale, operate switch S1 to the ON position.

Requirement: The ohmmeter indicates a resistance of from 20 to 50 ohms.

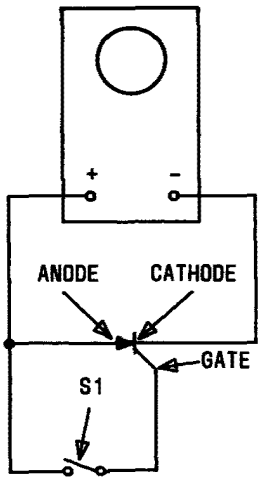

Fig. 6—SCR Test Set-Up

(3) Operate switch S1 to the OFF position.

(4) Momentarily disconnect one end of the lead from the cathode of the SCR to the negative voltage at the meter.

Requirement: The resistance reading is infinite.

(5) Reconnect the lead end that was removed in (4).

Requirement: The resistance reading is infinite until S1 is again closed.

(6) Some additional possible symptoms indicating an SCR malfunction are as follows:

(a) SCR reactor very hot, possibly to the point of giving off smoke.

(b) SCR heat sink cold after period of loading (test with thermometer).

TROUBLE CHART I

OPERATED AC INPUT FUSE(S) OR CIRCUIT BREAKER

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON POWER OFF/AUTOSTART	OUTPUT CURRENT – 0	CLOSURE OF SIB AND SIBR LEADS
PROBABLE CAUSE	**TEST PROCEDURE**	**CORRECTIVE ACTION**
Defective main transformer T1 or input reactor L1	Check per 5.05	Replace as required

TROUBLE CHART II

OPERATED F6.1 OUTPUT CAPACITOR AND F6.2 OUTPUT CAPACITOR ALARM FUSES

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA–RTN CLOSURE. CLOSURE OF SIF AND SIFR LEADS
PROBABLE CAUSE	**TEST PROCEDURE**	**CORRECTIVE ACTION**
Defective output capacitors C4.1 — C4.3	Check per 5.02	Replace faulty capacitors as required

TROUBLE CHART III

OPERATED F7.1 DC OUTPUT AND F7.2 DC OUTPUT ALARM FUSES

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA – RTN CLOSURE. CLOSURE OF SIF AND SIFR LEADS.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Short circuit in power circuit secondary	Correct short circuit condition	Replace operated fuses
B. Power Diode CR1 — CR6 shorted	Check per 5.03	Replace faulty diodes as necessary

TROUBLE CHART IV

OPERATED F1, F2, AND/OR F3 FUSE(S)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA – RTN CLOSURE. CLOSURE OF SIF AND SIFR LEADS.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective T3, T4, or T5 power supply transformer	Check transformers per 5.05	Replace transformers as necessary
B. Defective rectifier diodes on CP7	Check CR1—CR12 on CP7 per 5.03	Replace faulty diodes as necessary

TROUBLE CHART V

OPERATED F4 AND/OR F5 FUSE(S)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA – RTN CLOSURE. CLOSURE OF SIF AND SIFR LEADS.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective T6 autotransformer (L11 and L12 only)	Check autotransformer per 5.05	Replace as required
B. Defective ST3 contactor coil	Turn off input ac. Replace blown fuse and turn on input ac.	
	(1) If fuse operates then T6 transformer is defective.	Replace as necessary
	(2) If fuse does not operate until after rectifier is turned on, coil of ST3 is defective	Replace as necessary

TROUBLE CHART VI

OPERATED F8 OUTPUT VOLTS FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT CURRENT – NORMAL	NONE

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Short circuit applied across + and — output volts jacks	Correct short circuit condition	Replace fuse

TROUBLE CHART VII

OPERATED F9 RELAY AND ALARM FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA – RTN CLOSURE. CLOSURE OF SIF AND SIFR LEADS.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective Q1	Locate Q1 on heatsink at rear of meter panel. Check per 5.04	Replace as required
B. Defective CR25	Locate CR25 on heatsink at rear of meter panel. Check per 5.03	Replace as required

