

**KS-21113 L1 AND L2 RECTIFIERS**  
**LORAIN PRODUCTS CORPORATION**  
**152 VOLTS 200 AMPERES**  
**OPERATING METHODS**

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**1. GENERAL**

**1.01** The KS-21113 L1 and L2 rectifiers provide a regulated dc output voltage for automatically floating and charging a 70-cell, lead acid, battery plant. These rectifiers are primarily intended for use in the 415A power plants but may be used whenever their characteristics and design apply. The rectifiers are designed to operate on three-phase, 3-wire, 57- to 63-Hz ac input. The KS-21113 L1 is adapted to operate with an ac input of 208/240 volts and a dc output of 152 volts. The KS-21113 L2 is adapted to operate with an ac input of 480 volts and a dc output of 152 volts. The KS-21113 L1 and L2 rated current output is 0-200 amperes.

**1.02** Whenever this section is reissued, the reason for reissue will be listed in this paragraph. This section does affect the Equipment Test List.

**Warning 1:** *The voltages in 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 as destructive and dangerous short circuits may occur. Disconnect the ac input power to the rectifier before*

*working on the unit except when necessary to make tests.*

**Warning 2:** *This rectifier unit includes automatically controlled equipment. Care must be exercised to prevent the power plant from transferring to those parts on which maintenance work is being performed. Before working on the unit, take the necessary steps to prevent the automatic transfer of equipment by operating keys, removing fuses, blocking relays, etc. When the maintenance work has been completed, restore the plant to the normal operating condition.*

**Caution:** *No output fusing is provided in the rectifier; under no circumstances should rectifier be operated on battery without a KS-21114 control and dc distribution bay or other approved means of fusing.*

**1.03** This rectifier is designed to be serviced and maintained from the front only. All electrical connections can be made with the front covers removed (see Fig. 1). The current meter, controls, and fuses, with the exception of the output filter fuse which is located in the bottom of the rectifier cabinet, are mounted on a hinged control panel for access, maintenance, or replacement (Fig. 2).

**1.04** The instructions in this practice are based on circuit schematic drawing SD-82329-01 Issue 1 for the KS-21113 rectifier. For a detailed description of operation, see the corresponding circuit description. If this section is to be used with equipment reflecting later issue(s) of the drawing, reference should be made to the SD and CD to determine the extent of the change(s) and the manner in which the section may be affected.

**NOTICE**

Not for use or disclosure outside the  
Bell System except under written agreement

