

RECTIFIERS
KS-21520
48 VOLTS, 400 AMPERES
WARREN G-V COMMUNICATIONS
TROUBLE LOCATING

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Danger 2: Inductors and transformers of these rectifiers have class H insulation, and the temperatures of the inner windings may be approximately 170° C (338° F). The outside temperatures will be proportionately high. Heat sinks and studs of semiconductor power devices may be approximately 90° C (194° F). Contact with these components must be avoided to prevent burns.

Warning: Do not operate the S1, DC OUTPUT, switch to either BAT or EC position without first charging the output filter capacitors.

1. GENERAL

1.01 The KS-21520 semiconductor-type rectifiers provide regulated dc power from a 3-phase, 60 Hz ac power source for floating and charging central office 48-volt storage batteries. The L11 and L12 rectifiers are primarily intended for use in the 301C, 302A, and 302B power plants while the L21 and L22 rectifiers are intended for use in the 111A, 303A, 326A, and 326B power plants.

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph. This issue does not 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.

1.03 This issue of the section is based on drawing SD-82410-01, Issue 1. 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-21520 rectifiers per SD-82410-01, refer to Section 169-748-302. Procedures for maintaining the dc output switch of the KS-21520 rectifier per SD-82410-01, are contained in Section 169-748-502.

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.

NOTICE

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

2. LIST OF TOOLS, TEST APPARATUS, AND MATERIALS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
R-3040	Open End Wrench
TEST APPARATUS	
—	Ground Fault Circuit Interrupter, Hubbell No. GFP 115 or equivalent
—	Isolation Plug, Hubbell No. BL-12-767 or equivalent
KS-14510	Volt-Ohm-Milliammeter
KS-20599 L4	Digital Multimeter (or equivalent)
—	Oscilloscope-Tektronix 545B or equivalent
—	100-ohm, 10-watt resistor
—	Thermometer, Fisher Scientific Company No. 14-985 or equivalent
CP900	Extender Board (stored on the inside of the door)
MATERIALS	
KS-21343	Heat Conductive Compound
KS-14666 or KS-2423	Cloth, Cleaning

3. OPERATION

3.01 Normal operation of the KS-21520 rectifier shall be in accordance with Section 169-748-302. In the event of a trouble condition, the rectifier should be removed from service in accordance with Section 169-748-302.

3.02 Restoring the Rectifier to Service After a Trouble Condition: Under all trouble conditions, before placing the rectifier back in service, check the rectifier regulation, current limit, and alarm circuits for proper operation per Part 4 of Section 169-748-302.

4. TROUBLE LOCATING PROCEDURES

4.01 Failure of the KS-21520 rectifiers will usually be characterized by one of the following conditions:

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

The trouble flow chart in Fig. 1 is designed to analyze troubles in the rectifier from the standpoint of these four general symptoms. The output of the rectifier should be checked and the appropriate category of the flow chart should be consulted to isolate the trouble. For example, if initial inspection of a faulty rectifier reveals an operated fuse, refer to the indicated trouble chart.

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

Danger 2: Use care 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. Operation of the DC OUTPUT switch to the OFF position disconnects the rectifier output from the battery. However, battery voltage is always present on the BAT and EC terminations; terminals 1 and 12 of connector J2 and the input to the fuse block of the RELAY ALARM, F604 fuse. Connector J2 is located on the S1 switch assembly and the F604 fuseblock on the rear of the meter panel.