TROUBLE CHART VIII

NO DC OUTPUT CURRENT

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON POWER OFF/AUTOSTART	OUTPUT CURRENT – 0	CLOSURE OF SIB AND SIBR LEADS

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Low ac input voltage	Check ac input voltage between L1, L2, and L3 with KS-14510 volt-ohm-milliammeter. If the voltage is below the limit for which the taps on transformers T3 — T6 and inductor L2 were set and below normal voltage is expected to persist, reconnect transformers and inductor in accordance with Section 169-748-301.	Notify power company or readjust taps
B. External ac input fuse(s), or circuit breaker operated	See Trouble Chart I	
C. AC input power loss	Check ac input voltage	Notify power company if other than temporary condition
D. Plant remote shutdown (Ground on plant TR lead)	Check for ground fault in plant TR wiring external to rectifier if not the desired condition	Repair as necessary

TROUBLE CHART IX

UNBALANCE MONITOR OPERATION (HIGH RIPPLE)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA – RTN CLOSURE. CLOSURE OF SIF AND SIFR LEADS.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective CP5 circuit pack	Substitute a new or repaired CP5 circuit pack	Replace the CP5 circuit pack as required
B. Open power diode CR1 — CR6	Locate the power diodes on heat sinks in the middle of the rectifier. Check per 5.03	Replace diodes as necessary
C. Open thyristor CR7 — CR12	Locate the thyristors on heat sinks at the bottom of the rectifier. Check per 5.06	Replace faulty thyristors as required
D. Open ac (tank) capacitor C1.1 — C3.4	Locate capacitors at bottom of rectifier. Check per 5.02	Replace faulty capacitors as required
E. Leaky dc output capacitors	Locate capacitors at upper left part of rectifier. Check per 5.02	Replace faulty capacitors as required

TROUBLE CHART X

RECTIFIER WILL NOT START

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA – RTN CLOSURE. CLOSURE OF SIE AND SIER LEADS.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Circuit packs not making reliable contact with connectors	Inspect circuit packs and connectors for good connections	Reposition circuit packs as necessary
B. DC OUTPUT switch in OFF — TEST position but TEST switch is in OFF position		Operate TEST switch to ON position.

TROUBLE CHART XI

RECTIFIER WILL NOT START

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON TEST	OUTPUT CURRENT – 0	CLOSURE OF SIG AND SIGR LEADS

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective CP5 circuit pack	Substitute a new or repaired circuit pack	Replace the faulty circuit pack as required
B. Plant sense lead has open circuited (Sense fuse in plant operated)	Using the KS-14510 meter, check plant, RB (—BAT) and RG (+BAT), sense leads for proper voltage.	Repair or replace as required

TROUBLE CHART XII

HIGH VOLTAGE SHUTDOWN – RECTIFIER SHUTS DOWN IMMEDIATELY AFTER RESTARTING

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL POWER OFF/AUTOSTART	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA – RTN CLOSURE. CLOSURE OF SID AND SIDR LEADS

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective CP1 circuit pack	Substitute a new or repaired CP1 circuit pack	Replace defective CP1 circuit pack as necessary
B. Defective CP2 circuit pack	Substitute a new or repaired CP2 circuit pack	Replace defective CP2 circuit pack as necessary
C. Defective CP3 circuit pack	Substitute a new or repaired CP3 circuit pack	Replace defective CP3 circuit pack as necessary
D. Defective CP4 circuit pack	Substitute a new or repaired CP4 circuit pack	Replace defective CP4 circuit pack as necessary
E. Defective CP5 circuit pack	Substitute a new or repaired CP5 circuit pack	Replace defective CP5 circuit pack as necessary
F. Defective CP6 circuit pack	Substitute a new or repaired CP6 circuit pack	Replace faulty CP6 circuit pack as necessary
G. Defective CP8 circuit pack	Substitute a new or repaired CP8 circuit pack	Replace defective unit as necessary
H. Defective CP11 circuit pack	Substitute a new or repaired CP11 circuit pack	Replace defective unit as necessary
I. Open thyristor CR7 — CR12	Locate thyristors on heatsinks at bottom of rectifier. Check per 5.06	Replace faulty units as necessary
J. Defective discharge reactor L2	Locate reactor (inductor) at bottom left corner of rectifier. Check per 5.05	Replace faulty unit as necessary

