KS-19213, L11 AND L12, RECTIFIERS
48 VOLTS, 800 AMPERES
OPERATING METHODS

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1. GENERAL

1.01 The KS-19213, L11 and L12, rectifiers provide regulated dc power from an ac power source for charging storage batteries in 301C, 302A, and 302B power plants. The rectifiers are rated at 48 volts 800 amperes direct current; however, they will provide approximately 63 volts at full load when charging the main string plus emergency cells (27 cells) under manual control. The input power requirement is 3-phase, 3-wire, 60-Hz, ±2 percent alternating current. Taps are provided on the input transformer to match the ***nominal*** ac line voltage. The KS-19213, L11, rectifier operates within the absolute input limits of 190 and 250 volts ac, and the KS-19213, L12, rectifier operates within the absolute input limits of 400 and 500 volts ac. Either rectifier will regulate the output voltage within 1 percent with a variation of input voltage from −10 percent to +5 percent.

1.02 The reasons for reissuing this section are listed below. Revision arrows are used to emphasize the more significant changes. The Equipment Test List is not affected.

(a) Update to standard format

(b) Show SD-81630-02 rated A&M only

(c) Add a procedure for manual operation of the rectifier

(d) Change subparagraphs 3.02(4) and (8)

(e) Move caution to front of paragraph 3.05

(f) Change paragraphs 4.01 and 4.02.

Danger: Voltages inside the rectifier cabinet 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 or dangerous short circuits may occur.

Caution: Do not operate the CHG switch to the BAT or EM CELL position without first charging the output filter capacitors.

1.03 The rectifier may be connected to charge a 23-cell plant when the CS and CHG switches are set to the BAT position of 25 or 27 cells, when the CHG switch is set to the EM CELL position, and the CS switch is set to GR1 or GR1 and GR2 position, respectively.

1.04 The abbreviations cw and ccw refer to clockwise and counterclockwise, respectively.

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

1.06 The instructions given in this practice are based on circuit schematic drawing SD-81630-

02, Issue 6AC ▶which has been rated A&M only.◀ For a detailed description of operation, see the corresponding circuit description. If this section is to be used with equipment or apparatus that is associated with a later or earlier issue of the schematic drawing, reference should be made to the CD and SD to determine the extent of the changes and the manner in which the section may be affected.

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

1.08 The KS-19213, L201, bus bar modification kit and the KS-19213, L203, switch modification kit are field modification and replacement kits developed to correct an undesirable heating condition in the output of some KS-19213 rectifiers. These kits are intended for use in Lists 5 through 12 rectifiers, exclusively.

1.09 The KS-19213, L1 through L12, rectifiers are rated Mfr Disc and are replaced by KS-19790 or KS-19791 rectifiers.

1.10 If the rectifier should shut down and lock out automatically due to a blown fuse, set the OFF-NOR switch to the OFF position to release the relays before restoring the rectifier to service.

1.11 The MAN—AUTO potentiometer is equipped with a switch in the extreme ccw position. When the potentiometer is turned cw from its extreme ccw position, the switch operates and the rectifier will then be in the manual mode. ▶The MAN potentiometer provides manual control over the output voltage by adjusting the current flowing in the control windings. Either a charge (CHG) switch or a BAT DISC switch should be provided to disconnect the rectifier from the battery and load. If the CHG switch is set in the EM CELL position, the red EM CELL lamp will light indicating that the rectifier is set up for EM CELL charging.◀

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
—	Blocking and Insulating Tools As Required (use tools and apply as covered in Section 069-020-801)
—	10-Ohm, 50-Watt Minimum Resistor
—	6-Ampere, 125-Volt DC Rated Fuse
—	15-Ampere, 125-volt DC Rated Switch
TEST APPARATUS	
—	Oscilloscope, A. B. DuMont Lab, Inc, Type 304. This oscilloscope is not required for normal routine maintenance (see paragraph 5.06).
KS-8039*	DC Volt-Milliammeter
KS-16979	Volt-Ohm-Milliammeter

3. OPERATION

3.01 ***Preparing to Start:*** When preparing the rectifier for service, check that:

(a) The following controls are positioned as indicated (see note):

CONTROLS	POSITION
OFF-NOR switch	OFF
NOR-TST switch	NOR
REG-TST switch	REG
CHG switch	OFF
CS switch	BAT
SC circuit breaker	ON
PS circuit breaker	ON

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

(b) The input transformer taps have been selected to match the ac input voltage.

