RECTIFIER
KS-19216 L1, L2
130 VOLTS, 300 AMPERES
TROUBLE LOCATING

CONTENTS PAGE

1. GENERAL

1.01 The KS-19216 L1 and L2 semiconductor-type rectifiers provide regulated dc power from an ac power source for floating and charging central office 130-volt storage batteries. This rectifier is primarily used in 700-type power plants and is rated at a nominal 130-volts dc at 300 amperes.

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

Danger 1: The voltages inside this unit 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 or destructive and dangerous short circuits may occur. Disconnect ac supply before working on rectifier except when necessary to make tests.

Danger 2: There is a mid-position to the S6 dc output switch between the extreme left position (BAT) and the extreme right position (OFF) that feels like a contact position but does not remove battery voltage. Verify that switch is in OFF position.

1.03 This issue of the section is based on drawing SD-81633-01, Issue 4. If this section is to be used with equipment or apparatus that is associated with an earlier or later issue of the drawing, 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.

1.04 For more detailed information on the operation of the KS-19216 L1 and L2 rectifiers, refer to Section 169-724-301. Procedures for maintaining the dc output switch of the KS-19216 rectifier are contained in Section 169-724-701.

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

1.06 Semiconductor devices and printed circuit assemblies should be maintained in accordance with Section 032-173-301.

1.07 A solid state controller is available to replace the mechanical contact type AR1 ammeter relay. The solid state unit is designated KS-20522 Controller. The controller contains no moving parts or heated filaments and should provide more reliable service than the mechanical contact type ammeter relay. The KS-20522 Controller is available as part of a modification kit which includes mounting hardware, wire, installation and wiring information, and, when required, some minor external components. The KS-20522 Controller is available for several rectifier and plant applications. For additional

information on the KS-20522 Controller, refer to CD- and SD-82023-01 and Section 024-360-201.

2. LIST OF TEST APPARATUS

SPEC NO.	DESCRIPTION
KS-8039	Volt-Milliammeter
KS-14510	Volt-Ohm-Milliammeter
—	100-ohm, 10-watt resistor
—	Oscilloscope, Tektronix 545B (or equivalent)

3. OPERATION

3.01 ***Normal operation of the KS-19216*** rectifier shall be in accordance with Section 169-724-301. In the event of a trouble condition, the rectifier should be removed from service in accordance with Section 169-724-301. Before restoring the rectifier to service, it should again be checked in accordance with 3.02.

3.02 ***Restoring the Rectifier to Service After a Trouble Condition:*** Under all trouble conditions, before placing the rectifier back into service, proceed as follows.

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

Warning: Do not operate the S6 dc output switch from the OFF position to either the BAT, GR1, or GR1 and GR2 positions without first charging the output filter capacitors in accordance with Section 169-724-301.

POSITION	CONTROL
ON	CB1 circuit breaker
OFF	OFF-NOR switch
BAT	S6 dc output switch
AUTO	AUTO-MAN key
NOR	NOR-TST key
NOR	RAISE-NOR switch
NOR	LOWER-NOR switch

(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 voltage indication on the VM1 voltmeter droops at current limit. The indication on the AR1 ammeter relay should be between 320 and 340 amperes. Otherwise refer to the specific trouble condition.

Note: The plant voltmeter and the rectifier voltmeter (VM1) will not indicate the same voltage value due to the loop voltage drop of the charge leads.

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

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

4. TROUBLESHOOTING PROCEDURES

4.01 Failure of the KS-19216 L1 or L2 rectifier will usually be characterized by one of four conditions:

- Operated fuses and consequent loss of output
- Operated circuit breakers and consequent loss of output
- Loss of output without operation of fuses and circuit breakers
- Erratic output, either voltage or current or both.

The trouble flow chart in Fig. 1 is designed to analyze troubles in rectifiers from the standpoint of these four symptoms. For example, if initial inspection of a faulty rectifier indicates a fuse is operated, the section of the trouble flow chart which applies to that particular fuse should be consulted.

4.02 The rectifiers (Fig. 2) consist of a magnetic amplifier power control stage which is controlled by a regulating circuit. The regulating circuit senses dc output current for the purpose of current signaling and current and voltage limitation. Desired correction in the power output of the rectifier is obtained by regulating the current flow through L4, L5, and L6 saturable reactors. The control current through the reactors is regulated by the electronic control circuit which is a part of the regulating circuit.