Danger 3: If an electronic type voltmeter is used, the meter must be

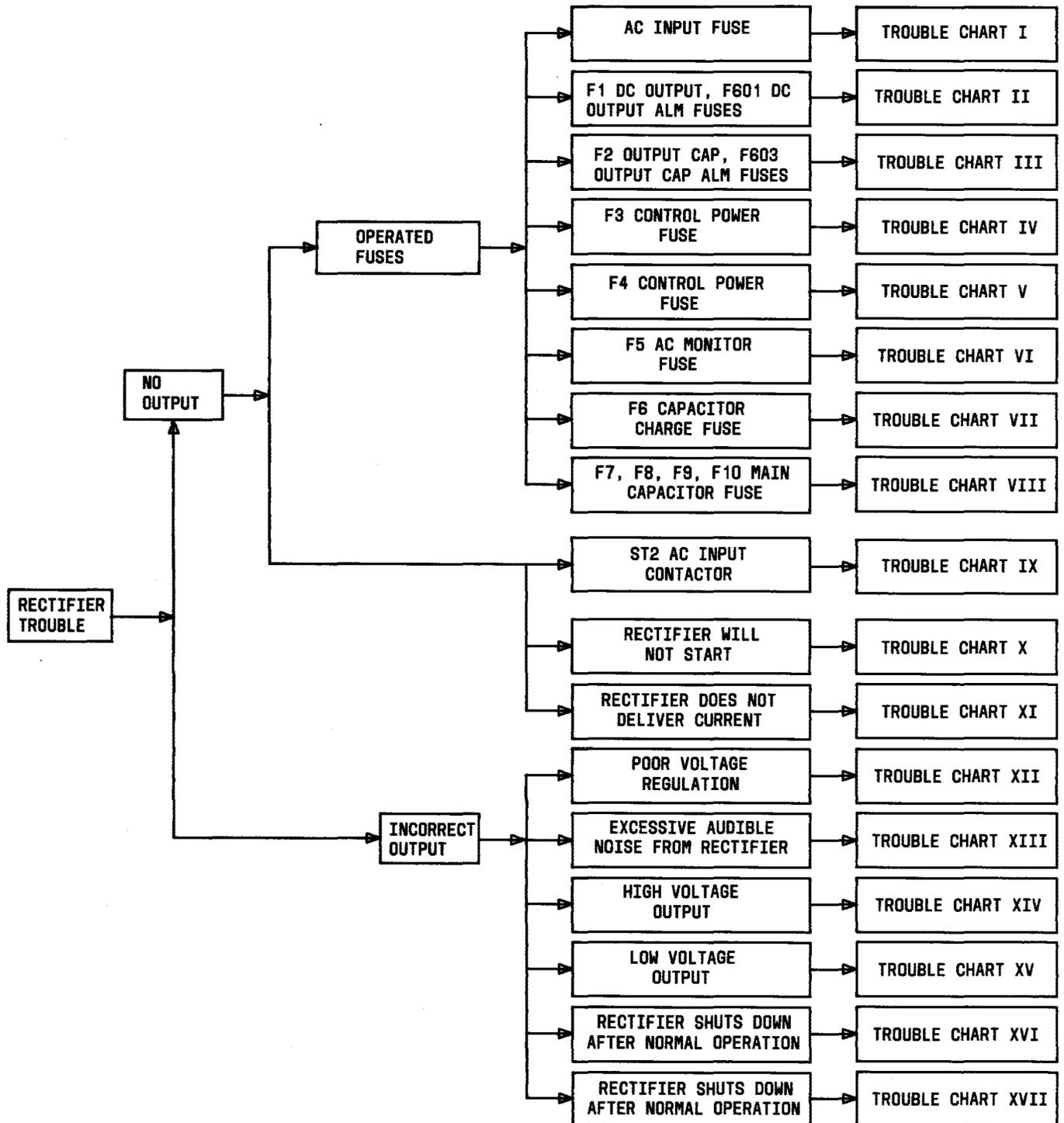


Fig. 1—Trouble Chart

isolated from ground using the following procedure.

- (1) *Connect the ground fault circuit interrupter, Hubbell No. GFP115 or equivalent, to a 115 volt source.*
- (2) *Insert the isolation plug, Hubbell No. BL-12-767 or equivalent, into the ground fault circuit interrupter.*
- (3) *Connect the ac operated instrument to the isolation plug.*

Warning 1: *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 ground potential when troubleshooting the rectifier.*

Warning 2: *Under no circumstances should fuses of higher rating than those specified be used.*

4.03 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 each other. 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.

4.04 When a trouble is traced to a printed circuit assembly, replace it with a 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. Following is a list of the circuit packs, the functions they control, and their mounting locations. The CP100 through CP500 and CP800 circuits plug into 22 pin edge connectors and are accessible through the door in the control panel. The CP600 mounts on the control panel and the CP700 mounts on the thyristor heat sinks. A CP900 extender board is provided for troubleshooting purposes.

- (a) The CP100 circuitry determines voltage set point and voltage regulation and limits the difference between output voltage and transformer secondary voltage. The OUTPUT VOLTAGE ADJUST control is accessible through the small hole in the control panel.
- (b) The CP200 contains the current limit, current walk-in and low current (LO) relay circuits. On L11 and L12 rectifiers, a second control for current limit set point is provided with selection of set point determined by the PL relay.
- (c) The CP300 contains the high voltage monitor circuits with adjustable reference voltage. The sensing circuits are contrived such that this reference voltage and the operate point of the monitor are exactly one tenth of the output voltage. The high voltage relay (HV) picks up when the monitor operates or when ground is applied to the plant HV lead causing the rectifier to shut down. The rectifier can be remotely restarted by the plant by closing RS to RSR.
- (d) The CP400 circuitry detects severe unbalance in rectifier circuits by measuring 120-Hz ripple current in the output. The rectifier failure relay is normally picked up and drops out when the unbalance monitor operates or when a fuse alarm activates, causing the rectifier to shut down and lock out. This shutdown can be reset by cycling the POWER switch to OFF and then to ON after the fault has been cleared.
- (e) The CP500 contains circuitry to monitor the magnitude and balance of the AC input voltage and to enable the TR shutdown. Shutdown via the CP500 does not lock out the rectifier and resets automatically when AC recovers to within acceptable limits or TR ground is removed.
- (f) The CP600 contains the light-emitting diode (LED) indicators and the interlock relay (INT). Removing a plug-in circuit pack or operating the DC output switch will cause a rectifier shutdown.
- (g) The CP700 mounts the R-C snubber circuits to limit rate of change of voltage on the thyristors.
- (h) The CP800 board receives an analog control signal from the CP100 or CP200 circuit board

and converts it into pulses, correctly positioned in phase to fire the controlling thyristors.

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

Danger: Voltages inside the rectifiers 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. Remove power from the circuit before removing and replacing printed circuit assemblies (circuit packs).

Warning 2: 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.

- 4.07 Trouble Charts and Tests:** Trouble Charts I through IX refer to operated fuses, Trouble Charts X through XII refer to rectifier failures in which no fuses are operated, and Trouble Charts XIII through XVIII refer to an incorrect output.

- 4.08 Test Point Symbols:** The test point symbols are stamped on circuit packs.

Note 1: Whenever a test procedure requires testing a circuit pack and components or test points are not accessible, the CP900 circuit pack board extender should be used.

Note 2: When checking the possible cause of a trouble, a (+) or (-) symbol after the component or test point indicates the polarity of the terminal. This should always be considered when connecting any test apparatus.

5. COMPONENT CHECKING PROCEDURES

- 5.01** The test procedures in 5.02 through 5.08 are given as an aid in determining defective components *not mounted* on a plug-in circuit card. In general, the components most likely to become defective with use are 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

Warning: Prior to testing a capacitor, it should be completely discharged to ground.

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, carefully 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 ordered. 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 the 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 possibility of 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 transformers.

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 Thyristors (Triacs) Malfunctioning thyristors or their associated circuitry may exhibit the following symptoms.

Danger: Make all temperature tests with a thermometer.

- Thyristor reactor(s) very hot, possibly to the point of giving off smoke.
- Thyristor heat sink cold after a period of loading.

The following method may be used to check for possible defective thyristors (Q1 or Q2).

- (1) Remove all sources of power from the rectifier.
- (2) Disconnect MT1 (large yellow lead) and both gate leads (yellow and white) from the thyristors.
- (3) Using the KS-20599 L4 digital volt-ohm-milliammeter set to the ohms function, measure the resistance from cathode to anode in both directions.