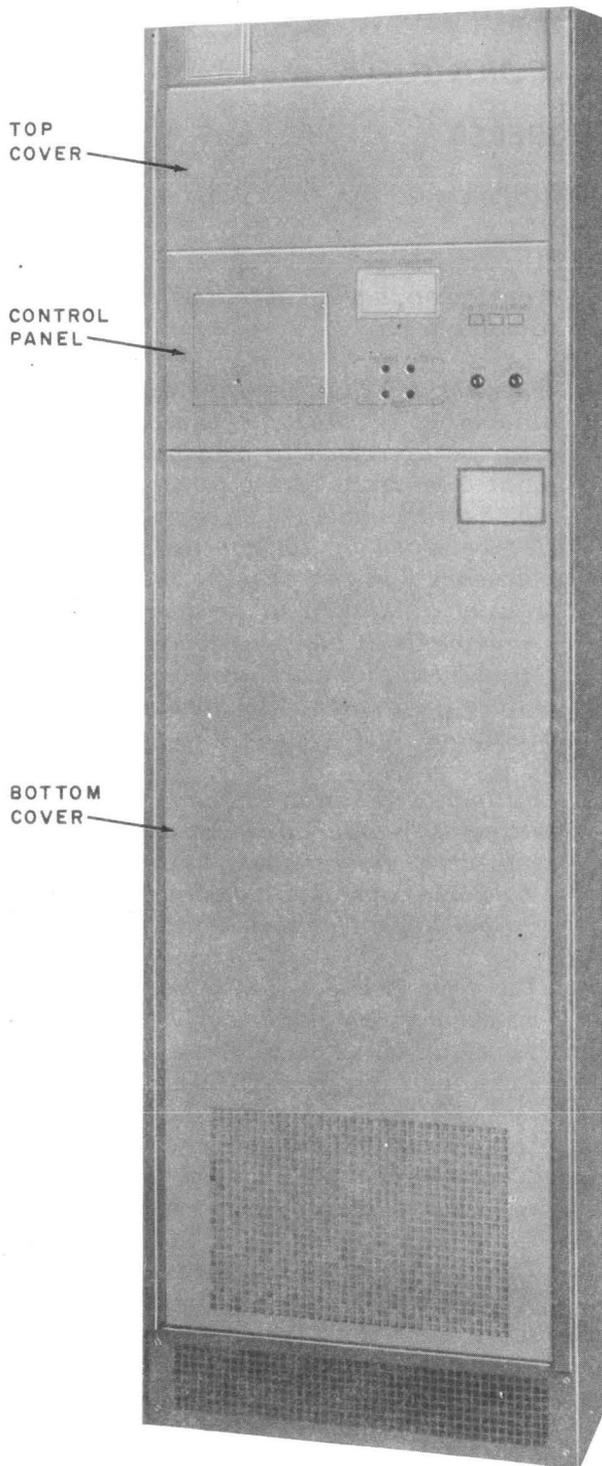


Fig. 1—KS-21113 L1 Rectifier-Covers Installed

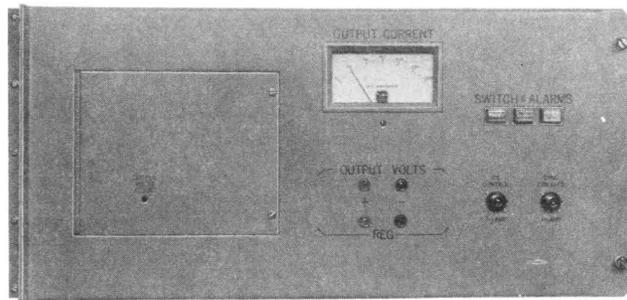


Fig. 2—KS-21113 Rectifier Control Panel—Access Door Closed

**2. LIST OF TOOLS AND TEST EQUIPMENT**

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
—	Trimpot Screwdriver or KS-6854 Screwdriver
KS-21113-L235	Extender Board
<b>TEST APPARATUS</b>	
KS-20599-L4	Digital Multimeter or approved equivalent (4 1/2 digits minimum)

**3. OPERATION**

**3.01 Preparing to Start:** When preparing to place the rectifier in service, check the following.

- (a) The external ac service fuse is installed and the external service circuit breaker is in the OFF position.
- (b) The external output protection fuse is removed.
- (c) The plant control plug (P1) is disconnected (Fig. 3).
- (d) The circuit packs are firmly in place (Fig. 4).
- (e) Verify that the transformers are connected for the correct input (208/240) voltage.

