

RECTIFIERS
KS-20491, L21, L22, L23, AND L24
24 VOLTS, 100 AMPERES
ITT—NORTH ELECTRIC COMPANY
OPERATING METHODS

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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-82462-01 and SD-82462-02 on which this section is based. Significant differences will be pointed out and correlated to the rectifiers. Since this issue is a general revision, no revision arrows have been used to denote significant changes. This issue does affect the Equipment Test List.

1.03 The rectifier is arranged for single-phase, 60 \pm 3 Hz, input and is suitable for use with battery power plants where 3-phase service is not available. The rectifier output current range is 0 to 100 amperes and is adaptable for the following variations:

1. GENERAL

1.01 This rectifier provides regulated dc power from a single-phase ac power source and will automatically charge and float 11- to 12-cell battery plants at currents up to 100 amperes or 13- to 14-cell battery plants at currents up to 80 amperes. The batteries may be of the lead antimony or lead calcium types. This rectifier is of the ferroresonant type and is primarily intended for use in the 100- and 300-type power plants. The rectifier may be used whenever the voltage and current capabilities and regulation characteristics meet the job requirement.

1.02 This section is reissued to include a second version of the KS-20491 rectifier. Although

KS-20491 RECTIFIERS		
LIST NO.	AC INPUT	DC OUTPUT
L21	208/240V	-24V
L22	480V	-24V
L23	208/240V	+24V
L24	480V	+24V

NOTICE

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

Note: For an 11- and 12-cell operation, the rated current output is 100 amperes from 23.87 to 29.60 volts. For a 14-cell operation, the rated current output is 80 amperes from 23.87 to 32.80 volts.

1.04 The rectifier will operate with a permissible input voltage variation as follows:

NOMINAL	VARIATION
208V	186 to 221V, Z&T Options
240V	216 to 253V, Z&V Options
480V	430 to 506V, Y Option

1.05 The rectifier is equipped with the following operating features:

- (a) An ac input voltage monitor which shuts down the rectifier when the ac input voltage drops below a predetermined value and automatically turns the rectifier on when the ac input voltage is restored to an acceptable level.
- (b) Automatic restart of the rectifier upon receiving a loop closure signal from the plant if the rectifier has been shut down and locked out by a temporary fault such as transient high voltage.
- (c) An output voltage monitor which shuts down and locks out the rectifier when the voltage exceeds a preset level. This level is set at 29.75 volts with an operating tolerance of ± 0.2 volts.

1.06 This rectifier utilizes a triac controlled ferroresonant transformer and voltage and current regulator circuits to electronically control the output voltage. The output voltage is protected by the external charge fuse or charge circuit breaker and by the current limit features.

Danger: Voltages inside the rectifier case are over 150 volts to ground. 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 alternating current supply before working on the rectifier, except when necessary to make tests.

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. The meter, controls, and fuses are mounted on a hinged panel for access, maintenance, or replacement.

1.08 This issue of the section is based on SD-82462-01, Issue 2B and SD-82462-02 Issue 3AC.

For a detailed description of the operation, see the corresponding circuit descriptions. 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.

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 (Three Required)
TEST APPARATUS	
KS-20538	Volt-Ohm-Milliammeter (VOM) (or equivalent)
KS-8039	DC Volt-Milliammeter (or equivalent)
KS-20599, L4	Digital Multimeter

3. OPERATION

3.01 The rectifier is completely automatic in the regulation of float voltage and should require no day-to-day routine adjustments. The rectifier normally remains energized and connected. In addition

to manual turnoff, it may be stopped and started by signals from the plant, and will shut down automatically upon occurrence of certain conditions.

3.02 If the load exceeds the safe capacity of the rectifier, the regulating circuit switches to constant current regulation. As the load diminishes, the rectifier brings the voltage to float value and returns to voltage regulation. The voltage at which the rectifier will regulate is determined by the setting of the OUTPUT VOLTS ADJUST potentiometer.