Requirement: The measured resistance is in excess of one megohm in both directions.

Note: Open thyristors are highly improbable.

5.07 Power Diode Replacement: The power diodes in this rectifier (CR1-CR4) are a disc type of device and are held in place by a spring

loaded clamp assembly. Special consideration must be given to replacing diodes and tightening the securing clamp. To replace a power diode, proceed as follows:

Danger: The power diodes and heat sinks can operate at temperatures in excess of 100°C. Allow sufficient time for these devices to cool before attempting replacement.

- (1) Operate the POWER switch to OFF and the DC OUTPUT SWITCH to the OFF position.
- (2) Remove the ac supply by operating the associated switch and fuse unit or circuit breaker in the ac bus duct or power service cabinet to the OFF position or remove the fuses.
- (3) Disconnect the J1 plant connector from the rectifier.
- (4) Using the R-3040 wrench, loosen but do not remove the two 1/2 inch hex nuts at the top of the clamp on the front heat sink on the diode to be replaced.

Note: If the nuts are brought to the ends of the studs there will be sufficient clearance to replace the diodes.

- (5) Hold the heat sink lightly against the diode while the nuts are loosened.

Note 1: It is not necessary to remove the wires connecting to the front heat sink.

Note 2: If the front heat sink is removed completely, it will be very difficult to hold a new diode in place, feed the studs through the heat sink and spring bar, and replace the nuts.

- (6) With the nuts loose, reach around both sides of the front heat sink with both hands and trap the diode disc between the fingertips.
- (7) Pull the front heat sink outward until the nuts restrain movement.
- (8) Hold the diode against the heat sink with the fingertips.

Note: There is a centering pin forced through a hole in the heat sink and into a locating hole in the diode.

- (9) Lift the diode with the fingertips to clear the pin and slide it to the left or right until it can be grasped in one hand and removed.
- (10) With the diode removed, and using a KS-14666 cloth, wipe the residual thermal compound from both the front and rear heat sinks.

Note 1: The centering pin should be felt protruding about 2/32 inch from the front heat sink.

Note 2: It is possible through improper installation of a diode that the centering pin has been forced back into the heat sink. If this is the case, it will be necessary to drive the pin back into position. Tap the end of the split pin coming through the spring bar with a light hammer until the other end protrudes approximately 1/8 inch through the sink; the excess will be forced back when the clamp is tightened.

- (11) Apply a very thin layer of KS-21343 heat conductive compound to both surfaces of the replacement diode.
- (12) Orient the diode so that the metal flanged end, cathode terminal, is toward the front heat sink.
- (13) Slide the diode behind the heat sink using the fingertips.
- (14) Again grasp the diode between the fingertips of both hands and position it so that the centering pin seats in the hole of the diode.
- (15) Hold the diode against the front sink and attempt to slide the device to the left and right.

Requirement: The pin restrains this motion.

- (16) Push the front sink to the rear and hold firmly in place while tightening the nuts finger tight.

Warning: The centering pin insures that the diode is properly positioned under the spring clamp. Improper installation will result in uneven pressure on the device and premature failure. With the nuts finger tight it should not be possible to push the diode to the left or right between the sinks.

- (17) Before securing the nuts, check the alignment of the gauge mounted to the spring bar.

Requirement: The top edge of the gauge marked 0 should align with the bottom edge of the spring bar. See Fig. 2.

Note: If necessary, bend the gauge to align with the spring bar.

- (18) Tighten the nuts uniformly to bend the spring bar and until the notch marked 1.0 (kilopounds) aligns with the bottom edge of the spring bar. See Fig. 2.

Warning: The spring clamp is designed to mount several sizes of disc diodes requiring more or less pressure. Recommended mounting force for the diodes in this rectifier is 700 to 1000 pounds. Greater pressures can cause premature failure of the device.

- (19) If the 1.0 mark is exceeded, back the nuts off several turns and retighten, proceeding slowly.

- (20) After changing a diode, connect the KS-20599L4 digital meter, set to the voltmeter function, to the output volts test jacks while operating the CAP CHG switch.

Note 1: This monitors the increase in voltage on the DC output capacitors and insures that the diode is installed in the correct polarity.

Note 2: A reversed diode will prevent the capacitors from charging and if the DC output switch is closed, will cause the DC output fuse to operate.

- (21) Return the rectifier to service in accordance with Section 169-748-302.

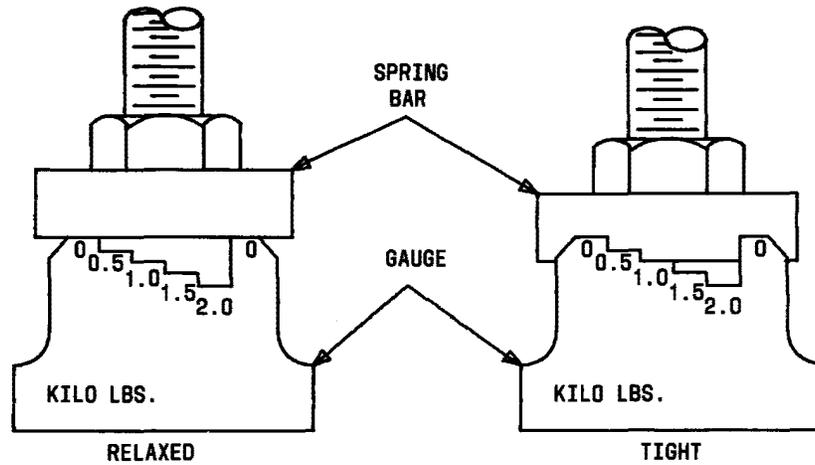


Fig. 2—Diode Replacement Gauge

5.08 Circuit Board Tests: Trouble locating on circuit boards in the unit is not recommended as much more time will be spent in isolating defective components than in replacing an entire circuit pack. Only a qualified technician with proper tools should attempt such repair.