4.03 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 faultly 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 (S2) key which, when operated to the MAN position, permits checking the performance of each major subdivision of equipment until the trouble is isolated. A MAN ADJ (R42) potentiometer is provided for use in conjunction with the AUTO-MAN (S2) key to manually control the control current when some of the more complex regulating circuits are temporarily disabled by operation of the AUTO-MAN (S2) key to the MAN position.

Warning: The MAN ADJ (R42) potentiometer should always be turned fully ccw before operation of AUTO-MAN (S2) key to MAN to avoid excessive voltage and current.

4.04 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 (AMI) 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 decreases the rectifier output.

4.05 When any kind of trouble is encountered, it is necessary 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, it will be necessary to take the initial steps with the system de-energized, energizing it in subdivisions for short periods only while electrical measurements are made. 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. Therefore, it is essential when testing to be on the alert for the need to quickly shut down the rectifier.

4.06 Jacks mounted on the front of the panel have been provided to enable the trouble locater to meter various portions of the circuit with the equipment fully energized. Consult Table A for values that should be read when the output voltage is 132.2 volts and the output current is 10.0 amperes. The control circuit should indicate 0.25 ampere. The values shown in the table are average. Specific values for individual rectifiers may vary from those given.

4.07 As a general troubleshooting procedure, check for faulty connections and broken, burned, or shorted wires. Inspect the harness wiring and leads from all components for possible breaks and shorts. Check that no adjacent terminals or lugs touch together. Check that all solder and pressure points make good electrical contact using a volt-ohmmeter. Inspect for evidence of poor connections at switch and bus joints. The main load carrying bolts should be tightened (including squeeze-connected lugs) within 6 weeks after installation cutover and once each year thereafter.

4.08 When a trouble is traced to a printed circuit assembly, replace it with the proper new or repaired printed circuit assembly. Do not attempt to repair defective printed circuit assemblies unless personnel are trained and equipped to repair printed circuit assemblies. Return the defective printed circuit assembly to the authorized repair facility in accordance with local instructions.

4.09 The following precautions should be observed prior to and during the interval of detecting and clearing troubles in the rectifier.

Danger 1: Do not apply AC power to the rectifier except when checking voltages, currents, or waveforms. To

