

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

24 VOLTS, 100 AMPERES

ITT-NORTH ELECTRIC COMPANY

TROUBLE-LOCATING INFORMATION

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1.	GENERAL	1	1.01 The KS-20491 rectifier (Fig. 1 and 2) provides regulated dc power from a single-phase ac source normally for use in charging and floating a 12-cell battery plant.
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5.	CONNECTING CIRCUITS		1.03 This 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 regulation for combined line and load variation is ±1 percent steady state when the rectifier is operating in an ambient temperature range of 10 to 50°C.
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Tables			1.06 This issue of the section is based on the following drawings:
A.	Circuit Boards	4	● SD-82462-01, Issue 1
B.	Critical Point Operating Voltages	10	● CD-82462-01, Issue 1.
C.	T1-T2 Transformer—Normal Operating Voltages	10	For a detailed description of the operation, see the corresponding circuit description. If this section is to

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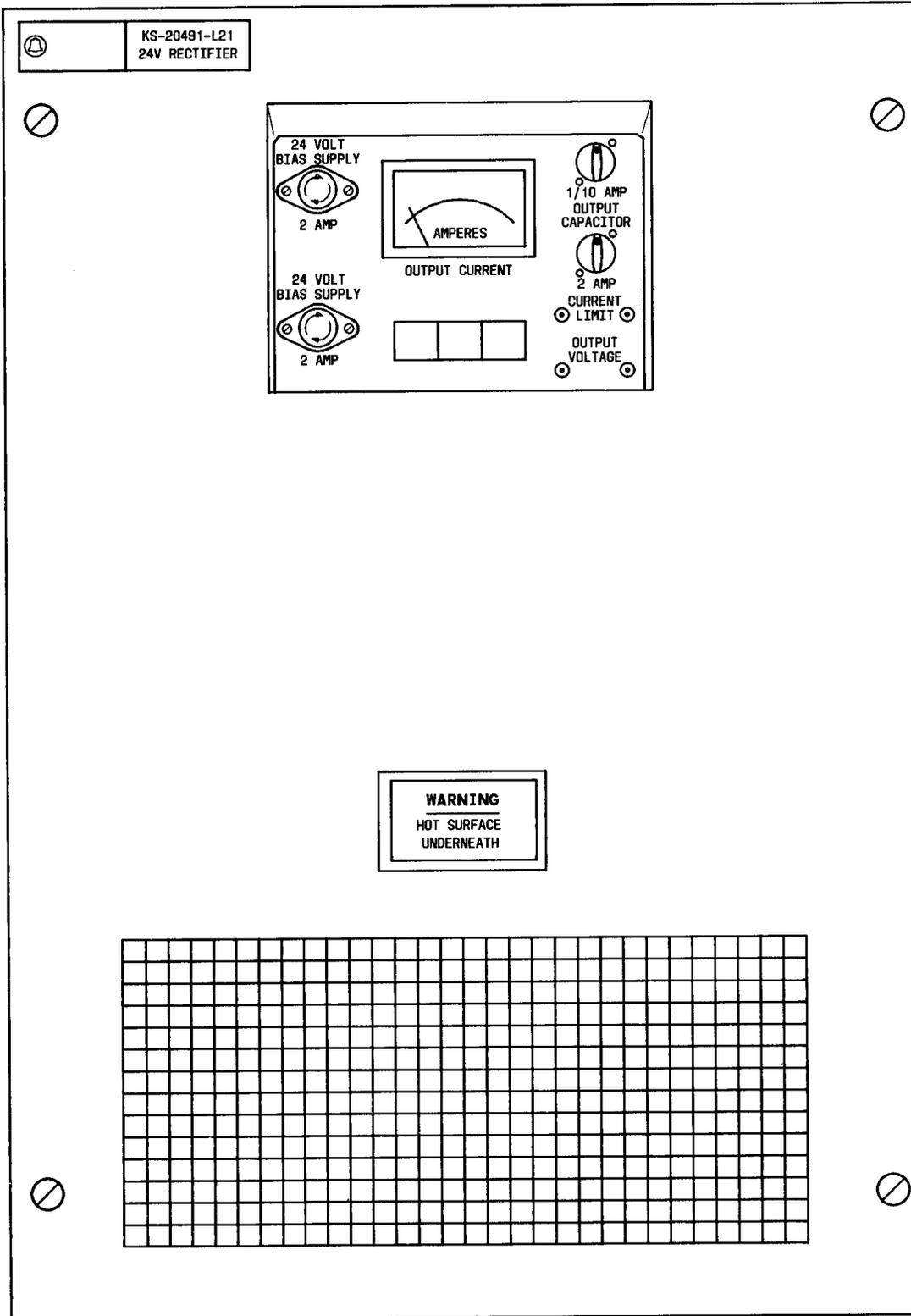


