RECTIFIERS
KS-20491, L21, L22, L23, L24
24 VOLTS, 100 AMPERES
LORAIN PRODUCTS CORPORATION
OPERATING METHODS

CONTENTS PAGE

1. GENERAL

1.01 This rectifier provides regulated dc power from a single-phase ac power source for use in charging and floating 11- or 12-cell batteries plus two end cells added in series with the original battery. Rated full output current is 100 amperes for 11 or 12 cells and 80 amperes for 13 or 14 cells. This rectifier is primarily intended for use in 110A, 111A, 303A, 301C, 302A, and 326 power plants. This rectifier is of the ferroresonant type. This type rectifier can provide a relatively constant dc output voltage and may be used whenever the voltage, current capacities, and regulation characteristics meet the application requirement.

1.02 This section is reissued to include a second version of the KS-20491 rectifier. Although the two rectifiers differ substantially in physical appearance, the electrical differences are such that the rectifiers lend themselves to a common description in this section. The first version will be referred to as rectifier -01, and the second as rectifier -02, with reference to the schematic diagrams SD-81997-01 and SD-81997-02 on which this section is based. Since this is a general revision, no revision arrows were used. This issue does affect the Equipment Test List.

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 rectifier is adaptable for the following variations:

KS-20491 RECTIFIERS

LIST NO.	AC INPUT	DC OUTPUT
L21	208/240V	−24V
L22	480V	−24V
L23	208/240V	+24V
L24	480V	+24V

1.04 The rectifier output voltage is adjustable from 23.87 to 32.80 volts. The output voltage is regulated within ±0.5 percent. For a 11- and 12-cell application, the rated output current is 100 amperes from 23.87 to 28.4 volts output. For a 13- and 14-cell application, the rated output current is 80 amperes from 28.2 to 32.8 volts output.

1.05 The rectifier will operate with a permissible input voltage variation of −10 percent to +5 percent about the nominal values. The rectifier is equipped with a low ac input voltage monitor to shut down but not lock out the unit in the event of low ac input voltage. When the voltage is restored to an acceptable level, the rectifier will automatically restart.

1.06 The rectifier is of the electronically controlled ferroresonant type in which the output is taken across the secondary of the power transformer.

1.07 This rectifier is designed to mount on a 23-inch relay rack framework or in a cabinet with similar mounting arrangements and can be serviced and maintained from the front only. All electrical connections can be made with the front cover removed or door opened. The meter, controls, and fuses are mounted on a hinged panel for access, maintenance, or replacement in the rectifier −01. In the rectifier −02, the panel is removable.

1.08 This issue is based on the following drawings:

- SD-81997-01, Issue 7B
- SD-81997-02, Issue 1
- SD-82030-01, Issue 5B.

For a detailed description of the operation, see the corresponding circuit description. If this section is to be used with equipment that is associated with an earlier or later issue 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.

1.09 The following circuit options apply to the KS-20491 rectifier −02:

- Option R: This option provides an external charge fuse.
- Option S: This option provides an internal output circuit breaker.

Note: Option S is not available with the rectifier −01.

2. APPARATUS

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

TOOLS	DESCRIPTION
—	3-Inch C Screwdriver
—	12-Inch Insulated Jumper—Alligator Clip Each End (Two Required)

TEST APPARATUS

KS-20538	Volt-Ohm-Milliammeter (VOM) (or equivalent)
KS-8039	DC Volt-Milliammeter (or equivalent)

3. OPERATION

3.01 The rectifier is completely automatic in the regulation of float voltage and should require no day-to-day routine adjustments. Normally it remains energized and connected to the load. In addition to manual turn-off, it may be stopped and started by signals from the plant, and will shut down automatically upon occurrence of certain trouble conditions.

3.02 The output circuitry of the rectifier is electronically protected by current limiting which is adjustable from 50 to 100 percent of the rated output current.

3.03 Facilities have been included in the rectifier to permit no-load testing by electronic circuitry, ie, while the rectifier is disconnected from load and battery.

3.04 In the event of a commerical power failure, the load will be driven by the plant battery until commerical power is restored or until the battery is discharged to a level insufficient to carry the load. When commercial power is restored, the rectifier output must be increased to carry the load and recharge the battery. The recommended float level of the battery is 2.17 volt/cell while the overcharge value is 2.20 volt/cell.

3.05 ***Preparing to Start:*** When putting the rectifier into service, check the following:

(a) Rectifier output terminals BAT and GRD are connected to battery.

(b) Plant control cable is connected to the rectifier.

(c) The POWER switch is operated to OFF.

Requirement: POWER-OFF lamp is lighted (if equipped).

(d) The ac service fuses and dc supply fuses are installed.