(c) All associated fuses are installed in their respective fuse holders, and are of the proper size and type.

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

(d) The bus duct switch is closed.

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

(1) Remove each of the four fuse holders which contain the C1 and C1 ALM fuses, the C2 and C2 ALM fuses, the C3 and C3 ALM fuses, and the C4 and C4 ALM fuses, respectively.

(2) Operate the CHG switch to the desired BAT (F) or EM CELL (EMC) position.

(3) 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) as shown in Fig. 1.

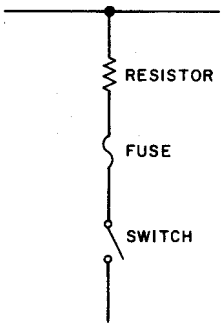

Fig. 1—Resistor,Fuse and Switch Combination

Danger: When connecting the resistor, fuse, and switch combination to the rectifier, care should be exercised to avoid dangerous and destructive short circuits from occurring.

(4) Connect the resistor, fuse, and switch combination across the BAT and load terminals on the back of the C1 and C1 ALM, and C2 and C2 ALM fuse blocks in accordance with Fig. 2.

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

(6) When the VM voltmeter indicates approximately battery or battery plus end cells voltage, replace the two fuse holders containing the C1 and C1 ALM fuses and the C2 and C2 ALM fuses.

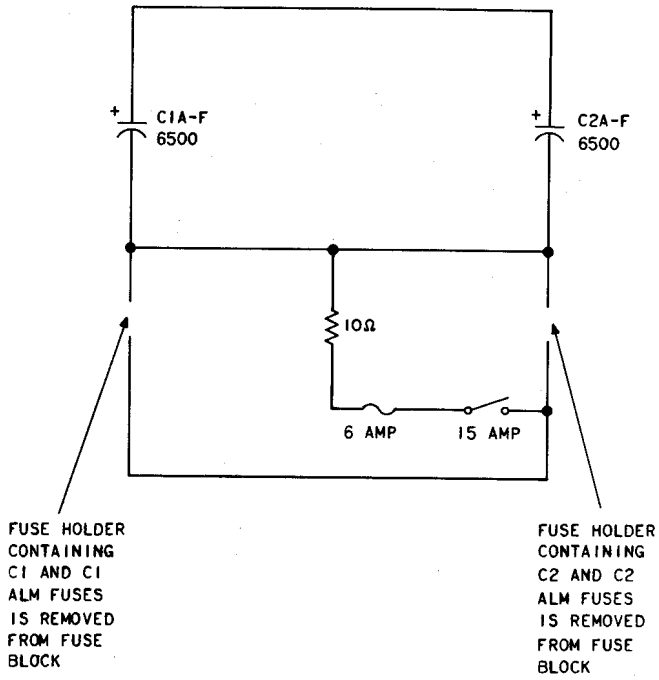

Fig. 2—Resistor Fuse and Switch Combination Connected to the Rectifier

(7) Operate the switch of the resistor, fuse, and switch combination to the off position.

Danger: When disconnecting the resistor, fuse, and switch combination from the rectifier, care should be exercised to avoid dangerous and destructive short circuits.

(8) Disconnect the resistor, fuse, and switch combination from the rectifier.

(9) Repeat (3) through (8) for the C3 and C3 ALM, and C4 and C4 ALM fuse blocks.

3.03 ***Starting:*** To start the rectifier, verify that the procedure in paragraph 3.01 has been followed and proceed as follows:

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

(2) Verify that the FLOAT—CHARGE key on the associated power plant is in the FLOAT position.

Note: The rectifier float voltage, set when the rectifier is not connected to the battery, may increase as much as one volt when the rectifier is connected to the plant control circuit. If there is reason to believe that the rectifier output voltage may be set high enough to cause shutdown or lockout when the rectifier is started, the FLT ADJ potentiometer should be adjusted substantially ccw just before starting. After the rectifier is started, the float voltage should be adjusted upward to the proper value as in (4).