Fig. 1—KS-20491 Rectifier—Front View

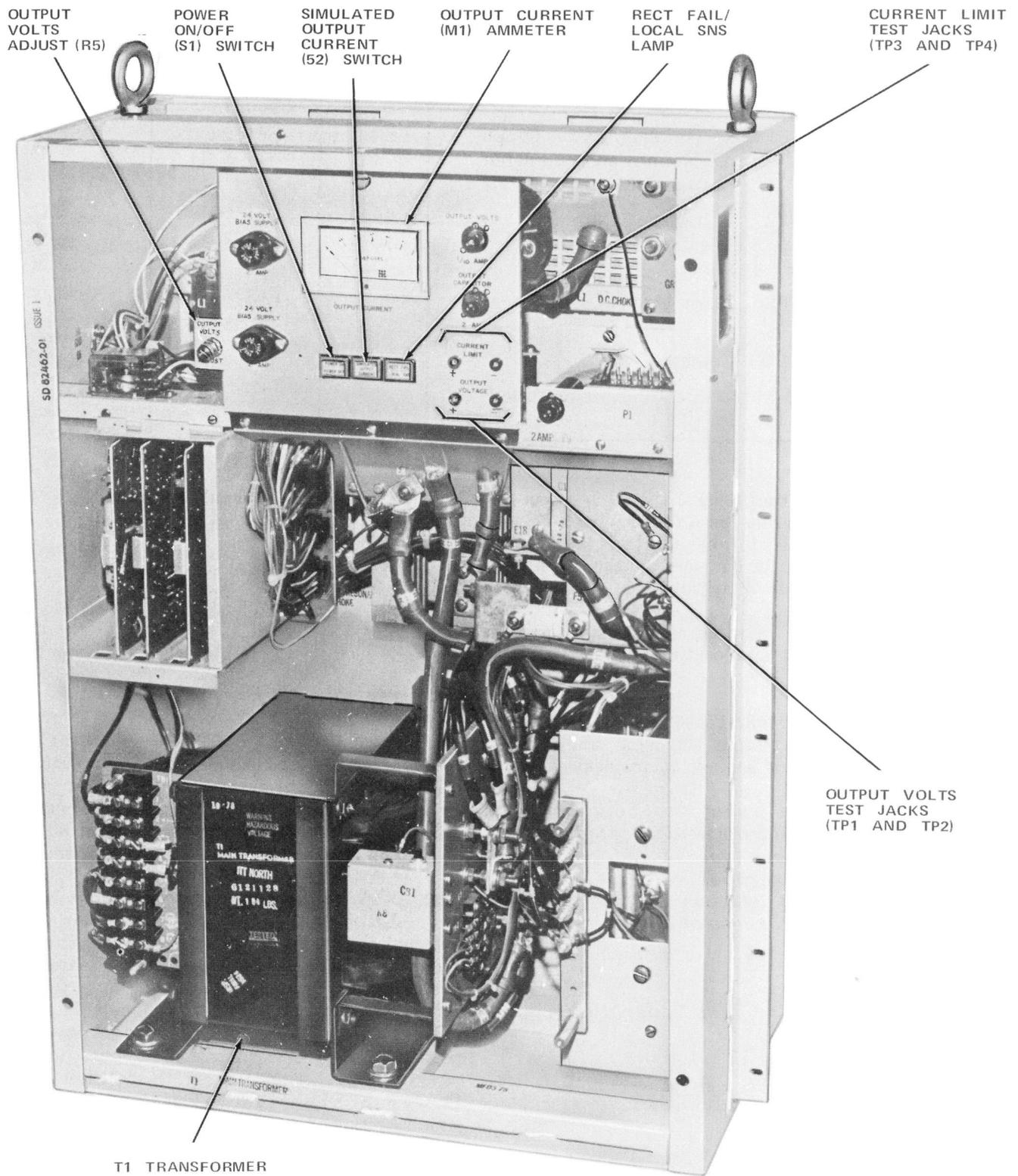


Fig. 2—KS-20491 Rectifier—Front Cover Removed

TABLE A

CIRCUIT BOARDS

CP	LIST NUMBER	KS-20491 RECTIFIER
CP1 — DC Auxiliary Power Supplies, AC Monitor and Simulated Output Current	L201	L21, 22, 23, & 24
CP2 — Voltage and Current Regulation and Current Limit	L202 L204	L21, 22, 23, & 24
CP3 — Alarm Circuits	L203 L205	L21, 22, 23, & 24
CP4 — Extender Board		
CP5 — Connector Card Mounting for CP1-CP3		

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.

1.07 Refer to Table B in paragraph 4.07 for information on testing and locating troubles in the printed circuit boards.

1.08 Refer to Section 032-173-301 for additional information for testing, replacing, and handling of circuit packs and semiconductor devices.

Danger: When using test equipment which is isolated from equipment ground, use extreme care due to the possible presence of hazardous voltages on the test equipment chassis. Triac circuit voltages are in excess of 300 volts.

2. APPARATUS

2.01 List of Tools and Test Apparatus:

TOOLS

3-Inch C Screwdriver

12-Inch Test Clip Cord

TEST APPARATUS

KS-8039 Volt-Milliammeter (or equivalent)

KS-20538 Volt-Ohm-Milliammeter (or equivalent)

KS-20599,L4 Digital Multimeter

Oscilloscope, Tektronix Model 545 with Type W Differential Input Preamplifier (or equivalent)

3. OPERATION

3.01 Normally the KS-20491 rectifier will remain energized and connected to the battery. In addition to manual turn-off, the rectifier may be stopped and started by signals from the plant. The rectifier will shut down and/or lock out automatically upon occurrence of certain trouble conditions.

3.02 With the rectifier output terminals BAT and GRD connected to the battery through the external charge fuse, the power plant control cable connected to the rectifier, the circuit breaker or switch and fuse unit in the bus duct or in the power service cabinet in the ON position, and the rectifier POWER ON-POWER OFF (S1) switch in the OFF position, the ac line voltage is supplied to the dc power circuit through fuses in the rectifier. The DC POWER SUPPLY CIRCUIT (CP1) furnishes bias supply voltages to various control circuits. The voltage regulator circuit (CP2) is connected to the RG and RB remote sensing leads.

