RECTIFIERS
KS-19211, L1
24 VOLTS, 800 AMPERES
OPERATING METHODS

CONTENTS PAGE

1. GENERAL

1.01 ◗The KS-19211, L1 rectifier provides regulated dc power from an ac power source for floating and charging central office 24-volt storage batteries. This rectifier is used in the 302A-type power plants and is rated at 24 volts, 800 amperes direct current; however, it will provide a maximum of 33.4 volts at full load for a 14-cell plant. The input power requirement is 3-phase, 3-wire, 60-Hz ± 1.2 Hz alternating current applied to the input transformer through an input contactor. Taps are provided on the input transformer to match the nominal ac line voltage. The KS-19211,L1 rectifier operates within the limits of 190 and 250 volts ac with an allowable line voltage variation of -10 percent to $+5$ percent.◖

1.02 This section is reissued to revise the general information, the operation procedure, and the routine checks; and to add a capacitor charging procedure and a reference to the switch testing, cleaning, and adjustment procedures. This reissue does affect the Equipment Test List.

Warning: Voltage inside the rectifier cabinet are over 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 or dangerous short circuits may occur.

Caution: ◗***Verify that the OFF-NOR switch is in the OFF position before operating the S3 switch from one position to another.***◖

1.03 The rectifier is completely automatic in the regulation of float voltage. It is started and stopped by the plant control circuit and by the operation of the OFF-NOR switch.

1.04 If the rectifier shuts down automatically due to a blown fuse, operate OFF-NOR switch to OFF to release the relays before restoring to service.

1.05 Routine checks should be made during a period when they will cause the least unfavorable reaction to service.

1.06 ◗The instructions are based on circuit schematic drawing SD-81628-01, Issue 2B. For a detailed description of operation, see the corresponding circuit description. If this section is to be used with equipment or apparatus reflecting later or earlier issues of 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 The abbreviations cw and ccw, used herein, refer to clockwise and counterclockwise rotation, respectively.

1.08 ◗The KS-19211 rectifier has been rated "Manufacture Discontinued" and is replaced by the KS-20039 rectifier.◖

1.09 For more detailed information on operation and maintenance of related equipment or apparatus, refer to the appropriate Bell System Practice.

2. LIST OF TOOLS AND TEST APPARATUS

The following apparatus is required for tests:

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-inch Screwdriver
—	→ 10 ohm, 50 watt Minimum Resistor
—	6-ampere, 125-volt DC Rated Fuse
—	15-ampere, 125-volt DC Rated Switch←
TEST APPARATUS	
—	A. B. DuMont Lab Inc. Type 304 Oscilloscope. This oscilloscope is not required for normal routine maintenance (see 5.05).
*KS-8039	DC Volt-Milliammeter (Special Weston No. 622). Refer to Section 100-515-101.
KS-14510, L1	Volt-Ohm-Milliammeter

*A digital type meter is a suitable substitute for this meter.

3. OPERATION

3.01 ***Preparing to Start:*** When preparing to start the rectifier, check the following.

(1) Circuit breaker CB1 is in the OFF position.

(2) The AC power input is connected with the proper taps selected.

(3) The associated fuses are installed and are of the proper type and size.

(4) Verify that the following controls are positioned as indicated.

CONTROL	POSITION
OFF-NOR switch	OFF
S3 switch	OFF
NOR-TST key	NOR
AUTO-MAN key	AUTO
MAN ADJ potentiometer	Fully ccw
RAISE-NOR switch	NOR
LOWER-NOR switch	NOR

Note: Do not disturb the setting of any other control at this time.

3.02 ***Charging Filter Capacitors:*** To charge the output filter capacitors, verify that the procedure in 3.01 has been followed and proceed as follows.

(1) Connect a 10-ohm, 50-watt minimum resistor; a 6-ampere, 125-volt dc rated fuse; and a 15-ampere, 125-volt dc rated switch (operated to the OFF position) in series.