TROUBLE CHART XIII

HIGH VOLTAGE SHUTDOWN – RECTIFIER SHUTS DOWN ONLY AFTER OUTPUT CURRENT BEGINS TO "WALK-IN"

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON RECT FAIL POWER OFF/AUTOSTART	OUTPUT CURRENT – 0	GROUND ON RFA LEAD OR RFA AND RFA – RTN CLOSURE OF SID AND SIDR LEADS

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Output volts not properly adjusted	Check adjustment in accordance with 4.05 of Section 169-748-301	Readjust as necessary
B. Internal high voltage monitor not properly adjusted	Check adjustment in accordance with 4.08 of Section 169-748-301	Readjust as necessary
C. Defective CP5 or CP6 circuit packs	Substitute new or repaired circuit packs	Replace faulty circuit packs as necessary
D. False ground on plant HV control lead	Check plant wiring for ground condition	Repair or replace faulty wiring as necessary
E. Current limit not properly adjusted	Check adjustment in accordance with 4.06 of Section 169-748-301	Readjust as necessary

TROUBLE CHART XIV

HIGH OR LOW OUTPUT CURRENT (OUTPUT VOLTAGE NEAR NORMAL)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT CURRENT – HIGH OR LOW	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Faulty CP4 circuit pack	Substitute a new or repaired CP4 circuit pack	Replace faulty circuit pack as required
B. Current limit not properly adjusted	Check adjustment in accordance with 4.06 of Section 169-748-301	Readjust as necessary
C. Ground on plant PL control lead (L11 and L12 only)	If not a desired condition, check wiring for a ground fault on PL lead	Repair or replace wiring as necessary
D. Output volts not properly adjusted	Check adjustment in accordance with 4.05 of Section 169-748-301	Readjust as necessary

TROUBLE CHART XV

HIGH OR LOW OUTPUT VOLTAGE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE		
PROBABLE CAUSE	**TEST PROCEDURE**	**CORRECTIVE ACTION**
A. Output volts not properly adjusted	Check adjustment in accordance with 4.05 of Section 169-748-301	Readjust as necessary
B. Current limit not properly adjusted	Check adjustment in accordance with 4.06 of Section 169-748-301	Readjust as necessary
C. Faulty CP4 circuit pack	Substitute a new or repaired CP4 circuit pack	Replace faulty circuit pack as required

TROUBLE CHART XVI

LOW OUTPUT ALARM OPERATED*

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON		CA AND CB LEADS OPEN
PROBABLE CAUSE	**TEST PROCEDURE**	**CORRECTIVE ACTION**
* Normal condition if rectifier is delivering less than 10 percent of its rated output current.		
A. OUTPUT VOLTS not properly adjusted	Check adjustment in accordance with 4.05 of Section 169-748-301	Readjust as required
B. Faulty CP4 circuit pack	Substitute a new or repaired CP4 circuit pack	Replace faulty circuit pack as required
C. Faulty CP5 circuit pack	Substitute a new or repaired CP5 circuit pack	Replace faulty circuit pack as required

TROUBLE CHART XVII

OUTPUT EXCESSIVELY NOISY (UNBALANCE MONITOR INOPERATIVE)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT CURRENT – ERRATIC AND LOW	
PROBABLE CAUSE	**TEST PROCEDURE**	**CORRECTIVE ACTION**
A. Defective CP5 circuit pack	Substitute a new or repaired CP5 circuit pack	Replace the faulty circuit pack as necessary
B. Open power diode CR1 — CR6	Locate the power diodes on heat sinks in the middle of the rectifier. Check per 5.03	Replace diodes as necessary
C. Open thyristor CR7 — CR12	Locate the thyristors on heat sinks at the bottom of the rectifier. Check per 5.06	Replace faulty thyristors as required