Note: The trimmer potentiometers on the circuit boards are factory adjusted in special test fixtures to compensate for tolerance of components. It is unlikely that a board can be repaired by turning one of these potentiometers.

Readjustment should be necessary only in the event critical components on the circuit board are changed.

Several test points are available on the printed circuit boards, and when the extender board is used, readings may be taken at any terminal on the edge connector. The following is a listing of normal voltages and/or waveshapes at each test point:

(1) **CP100**

TEST POINT	READING	COMMENT
(a) J101	-10 VDC	Adjustable by R107
(b) J102	-15 VDC $\pm 5\%$	Power Supply for CP100
(c) TP103	-2 VDC -1 to -7 VDC Range -13 to -15 VDC	In TEST, 50 VDC output Becomes increasingly negative as output voltage and/or load increases Rectifier in Current Limit
(d) TP104	0 to -1 VDC	In TEST, 50 VDC output
(e) TP105	-4.5 VDC	In TEST, 50 VDC output
(f) TP106	-10 VDC	In TEST, 50 VDC output
(g) TP107	-5 VDC	In TEST, 50 VDC output

(2) CP200

TEST POINT	READING	COMMENT
(a) J201	-13 to -15 VDC -1 to -7 VDC Range	In TEST, 50 VDC output Rectifier in Current Limit becomes decreasingly negative as output voltage decreases
(b) J202	-15 VDC	CP200 Power Supply
(c) TP203	0 to -400mV	Proportional to output current or simulated current
(d) TP204	100 to 200 times voltage at TP203 Adjustable by R207	Reaches 5. 6V \pm 5% when LO relay picks up
(e) TP205	+3 to -1 VDC -13 to -15 VDC	LO Relay dropped out LO Relay picked up
(f) TP206	5.6 VDC	LO Relay Circuit reference voltage
(g) TP207	10 to 25 times voltage at TP203 depending on current limit set point	Reaches value at TP208 when rectifier enters current limit
(h) TP208	5 VDC after walk-in Adjustable by R217	Current Limit Reference. Increases slowly from zero when rectifier is first energized

Note: Simulated Output Current can be used
for current dependent voltages.

(3) CP300

TEST POINT	READING	COMMENT
(a) J301	-5. 00 VDC	At 50. 0 VDC output. Set for exactly 1/10 output voltage by R303
(b) J302	-5. 18 VDC Adjustable by R306	High Voltage Shutdown set point One tenth of desired value
(c) J303	-15 VDC	CP300 Power Supply
(d) TP304	0 to -2 VDC -13 to -15 VDC	Normal Operation During high voltage condition, voltage at J302 to less than at J301 to test

(4) **CP400**

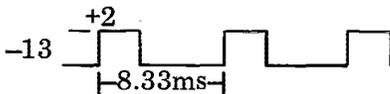
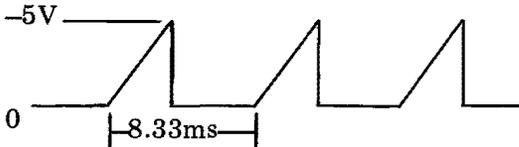
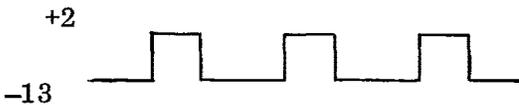
TEST POINT	READING	COMMENT
(a) J401	Less than 1 VAC 3.5 to 5 VAC Maximize R410	Normal Operation During unbalance condition, remove F10 Remove F10 and apply 50 amp dummy load to test
(b) J402	-7.5 VDC $\pm 5\%$	CP300 Power Supply
(c) J403	-15 VDC $\pm 5\%$	CP300 Power Supply
(d) TP404	1/20 voltage at J401	Measure curing unbalance
(e) TP405	Less than -1 VDC greater than -7.5 VDC	Normal Operation During Unbalance
(f) TP406	0 to -2 VDC -13 to -15 VDC	Normal Operation During Unbalance and Shutdown

(5) **CP500**

TEST POINT	READING	COMMENT
(a) J501	-4.9 VDC Adjustable by R511	AC Monitor Shutdown Reference Voltage
(b) J502	-15 VDC	CP500 Power Supply
(c) TP503	-5.8 VDC	At Nominal AC input, proportional to AC input voltage
(d) TP504	-5.6 VDC $\pm 5\%$	Reference zener voltage
(e) TP505	-11 to -15 VDC 0 to -2 VDC	Normal Operation During AC Monitor Shutdown
(f) TP506	-13 to -15 VDC 0 to -2 VDC	Normal Operation During AC Monitor Shutdown

(6) **CP800:** Use the 545B oscilloscope to check the CP800 circuit board. The scope should be isolated from the AC supply. The waveshapes

are referenced to the + OUTPUT VOLTS test jack.

TEST POINT	READING	COMMENT
(a) J801	+2.5 to +4 VDC	Bias Power Supply
(b) J802	-15 VDC ±5%	CP800 Power Supply
(c) TP803 thru TP810	Symmetric Square Waves, 13 to 20V peak to peak	Buffered synchronizing signals TP803 and TP804 are complementary TP805 and TP806 are complementary, etc
(d) CP800 Pin 3 CP800 Pin 21	Square Wave 1 to 2V P-P	Primary synchronizing signals from T1A and T1B
(e) CP800 Pin 14 CP800 Pin 15	Square Wave 8 to 12V P-P	Secondary synchronizing signal From T1A and T1B
(f) TP811	Asymmetric Square Wave 13 to 20V P-P	Gate Pulse to Q2 
(g) TP812 & TP813	Triangular Ramp Signal -5.0V Peak Typical	
(h) TP814	-1 to -7 VDC	ACS Signal
(i) TP815	Asymmetric Square Wave 13 to 20V Peak to Peak	Gate Pulse to Q1 

5.09 Trouble Chart Preface

Shutdowns: A failure in the rectifier is usually accompanied by a shutdown and alarm indication. Before attempting to restart the unit, the failure should be analyzed for possible causes and corrective action taken. The illuminating indicators (LED's) on the control panel plus the plant signal leads should provide sufficient information to determine the reason for shutdown. The following LED indications might exist after a shutdown from normal operation and before the POWER switch has been moved to the OFF position.