Note: The rectifier will provide output voltages of 23.87 to 29.60 volts at 100 amps or below for 11- to 12-cell operation and from 23.87 to 32.80 volts at 80 amps or below for 14-cell operation.

3.03 The rectifier can be tested without disturbing the office load by following the procedure outlined in paragraph 4.05.

3.04 A circuit is provided to simulate an adjustable output current up to 125 amperes. The simulated output current circuit is enabled only when the SIMULATED OUTPUT CURRENT pushbutton is maintained depressed.

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

- (a) The POWER switch is in the OFF position. (The POWER OFF lamp is lighted, if equipped.)
- (b) The plant control cable is connected to the rectifier.
- (c) The ac service fuses are installed.
- (d) If equipped, verify output circuit breaker is set to ON or charge and charge alarm fuses are installed.

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

- (1) Depress the POWER switch to ON.

Requirement: The POWER ON lamp lights (if equipped).

- (2) After waiting approximately 15 seconds to allow for completion of walk-in before making

adjustments, loosen the locking device and rotate the OUTPUT VOLTS ADJUST potentiometer cw to increase or ccw to decrease the output voltage of the rectifier until the voltage at the battery (as indicated on the plant voltmeter) is the required value. Tighten the locking device for the OUTPUT VOLTS ADJUST potentiometer being careful not to disturb the setting.

Requirement: The voltage at the battery should meet the voltage values specified in the appropriate plant Bell System Practice.

- (3) Observe the OUTPUT CURRENT ammeter to make sure the rectifier accepts its portion of the load (see the appropriate plant Bell System Practice for voltage and current adjustment of the rectifier).

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

- (1) Depress the POWER switch to OFF.

Requirement: The POWER OFF lamp lights (if equipped).

- (2) If the rectifier is to be left out of service for an extended period of time, remove the ac service fuses, output circuit breaker or charge and charge alarm fuses, and disconnect the plant 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 float voltage as outlined in paragraph 4.06.

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 circuit 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.

Warning: *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 the Rectifier in the Test Mode:

The rectifier should be tested and adjusted in the test mode and disconnected from the office load. To place the rectifier in the test mode, use the following procedure:

- (1) Turn the rectifier off by operating the POWER switch to OFF.
- (2) Remove rectifier front cover.
- (3) Disconnect the rectifier from the office load as follows:
 - (a) **Rectifier -01:** Remove the external charge fuse and charge alarm fuse or operate the external charge circuit breaker to OFF.
 - (b) **Rectifier -02:** Operate the external circuit breaker to OFF, or remove the external charge fuse and charge alarm fuse (Option -R), or operate the output circuit breaker CB2 to OFF (Option -S).

Note: External charge and charge alarm fuses are located at top of rectifier bay.

- (4) Disconnect the plant control disconnect (J1) jack from the rectifier.

- (5) If equipped with Option -R, connect a jumper between the BAT output terminal and the CBS lead (terminal 15 of the plant control disconnect, P1 plug). See Table A and Fig. 1.

- (6) The rectifier is now in the test mode and may be turned on without disturbing the office load.

4.06 Output Voltage Adjustment: To adjust the 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 lights (if equipped).

- (2) Connect the KS-20599, L4, digital multimeter, set to 100 DCV scale, to the OUTPUT VOLTAGE test jacks.

- (3) Loosen the locking device and slowly rotate the OUTPUT VOLTS ADJUST potentiometer until the reading on the digital multimeter is equal to the battery float voltage requirements 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 digital multimeter.

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

4.07 Current Limit Adjustment: If it is necessary to readjust the current limit point, 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) With the rectifier turned off, loosen the locking device and rotate the CURRENT LIMIT ADJUST potentiometer fully cw.