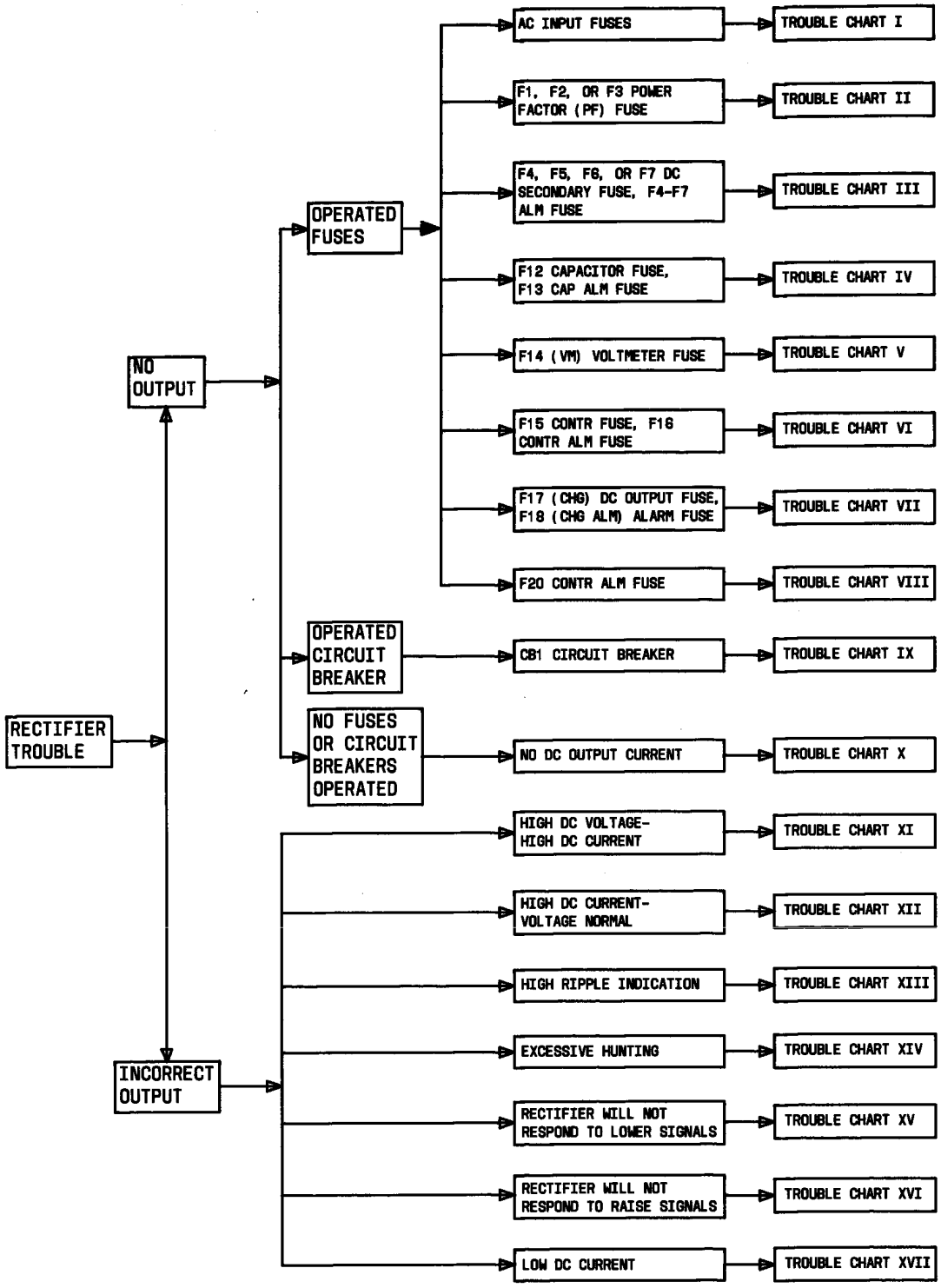

Fig. 1—Trouble Flow Chart

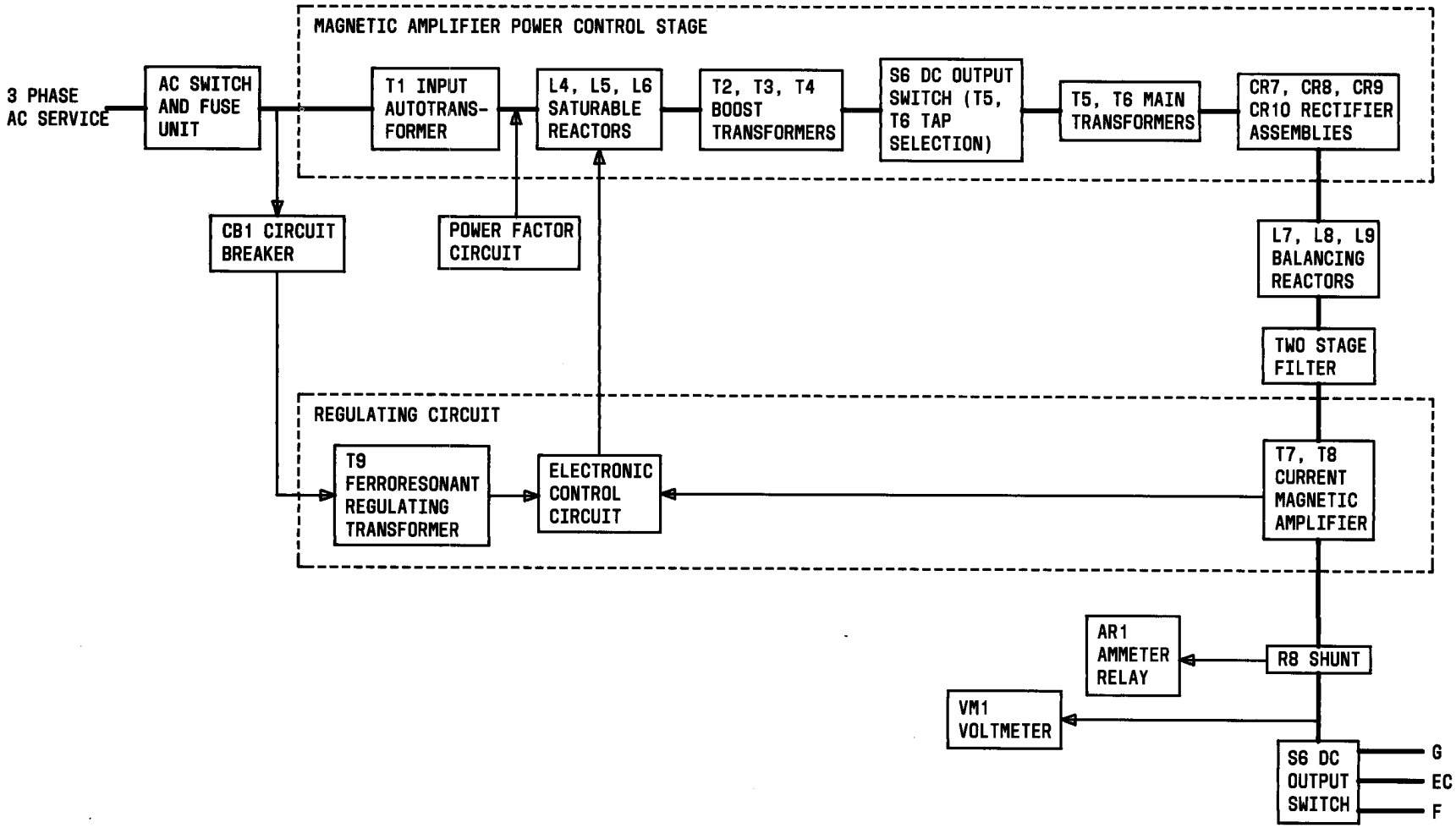

Fig. 2—KS-19216 Rectifier—Block Diagram

TABLE A – POINT-TO-POINT VOLTAGES

METER CONNECTIONS (TEST POINTS)	EQUIPMENT LOCATION	METER SCALE	METER READING (VOLTS)
T1 – T2	AC Contactor, K1	300	205.4 ac
T1 – T3		300	205.4 ac
T2 – T3		300	205.4 ac
Term. 2, phase A – Term. 2, phase B	Transformer T1	300	205.4 ac
Term. 2, phase A – Term. 2, phase C		300	205.4 ac
Term. 2, phase B – Term. 2, phase C		300	205.4 ac
Term. 6, phase A – Term. 2, phase B		300	217.5 ac
Term. 6, phase B – Term. 2, phase C		300	217.5 ac
Term. 6, phase C – Term. 2, phase A		300	217.5 ac
Term. 5, phase X – Term. 1, phase X	Transformers T5 and T9	300	276 ac
Term. 5, phase Y – Term. 1, phase Y		300	276 ac
Term. 5, phase Z – Term. 1, phase Z		300	276 ac
J2(+) – J1(–)	Front Panel	300	132.2 dc
J4 – J3 Grd		300	60.0 dc*
J5 – J3 Grd		60	12.0 dc*
J6 – J3 Grd		60	11.8 dc*
J7 – J3 Grd		60	11.9 dc*
J8 – J3 Grd		60	12.0 dc*
J9 – J3 Grd		60	10.0 dc*
J10 – J3 Grd		60	10.0 dc*
J11 – J3 Grd		60	30.0 dc*
J12 – J3 Grd		60	30.0 dc*

* Voltage may be positive or negative, depending upon option installed.

completely isolate the rectifier from the ac line, the AC switch at the bus plug-in unit or power service must be operated to the OFF position.

Danger 2: Plus side of battery is grounded. When using an oscilloscope or any other test equipment powered from the ac line which has one probe connected to the chassis, that probe must always be connected to frame ground when troubleshooting the rectifier.

Warning 1: Under no circumstances should fuses of higher ratings than those specified be used.