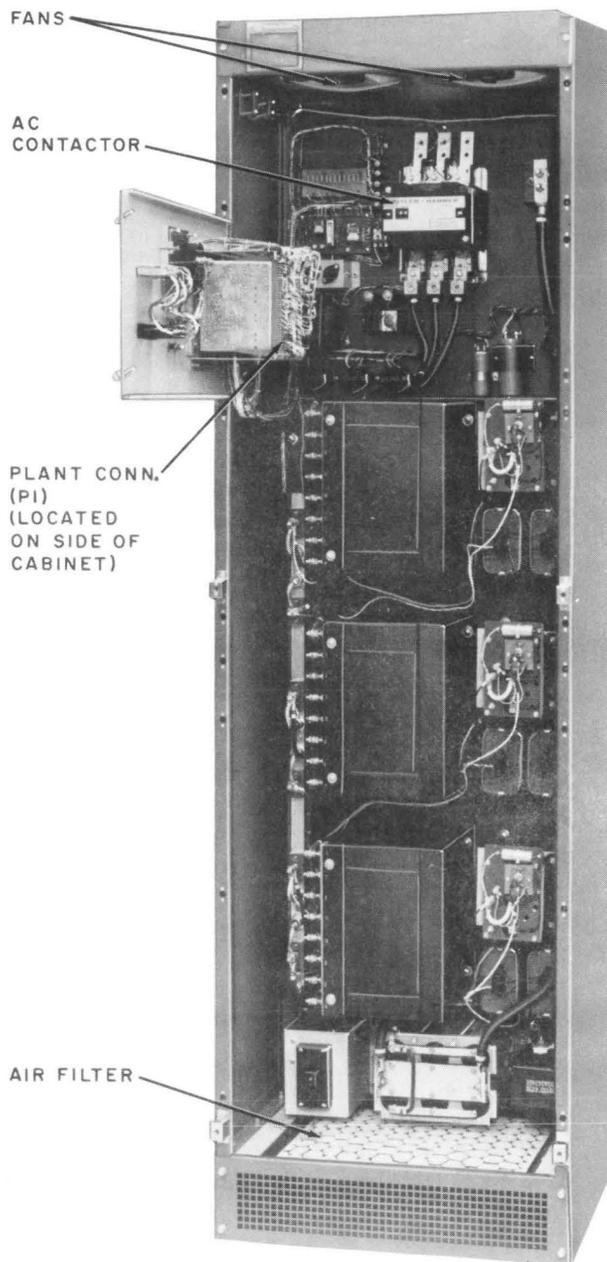


Fig. 3—KS-2113 Rectifier—Covers Removed

**3.02 Starting:** To start the rectifier, proceed as follows.

- (1) Operate associated ac external service circuit breaker to the ON position.

NOTE:  
SKETCH AND CIRCUIT PACK  
READ LEFT TO RIGHT

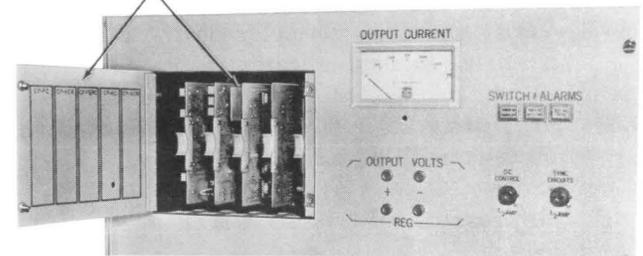


Fig. 4—KS-2113 Rectifier Control Panel—Circuit Cards in Place

**Requirement:** The POWER OFF lamp is lighted.

**Caution:** If the POWER ON/POWER OFF switch is in the ON position, the rectifier will start.

- (2) Depress the POWER ON/POWER OFF switch to the POWER ON position.

**Requirement:** The rectifier starts, the POWER OFF lamp is extinguished; the POWER ON lamp is lighted, and the fans start.

**Warning:** The following steps are performed with the rectifier operating; extreme care should be exercised because of the potentially dangerous high voltage throughout the rectifier.

- (3) Adjust the OUTPUT VOLTS ADJUST potentiometer (R7), located on circuit card VCR, until the output voltage of the rectifier equals that of the battery as indicated on the KS-20599 multimeter connected to the OUTPUT VOLTS jacks.
- (4) Install the EXTERNAL CHARGE and ALM fuses in the associated KS-21114 cabinet.
- (5) Connect the plant control plug (P1).
- (6) Using the KS-20599 multimeter, connected to the REG jacks, ascertain the output voltage is a constant 2.17 volts per battery cell. Readjust the OUTPUT VOLTS ADJUST

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potentiometer (R7), if necessary, until the output voltage is a steady 2.17 volts.

- (7) Verify that the voltmeter on the associated KS-21114 dc bay indicates  $151.9 \pm 0.76$  volts.

**3.03 Stopping:** To shut the rectifier down, proceed as follows.

- (1) Depress the POWER ON/POWER OFF switch.

**Requirement:** The rectifier shuts down, the POWER ON lamp is extinguished, the POWER OFF lamp is lighted, and the fans stop.

- (2) Remove the ac service fuses and operate the associated ac circuit breaker(s) to the OFF position. Remove the external output protection fuse if the rectifier is to be left out of service for an extended period of time.

**Warning:** All power should be disconnected before attempting maintenance in the power sections of the rectifier. The battery should be disconnected when the rectifier is shut down for extended periods or for maintenance. Be careful not to short circuit the battery or sensing terminals.

## 4. ROUTINE CHECKS AND ADJUSTMENTS

**Warning:** Do not attempt to service the rectifier when the red AUTO-START lamp is lighted. The unit is not locked out and can restart from remote action without notice.