3.03 ***To start the rectifier,*** depress the rectifier POWER ON-POWER OFF (S1) switch to the

ON position. The ac input contactor operates to connect ac input power to the rectifier power circuit and the POWER ON lamp lights. Simultaneously, the regulator walk-in (gradual increase in output current) 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.

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

3.04 To shut down the rectifier, the POWER ON-POWER OFF (S1) switch is depressed and released, and the POWER OFF lamp is lighted.

3.05 High 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.

3.06 Rectifier Overvoltage Shutdown: The rectifier is provided with an overvoltage shutdown circuit that will shut down and lock out the rectifier and activate its failure alarms when the output terminal voltage exceeds a preset level. This level is factory set at 29.75 ± 0.2 volts.

3.07 Rectifier Automatic Restart: The rectifier is provided with an automatic restart circuit which will restart the rectifier under the following conditions:

- (a) The closure of the RS and RSR leads by plant after HV shutdown.
- (b) Return of the AC after momentary power outage.

- (c) Application and removal of a ground on the TR lead.

3.08 Blown External Charge Fuse: If a rectifier fault should occur to short the rectifier output terminals, the external charge fuse will operate, blowing its associated charge alarm fuse. When the external charge alarm fuse operates, battery voltage is placed on the plant CFA lead (through a resistor) which shuts down and locks out the rectifier, and a ground signal is sent to the power plant circuit over the RFA lead.

3.09 Rectifier Testing: In order to perform tests and adjustments on the rectifier independently of battery load, proceed as follows:

- (a) Remove the external charge and charge alarm fuses or operate the external charge circuit breaker to OFF.
- (b) Disconnect the PLANT CONTROL DISCONNECT (J1) connector.

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 BAT and GRD output terminals. The output voltage may be set and current functions may be adjusted and tested independently from battery load.