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

Requirement: The rectifier starts and assumes some load.

(4) Adjust the FLT ADJ potentiometer until the power plant voltmeter indicates the required float voltage specified in the associated power plant Bell System Practice.

Note 1: In the absence of such a requirement in the power plant Bell System Practice, the nominal float voltage for the battery in a standard plant is 2.17 volts per cell. For further information on this subject, refer to Section 157-601-301.

Note 2: The voltage reading at the rectifier is not always the same as the voltage reading at the power plant meter. Any difference will be due to meter error or line drop. The error should be noted in some way on the rectifier VM voltmeter. Do not use any meter located at the rectifier when adjusting the float voltage with the plant connected.

Note 3: The following charge voltage adjustment is not to be used if the rectifiers are used with the 301C power plant. The charge voltage adjustment procedure for the 301C power plant is covered in the associated power plant Bell System Practice.

(5) Operate the FLOAT-CHARGE key on the associated power plant to the CHARGE position.

(6) Adjust the CHG ADJ potentiometer until the plant voltmeter indicates the required charge voltage as specified in the associated power plant Bell System Practice.

Note 1: In the absence of such a requirement, the nominal charge voltage for the battery of a standard plant is 2.2 volts per cell. For additional information on the required charge voltage, refer to Section 157-601-701.

Note 2: The voltage reading at the rectifier is not always the same as the reading at the plant. Any difference will be due to meter error or line drop. This error should be noted in some way on the rectifier voltmeter. Do not use any meter located at the rectifier when adjusting the voltage with the plant connected.

(7) Return the FLOAT-CHARGE key on the power plant to the FLOAT position.

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

(1) Rotate the FLT ADJ potentiometer ccw to reduce the output current to a minimum.

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

Note: If the rectifier is to be left out of service for an extended period of time, operate the CHG switch to the OFF position. Remove all associated fuses from their respective fuse holders and refer to Section 032-110-701 for information on maintaining electrolytic capacitors while out of service.

Caution: ◗Before removing the rectifier from service, there should be sufficient charging unit capacity available in the power plant to pick up the load dropped by the rectifier.◖

3.05 ***Removing a Rectifier From Service:*** Remove a rectifier from service in accordance with the appropriate power plant Bell System Practices.

3.06 ***Restoring a Rectifier to Service:*** Restore a rectifier to service in accordance with the appropriate power plant Bell System Practices.

4. ROUTINE CHECKS

4.01 It is suggested that the following routine checks be performed in accordance with the

Equipment Test List, after trouble conditions have been corrected, or after the rectifier has been out of service for a long period of time.

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 Keep the ventilating passages clear to insure proper cooling during operation. The inside of the rectifier should be dusted as often as local conditions require.

> ***Note:*** The gain potentiometer has been factory adjusted and should not require adjustment.

4.04 Before performing the following checks, verify that the following controls are positioned as indicated and proceed as follows:

> ***Note:*** Set the OFF-NOR switch to the OFF position before changing the CHG and CS switches from one position to another.

CONTROL	POSITION
OFF-NOR switch	OFF
NOR-TST switch	TST
MAN-AUTO potentiometer	AUTO
SC circuit breaker	ON
PS circuit breaker	ON
CHG switch	OFF
CS switch	BAT
CC TST potentiomenter	Fully ccw

4.05 ***Overload Relay Check:*** See paragraph 4.04 and proceed as follows:

(1) Set the OFF-NOR switch to the NOR position.

(2) Mark the setting of the CCH potentiometer; then rotate it fully cw.

(3) Set the CC TST switch to the ON position and hold.

(4) Rotate the CC TST potentiometer cw until the A ammeter indicates 800 amperes. Hold this setting for 30 seconds.

> ***Requirement:*** The OL2 relay should not operate.

(5) Rotate the CC TST potentiometer cw until the A ammeter indicates 900 amperes.

> ***Requirement:*** The OL2 relay should operate and shut down the rectifier within 5 minutes. The OVLD and RECT FAIL lamps should light when the OL2 relay operates.

(6) Release the CC TST switch.

(7) Rotate the CC TST potentiometer fully ccw.

(8) Return the CCH potentiometer to its prior setting.