(e) The dc circuit breaker CB1 is operated to ON (Option S, rectifier -02) or charge and charge alarm fuses are installed (rectifier -01 or Option R, rectifier -02).

3.06 ***Starting:*** To start the rectifier, proceed as follows:

(1) Depress the POWER switch to ON.

Requirement: The POWER-ON lamp is lighted (if equipped).

(2) Observe the OUTPUT CURRENT meter.

Requirement: Depending upon the battery voltage, load current, and number of rectifiers in the plant, the rectifier may or may not assume part of the load. If the plant is equipped with only two rectifiers, the second should assume the load.

3.07 ***Stopping:*** To stop the rectifier, proceed as follows:

(1) Depress the POWER switch to OFF.

Requirement 1: The POWER OFF lamp is lighted (if equipped).

Requirement 2: The OUTPUT CURRENT meter should indicate zero current.

(2) If the rectifier is to be left out of service for an extended period of time, remove the ac service fuses, external charge and charge alarm fuses, and disconnect the control cable.

Danger: 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

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. 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 output voltage as outlined in paragraph 4.06.

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

4.04 If possible, periodically check all relays for condition of contacts, making sure that they are in accordance with the circuit requirement table and Bell System Practices which apply.

Danger: When using a portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be

tested. If connections are to be changed from one instrument range to another, the power should first be disconnected from equipment being tested or, if test picks are being used, they should be removed from the equipment under test.

4.05 ***Placing Rectifier in Test Mode:*** To place rectifier in test mode, proceed as follows:

(1) Depress the POWER switch to OFF.

Requirement: POWER OFF lamp is lighted (if equipped).

(2) Remove front cover from rectifier, or open door.

(3) Unplug the control cable to the plant.

(4) Remove the external charge fuse and charge alarm fuse, or operate circuit breaker CB1 (if equipped) to OFF.

(5) Connect a jumper between the BAT output terminal and terminal 15 of P1 plug.

4.06 ***Output Voltage Adjustment:*** To adjust the rectifier output voltage, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

(1) Depress the POWER switch to ON.

Requirement: The POWER ON lamp is lighted (if equipped).

(2) Connect the KS-8039 volt-milliammeter, set to the 30-volt scale, to the OUTPUT VOLTS jacks.

(3) Loosen the locking device and slowly rotate the OUTPUT VOLTS ADJUST potentiometer until the reading on the KS-8039 volt-milliammeter is equal to the battery float voltage requirement at the associated power plant or 2.17 volts per cell if no battery float requirement is given. Tighten the locking device for the OUTPUT VOLTS ADJUST potentiometer being careful not to disturb the setting.

(4) Disconnect the volt-milliammeter.

Note: Return the rectifier to service per paragraph 4.13, or continue with paragraph 4.07

4.07 ***Current Limit Adjustment:*** To adjust the current limit of the rectifier, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

Note: The CURRENT LIMIT ADJUST potentiometer is factory set for 100 amperes.

(1) Loosen the locking device and rotate CURRENT LIMIT ADJUST fully cw.

(2) Connect KS-20538 VOM, set to the 60-volt dc scale, as follows:

(a) On rectifiers equipped with CURRENT LIMIT test jacks, ***reverse*** the polarity of the test probes when making the connection.

(b) On rectifiers equipped with OUTPUT VOLTS test jacks, observe ***correct*** polarity when making the connection.

(3) Depress the POWER switch to ON.

(4) Depress and maintain depressed the SIMULATED OUTPUT CURRENT switch while turning the SIMULATED OUTPUT CURRENT potentiometer cw until the OUTPUT CURRENT meter indicates the desired maximum output current.

(5) Rotate CURRENT LIMIT ADJUST ccw until the VOM indicates that the output voltage is beginning to drop (rectifiers equipped with OUTPUT VOLTS test jacks) or that the VOM, switched to 3Vdc scale, indicates 1.25 to 1.5 volts (rectifiers equipped with CURRENT LIMIT test jacks).

(6) Return the VOM to the 60-volt range.

(7) Release the SIMULATED OUTPUT CURRENT switch.

(8) Turn the SIMULATED OUTPUT CURRENT potentiometer fully ccw.

(9) Tighten the locking device for the CURRENT LIMIT ADJUST potentiometer being careful not to disturb the setting.

(10) Disconnect the VOM.

Note: Return the rectifier to service per paragraph 4.13, or continue with paragraph 4.08.

4.08 ***Overvoltage Shutdown Adjustment:*** To adjust the overvoltage shutdown, verify that

the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

Note: The OV ADJUST potentiometer is factory set to shut down and lock out the rectifier if the output voltage exceeds 30 volts.

(1) With the rectifier turned off, rotate the OV ADJ potentiometer fully cw.