Warning 2: Use caution when working with wrenches and test leads to prevent shorting the DC circuit. Always disconnect the rectifier from battery and the ac service before performing repairs.

4.10 Static tests of certain components, such as diodes, transformers, and transistors used in KS-19216 rectifiers, are provided in Part 5. These tests are referenced in the Trouble Charts.

4.11 The following danger and warnings should be observed while operating or performing maintenance on the rectifier.

Danger: Voltages inside the rectifier are over 150 volts to ground. Avoid all contact with terminals.

Warning 1: Do not remove any printed circuit assembly while the rectifier is in operation.

Warning 2: Verify that the OFF-NOR switch is in the OFF position before operating the S5 switch from one position to another.

Warning 3: With the rectifier shut down and disconnected from the battery [DC OUTPUT (S6) switch in the OFF position], the filter capacitors in the rectifier will discharge in approximately 1 minute. The output capacitors should be charged in accordance with Section 169-724-301 prior to operation of the DC OUTPUT (S6) switch to the BAT or GR positions.

Warning 4: Operation of the rectifier while a trouble exists may cause additional failures of some components. It is essential, while testing, to be alert to the need of quickly shutting down the rectifier until the trouble is localized and corrected.

5. COMPONENT CHECKING PROCEDURES

5.01 The test procedures in 5.02 through 5.05 are given to aid in determining a defective component not mounted on a circuit card. In general, the components most likely to become defective with use are the V1 electron tube, semiconductor devices, and capacitors. These tests should be made with the rectifier disconnected from ac input power and battery potential.