4.06 ***Current Limit Circuit Checks:*** See paragraph 4.04 and proceed as follows:

(a) ***Maximum Current Limit Circuit Check:*** To perform the maximum current limit circuit check, proceed as follows:

(1) Adjust the FLT ADJ potentiometer for a 49.9-volt indication on the VM voltmeter.

(2) Set the CC TST switch to the ON position and hold.

(3) Adjust the CC TST potentiometer until the A ammeter indicates 840 amperes.

> ***Requirement:*** The VM voltmeter should indicate a voltage of not more than 49.4 volts.

> ***Note:*** If the requirements are not met in (3), adjust the CCH potentiometer to obtain 49.4 volts.

(4) Release the CC TST switch.

(5) Rotate the CC TST potentiometer fully ccw.

(b) ***Low Current Limit Circuit Check:*** To perform the low current limit circuit check, proceed as follows:

> ***Note:*** This test is not necessary in a 302A power plant if G1 is a rectifier or in a 301C

power plant if this rectifier is used on the job analysis circuit.

(1) Block the CCL relay operated.

(2) Set the CC TST switch to the ON position and hold.

(3) Rotate the CC TST potentiometer cw until the A ammeter on the rectifier under test indicates the values given in the Test Current column of Table A as related to the applicable Percent of Load.

TABLE A

G1 MOTOR GENERATOR		G0 RECTIFIER		RECTIFIER TEST CURRENT
RATING	LOAD	AMPS	PERCENT OF LOAD	
400	250	550	69%	570-630
500	300	500	62½%	480-520
750	400	400	50%	380-420
1200	400	400	50%	380-420

Requirement: The VM voltmeter should indicate no lower than 48.9 volts at the low point in the range and no higher than 49.4 volts at the high point in the range.

Note: The current limit is controlled by the CCL potentiometer. Turn the CCL potentiometer cw to increase the value of current limit. An adjustment may be necessary to meet the preceding requirement.

(4) Release the CC TST switch.

(5) Rotate the CC TST potentiometer fully ccw.

(6) Remove the blocking tool from the CCL relay.

4.07 ***Float and Charge Voltage Adjustment:*** Remove the rectifier from service in accordance with the appropriate power plant Bell System Practice and proceed as follows: (See paragraph 3.03.)

(1) Verify that the controls listed in paragraph 4.03 are positioned as indicated.

(2) Connect the KS-8039 meter between the REG NEG (VM BAT) and REG POS (VM GRD) jacks.

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

(4) Depress and hold the CC TST switch.

(5) Rotate the CC TST potentiometer cw until the A ammeter indicates 800 amperes.

(6) Adjust the FLT ADJ potentiometer until the KS-8039 meter indicates the required float voltage specified in the associated power plant Bell System Practice.

Note 1: In the absence of such a requirement, the nominal float voltage for a standard battery in a plant is 2.17 volts per cell. For further information on this subject, refer to Section 157-601-301.

Note 2: At this time a comparison should be made between the KS-8039 meter reading and the rectifier VM voltmeter reading. They should be the same. Any error should be corrected on the rectifier VM voltmeter by adjusting the zero adjust or noted in some manner on the rectifier VM voltmeter.

Note 3: The following charge voltage adjustment is not to be used if the rectifiers are used with the 301C power plant. The charge voltage adjustment procedure for the 301C power plant is covered in the associated power plant Bell System Practice.

(7) Block the C relay nonoperated.

(8) Adjust the CHG ADJ potentiometer until the KS-8039 voltmeter indicates the required charge voltage as specified in the associated power plant Bell System Practice.

Note: In the absence of such a requirement, the nominal charge voltage for the battery of a standard plant is 2.2 volts per cell. For additional information on the required charge voltage, refer to Section 157-601-701.

(9) Remove the blocking tools from the C relay.

(10) Release the CC TST switch.

(11) Rotate the CC TST potentiometer fully ccw.

(12) Disconnect the KS-8039 meter from the rectifier.

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

4.08 ***Automatic Shutdown Checks:*** Verify that the controls listed in paragraph 4.04 are positioned as indicated and proceed as follows:

(a) ***TR Lead Shutdown Check:*** To perform the TR lead shutdown check, proceed as follows:

Note: All rectifiers do not have the TR lead connected.