- (2) Connect DMM to rectifier as follows:

TABLE A

PLANT CONTROL DISCONNECT PLUG—PIN DESIGNATION

PIN	DESIGNATION	FUNCTION
1	RB	REG BATTERY
3	RG	REG GROUND
4	RS	REMOTE START
5	RSR	REMOTE START RETURN
6	HV	HIGH VOLTAGE SHUTDOWN
7	TR	REMOTE SELECTIVE SHUTDOWN
8	RFA	RECTIFIER FAIL ALARM
9	CA	LOW CURRENT
10	CB	LOW CURRENT
12	RFA-RTN	RFA— RECTIFIER FAIL ALARM RETURN
14	CFA	CHARGE FUSE ALARM
15	CBS	CONTROL BATTERY SUPPLY

(a) On rectifier -01, connect the KS-20599, L4, digital multimeter, set to 10 DCV scale, to the CURRENT LIMIT test jacks.

(b) On rectifier -02, connect the KS-20599, L4, digital multimeter, set to 100 DCV scale, to the REG+ and REG- test jacks.

(3) Depress the POWER switch to ON.

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

Requirement: The SIMULATED OUTPUT CURRENT lamp is lighted (if equipped).

(5) Rotate the SIMULATED OUTPUT CURRENT potentiometer cw until the OUTPUT CURRENT ammeter indicates the desired maximum output current. In the absence of a plant requirement, adjust to 100 amperes.

(6) Rotate the CURRENT LIMIT ADJUST potentiometer slowly until the digital multimeter indicates a decrease in voltage (rectifier -02) or an increase in voltage (rectifier -01).

(7) Release the SIMULATED OUTPUT CURRENT switch.

Requirement: The SIMULATED OUTPUT CURRENT lamp extinguishes (if equipped).

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

(9) Disconnect the digital multimeter.

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

4.08 Overvoltage Shutdown Adjustment in Plant Without End Cell: If it is necessary to readjust the overvoltage shutdown setting, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

Note: The OVS ADJ potentiometer (located on CP3) is factory set to shut down and lock out the rectifier if the output voltage exceeds 29.75 \pm 0.2 volts.

(1) With rectifier turned off, remove CP3, insert CP4 extender board, and insert CP3 into extender board.

Note: The CP4 extender board is mounted inside of the rectifier front cover.

(2) Rotate the OVS ADJ potentiometer fully cw.

(3) Connect the KS-20599, L4, digital multimeter, set to 100 DCV scale, to the OUTPUT VOLTS

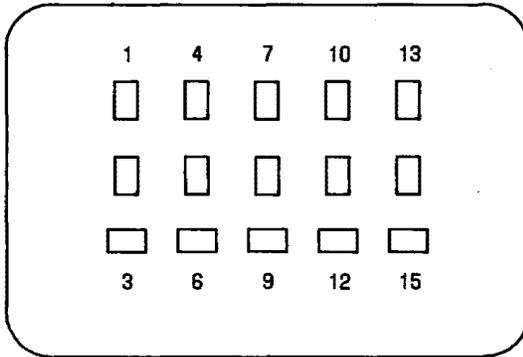


Fig. 1—P1 Plug Wiring Side

test jacks or REG+ and REG- test jacks located on the rectifier control panel.

- (4) Turn the rectifier on by depressing the POWER switch to ON.
- (5) Adjust the OUTPUT VOLTS ADJUST potentiometer cw until the meter indicates 29.75 volts.
- (6) Slowly rotate the OVS ADJ potentiometer ccw until the rectifier shuts down.
- (7) To restore the rectifier, rotate the OUTPUT VOLTS ADJUST potentiometer fully ccw.
- (8) Turn the rectifier on by depressing the POWER switch to OFF and then to ON.
- (9) Adjust the output voltage to the desired level in accordance with paragraph 4.06.
- (10) Disconnect digital multimeter.

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

4.09 Overvoltage Shutdown Adjustment in Plant With End Cells: To set overvoltage shutdown, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

Note: When charging end cells, it may be necessary to reset the overvoltage shutdown feature for 35-volt operation.