4. TROUBLE-LOCATING PROCEDURES

4.01 Troubles in the KS-20491 rectifier can be listed in two categories.

- Loss of output
- Undesired output, either voltage or current, or both.

The trouble flowchart in Fig. 3 is designed to locate troubles from this viewpoint. The output of the rectifier should be checked and the appropriate category of the flowchart should be consulted to isolate the trouble.

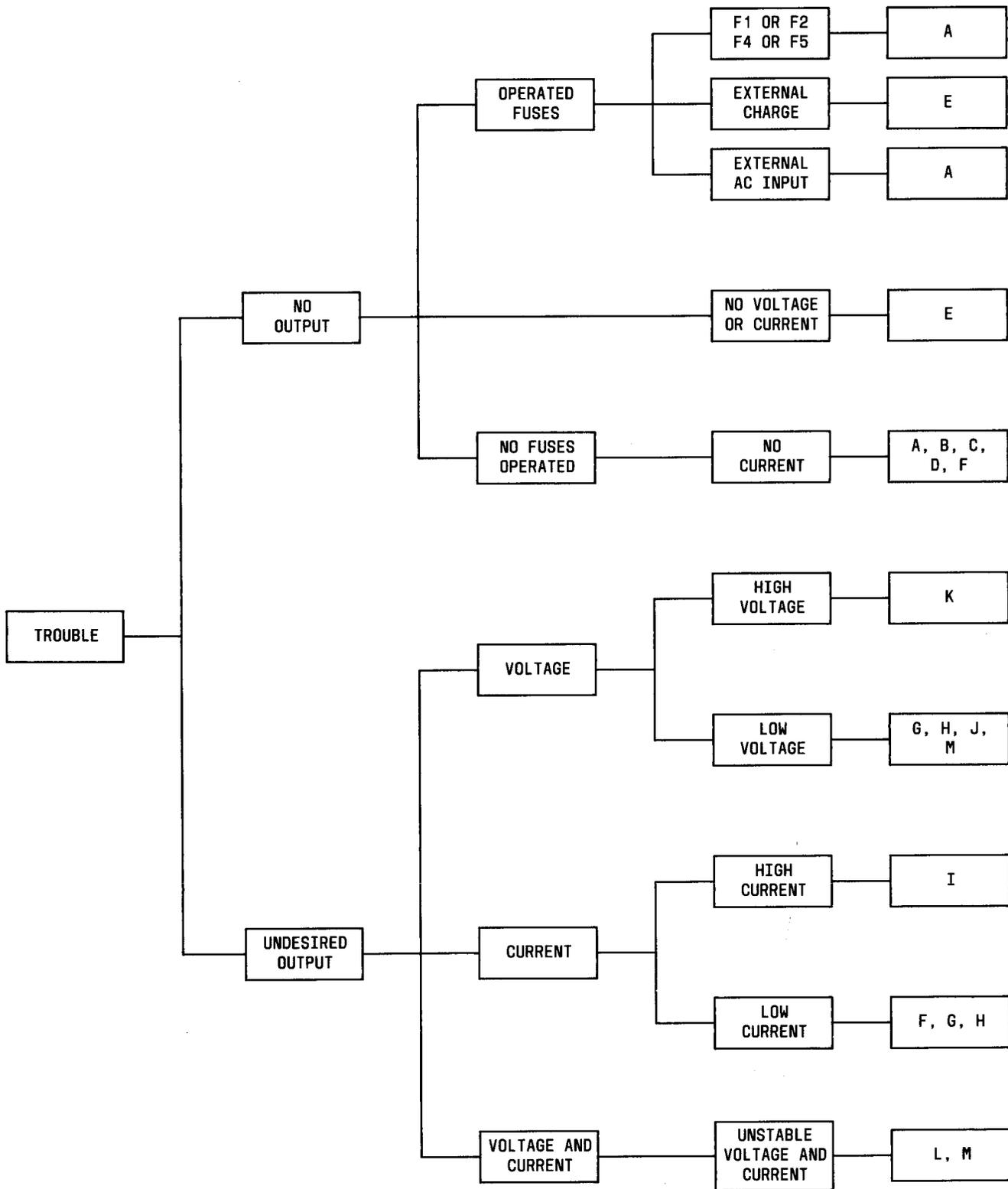


Fig. 3—Trouble-Locating Flowchart

4.02 Trouble-locating should begin with a visual inspection. Check for faulty connections, broken, burned, or shorted wires. Inspect the wiring harness and leads from all components for possible breaks and shorts. Check that all solder joints make good electrical contact.