(2) ***Caution: When connecting the resistor, fuse, and switch combination to the rectifier, always connect the combination to the charge and discharge side of the F or EC bus bar last to prevent short circuits from occurring.***

Connect the resistor, fuse, and switch combination between the switch side of the F10 fuse and the charge and discharge side of the F bus bar (if S3 switch is to be operated to the BAT position) or the EC bus bar (if S3 switch is to be operated to the GR1 or GR1 & GR2 position).

(3) Operate the switch of the resistor, fuse, and switch combination to the ON position.

(4) When the rectifier output VM voltmeter indicates the approximate battery or battery plus end-cell voltage, operate the S3 switch to the desired BAT, GR1, or GR1 & GR2 position.

(5) Operate the switch of the resistor, fuse, and switch combination to the OFF position.

(6) ***Caution: When disconnecting the resistor, fuse, and switch combination from the rectifier, always disconnect both ends of the combination from the rectifier at the same time to prevent short circuits from occurring.***

Disconnect the resistor, fuse, and switch combination from the rectifier.

3.03 ***Starting for Automatic Operation:*** To start the rectifier in the automatic mode of operation, verify that the procedure in 3.01 has been followed and proceed as follows.

Caution 1: Do not operate the S3 switch to the BAT, GR1, or GR1 and GR2 position without first charging the output filter capacitors. (See 3.02.)

Caution 2: Verify that the OFF-NOR switch is in the OFF position before operating the S3 switch from one positiion to another.

(1) Charge the output filter capacitors in accordance with 3.02.

(2) Operate circuit breaker CB1 to the ON position.

(3) Operate the OFF-NOR switch to the NOR position.

Note: The rectifier output is automatically adjusted by the operation of the relays in response to signals from the connecting circuit.

3.04 ***Starting for Manual Operation:*** If it is necessary to operate the rectifier in the manual mode of operation, proceed as follows.

Caution: An operator must be on duty continuously when the rectifier is operating in the manual mode.

(1) Verify that the rectifier has been started in accordance with 3.03 and is operating normally.

(2) Operate the NOR-TST key to the TST position.

(3) If the rectifier output current is low, operate the RAISE-NOR switch to the RAISE position and hold until the rectifier output AM ammeter indicates the desired output current.

(4) If the rectifier output current is high, operate the LOWER-NOR switch to the LOWER position and hold until the rectifier output AM ammeter indicates the desired output current.

Note: Before transferring the rectifier from the manual mode of operation to the automatic mode of operation, the rectifier load should be reduced to a minimum value.

3.05 ***Stopping:*** To stop the rectifier, proceed as follows.

(1) Decrease the load on the rectifier to a minimum in accordance with Section 167-621-301.

(2) Operate the OFF-NOR switch to the OFF position.

(3) Operate circuit breaker CB1 to the OFF position.

Note: If the rectifier is to be left out of service for an extended period of time, remove all associated fuses from their respective fuse holders; disconnect the load from the output of the rectifier; disconnect the nominal ac input power from the input of the rectifier; and refer to Section 032-110-701 for information on maintaining electrolytic capacitors that are not in service.

3.06 ***Removing from Service:*** Remove the rectifier from service in accordance with Section 167-621-301.

3.07 ***Restoring to Service:*** Restore the rectifier to service in accordance with Section 167-621-301.

ROUTINE CHECKS

4.01 It is suggested that the following routine checks be made in accordance with the Equipment Test List.

4.02 ***Contactor and Relays:*** As often as local experience demands, the contactor and relays should be inspected for adjustment and condition of contacts, making sure that they are in accordance with the circuit requirements table and the Bell System Practices which apply.

4.03 ***Voltage-Limiting Circuit Check:*** To check the voltage-limiting circuit, proceed as follows.

(1) Remove the rectifier from service in accordance with the appropriate power plant Bell System Practice.

(2) ▶Verify that the controls listed are in the positions indicated.