Note 1: Moving the POWER switch to OFF will reset some rectifier alarm conditions.

Note 2: When the POWER switch is ON, the POWER ON indicator will be illuminated even though an alarm condition exists.

Note 3: If the rectifier is being operated in the EC mode (L11 and L12 units only) the END CELL indicator will be lighted even though an alarm condition exists.

Danger: When the POWER OFF-AUTO START indicator is lighted, the rectifier may be restarted from a remote

location. Move the POWER switch to OFF before removing protective guards, operate the DC OUTPUT switch to OFF and disconnect the ac service before attempting to work on the rectifier.

(1) The POWER OFF-AUTO START indicator only will light for a TR shutdown or an AC monitor shutdown. These shutdowns will occur in normal operation and trouble is not usually indicated.

(a) Continuity will exist from SIC(22) to SICR(23) at J1 for a TR shutdown. A TR shutdown can only be initiated by a ground on the TR(7) plant terminal.

Note: This shutdown will reset automatically when the ground signal is removed.

(b) Continuity will exist from SIB(20) to SIBR(21) for an AC monitor shutdown. An AC monitor shutdown normally means that the AC voltage to the rectifier is below limits or absent due to:

- Power failure
- Operated ac service fuse
- Open ac switch or circuit breaker
- Operated control fuses (F3 and F4)
- Operated AC monitor fuse (F5).

Note: This shutdown will reset automatically when normal conditions are restored and the rectifier restarted.

(2) The POWER OFF-AUTO START and RECT FAIL indicators both will light for a high voltage shutdown.

Note 1: This is accompanied by a closure from SID(24) to SIDR(25) at J1. The shutdown can be initiated by a ground signal on the HV(6) plant terminal or by voltage above the preset limit at the HVB(11) and HVG(12) plant terminals of P1/J1.

Note 2: Some types of failures in the regulating circuits can cause high voltage and

the rectifier should be checked thoroughly before returning to service.

Note 3: This shutdown can be reset by moving the POWER switch to OFF then to ON or by a closure between plant terminals RS(14) and RSR(15) but will reoccur if high voltage persists.

(3) The RECT FAIL and TEST indicators will light for a loss of sensing voltage on the RB(1) and RG(3) plant terminals of P1/J1.

Note 1: This will be accompanied by a closure from SIE(26) to SIER(27) at J1. In the BAT or EC mode of operation, sensing voltage must be present at the RB(1) and RG(3) plant terminals or the rectifier will shut down.

Note 2: This shutdown can be reset by restoring sensing and moving the POWER switch to OFF then to ON.

(4) The RECT FAIL indicator only will light for an open interlock shutdown, a fuse alarm shutdown, or an unbalance monitor shutdown.

(a) Continuity will exist from SIE(26) to SIER(27) for an interlock shutdown. An interlock shutdown will occur if the DC OUTPUT switch is not locked in position or if a plug-in printed circuit board is out of place.

Note: To reset this shutdown, the open interlock must be closed and the POWER switch cycled to OFF.

(b) Continuity will exist from SIF(28) to SIFR(29) for a fuse alarm shutdown. This will occur if one of the type 70 alarm fuses operates.

Note 1: Before replacing a fuse, the cause for failure should be determined.

Note 2: To reset a fuse alarm shutdown, the operated fuse must be replaced and the power switch cycled to OFF.

(c) Continuity will exist from SIF(28) to SIFR(29) for an unbalance monitor shutdown. This shutdown is initiated when unbalanced

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operation of the two main transformers occurs and normally indicates malfunction in the rectifier circuitry.

Note 1: An interlock or fuse alarm shutdown can be distinguished from an unbalanced monitor operation by noting if the RECT FAIL indicator remains lighted when the POWER switch is moved to OFF.

Note 2: Unbalance shutdowns are reset (RECT FAIL indicator extinguishes) by moving the POWER switch to OFF.

Note 3: If an unbalance failure is not corrected, the rectifier may restart but will shutdown again after a short delay.

TROUBLE CHART I

OPERATED AC INPUT FUSES OR CIRCUIT BREAKER

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF - AUTO START	OUTPUT CURRENT - 0	CLOSURE OF SIC - SICR
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted power diode CR1 through CR4	Completely remove power from rectifier and check per 5.03	Replace as necessary
B. Shorted T1 transformer	Same as above	Replace as necessary

TROUBLE CHART II

OPERATED F1 DC OUTPUT AND F601 DC OUTPUT ALARM FUSES

LED INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT CURRENT - 0	CLOSURE OF SIE - SIER RFA AND/OR RFA-RTN
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted power diode CR1 through CR4	Completely remove power from the rectifier and check per 5.03	Replace as necessary
B. Short to ground in output inductor L1 and L2 or in bus work	Completely remove power from the rectifier. Check L1 and L2 for short circuit to ground	Repair or replace as necessary

TROUBLE CHART III

OPERATED F2 OUTPUT CAPACITOR AND F603 OUTPUT CAP ALARM FUSE

LED INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT CURRENT - 0	CLOSURE OF SIE - SIER RFA AND/OR RFA-RTN
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted filter capacitor C3A through C3H	Completely remove power from the rectifier and check per 5.02	Replace as necessary
B. High ripple current due to unbalanced operation (unbalance monitor inoperative)	(a) Check that all transformer voltage tap connections are correct and that the main capacitor fuses, F7-F10, are good and in place.	(1) Replace components as necessary (2) Replace defective CP400

TROUBLE CHART III (Contd)

OPERATED F2 OUTPUT CAPACITOR AND F603 OUTPUT CAP ALARM FUSE

LED INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT CURRENT – 0	CLOSURE OF SIE – SIER RFA AND/OR RFA–RTN
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

B. (Contd)

Danger: Potentials in excess of 400 volts AC are present on the main capacitors. Always turn the rectifier off before working near these components. Do not attempt to remove or replace fuses F7 – F10 with the rectifier on as the inrush to the capacitors will operate the fuse.