**4.01** Routine checks are intended to detect defects particularly in infrequently operating parts of the equipment and, insofar as possible, to guard against circuit failures which interfere with service. Except for cleaning of filters, checks and adjustments, other than those required by trouble conditions, should be performed during a period when there will be a minimum interference to service.

**4.02** Periodically check the output float voltage on the associated power plant voltmeter when the unit is operating on voltage control. If the voltage is not correct, readjust the rectifier float voltage as outlined in 4.05.

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

**4.04** If the relays are mounted on circuit boards, they can be checked by use of the extender board furnished with the rectifier, and must be replaced in case of malfunction. If possible, periodically check all other relays for condition of contacts, making sure that they are in accordance with the circuit requirements table and Bell System Practices which apply.

**Caution:** 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.

**Note:** Before making the following tests, remove the rectifier from service by removing the external battery protective fuse and unplugging the plant control plug (P1).

**4.05 Output Voltage Adjustment** is made as follows.

- (1) Operate the POWER ON/POWER OFF switch to the POWER ON position.

**Requirement:** The rectifier starts, the POWER-OFF lamp is extinguished, and the POWER ON lamp is lighted.

- (2) Connect the KS-20599 multimeter, set on the 1000-volt dc scale, to the REG jacks.

**Requirement:** The voltage indicated on the KS-20599 multimeter is equal to the battery float requirement at the associated power plant or 2.17 volts per cell if no battery float requirement is given. Verify that the voltmeter on the associated KS-21114 bay indicates  $151.9 \pm 0.76$  volts. If this requirement is met, proceed to (4). If the requirement is not met, continue with (3).

(3) Adjust the OUTPUT VOLTS ADJUST potentiometer until the output voltage of the rectifier is equal to the battery float requirement per 3.02(7) at the associated power plant or 2.17 volts per cell if no battery float requirement is given.

(4) Disconnect the KS-20599 multimeter.

(5) If no further checks or adjustments are to be performed, return the rectifier to normal service.

**4.06 Current Limiting Adjustment** when necessary, is accomplished as follows.

**Note:** The CURRENT LIMIT ADJUST potentiometer is factory set for 200 amperes.

(1) Depress the POWER ON/POWER OFF switch to the POWER OFF position.

**Requirement:** The rectifier shuts down, the POWER ON lamp is extinguished, and the POWER OFF lamp is lighted.

(2) Remove the external output protection fuse and plant control plug (P1).

(3) Connect a dummy load to the output of the rectifier capable of exceeding 200 amperes.

(4) Depress the POWER ON/POWER OFF switch to the POWER ON position.

**Requirement:** The rectifier starts, the POWER OFF lamp is extinguished, and the POWER ON lamp is lighted.

(5) With the dummy load on the output adjusted in excess of 200 amperes, adjust the CURRENT LIMIT ADJUST potentiometer (R31), located on circuit card VCR, until ammeter (M1) on the control panel indicates 200 amperes.

**Requirement:** The ammeter (M1) indicates 200 amperes.

(6) Remove the dummy load.

(7) If no further checks or adjustments are to be performed, return the rectifier to normal service.

**4.07 TR Shutdown**

(1) Using a suitable jumper, connect ground to terminal 7 of the plant control plug (P1).

**Requirement:** The rectifier shuts down.

(2) Remove the jumper.

**Requirement:** The rectifier restarts.

(3) If no further checks or adjustments are to be performed, return the rectifier to normal service.

**4.08 HV Shutdown**

(1) Connect ground to pin 6 of the plant control plug (P1).

**Requirement:** The rectifier will shut down providing the rectifier is supplying more than 10 amps of load current.

(2) Remove ground.

**Requirement:** Rectifier remains off. To restart rectifier, see 4.09.

**4.09 Auto-Start**

(1) Connect ground to pin 4 of the plant control plug (P1).

**Requirement:** The rectifier will restart if the rectifier was disabled by an HV shutdown.

(2) Remove ground.

(3) If no further checks or adjustments are to be performed, return the rectifier to normal service.

**5. TROUBLES**

**5.01** If trouble is encountered with the rectifier, first decide whether to locate trouble with the unit operating or not. The rectifier has been designed to make parts accessible for testing with power on. Generally trouble can be located quicker with the equipment energized. If the trouble is of a nature to cause excessive output, limit operation to short periods while making checks. In case any parts overheat, shut the unit down immediately.