CONTROL	POSITION
CB1 circuit breaker	ON
OFF-NOR switch	OFF
S3 switch	OFF
RAISE-NOR switch	NOR
LOWER-NOR switch	NOR
AUTO-MAN key	AUTO
NOR-TST key	TST

(3) Connect the KS-8039 meter, set to the 75-volt DC scale, between the J1(+) and J2(−) test jacks.

(4) Operate the OFF-NOR switch to the NOR position.

(5) Operate the RAISE-NOR switch to the RAISE position and hold until the KS-8039 meter indication stops increasing.

Requirement: The KS-8039 meter should indicate between 26.5 and 27.1 volts for an 11-cell connection or between 28.7 and 29.3 volts for a 12-cell connection.

Note 1: A comparison should be made here between the KS-8039 meter and the rectifier output VM meter. The meters should agree. Any error should be corrected by adjusting the zero adjust on the rectifier meter or noted in some way on the meter.

Note 2: If the requirement in (5) is met, proceed to (7). If the requirement is not met, continue with (6).

(6) Adjust the MAX VOLT LIM (R90) potentiometer until the KS-8039 meter indicates 26.8 volts for an 11-cell output connection or 29.0 volts for a 12-cell connection.

(7) Operate the LOWER-NOR switch to the LOWER position and hold until the KS-8039 meter indication stops decreasing.

(8) Operate the OFF-NOR switch to the OFF position.

(9) Disconnect the KS-8039 meter.

(10) Restore the rectifier to service in accordance with the appropriate power plant Bell System Practice.

4.04 ***Current-Limiting Circuit Check:*** To check the current-limiting circuit, proceed as follows.

Note: The MAX CUR LIM (R65) potentiometer is factory set and should not be moved unless it is necessary.

(1) Verify that the controls listed are in the given positions.

Caution 1: Verify that the OFF-NOR switch is in the OFF position before operating the S3 switch from one position to another.

Caution 2: Do not operate the S3 switch to the BAT, GR1, or GR1 & GR2 positions without first charging the output filter capacitors.

CONTROL	POSITION
CB1 circuit breaker	ON
OFF-NOR switch	OFF
S3 switch	BAT
RAISE-NOR switch	NOR
LOWER-NOR switch	NOR
AUTO-MAN key	AUTO
NOR-TST key	TST

(2) Operate the OFF-NOR switch to the NOR position.

(3) Operate the RAISE-NOR switch to the RAISE position and hold until the output current limits.

Requirement: The rectifier output AM ammeter indicates between 820 and 860 amperes.

Note: If the requirement is met in (3), proceed to (7). If it is not met, proceed with (4).

(4) If the current limits before 820 amperes, rotate the MAX CUR LIM (R65) potentiometer cw to increase the current limit.

(5) If the current does not limit before 860 amperes, rotate the MAX CUR LIM (R65) potentiometer ccw to decrease the current limit.

(6) Repeat (1) through (5) as necessary until the requirement in (3) is met.

(7) Operate the LOWER-NOR switch to the LOWER position and hold until the output current is reduced to a minimum.

(8) Operate the OFF-NOR switch to the OFF position.

(9) Restore the rectifier to service in accordance with the appropriate power plant Bell System Practice.

4.05 ***Switch Testing, Cleaning, and Adjustment:*** the S3 switch should be tested, cleaned and lubricated, and adjusted in accordance with Section 169-708-701.

Note: The inside of the rectifier shall be dusted periodically.◀

5. TROUBLES

5.01 The rectifiers consist of a main power circuit controlled through an electronic regulating circuit. In addition, the output of the current sensing circuit is introduced into the regulating circuit for the purpose of current signaling and limitation. The output of the regulating circuit is introduced into the main power circuit to effect the desired corrections in the power output. In the maintenance of intricate equipment, trouble must be localized in an orderly way. This is difficult in the case of a circuit having this feedback or loop arrangement because trouble anywhere in the loop will give faulty operation of other parts of the loop which may be trouble free. In these rectifiers provision has been made for opening the loop by means of the AUTO-MAN key which, when operated to the MAN position, permits isolating the trouble to the regulator. A MAN ADJ (R14) potentiometer is provided for use in conjunction with the AUTO-MAN key to manually control the control current when some of the more complex regulating circuits are temporarily disabled by operation of the AUTO-MAN key to the MAN position.