Note 1: Operation of one of the F7 – F10 fuses will result in loss of some rectifier output capability.

Note 2: Some types of unbalance failures may not be apparent in the TEST mode as some load current is required to operate the 120-Hz monitor on CP500. To check the unbalance monitor operation, a dummy load of approximately 100 amperes, connected to the ± TEST terminations, is required.

- (b) Check power thyristors Q1 and Q2, for shorts per 5.06. If shorted, also check associated main inductors L3 or L4 for damage before replacing the thyristors.

Danger: Voltages in excess of 400 volts AC are present on the thyristors. Always turn the rectifier off before working near these components.

- (c) Verify that gate current is flowing to the thyristors by measuring the voltage drop across resistors R601 and R602.

TROUBLE CHART III (Contd)

OPERATED F2 OUTPUT CAPACITOR AND F603 OUTPUT CAP ALARM FUSE

LED INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT CURRENT – 0	CLOSURE OF SIE – SIER RFA AND/OR RFA–RTN
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

B. (Contd)

Danger: If adequate gate current is flowing, the surfaces of these resistors will be hot.

Requirement: The measured voltage is approximately 50 volts (battery voltage) whether the rectifier is on or off but connected to the plant.

- (d) Replace the CP800 circuit board.

Note: It is unlikely that the regulating circuits CP100 or CP200 will cause unbalanced operation as the output signal (ACS) from these circuits is common to both main power circuits.

- (e) Measure the synchronizing signals across the Y1 – Y2 and Z1 – Z2 windings of the T1A and T1B main transformers.

Requirement: 3 to 5 volts AC is available across each winding.

- (f) Remove the CP800 circuit board and check the control inductors L601 and L602 for open circuit.

Requirement: The resistance of each inductor is approximately 200 ohms.

- (g) Check for proper output of the T1A and T1B main transformers by operating the unit in the TEST mode with the Q1 and Q2 power thyristors off (yellow MT1 and gate leads to each thyristor removed and insulated per 5.06).

TROUBLE CHART III (Contd)

OPERATED F2 OUTPUT CAPACITOR AND F603 OUTPUT CAP ALARM FUSE

LED INDICATION	METER INDICATION	PLANT SIGNALS
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

RECT FAIL

OUTPUT CURRENT – 0

CLOSURE OF SIE – SIER
RFA AND/OR RFA-RTN

B. (Contd)

Requirement 1: High dc output volts with an increase in audible noise is present. Voltage measured across the output volts jacks is approximately 70 volts dc.

Requirement 2: The ac voltage from each power diode (CR1 – CR4), measured from the front heat sink to ground, is approximately 60 volts ac and the same for each diode.

Note 1: Low or zero output voltage indicates a defective (shorted) transformer.

These operate the unit in the TEST mode with thyristors, Q1 and Q2, fully on (yellow MT1 and gate leads connected but REG, F605 fuse removed).

Note 2: This check simulates minimum rectifier output (low end limit).

Requirement 1: Output voltage across the output volts jacks is 35 to 40 volts dc.

Requirement 2: The ac voltage from each power diode (CR1 – CR4), measured from the front heat sink to ground, is 25 to 30 volts ac and the same for each diode.

C. Overload (current limit inoperative)

Completely remove power from the rectifier and make the following checks.
(a) Output inductor L1 for short circuit
(b) Power diode CR1 – CR4 for short circuit

- (1) Replace components as necessary
- (2) Replace defective CP200

TROUBLE CHART IV

OPERATED F3 CONTROL POWER FUSE*

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF – AUTO START	OUTPUT CURRENT – 0	CLOSURE ON SIB AND SIBR
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Short circuit in capacitor C201 on CP200	Check per 5.02	Replace CP200 as required
B. Defective T2 control power transformer	Check per 5.05	Replace as required

* Does not activate the failure alarm.

TROUBLE CHART V

OPERATED F4 CONTROL POWER FUSE*

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF – AUTO START	OUTPUT CURRENT – 0	CLOSURE ON SIB AND SIBR
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Shorted AC input contactor coil	Using a KS-14510 volt-ohm-milliammeter, check between contactor coil terminals 1 and 2 for a short circuit condition	Replace as necessary

* Does not activate the failure alarm.

TROUBLE CHART VI

OPERATED F5 AC MONITOR FUSE*

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF – AUTO START	OUTPUT CURRENT – 0	CLOSURE ON SIB AND SIBR
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Short circuit in capacitor C501, C502, or C503 on CP500	Check per 5.02	Replace CP500 as necessary
B. Defective T3 AC monitor transformer	Check per 5.05	Replace as necessary

* Does not activate the failure alarm.

TROUBLE CHART VII

OPERATED F6 CAP CHG FUSE*

LED INDICATION	METER INDICATION	PLANT SIGNALS
OUTPUT CURRENT – 0		
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Shorted series resistor R1	Remove all sources of power from the rectifier and using a KS-14510 meter, set to the ohms function, test for a short circuit condition.	Replace as necessary

* Does not activate the failure alarm.