Warning 1: When using an ohmmeter for checking semiconductors, use mid-range ohm scale (scales below RX10,000 and above RX10). The high scale ohmmeter voltage may damage the semiconductor device. A scale too low can force excessive current through some semiconductors. Refer to Section 032-173-301.

Warning 2: Before soldering or unsoldering leads of semiconductors, refer to Section 032-173-301. Always use a heat sink when soldering leads on semiconductor devices.

Warning 3: Before checking circuits which contain electrolytic capacitors, reference should be made to Section 032-110-501.

5.02 ***Capacitors:*** When checking capacitors, determine if the capacitor can be checked safely in the circuit without disconnecting one lead from the capacitor. If either ac or dc voltage sources cannot be isolated from the capacitor under test, disconnect one lead from the capacitor terminal. Initially, the capacitor should be discharged by temporarily connecting a 100-ohm, 10-watt resistor across the capacitor terminals. When checking electrolytic capacitors, proper polarity of the test meter to the capacitor terminals must be observed. When using the KS-14510 meter, the black lead of the test meter must be connected to the (+) positive terminals of the capacitor and the red lead of the test meter is connected to the (-) negative capacitor terminal. When testing paper or mica capacitors, polarity of meter leads is not significant. To check a capacitor, proceed as follows.

(1) Set the KS-14510 meter on OHMS X 10,000 scale. (The ohmmeter battery voltage on the OHMS X 10,000 scale is 30 volts dc.)

(2) Connect the meter leads across the capacitor terminals (observing proper polarity for electrolytic capacitors).

Requirement: The ohmmeter indicates low resistance initially and then indicates an increase in resistance as the capacitor charges. Normal resistance readings are as follows:

(a) Paper or mica capacitor of less than 1 microfarad should read 100 megohms or more.

(b) Paper capacitors of more than 1 microfarad should read less than 100 megohms.

(c) Electrolytic capacitors should read greater than 100,000 ohms.

Note: For replacement and maintenance of aluminum type electrolytic capacitors, refer to Section 032-110-701.

5.03 ***Diodes:*** To check a diode, proceed as follows.

(1) Set the KS-14510 meter on the OHMS X 1000 scale. (The OHMS X 1000 scale provides minimum current drain—0.075 milliamperes).

(2) Connect the meter leads across the diode leads. Then reverse the meter connections across the diode.

Requirement: The meter indicates high resistance in one direction and low resistance in the opposite direction.

Note 1: Low resistance or high resistance in both directions indicates a possibly defective diode. If the check indicates a defective diode, disconnect one lead from the diode and repeat the resistance check.

Note 2: For additional information on diode test, refer to Section 032-173-301.

5.04 ***Transistors:*** To check a transistor, proceed as follows.

(1) Set the KS-14510 meter on the OHMS X 10 scale (digital meter on 1000 OHMS).

(2) Connect the meter leads as follows.

(a) Connect meter between emitter and collector leads of the transistor. Then reverse the meter connections to the emitter and collector.

Requirement: The meter indicates high resistance in both directions.

Note: Low or zero resistance in either direction indicates a defective transistor. If the check indicates a defective transistor, disconnect the emitter or collector lead and repeat the resistance check.

(b) Connect the meter between the emitter and base leads of the transistor then reverse the meter connections to the emitter and base.

Requirement: The meter indicates low resistance in one direction and high resistance in the opposite direction.

Note: Zero resistance indicates a shorted junction, infinite (∞) resistance indicates an open junction. If a short or open is indicated, disconnect the emitter lead and repeat the resistance check.

(c) Connect the meter between the collector and base leads of the transistor. Then reverse the meter connections to the collector and base.

Requirement: The meter indicates low resistance in one direction and high resistance in the opposite direction.

Note: Zero resistance indicates a shorted junction, infinite (∞) resistance indicates an open junction. If a short or open is indicated, disconnect the collector lead and repeat the resistance check.

5.05 ***Transformers:*** If a trouble condition still exists after checking the possibly defective circuit cards, semiconductor devices, and capacitors, check for a possible defective transformer as follows.

(1) Set the KS-14510 meter on OHMS X 1000 scale.

(2) Connect the meter leads across each winding of the transformer.

Requirement: The meter indicates continuity—low resistance.

Note: High or infinite (∞) resistance indicates a defective winding.