4.03 Troubleshooting of the main frame should not be attempted until all printed circuit boards (CP1 through CP3) making up the KS-20491 regulator have been found to be good.

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.

4.05 When trouble is encountered, the source of trouble may be determined by the visual indicators or indicator lamps. This rectifier is equipped with the following lamps.

LAMPS	CAUSE OF OPERATION
RECT FAIL	Lighted in the event of operation of the external charge fuse, or the circuit breaker, or whenever RFA relay releases due to low input line voltage, HV shutdown or battery from plant on the CFA lead. RFA released shuts down and locks out the rectifier.
SIMULATED OUTPUT CURRENT	Lighted whenever the SIMULATED OUTPUT CURRENT (S2) switch is depressed.
POWER ON	Lighted when POWER ON — POWER OFF (S1) switch is in the ON position.
POWER OFF	Lighted when POWER ON — POWER OFF (S1) switch is in the OFF position.
LOCAL SNS	Lighted when RG or RB lead is broken. (SNS relay released).

TROUBLE CHART

4.06 Check the following trouble chart for troubles occurring in the rectifier.

TROUBLE CHART

ITEM	TROUBLE CONDITION	PROBABLE CAUSE	REMEDY
A.	Rectifier shutdown. POWER OFF, RECT FAIL lamps lighted	(1) AC service failure (2) Operated fuses F1 or F2, F4 and F5	Check AC voltage between L1 and L2 for low line voltage, as outlined in paragraph 4.12. Replace fuses. If fuse does not hold, check for defective T2 transformer or defective C1-C5 capacitors.
B.	Rectifier shutdown. POWER ON — POWER OFF lamps lighted	False ground signal on TR lead from plant	Check wiring of TR lead to plant for false ground.
C.	Rectifier shutdown. Interlock release. RECT FAIL, POWER ON lamps lighted	Circuit packs not making reliable contact with connectors	Check carefully that circuit packs CP1-CP3 are firmly inserted in connectors.
D.	Rectifier shutdown. RECT FAIL, POWER ON lamps lighted	(1) Defective ALARM CIRCUITS circuit pack (2) Defective relay ST1 (3) Defective contactor ST2 (4) Defective POWER ON-POWER OFF (S1) switch	Replace circuit pack CP3. Replace relay ST1. Replace contactor ST2. Replace (S1) switch.
E.	Rectifier shutdown. EXTERNAL CHARGE FUSE or circuit breaker operated. POWER ON lamp lighted. RECT FAIL lighted	Defective diode in POWER CIRCUIT SECONDARY	Disconnect AC input and operate POWER ON — POWER OFF (S1) switch once. Use a KS-20538 volt-ohm-milliammeter and check for defective diodes CR1 or CR 2.
F.	Rectifier operating. No DC output current. POWER ON lamp lighted	(1) OUTPUT VOLTS ADJUST (R5) rheostat not properly adjusted (2) VOLTAGE REGULATOR and CURRENT LIMIT CIRCUITS circuit pack defective	Check output volts adjustment as outlined in Section 169-703-302. Replace circuit pack CP2.

TROUBLE CHART (Contd)

ITEM	TROUBLE CONDITION	PROBABLE CAUSE	REMEDY
G.	Rectifier operating. Low output voltage or current. POWER ON lamp lighted	(1) OUTPUT VOLTS ADJUST (R5) rheostat not properly adjusted (2) CURRENT LIMIT ADJUST (222) rheostat not properly adjusted (3) Excessive charge lead drop (4) Low AC input voltage	Check output volts adjustment as outlined in Section 169-743-302. Check current limit adjustment as outlined in Section 169-743-302. Check rectifier output lugs for tightness and good connection. Check AC input voltage between L1 and L2 as outlined in paragraph 4.11.
H.	Rectifier operating. Low output voltage or current. POWER ON, LOC SNS lamps lighted	Loss of sensing. (Open RB or RG leads). Operated sense lead fuse. SNS relay released	Check plant sensing circuit for an open. Replace sense lead fuse if necessary.
I.	Rectifier operating. High DC output current (output voltage near normal). POWER ON lamp lighted	(1) CURRENT LIMIT ADJUST (222) rheostat not properly adjusted (2) Defective current limit circuit	Check current limit adjustment as outlined in Section 169-743-302. Replace CP2.
J.	Rectifier operating. Low output voltage. POWER ON lamp lighted	(1) Defective SRS relay or C107 capacitor on CP1. (2) Shorted Q201, defective walk-in circuit or defective A205 on CP2 (3) Shorted Q1 Triac	Replace CP1. Replace CP2. Check Q1 for short and replace as required.
K.	Rectifier operating. High output voltage. POWER ON lamp lighted	(1) OUTPUT VOLTS ADJUST not properly adjusted (2) Defective Q1 Triac (3) Defective CP2	Check output volts adjustment as outlined in Section 169-743-302. Check Q1 for open as outlined in paragraph 4.09. Replace if required. Replace CP2.