(1) Operate the OFF-NOR switch to NOR.

(2) Connect ground to terminal 7 of terminal board 1.

Requirement: The rectifier should shut down.

(3) Remove ground from terminal 7 of terminal board 1.

Requirement: The rectifier should start.

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

(b) ***HV Lead Shutdown Check:*** To perform the HV lead shutdown check, proceed as follows:

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

(2) Mark the setting and then rotate the FLT ADJ potentiometer fully ccw.

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

(4) Rotate the FLT ADJ potentiometer slowly cw until the A ammeter indicates slightly more than 80 amperes.

Requirement: The AR1 relay should operate.

(5) Insulate the 9 contact of the AR1 relay.

(6) Connect ground from the TST test block to the 2L coil of the HV relay.

Requirement: The rectifier should shut down and the RECT FAIL lamp should light.

(7) Remove the ground from the 2L coil of the HV relay.

Requirement: The rectifier should be locked out.

(8) Set the OFF-NOR switch to the OFF position and then return to the NOR position.

Requirement: The rectifier should start and the RECT FAIL lamp should be extinguished.

(9) Return the FLT ADJ potentiometer to its original position.

(10) Remove the insulation from the 9 contact of the AR1 relay.

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

4.09 ***Switch Testing, Cleaning, and Adjusting:*** The CHG switch should be tested, cleaned, lubricated, and adjusted in accordance with Section 169-715-701.

5. TROUBLES

5.01 These 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 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, provisions have been made for operating the rectifier manually by means of the MAN switch and potentiometer. This isolates trouble to the automatic control.

Caution: The MAN potentiometer should always be rotated fully ccw except when operating in the manual mode.

5.02 The purpose of the A ammeter is to give a continuous indication of the output of the rectifier. A MAN potentiometer is provided to manually control the saturating current, in which case some of the features of the more complex regulating circuits are temporarily disabled.

5.03 When any kind of trouble is encountered, it is necessary to decide whether the trouble can be located with the equipment operating or deenergized. These rectifiers have been designed to make some parts accessible for testing with the power connected. Jacks, which are accessible when the front doors are open, are mounted on the front of the control panel. 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, take the initial steps with the system deenergized, and energize it for short periods only while electrical measurements are made. Also, operation for more than a few minutes at a time while trouble exists, even though the output may not be excessive, may result in overheating of some components. It is essential, when testing, to be alert to the need for quickly shutting down the rectifier at any time until the trouble is localized and cleared.

Trouble Chart

5.04 Should any of the following troubles develop, it is suggested that the possible cause 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 CHART

TROUBLE	POSSIBLE CAUSE
(a) No dc output current	Blown ac supply or control fuse.
	PS circuit breaker in OFF position.
	BC relay failure.
	CHG fuse blown.
	Excessive bias current due to shorted R13 resistor.
(b) Low dc output voltage	Current-limiting circuit out of adjustment.
	Faulty current-sensing circuit.
	Fault regulator circuit.
	Low line voltage or T1 transformer taps incorrect.
	Rectifier operating single phase.
	Defective magnetic amplifier.
(c) High dc output voltage	High line voltage or T1 transformer taps incorrect.
	Defective magnetic amplifier.
	Faulty current-sensing current.
	Faulty regulator circuit.
(d) Output excessively noisy	Defective filter capacitors.
	Unbalanced ac line voltage (more than 5 percent).
	Defective rectifier stacks.
(e) Ripple indication greater than 200 millivolts at battery	Defective L1, L2, or L3 magnetic amplifier (see paragraph 5.06).
	Defective filter.
	Open phase.

5.05 Do not troubleshoot any of the transistorized control boards in the rectifier. These should be replaced when trouble is encountered with automatic control features.

5.06 To check for a defective magnetic amplifier, proceed as follows:

(a) Connect the oscilloscope between ground and the negative side of C1 through 4 capacitors.

(b) Adjust the sweep frequency so as to have six complete cycles present on the oscilloscope. If all waves are approximately of equal height, the cores of L1, L2, and L3 magnetic amplifiers are balanced and the trouble is elsewhere (check filter). If they are not equal height, it is an indication of a defective magnetic amplifier or a shorted diode.

(c) Check the diodes for short circuits.

(d) Replace any defective components.