(3) Connect the meter leads between the case and one winding terminal of the transformer.

Requirement: The meter indicates an open—infinite (∞) resistance.

Note: Low or zero resistance indicates a defective transformer.

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

(a) Connect the oscilloscope between terminal 1 of L10 and the F21 (K4) fuse.

(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 per 5.03 and the resistors for open circuit with the KS-14510 L1 meter.

(d) Replace any defective components.

TROUBLE CHART 1

OPERATED AC INPUT FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT VOLTAGE 0* AMI CURRENT 0 ARI CURRENT 0	GROUND ON LP LEAD BATTERY ON AR LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective power diodes CR7, CR8, CR9, or CR10	Check diodes per 5.03	Replace as necessary
B. Shorted windings or short to ground in transformer	Check transformer windings of T1 through T5 transformers per 5.05	Replace as necessary

* If trouble condition exists and DC OUTPUT (S6) switch is in BAT or EC position, OUTPUT VOLTAGE meter will indicate battery voltage.

TROUBLE CHART II

OPERATED F1, F2, OR F3 POWER FACTOR (PF) FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
ASSOCIATED INDICATOR LAMP (DS1, DS2, OR DS3) WILL NOT LIGHT WHEN DEPRESSED	OUTPUT VOLTAGE NORMAL AMI CURRENT NORMAL ARI CURRENT NORMAL	

PROBABLE CAUSE	TEST PROCEDURE	PLANT SIGNALS
Defective capacitor unit in phase which has operated fuse	Check capacitor units in accordance with 5.02	Replace as necessary
Lamp	ASSOCIATED CAPACITOR UNITS	
DS1	C17-C24	
DS2	C9-C16	
DS3	C1-C8	

TROUBLE CHART III

OPERATED F4, F5, F6, OR F7 DC SECONDARY FUSE, F4-F7 ALM FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT VOLTAGE 0* AMI CURRENT 0 ARI CURRENT 0	GROUND ON LP LEAD BATTERY ON FA LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted secondary diode (CR7, CR8, CR9, or CR10)	(1) Operate S1 RECT OFF-NOR switch to OFF position (2) Operate S6 DC OUTPUT switch to OFF position (3) Remove F12 and F13 fuses (4) Remove leads from associated rectifier stack (5) Use KS-14510 volt-ohm-milliammeter and check per 5.03 for shorted diodes	Defective diode indicates low resistance in both directions. Repair stack as necessary.
B. Shorted secondary thyrector diode (CR11-CR22)	(1) Repeat (1) through (3) above (2) Remove one lead of suspect thyrector (3) Use KS-14510 volt-ohm-milliammeter to check for shorted thyrector	Defective thyrector indicates low resistance in both directions. Replace as necessary

* If trouble condition exists and DC OUTPUT (S6) switch is in BAT or EC position, OUTPUT VOLTAGE meter will indicate battery voltage.

TROUBLE CHART IV

OPERATED F12 CAPACITOR FUSE, F13 CAP ALM FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT VOLTAGE 0* AMI CURRENT 0 ARI CURRENT 0	BATTERY ON FA LEAD GROUND ON LP LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Blown fuse in one leg of AC supply	Check for blown fuse	Replace fuse
B. Shorted capacitor unit in C25 through C36 capacitor bank	Check capacitor per 5.02	Replace defective units as necessary

* If trouble condition exists and DC OUTPUT (S6) switch is in BAT or EC position, OUTPUT VOLTAGE meter will indicate battery voltage.

TROUBLE CHART V

OPERATED F14 (VM) VOLTMETER FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT VOLTAGE 0 AMI CURRENT NORMAL ARI CURRENT NORMAL	NONE

PROBABLE CAUSE	TEST PROCEDURE	PLANT SIGNALS
A. Y OPTION (NEGATIVE PLANTS) Trouble ground at TS4-15	Using KS-14510 meter, locate trouble ground at TS4-15. Check for possible shorted voltmeter (VMI)	Repair as necessary
B. Z OPTION (POSITIVE PLANTS) Trouble ground at TS4-14	Using KS-14510 meter, locate trouble ground at TS4-14. Check for possible shorted voltmeter (VMI).	Repair as necessary

TROUBLE CHART VI

OPERATED F15 CONTR FUSE, F16 CONTR ALM FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT VOLTAGE 0* AMI CURRENT 0 ARI CURRENT 0	GROUND ON LP LEAD BATTERY ON FA LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Defective coil winding of K1 CONTR contactor	Test operate K1 contactor	If K1 contactor fails to operate at rated current, replace unit

* If trouble condition exists and DC OUTPUT (S6) switch in in BAT or EC position, OUTPUT VOLTAGE meter will indicate battery voltage.