(2) Connect the KS-8039 meter, set to the 75 Vdc scale, to the OUTPUT VOLTS test jacks, (+) and (−), observing proper polarity.

(3) Remove CP3 circuit pack (if equipped), insert extender board into the connector, and insert CP3 into the extender board.

(4) Turn the rectifier on by depressing the POWER switch to ON.

(5) Adjust the OUTPUT VOLTS ADJUST cw until the KS-8039 meter indicates 30 volts.

(6) Slowly rotate the OVS ADJ ccw until the rectifier shuts down.

(7) Rotate the OUTPUT VOLTS ADJUST fully ccw.

(8) Remove extender board and reinsert CP3 into control panel.

(9) Turn the rectifier on by depressing the POWER switch to OFF, then to ON.

(10) Adjust the output voltage to the desired level in accordance with paragraph 4.06.

(11) Disconnect KS-8039 meter.

Note: Return the rectifier to service per paragraph 4.13, or continue with paragraph 4.09.

4.09 ***TR Shutdown Check:*** To check the TR shutdown circuit, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

(1) Turn the rectifier on and use a suitable jumper to connect ground to pin 7 of the P1 plug.

Requirement: The rectifier shuts down.

(2) Remove the jumper.

Requirement: The rectifier restarts.

Note: Return the rectifier to service per paragraph 4.13, or continue with paragraph 4.10.

4.10 ***HV Shutdown Check:*** To check the HV shutdown circuit, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

(1) Turn the rectifier on and use a suitable jumper to connect ground to pin 6 of the P1 plug.

(2) Depress and hold the SIMULATED OUTPUT CURRENT switch.

(3) Rotate the SIMULATED OUTPUT CURRENT potentiometer cw.

Requirement: The rectifier shuts down and locks out when the OUTPUT CURRENT ammeter indicates about 5 amperes.

(4) Release the SIMULATED OUTPUT CURRENT switch.

(5) Remove the jumper.

(6) Depress the POWER switch to OFF then to ON to restart the rectifier.

(7) Rotate the SIMULATED OUTPUT CURRENT potentiometer fully ccw.

Note: Return the rectifier to service per paragraph 4.13, or continue with paragraph 4.11.

4.11 ***Overvoltage Shutdown and Lockout Check:*** To check overvoltage shutdown and lockout, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

(1) Turn the rectifier on and connect the KS-8039 meter, set to the 75-volt scale, to the (+) and (−) rectifier OUTPUT VOLTAGE jacks.

(2) Using the OUTPUT VOLTS ADJUST potentiometer, slowly increase the voltage.

Requirement: The rectifier shuts down and locks out when the voltage is between 29.55 and

29.95 volts (rectifier -01) or between 29.8 and 30.02 (rectifier -02).

Note: If shutdown occurs below or above these limits, adjust the shutdown voltage in accordance with paragraph 4.08.

(3) Disconnect the KS-8039 meter from the rectifier OUTPUT VOLTAGE jacks.

Note: Return the rectifier to service per paragraph 4.13, or continue with paragraph 4.12.

4.12 ***Automatic Restart Check:*** To check automatic restart, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

(1) Provide a connection between the RS and RSR leads (pins 4 and 5) of P1.

(2) Simulate an HV shutdown in accordance with paragraph 4.10 except that the SIMULATED OUTPUT CURRENT switch should be released immediately after shutdown occurs.

Requirement: The rectifier automatically restarts approximately 2 seconds after shutdown.

(3) Simulate a second HV shutdown in accordance with paragraph 4.10.

Requirement: The rectifier does not restart until the POWER switch is depressed to OFF then to ON.

(4) Depress POWER switch to OFF.

Note: Continue with paragraph 4.13 to return rectifier to service.

4.13 ***Returning Rectifier to Service:*** To return the rectifier to service, proceed as follows:

Warning: Make sure the rectifier output filter capacitors are charged before the charge and charge alarm fuses are installed or the output circuit breaker is operated to ON.

(1) Refer to the associated plant Bell System Practice, then replace the external charge and charge alarm fuses or operate the external charge circuit breaker to ON.

(2) Remove the jumper between the BAT output terminal and the CBS lead (terminal 15 of the PLANT CONTROL DISCONNECT P1 plug).

(3) Reconnect the PLANT CONTROL DISCONNECT (P1) TO (J1).

(4) Return CP4 extender board to inside of rectifier cover.

(5) Replace rectifier front cover.

(6) Restore rectifier to service by depressing POWER switch to ON.

5. TROUBLES

5.01 Refer to the following sections for trouble locating information on the KS-20491 rectifiers manufactured by the Lorain Products Corporation:

(1) Section 169-743-311 (SD-81997-01)

(2) Section 169-743-313 (SD-81997-02).