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**5.02** A failure in the rectifier is usually accompanied by a shutdown and alarm indications. The lamps on the control panel plus the plant signal leads should provide sufficient information to determine the reason for shutdown. The trouble

flow chart in Fig. 5 provides the possible lamp indications for the associated plant troubles. Trouble charts I and II provide the possible causes of the troubles and their associated remedies.

**TROUBLE CHART I**

<b>STEP</b>	<b>POSSIBLE CAUSE</b>	<b>REMEDY</b>
1	R7 OUTPUT VOLTS ADJ not properly adjusted	Check output volts adjustment as outlined in 4.05.
2	R31 CURRENT LIMIT ADJ not properly adjusted	Check current limit adjustment as outlined in 4.06.
3	R7 OUTPUT VOLTS ADJ not properly adjusted	Check output volts adjustment as outlined in 4.05.
	R31 CURRENT LIMIT ADJ not properly adjusted	Check current limit adjustment as outlined in 4.06.
	Excessive charge lead drop	Check rectifier output lugs for tightness and good condition.
	Low ac input voltage	Check ac input voltage between L1 and L2 with a volt-ohm-milliammeter. If the voltage is below limits for which taps on T1, T2, or T3 transformers were set in accordance with notes on the schematic drawing and lower voltage is expected to persist, reconnect transformers T1, T2, and T3 in accordance with the notes.
	Loss of sensing	Check plant sensing circuit for an open circuit. Check that SNS1 and SNS2 relays on the alarm sensing circuit board AS are energized.
	Shorted +24B power supply	Check for shorted transistor Q1.
4	Excessive charge lead drop	Check rectifier output lugs for tightness and good condition.
	Voltage and current regulator circuit board VCR defective	Substitute circuit card VCR.
5	Defective diode CR1, CR2, CR4, CR5, CR6, CR7	Disconnect ac input and remove charge fuse. Use volt-ohm-milliammeter to check for defective diode.
	Unbalanced power circuit, transformers T1, T2, and T3 not delivering equally, due to maladjustment of balance controls R2.0, R2.1, and R2.2 on circuit card PC.	Readjust controls R2.0, R2.1, and R2.2 on circuit card PC.

STEP	POSSIBLE CAUSE	REMEDY
5	Defective Triac CR1 on triac assembly	Replace Triac assembly TA.
<b>TROUBLE CHART II</b>		
1	R7 OUTPUT VOLTS ADJ not properly adjusted	Check output volts adjustment as outlined in 4.05.
	Voltage and current regulator circuit card defective	Substitute circuit card VCR.
2	S1 in OFF position	Operate switch S1 to the ON position.
3	Ground applied to "TR" lead	Check "TR" lead to plant for false ground.
	Low or absent ac line voltage	Check ac voltage between L1 and L2 and L3 for low or zero voltage. See schematic drawing for appropriate voltages.
4	Loose or absent circuit card	Check carefully that all circuit cards (PC, VCR, AC, PS/RC, and ACM) are firmly in connectors.
5	Both ventilating fans failed	Replace the failed fans.
6	HV shutdown lead	Check wiring of "HV" to plant for false ground.
		Substitute circuit card VCR.
		Check triacs on triac assemblies.
	Blown Fuse	Check external charge fuse. If charge fuse has operated, check diodes (CR1, CR2, CR4, CR5, CR6, and CR7).
		Check ac derived power supply fuse F5.
		Check control fuse F2.
		Check capacitor fuse F1. If capacitor fuse has operated, check filter capacitors (C3-C8).
	Loss of $\pm 12$ VDC Power Supply	Check Power Supply fuses F3 and F4.
		Substitute circuit card PS/RC.
		Check auxiliary power supply transformer T7.