TROUBLE CHART VII

OPERATED F17 (CHG) DC OUTPUT FUSE, F18 (CHG ALM) ALARM FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL OVLD (OVER LOAD)	OUTPUT VOLTAGE 0* AMI CURRENT 0 ARI CURRENT 0	GROUND ON LP LEAD GROUND ON GR LEAD BATTERY ON FA LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Overload permitted by incorrect adjustment of R23 MAX CUR LIM potentiometer	Check current limiting circuit in accordance with Section 169-724-301	Adjust as necessary

* If trouble condition exists and DC OUTPUT (S6) switch is in BAT or EC position, OUTPUT VOLTAGEmeter will indicate battery voltage.

TROUBLE CHART VIII

OPERATED F20 CONTR ALM FUSE

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT VOLTAGE 0* AMI CURRENT 0 ARI CURRENT 0	GROUND ON LP LEAD BATTERY ON FA LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Ground in immediate circuit wiring and equipment served by F20 fuse	(1) Operate S1 RECT OFF-NOR switch to OFF position (2) Operate S6 DC OUTPUT switch to OFF position (3) See caution. Use KS-14510 volt-ohm-milliammeter to check for shorts to ground *Caution: Battery voltage is always present on BAT input of F20 fuse.*	If no shorts are found, replace F20 fuse and restore rectifier to operation. If shorts are found, repair as necessary, replace fuse, and restore rectifier to operation.

* If trouble condition exists and DC OUTPUT (S6) switch is in BAT or EC position, OUTPUT VOLTAGE meter will indicate battery voltage.

TROUBLE CHART IX

OPERATED CB1 CIRCUIT BREAKER

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT VOLTAGE 0* AMI CURRENT 0 ARI CURRENT 0	GROUND ON LP LEAD BATTERY ON AR LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Shorted diode in secondary of T9 transformer	(1) Operate S1 RECT OFF-NOR switch to OFF position. (2) Operate S6 DC OUTPUT switch to OFF position (3) Remove AC input fuses (4) Check CR24 through CR31, CR50, and CR51 diodes for shorts using KS-14510 volt-ohm-milliammeter and procedure	Low resistance in both directions indicates defective diode. Replace as necessary.

* If trouble condition exists and DC OUTPUT (S6) switch is in BAT or EC position, OUTPUT VOLTAGE meter will indicate battery voltage.

TROUBLE CHART X

NO DC OUTPUT CURRENT

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT VOLTAGE 0* AMI CURRENT 0 ARI CURRENT 0	GROUND ON LP LEAD BATTERY ON AR LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective relay — K7, K6, or K2	Test operate each relay	Replace defective relays
B. Switch S6 DC OUTPUT handle not in pushed in or interlocking position	Check that S6 switch is in its fully "pushed in" position. Do not turn from BAT position.	
C. Defective K1 contactor	Test operate K1 contactor	Replace as necessary
D. Defective U1 electron tube		Replace tube
E. Open winding on T9 transformer	(1) Operate S1 RECT OFF-NOR switch to OFF position (2) Operate S6 DC OUTPUT switch to OFF position (3) Remove AC input fuses (4) Check T9 transformer windings for continuity per 5.05	Replace transformer if defective windings are found

* If trouble condition exists and DC OUTPUT (S6) switch is in BAT or EC position, OUTPUT VOLTAGE meter will indicate battery voltage.

TROUBLE CHART XI

HIGH DC VOLTAGE – HIGH DC CURRENT

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT VOLTAGE HIGH ARI CURRENT HIGH	GROUND ON OC LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Incorrect setting of MAX VOLT LIM R45 potentiometer	Check setting of voltage limiting circuit in accordance with Section 169-724-301	Adjust as necessary
B. High line voltage or T1 transformer taps incorrect	Check line voltage	If other than a temporary situation, notify power company and consult supervisor. Reconnect taps on T1 transformer in accordance with SD-81633-01

TROUBLE CHART XII

HIGH DC OUTPUT CURRENT – VOLTAGE NORMAL

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
	OUTPUT VOLTAGE NORMAL ARI CURRENT HIGH	GROUND ON OC LEAD

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
MAX CUR LIM (R23) potentiometer not adjusted properly	Check setting of current limit circuit in accordance with Section 169-724-301	Adjust as necessary

