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

CONTENTS PAGE

KS-20491 RECTIFIERS

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

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 full load or 13- to 14-cell battery plants at 80 percent of rated full load. 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 requirement with which it will be associated.

1.02 When this section is reissued, the reason for reissue will be given in this paragraph. This issue does affect the Equipment Test List.

1.03 The rectifier is arranged for single-phase, 60 ±3 Hz, 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.

The rated current output is 0 to 100 amperes.

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

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 to shut 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) An output voltage monitor to shut down and lock 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.

(c) 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.

1.06 This rectifier utilizes a triac 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 the following drawings:

- SD-82462-01, Issue 1
- CD-82462-01, Issue 1.

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.

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch C Screwdriver
TEST APPARATUS	
KS-20538	Volt-Ohm-Milliammeter (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. Normally it 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 (R5) rheostat.

3.03 If it is desirable to CHARGE the battery, the OUTPUT VOLTS ADJUST (R5) rheostat must be rotated cw to shift the operating point of the rectifier from 2.17 volts per cell to 2.20 volts per cell. The office load will then be subjected to the CHARGE voltage of 26.04 volts with 12 cells.

3.04 The rectifier will provide an OVERCHARGE voltage up to 2.30 volts per cell for 11- or 12-cell batteries at rated full load. If it is necessary to OVERCHARGE the battery, the OUTPUT VOLTS ADJUST (R5) rheostat must be rotated cw to shift the operating point of the rectifier from 2.17 volts per cell to the required OVERCHARGE voltage (up to 2.30 volts per cell). The office load will then be subjected to the OVERCHARGE voltage.

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 with a permissible input voltage variation as follows:

RECTIFIER CONNECTED FOR	AC INPUT VOLTAGE
208V	186V — 221V
240V	216V — 253V
480V	430V — 506V

3.05 The rectifier can be tested without disturbing the office load by removing the external charge and charge alarm fuses (or operating the external charge circuit breaker to off) and disconnecting the plant control cable. It can be operated in the FLOAT, CHARGE, and OVERCHARGE conditions from no load to full load by adding an external resistance load across the BAT and GRD output terminals.

3.06 A circuit is provided to simulate an adjustable load up to 125 percent of the output current rating of the rectifier. The simulated output current circuit is enabled only when the SIMULATED OUTPUT CURRENT pushbutton is maintained depressed.

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

(a) The POWER ON-POWER OFF (S1) switch is in the OFF position.

Requirement: The POWER OFF lamp is lighted.

(b) The plant control cable is connected to the rectifier.

(c) The ac service fuses are installed.

(d) The output circuit breaker or charge and charge alarm fuses of the proper size and type are in place.

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

(1) Depress the POWER ON-POWER OFF (S1) switch.

Requirement: The POWER ON lamp lights.

(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 (R5) rheostat 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 (R5) rheostat 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 (M1) 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).

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

(1) Depress the POWER ON-POWER OFF (S1) switch.

Requirement: The POWER OFF lamp lights.

(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, periodicaly 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 ON-POWER OFF (S1) switch to OFF.

(2) Remove rectifier front cover.

(3) Remove the output circuit breaker or charge and charge alarm fuses or operate the external charge circuit breaker to OFF.

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

(4) Disconnect the PLANT CONTROL DISCONNECT (J1) connector from the rectifier.

(5) Connect a jumper between the BAT output terminal and the CBS lead (terminal 15 of the PLANT CONTROL DISCONNECT, P1 connector). See Table A.

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

4.06 ***Output Voltage Adjustment:***

(1) Depress the POWER ON-POWER OFF (S1) switch.

> ***Requirement:*** The POWER ON lamp lights.

(2) Connect the KS-20599, L4, digital multimeter, set to 10 DCV scale, to the OUTPUT VOLTS.

(3) Loosen the locking device and slowly rotate the OUTPUT VOLTS ADJUST (R5) rheostat until the reading on the KS-20599, L4, 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 (R5) rheostat being careful not to disturb the setting.