Caution: The MAN ADJ (R14) potentiometer should always be turned fully ccw before operation of AUTO-MAN key to MAN to avoid excessive voltage and current.

5.02 Although it may vary widely with extreme conditions, the control current, when observed in connection with daily routine and compared with operating experience, can serve as a guide to the causes of unusual operation or trouble conditions. The purpose of the CONTROL ammeter is to give a continuous indication of the output of the regulating circuit. This output also controls the output of the rectifier. The control current supply circuit and main power circuit are generally performing satisfactorily if increasing the amount of control current increases the rectifier output and decreasing the control current decreases the rectifier output.

5.03 When any kind of trouble is encountered, it is necessary first to decide whether to locate the trouble with the equipment operating or de-energized. Trouble is easier to find if the equipment can be fully energized. However, if it is of a nature that causes excessive output from the equipment, perform the initial steps with the system de-energized, and energize it for short periods only while electrical measurements are made. Operation for more than a few minutes at a time while trouble exists, even through the output may not be excessive, may result in overheating of some components. Therefore, it is essential when testing to be alert for the need to quickly shut down the rectifier.

5.04 Should any of the following troubles develop, it is suggested that the possible causes be checked in the order given. If the trouble is not found, look for loose or open connections or short circuits due to foreign matter lying across wiring terminals.

TROUBLE	POSSIBLE CAUSE
(a) No dc output current (no saturating current)	Blown ac supply fuse CB1 circuit breaker in OFF position K3, K5, K12, K13, or K14 relay failure AC contactor not operated
(b) Low dc output current (low control current)	RAISE circuit adjustment Low line voltage or T1 transformer taps incorrect Faulty transistor amplifier
(c) Low dc output current (high saturating current)	Rectifier operating single phase
(d) High dc output current (output voltage normal)	Defective transistor amplifier
(e) Output current high (output voltage high)	RAISE circuit adjustment Defective transistor amplifier High line voltage or T1 transformer taps incorrect
(f) High dc output voltage (output current less than full load)	Rectifier in MAN position
(g) Output excessively noisy	Defective filter capacitors Unbalanced ac input voltage Defective rectifier stacks R4-R6 potentiometers require adjustment
(h) Hunting	ANTI-HUNT (R51 and R66) potentiometers require adjustment (see 5.06).
(i) High ripple indication	Defective L4-L6 saturable reactors (see 5.05). Incorrect adjustment of R4-R6 balancing potentiometers. Defective filter.

Caution: Hunting should be corrected as soon as possible to prevent damage to the rectifier.

5.05 To check for a defective saturable reactor proceed as follows:

(a) Connect the oscilloscope between terminal 1 of L8 and terminal 2 of L7.

(b) Adjust the sweep frequency so as to have six complete cycles present on the oscilloscope. If all waves are approximately equal in height, the cores of L4, L5, and L6 saturable reactors are balanced and the trouble is elsewhere. If they are not of equal height, it is an indication of a defective saturable reactor, a shorted CR1 to CR6 diode, or a defective R1 to R6 resistor.

(c) Check the diodes for short circuit and the resistors for open circuit with the KS-14510, L1 meter in accordance with Section 032-173-301.

(d) Replace any defective components.

5.06 If there is cyclic hunting, adjust R51 and R66 potentiometers. Start with both potentiometers rotated fully clockwise and proceed as follows.

(a) Rotate R51 slowly ccw until hunting is eliminated.

(b) If the rectifier continues or increases hunting, rotate R51 to maximum cw position, then rotate R66 ccw 1/4-turn and again rotate R51 ccw until hunting is eliminated.

(c) Repeat (b) if hunting continues. Advance R66 by 1/4-turn each time.