TROUBLE CHART XIII

HIGH RIPPLE INDICATION

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT VOLTAGE NORMAL AMI CURRENT NORMAL ARI CURRENT NORMAL	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Defective capacitor unit(s) in C25 through C36 capacitor bank or faulty connection	(1) Operate S1 RECT OFF-NOR (2) Operate S6 DC OUTPUT switch (3) Remove AC input fuses (4) Remove F12 and F13 fuses (5) Check C25 through C36 capacitors per 5.02	Replace defective units or repair faulty connections as necessary
B. Defective saturable reactor	Check saturable reactors per 5.06	Repair as necessary
C. Open diode in main rectifying diode bank (CR7, CR8, CR9, or CR10)	(1) Repeat (1) through (4) above (2) Check diodes per 5.03	Replace defective diodes as necessary

TROUBLE CHART XIV

EXCESSIVE HUNTING

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT VOLTAGE ERRATIC AMI CURRENT ERRATIC ARI CURRENT ERRATIC	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Incorrect adjustment of ANTI-HUNT (R29) and (R46) potentiometers. See caution and note *Note:* ANTI-HUNT (R29) potentiometer has been removed from KS-19216 rectifiers with Serial No. 25, 39, 40, 41, and higher. On these rectifiers, cyclic hunting is eliminated by adjustment of ANTI-HUNT (R46) potentiometer only. *Caution: Hunting should be corrected as soon as possible to prevent damage to the rectifier.*	(1) Rotate ANTI-HUNT (R29) potentiometer, if applicable, and ANTI-HUNT (R46) potentiometer fully cw (2) Slowly rotate ANTI-HUNT (R29) potentiometer cw until hunting is eliminated. (3) If hunting continues or hunting increases, rotate ANTI-HUNT (R29) potentiometer to maximum cw position, then rotate ANTI-HUNT (R46) potentiometer ccw 1/8 turn and again rotate ANTI-HUNT (R29) potentiometer ccw until hunting is eliminated (4) Repeat (3) if hunting continues. Advance ANTI-HUNT (R46) potentiometer by 1/8 turn each time	

TROUBLE CHART XV

RECTIFIER WILL NOT RESPOND TO LOWER SIGNALS

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT VOLTAGE NORMAL ARI CURRENT WILL NOT DECREASE	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Lower ADJ R39 potentiometer incorrectly adjusted	Check adjustment of R39 potentiometer	Adjust R39 so that the rectifier will go from full load to no load in 20 seconds
B. Defective U1 electron tube		Replace tube
C. Incorrect adjustment of AR1 ammeter relay	Check adjustment of AR1 ammeter relay. Low contact should be adjusted to 15 amperes unless otherwise specified	Adjust as necessary
D. Open circuit condition on plant RL lead preventing battery signal from reaching rectifier	Check for battery on RL lead	Repair trouble leads or connectors
E. Defective K8 relay	Test operate K8 relay	Replace as necessary

TROUBLE CHART XVI

RECTIFIER WILL NOT RESPOND TO RAISE SIGNALS

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT VOLTAGE NORMAL ARI CURRENT WILL NOT INCREASE	

PROBABLE CAUSE	TEST PROCEDURE	PLANT SIGNALS
A. RAISE ADJ R38 potentiometer incorrectly adjusted	Check adjustment of R38 potentiometer	Adjust R38 so that the rectifier will go from no load to full load in 20 seconds
B. Defective V1 electron tube		Replace tube
C. Incorrect adjustment of ARI ammeter relay	Check adjustment of ARI ammeter relay. High contact should be adjusted to 300 amperes unless otherwise specified	Adjust as necessary
D. Open circuit condition on plant RR lead preventing battery signal from reaching rectifier	Check for battery on RR lead	Repair trouble leads or connectors.
E. Defective K9 relay	Test operate K9 relay	Replace as necessary

TROUBLE CHART XVII

LOW DC CURRENT

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
NONE	OUTPUT VOLTAGE NORMAL ARI CURRENT LOW	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. MAX CUR LIM R23 potentiometer incorrectly adjusted	Check adjustment of current limiting circuit in accordance with Section 169-724-301	Adjust as necessary
B. Low AC input line voltage	Check ac input voltage using KS-14510 volt-ohm-milliammeter	If low, notify supervisor. If other than a temporary situation, reconnect taps on T1 transformer in accordance with Note 107, SD-81633-01
C. Excessive charging lead drop	Check rectifier dc output leads G, F, and EC. Check connections for cleanliness, tightness, and good contact	Clean and tighten as necessary