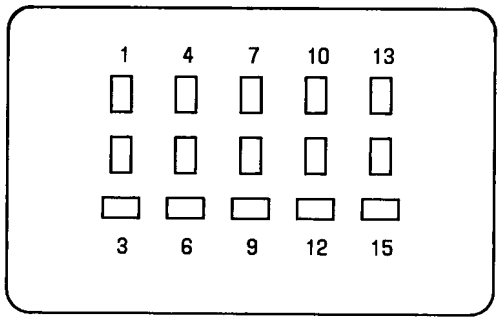
4.07 ***Current Limiting Adjustment:***

> ***Note:*** The CURRENT LIMIT ADJUST (R222) rheostat is factory set for 100 amperes. If it is necessary to readjust the current limit point, proceed as follows:

(1) Turn off the rectifier by depressing the POWER ON-POWER OFF (S1) switch.

> ***Requirement:*** The POWER OFF lamp lights.

TABLE A



P1 WIRING SIDE

TERMINAL	DESIGNATION	DESCRIPTION
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- (Rectifies fail alarm) RETURN
14	CFA	CHARGE FUSE ALARM
15	CBS	CONTROL BATTERY SUPPLY

(2) Loosen the locking device and rotate the CURRENT LIMIT ADJUST (R222) rheostat fully cw.

(3) Located on the rectifier control panel, connect the KS-20599, L4, digital multimeter, set to 10 DCV scale, to the CURRENT LIMIT test jacks.

(4) Depress the POWER ON-POWER OFF (S1) switch to start the rectifier.

Warning: Make sure the output circuit breaker or charge and charge alarm fuses are removed or external charge circuit breaker is operated to OFF before operating the SIMULATED OUTPUT CURRENT feature.

(5) Depress and hold the SIMULATED OUTPUT CURRENT (S2) switch.

Requirement: The SIMULATED OUTPUT CURRENT lamp is lighted.

(6) Rotate the SIMULATED OUTPUT CURRENT (R106) rheostat cw until the OUTPUT CURRENT (M1) ammeter indicates the desired maximum output current. In the absence of a plant requirement, adjust to 100 amperes.

(7) Rotate the CURRENT LIMIT ADJUST (R222) rheostat slowly until the KS-20599, L4, digital multimeter indicates increasing voltage.

Note: When the rectifier is not current limiting, the KS-20599, L4, meter indicates 0 volts. This voltage will begin to increase when the desired current limit setting is reached.

(8) Release the SIMULATED OUTPUT CURRENT (S2) switch.

Requirement: The SIMULATED OUTPUT CURRENT lamp extinguishes.

(9) Rotate the SIMULATED OUTPUT CURRENT (R106) rheostat fully ccw.

(10) Remove the KS-20599, L4, digital multimeter.

4.08 ***Overvoltage Shutdown Adjustment:***

Note: The OV ADJ (R315) potentiometer is factory set to shut down and lock out the rectifier if the output voltage exceeds 29.75 ±0.2 volts. If it is necessary to readjust the overvoltage shutdown setting, proceed as follows:

(1) Turn the rectifier off by depressing the POWER ON-POWER OFF (S1) switch.

Requirement: The POWER OFF lamp lights.

(2) Remove CP3, insert CP4 extender board, and replace CP3 into extender board.

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

(3) Rotate the OV ADJ (R315) potentiometer fully cw.

(4) Located on the rectifier control panel, connect the KS-20599, L4, digital multimeter, set to 10 DCV scale, to the OUTPUT VOLTS test jacks.

(5) Turn the rectifier on by depressing the POWER ON-POWER OFF (S1) switch.

(6) Adjust the OUTPUT VOLTS ADJUST (R5) rheostat cw until the meter indicates 29.75 volts.

(7) Slowly rotate the OV ADJ (R315) potentiometer ccw until the rectifier shuts down.

(8) To restore the rectifier, rotate the OUTPUT VOLTS ADJUST (R5) rheostat fully ccw.