TROUBLE CHART VIII

OPERATED F7, F8, F9, OR F10 MAIN CAPACITOR FUSE

LED INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT CURRENT – 0	CLOSURE ON SIF AND SIFR RFA AND/OR RFA-RTN
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Shorted main capacitor C1A – C1C, C2A – C2C, C1D – C1G (Y, Z) C1D – C1F (W, X) C2D – C2G (Y, Z) C2D – CCF (W, X)	Remove all power from rectifier and check per 5.02	Replace as necessary

TROUBLE CHART IX

NON-OPERATED ST2 AC INPUT CONTACTOR

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF – AUTO START	OUTPUT CURRENT – 0	
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Failure of the ac service (LED Indication POWER OFF – AUTO START)	Measure the voltage in the power service cabinet	Notify the power company if other than a temporary condition
B. Faulty ST2 contactor	Remove power from the rectifier, check contactor coil terminals for continuity	Repair or replace as necessary

TROUBLE CHART X

RECTIFIER WILL NOT START

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF – AUTO START	OUTPUT CURRENT – 0	A. CLOSURE OF SIB AND SIBR (FOR NO AC) B. CLOSURE OF SIC AND SICR (FOR TR) C. CLOSURE OF SID AND SIDR (FOR HV) D. CLOSURE OF SIA AND SIAR (POWER SWITCH OFF) E. CLOSURE OF SIE AND SIER (INTERLOCK OPEN)
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Failure of the ac service	Check input voltages phase-to-phase in power service cabinet	Notify power company if other than a temporary situation
B. TR relay is picked up	(1) Make certain that the relay contacts are not binding <i>Note:</i> There should be no voltage on the coil of the relay (2) Faulty ground on TR lead	Repair or replace as required
C. AC relay is dropped out (Defective CP500)	Check relay for necessary voltage indication on the coil terminals Remove power from the rectifier and determine that continuity exists in the relay coil	Replace relay as necessary
D. HV relay is picked up (Defective CP300; RECT FAIL indicator lights)	Make certain that the relay contacts are not binding <i>Note:</i> There should be no voltage on the coil of the relay	Repair or replace as required
E. RF relay is dropped out (Defective CP400; RECT FAIL indicator lights)	Check relay for necessary voltage indication on the coil terminals. Remove power from the rectifier and determine that continuity exists in the relay coil	Replace relay as necessary
F. The power switch is in the OFF position.		Push the switch to ON
G. One or more circuit packs not properly installed. (LED indication RECT FAIL)	Check that all circuit packs are firmly installed in their proper locations	Reinstall circuit packs as required

TROUBLE CHART X (Contd)

RECTIFIER WILL NOT START

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF – AUTO START	OUTPUT CURRENT – 0	A. CLOSURE OF SIB AND SIBR (FOR NO AC) B. CLOSURE OF SIC AND SICR (FOR TR) C. CLOSURE OF SID AND SIDR (FOR HV) D. CLOSURE OF SIA AND SIAR (POWER SWITCH OFF) E. CLOSURE OF SIE AND SIER (INTERLOCK OPEN)
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
H. DC OUTPUT (S1) switch not firmly set in the desired position (LED indication RECT FAIL)	Check that the locking pin has fallen into the hole in the face-plate	Reposition as required
I. Wiring associated with the interlock path open	Trace wiring in rectifier	Repair or replace as necessary

TROUBLE CHART XI

RECTIFIER STARTS BUT DOES NOT DELIVER CURRENT

LED INDICATION	METER INDICATION	PLANT SIGNALS
	OUTPUT CURRENT – 0	OPEN CA – CB
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Output voltage of rectifier set too low (below battery voltage)	Operate the DC OUTPUT switch (S1) to the TEST mode and verify that output can be adjusted with the OUTPUT VOLTS ADJUST control. If the output in the TEST position is very low (35 – 40 Vdc) and will not adjust, check the ACS signal at TP814 on CP800.	Readjust as required or replace CP800
	<i>Note 1:</i> The + output volts test jack is common.	
	<i>Note 2:</i> A voltage of from –8 to –15 volts indicates that the CP100 board is good and is trying to increase the voltage.	

TROUBLE CHART XI (Contd)

RECTIFIER STARTS BUT DOES NOT DELIVER CURRENT

LED INDICATION	METER INDICATION	PLANT SIGNALS
	OUTPUT CURRENT – 0	OPEN CA – CB
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. (Contd)	Substitute a new or repaired CP800.	
B. Defective CP100 or CP200 circuit packs	An ACS voltage of –1 to +4 volts (on CP800) would indicate a bad CP100 or CP200. Substitute a new or repaired CP100 and CP200 one at a time.	Replace circuit packs as required

TROUBLE CHART XII

POOR VOLTAGE REGULATION

LED INDICATION	METER INDICATION	PLANT SIGNALS
	OUTPUT CURRENT – ERRATIC	
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. CURRENT LIMIT FULL LOAD control (R202) improperly set	Check in accordance with Section 169-748-301	Readjust as required
B. Sensing terminals RB and RG improperly connected in the plant	Check connections in accordance with the plant SD	Make repairs as necessary
C. Defective CP100 or CP200 circuit packs	Substitute new or repaired circuit packs CP100 and CP200	Replace as necessary

TROUBLE CHART XIII

EXCESSIVE AUDIBLE NOISE FROM RECTIFIER		
LED INDICATION	METER INDICATION	PLANT SIGNALS
OUTPUT CURRENT – NORMAL		
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Faulty magnetic component	Test in accordance with 5.05	Replace as required
B. Excessive loop drop developed in the connections to the battery	Check rectifier terminal voltage. If it is above 64 Vdc, the cause is as stated	Repair and replace connections as required
C. Loose mounting hardware on large magnetics or other components	Operate the POWER switch to OFF, remove the ac and then check the connections	Tighten as required

TROUBLE CHART XIV

HIGH OUTPUT VOLTAGE

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF – AUTO START RECT FAIL	OUTPUT CURRENT – 0	CLOSURE ON RFA AND RFA RTN SID AND SIDR (FOR HV)
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

Faulty circuit packs
CP100, CP200, or
CP800

(a) Operate the DC OUTPUT (S1) switch to the TEST position to verify that a high voltage condition exists and that the OUTPUT VOLTAGE ADJUST control will not vary the output.

Replace faulty circuit packs as necessary

Note 1: High voltage shutdown is inhibited when approximately 10 percent of rated output current flows.