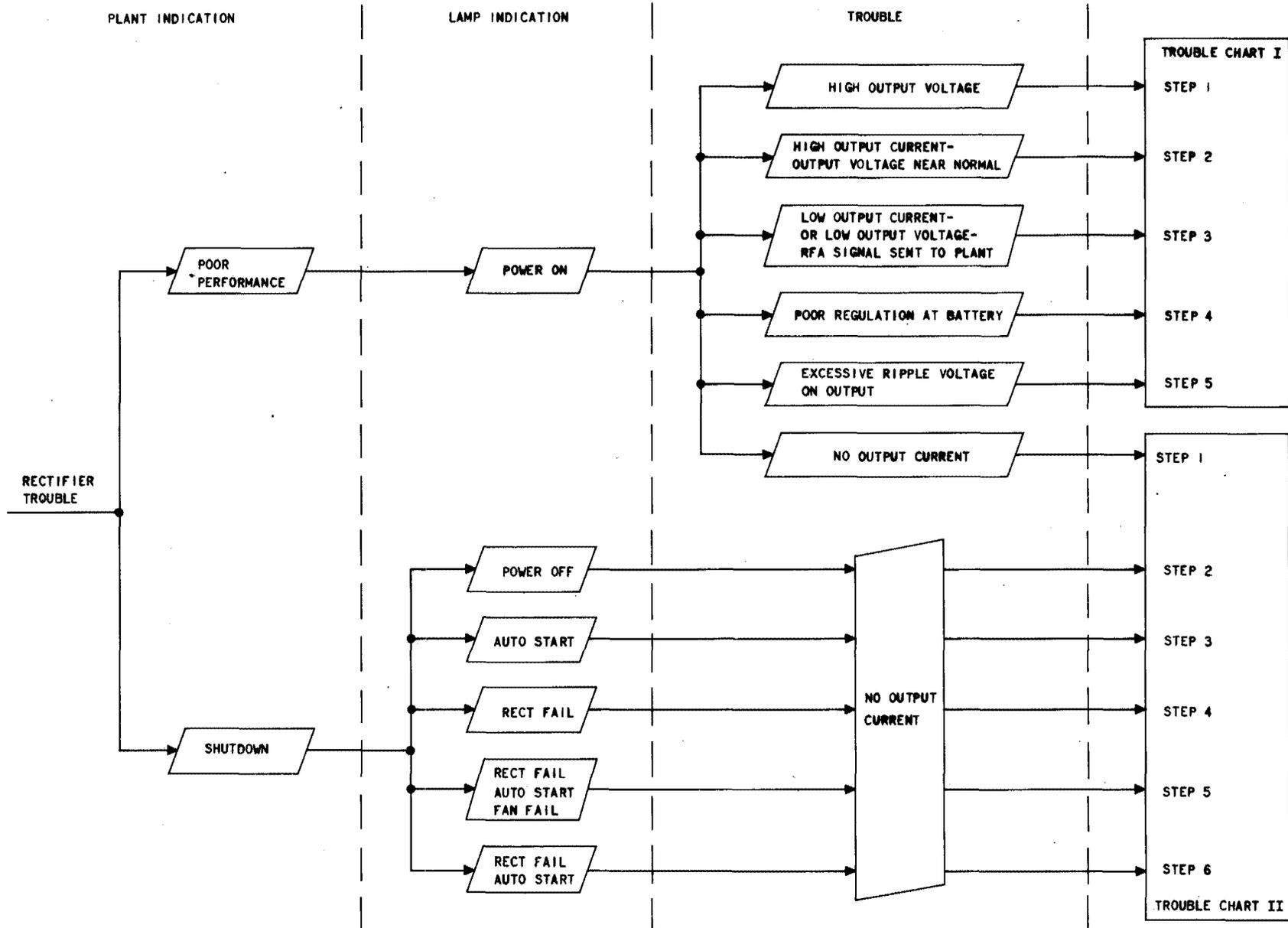


Fig. 5—Trouble Flow Chart

**5.03** Should any component of the following circuits become defective, replace the complete circuit board.

DC Power Supply Circuit—PS/RC  
AC Voltage Monitor—ACM  
Pulse Circuit—PC  
Voltage and Current Regulator—VCR  
Alarm Circuits—AC

**5.04** Voltage checks may be made on circuit boards by using the extender board furnished with the system. Should any circuit board become defective, it is desirable to replace it with a properly adjusted spare. The replaced board could then be checked and repaired without affecting rectifier service. Test-bench circuit board troubleshooting is not required; a spare rectifier is preferred.