(9) Turn the rectifier on by depressing the POWER ON-POWER OFF (S1) switch to OFF (POWER OFF lamp lights) and then to ON (POWER ON lamp lights).

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

4.09 ***Overvoltage Shutdown Setting (End Cell):***

Note: If end-cell operation is required, it is necessary to reset the overvoltage shutdown feature for 35 volts operation. Proceed as follows:

(1) Turn the rectifier off by depressing the POWER ON-POWER OFF (S1) switch.

(2) Remove CP3 from its connector, insert CP4 extender board in its place, and plug CP3 into the extender board.

(3) Rotate OV ADJ (R315) potentiometer fully cw.

(4) Remove CP2 from its connector and, using an insulated jumper wire, short resistor R249.

(5) Replace CP2 into its connector.

(6) Turn the OUTPUT VOLTS ADJ (R5) fully ccw.

(7) Turn the rectifier on by depressing the POWER ON-POWER OFF (S1) switch.

(8) Observing proper polarity, connect the KS-20599, L4, meter, set to 10 DCV scale, to the OUTPUT VOLTS test jacks.

(9) Adjust the OUTPUT VOLTS ADJUST (R5) rheostat until the VOM indicates 35 volts.

(10) Slowly rotate OV ADJ (R315) potentiometer ccw until the rectifier shuts down.

(11) To restore rectifier, rotate the OUTPUT VOLTS ADJUST (R5) rheostat fully ccw.

(12) Remove the CP4 extender board and replace CP3 in its connector.

(13) Remove the jumper wire from R249 and replace CP2 in its connector.

(14) Turn the rectifier on by depressing the POWER ON-POWER OFF (S1) switch, first to OFF and then to ON.

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

4.10 ***TR Shutdown:***

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

Requirement: The rectifier shuts down.

(2) Remove the jumper.

Requirement: The rectifier restarts.

4.11 ***HV Shutdown:***

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

(2) Depress and hold the SIMULATED OUTPUT CURRENT (S2) switch.

(3) Rotate the SIMULATED OUTPUT CURRENT (R106) rheostat cw.

Requirement: The rectifier shuts down when the OUTPUT CURRENT (M1) ammeter indicates about 5 amperes.

(4) Release the SIMULATED OUTPUT CURRENT (S2) switch.

(5) Remove the jumper.

(6) Depress the POWER ON-POWER OFF (S1) switch twice to release the relays and restart the rectifier.

(7) Rotate the SIMULATED OUTPUT CURRENT (R106) rheostat fully ccw.

4.12 ***Remote Recycle Check:***

(1) Turn the rectifier on by depressing the POWER ON-POWER OFF (S1) switch.

Warning: Make sure that the external charge and charge alarm fuses are removed or external charge circuit breaker is operated to OFF before operating the SIMULATED OUTPUT CURRENT feature.

(2) Depress and hold the SIMULATED OUTPUT CURRENT (S2) switch.

Requirement: The SIMULATED OUTPUT CURRENT lamp lights.

(3) Rotate the SIMULATED OUTPUT CURRENT (R106) rheostat cw until the OUTPUT CURRENT (M1) ammeter indicates 10 amperes.

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

Requirement: The rectifier shuts down and locks out.

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

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

(6) Temporarily remove the jumper from pin 4 of P1 plug and then replace.

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

(7) Release the SIMULATED OUTPUT CURRENT (S2) switch.

(8) Remove the jumpers from pin 6 of P1 to ground and from pins 4 and 5 of P1 plug.

(9) Turn off rectifier by depressing the POWER ON-POWER OFF switch once.

(10) Turn the SIMULATED OUTPUT CURRENT (R106) rheostat on CP1 fully ccw.

(11) Disconnect the digital multimeter.

(12) Replace the external charge and charge alarm fuses or operate the external charge circuit breaker to ON.

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

(14) Reconnect the PLANT ~~CONTROL~~ DISCONNECT (P1) to (J1).

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

(16) Replace rectifier front cover.

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.