Note 2: If the plant load is greater than 500 amperes, a failure which would normally generate high voltage may instead be noticed as high output current. The inherent ferroresonant current limit may allow the rectifier to continue operating for some period.

In the TEST mode, with no load present, the high voltage will be apparent.

(b) Measure the voltage of the ACS signal from CP814 on CP800 to + OUTPUT VOLTS test jack.

Note 1: Values from +4 to -1 volts would indicate that the regulating circuits (CP100 and CP200) are functioning and trying to lower the output.

Note 2: ACS voltages of from -8 to -15 volts indicate a faulty CP100 or CP200.

TRouble CHART XIV (Contd)

HIGH OUTPUT VOLTAGE

LED INDICATION	METER INDICATION	PLANT SIGNALS
POWER OFF – AUTO START RECT FAIL	OUTPUT CURRENT – 0	CLOSURE ON RFA AND RFA RTN SID AND SIDR (FOR HV)
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

(c) Measure the voltage across R601 and R602.

Note: If the meter readings indicate approximately 50 volts across the resistors, this is a symptom of:

- A faulty CP800
- Gate current not being provided to the thyristors

(d) Check the wiring associated with the gate circuits. Check for opens and shorts using the SD and T drawings for reference.

(e) Check the thyristors, Q1 and Q2, per 5.06.

TRouble CHART XV

LOW VOLTAGE OUTPUT

LED INDICATION	METER INDICATION	PLANT SIGNALS
	OUTPUT CURRENT – LOW	OPEN ON CA – CB LEADS
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

A. OUTPUT VOLTAGE ADJUST (R101) improperly set

Connect a KS-20599L4 digital volt-ohm-milliammeter, set to the voltmeter function, to the output voltage test jacks. Measure the output voltage

Readjust per Section 169-748-301

B. Shorted transformer (Unbalance Monitor inoperative)

Operate the rectifier in the TEST mode with both thyristors disconnected (yellow MT1 and gate leads). The ac voltage from each power diode (front heat sink) to ground would be low or zero volts

Replace as necessary

TROUBLE CHART XVI

RECTIFIER SHUTS DOWN AFTER NORMAL OPERATION

LED INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT CURRENT – 0	CLOSURE ON RFA AND/OR RFA – RTN
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

Unbalance Monitor Operated	(a) Check that all transformer voltage tap connections are correct and that the main capacitor fuses, F7 – F10, are good and in place.	Replace faulty components as necessary
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Danger: Potentials in excess of 400 volts AC are present on the main capacitors. Always turn the rectifier off before working near these components. Do not attempt to remove or replace fuses F7 – F10 with the rectifier on as the inrush to the rectifier will operate the fuse.

Note 1: Operation of one of the F7 –F10 fuses will result in loss of some rectifier output capability.

Note 2: Some types of unbalance failures may not be apparent in the TEST mode as some load current is required to operate the 120-Hz monitor on CP500. To check the unbalance monitor operation, a dummy load of approximately 100 amperes, connected to the ± TEST terminations, is required.

(b) Check power thyristors, Q1 and Q2, for shorts per 5.06. If shorted, also check associated main Inductors L3 or L4 for damage before replacing the thyristor.

Danger: Voltages in excess of 400 volts ac are present on the thyristors. Always turn the rectifier off before working near these components.

TROUBLE CHART XVI (Contd)

RECTIFIER SHUTS DOWN AFTER NORMAL OPERATION

LED INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT CURRENT – 0	CLOSURE ON RFA AND/OR RFA – RTN
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

- (c) Verify that gate current is flowing to the thyristors by measuring the voltage drop across resistors R601 and R602.

Danger: If adequate gate current is flowing the surfaces of these resistors will be hot.

Requirement: The measured voltage is approximately 50 volts (battery voltage) whether the rectifier is on or off but connected to the plant.

- (d) Replace the CP800 circuit board.

Note: It is unlikely that the regulating circuits CP100 or CP200 will cause unbalanced operation as the output signal (ACS) from these circuits is common to both main power circuits.

- (e) Measure the synchronizing signals across the Y1 – Y2 and Z1 – Z2 windings of the T1A and T1B main transformers.

Requirement: 3 to 5 volts ac is available across each winding.

- (f) Remove the CP800 circuit board and check the control inductors L601 and L602 for open circuit.

Requirement: The resistance of each inductor is approximately 200 ohms.

TROUBLE CHART XVI (Contd)

RECTIFIER SHUTS DOWN AFTER NORMAL OPERATION

LED INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT CURRENT – 0	CLOSURE ON RFA AND/OR RFA – RTN
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION

- (g) Check for proper output of the T1A and T1B main transformers by operating the unit in the TEST mode with the Q1 and Q2 power thyristors off (yellow MT1 and gate leads to each thyristor removed and insulated per 5.06).

Requirement 1: High dc output volts with an increase in audible noise is present. Voltage measured across the output volts jacks is approximately 70 volts dc.

Requirement 2: The ac voltage from each power diode (CR1 – CR4), measured from the front heat sink to ground, is approximately 60 volts ac and the same for each diode.

Note 1: Low or zero output voltage indicates a defective (shorted) transformer.

Then operate the unit in the TEST mode with thyristors, Q1 and Q2, fully on (yellow MT1 and gate leads connected but REG, F605 fuse removed).

Note 2: This check simulates minimum rectifier output (low end limit).

Requirement 1: Output voltage across the output volts jacks is 35 to 40 volts dc.

Requirement 2: The ac voltage from each power diode (CR1 – CR4), measured from the front heat sink to ground, is 25 to 30 volts ac and the same for each diode.

TROUBLE CHART XVII

RECTIFIER SHUTDOWN AFTER NORMAL OPERATION

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL TEST	OUTPUT CURRENT - 0	CLOSURE ON RFA AND RFA - RTN SIG AND SIGR (FOR TEST)
PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
Loss of sensing voltage	Check for sensing voltage at RB(1) and RG(3) plant terminals	Repair as necessary and operate the POWER switch to OFF and then to ON