TROUBLE CHART (Contd)

ITEM	TROUBLE CONDITION	PROBABLE CAUSE	REMEDY
L.	Rectifier operating. Unstable output. POWER ON lamp lighted	VOLTAGE REGULATOR and CURRENT LIMIT CIRCUITS circuit pack defective	Replace circuit pack CP2.
M.	Rectifier operating. Poor regulation at battery. POWER ON lamp lighted	(1) Excessive charge lead drop (2) VOLTAGE REGULATOR and CURRENT LIMIT CIRCUITS circuit pack CP2 defective	Check rectifier output lugs for tightness and good connection. Replace circuit pack CP2.

4.07 Table B provides a set of normal operating voltages at critical points of the circuit. Test jacks of different colors are provided on the accessible edges of the CP boards.

Note: All measurements are to be made with a digital multimeter with the meter (+) terminal connected to the test point in the table and the (-) terminal connected to the green test jack on CP1.

TABLE B

CRITICAL POINT OPERATING VOLTAGES

TEST POINT + LEAD OF METER		VOLTAGE READING VDC
Red	CP1	-22.0
Brown		-08.0
Black		-12.0
Yellow		+10.8
Orange		+00.6
Blue		-10.0
Slate		-10.4
Black	CP2	-22.47
Red		-01.20
Brown		+00.00
Orange		+00.00
Brown	CP3	-21.00

4.08 Table C provides a set of normal voltages for the T1 and T2 transformers.

TABLE C

T1-T2 TRANSFORMER NORMAL OPERATING VOLTAGES

TRANSFORMER	WINDING	READING AT NO LOAD
T1	5 - 6A	20.6 Vac
	6B - 7A	20.6 Vac
	7B - 8	210.0 Vac
	8 - 9	183.0 Vac
	12 - 13	29.0 Vac
	10 - 11	34.0 Vac
T2	6 - 7	20.0 Vac
	7 - 8	20.0 Vac

THYRISTORS

4.09 Silicon Controlled Rectifier—Thyristor (SCR): The SCR can be tested in the following manner:

- (1) Determine the polarity of the ohmmeter leads and connect the positive (+) lead to the cathode and the negative (-) lead to the anode. The value of resistance shall be 1 megohm minimum. Reverse the meter leads; the value of resistance shall be 1 megohm minimum. (Refer to Fig. 4.)

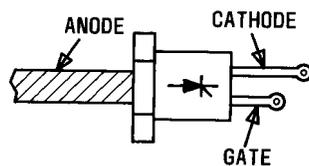


Fig. 4—Silicon Controlled Rectifier-Thyristor

- (2) With the meter still connected negative (-) to cathode, positive (+) to anode, using the 12-inch test clip cord, short the gate to the anode. The value of resistance should decrease to less than 1K ohm.

4.10 The Triac is a bidirectional thyristor which can be tested in the following manner:

- (1) Determine the polarity of the ohmmeter leads and connect the positive (+) lead to MT1 and the negative (-) lead to MT2 of the triac. (Refer to SD-82462-01-B1 and Fig. 5.) The value of resistance shall be 1 megohm minimum. Reverse the meter leads; the resistance shall be 1 megohm minimum.