- (1) With rectifier turned off, remove CP3 from its connector, insert CP4 extender board in its place, and plug CP3 into the extender board.
- (2) Rotate OVS ADJ potentiometer fully cw.
- (3) Remove CP2 from its connector and, using an insulated jumper wire, short resistor R249.
- (4) Replace CP2 into its connector.
- (5) Turn the OUTPUT VOLTS ADJ fully ccw.
- (6) Turn the rectifier on by depressing the POWER switch to ON.
- (7) Observing proper polarity, connect the KS-20599, L4, meter, set to 100 DCV scale, to the OUTPUT VOLTS test jacks or REG+ and REG- test jacks.
- (8) Adjust the OUTPUT VOLTS ADJUST potentiometer until the KS-20599, L4, meter indicates 35 volts.
- (9) Slowly rotate OVS ADJ potentiometer ccw until the rectifier shuts down.
- (10) To restore rectifier, rotate the OUTPUT VOLTS ADJUST potentiometer fully ccw.
- (11) Remove the CP4 extender board and replace CP3 in its connector.
- (12) Remove the jumper wire from R249 and replace CP2 in its connector.
- (13) Turn the rectifier on by depressing the POWER switch, first to OFF and then to ON.
- (14) Adjust the output voltage to the desired level in accordance with paragraph 4.06 and disconnect digital multimeter.

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

4.10 TR Shutdown: To cause a TR shutdown, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

- (1) With rectifier turned on, 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 4.11.

4.11 HV Shutdown: To cause a HV shutdown, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

- (1) With the rectifier turned on, 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 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 and 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 4.12.

4.12 Remote Recycle Check: To check the remote recycle circuit, verify that the rectifier is in the test mode per paragraph 4.05; then proceed as follows:

- (1) With the rectifier turned off, depress and hold the SIMULATED OUTPUT CURRENT switch.

Requirement: The SIMULATED OUTPUT CURRENT lamp lights (if equipped).

- (2) Rotate the SIMULATED OUTPUT CURRENT potentiometer cw until the OUTPUT CURRENT ammeter indicates 10 amperes.

- (3) Using a suitable jumper, connect ground to pin 6 of the P1 plug.

Requirement: The rectifier shuts down and locks out.

- (4) Using a suitable jumper, connect pin 4 to pin 5 of the P1 plug.

Requirement: The rectifier restarts after 2 seconds and then shuts down and locks out again.

- (5) Disconnect the jumper from pin 4 of P1 plug and then temporarily reconnect the jumper to pin 4.

Requirement: The rectifier restarts after 2 seconds and then shuts down and locks out.

- (6) Release the SIMULATED OUTPUT CURRENT switch.
- (7) Disconnect the jumpers from pin 6 of P1 to ground and from pin 4 and 5 of P1 plug.
- (8) Turn off rectifier by depressing the POWER switch to OFF.
- (9) Turn the SIMULATED OUTPUT CURRENT potentiometer on CP1 fully ccw.

4.13 Returning Rectifier to Service: To return rectifier to service, refer to the associated plant Bell System Practice; then proceed as follows:

Warning: Make sure that the output filter capacitors are charged before the rectifier is reconnected to the plant.

- (1) Reconnect the rectifier output to the associated plant as follows:
 - (a) **Rectifier -01:** Replace the external charge and charge alarm fuses or operate the external charge circuit breaker to ON.
 - (b) **Rectifier -02:** Operate the external charge circuit breaker to ON, or reinstall

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the external charge fuse and charge alarm fuse (Option -R). For a rectifier equipped with Option -S, operate the output circuit breaker (CB2) to ON.

- (2) Disconnect the jumper between the BAT output terminal and the CBS lead (pin 15 of the plant control disconnect P1 plug).
- (3) Reconnect the plant control disconnect P1 plug to J1 jack.
- (4) Return CP4 extender board to inside of rectifier cover.

(5) Install rectifier front cover.

(6) Start rectifier by depressing POWER switch to ON.

5. TROUBLES

5.01 Refer to Section 169-743-312 for trouble-locating information for the KS-20491 rectifier manufactured by the ITT-North Electric Company.