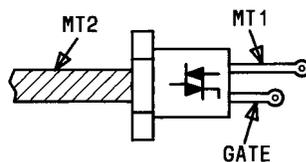
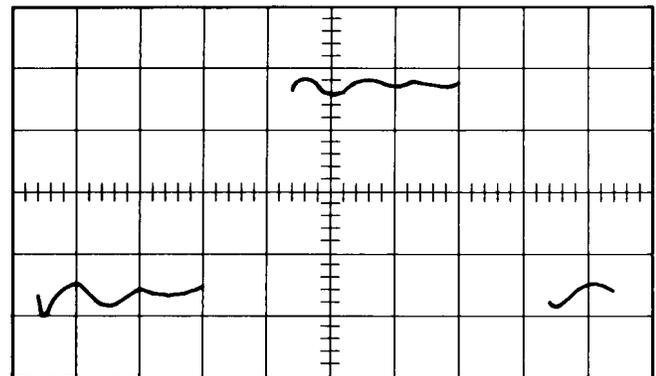


Fig. 5—Triac

- (2) With the meter leads still connected to the MT1 and MT2, using the 12-inch test clip cord, short the gate to MT2. The value of resistance should be between 10 to 500 ohms. Reverse the meter leads on MT1 and MT2 and again short the gate to MT2. The value of resistance should be between 10 to 500 ohms.
- (3) Refer to paragraph 4.11 for checking the triac voltage waveshapes (Fig. 6 and 7).

4.11 Triac Voltage Waveshape:



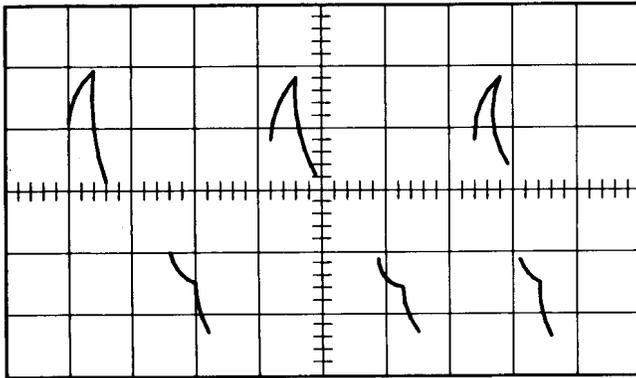
Measured MT1 (+) and MT2 (-)
 Vert. 200 V/CM
 Horiz. 2 Mil SEC/CM
 Rect. Output Voltage 32.B Vdc
 Rect. Output Current 80 Adc
 Resistive Load

Fig. 6—Triac Voltage Waveshape

Danger 1: When using test equipment which is isolated from equipment ground, use extreme care due to the possible presence of hazardous voltages on the test equipment chassis. (For example, MT1 and MT2 of triac is in excess of 300 volts.)

Danger 2: When using test equipment powered from AC line which has one probe (lead) connected to chassis, that probe (lead) must always be connected to equipment ground. If waveshape re-

quires connection of probe (lead) to a point other than equipment ground, the equipment must be isolated from ground through a suitable adaptor plug when troubleshooting the rectifier.



Measured MT2 (-) and Gate (+)
 Vert. .5 V/CM
 Horiz. 5 Mil SEC/CM
 Rect. Output Voltage 32.8 Vdc
 Rect. Output Current 80 Adc
 Resistive Load

Fig. 7—Triac Gate Voltage

4.12 AC Input Check:

- (1) Check that the external ac input fuses are installed and the switch is in the ON position or the external circuit breaker in the bus duct or in the power service cabinet is in the ON position.

- (2) Depress the POWER ON-POWER OFF (S1) switch to the OFF position. The POWER OFF lamp lights.

- (3) Remove the F1 and F2 fuses.

- (4) Using the KS-20599, L4, digital multimeter, set to ACV and 1K, measure the ac input at terminals L1 and L2 of the ST2 contactor. The meter should indicate the following:

<u>NOMINAL VALUE</u>	<u>OPTION</u>	<u>ABSOLUTE LIMITS</u>
208 Volts	Z, T	186 – 221 Volts
240 Volts	Z, V	216 – 253 Volts
480 Volts	Y	430 – 506 Volts

- (5) Remove the multimeter.

- (6) Replace the F1 and F2 fuses.

5. CONNECTING CIRCUITS

5.01 This circuit will function with the following circuits:

- SD-81612-01, Charge and Discharge Circuit, 111A Power Plant
- SD-82299-01, Charge Bay Circuit.