RECTIFIERS
AND CHARGE-FAILURE ALARM RELAYS
KS-15661 TYPE
OPERATING METHODS

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1. GENERAL

1.01 This section covers the operation of the following KS-15661 type equipment manufactured by Lorain Products Corporation.

(a) The KS-15661 type, saturable reactor, semiconductor, automatically regulated, FLOTROL rectifiers.

(b) The KS-15661 type charge-failure alarm relays which are used with the rectifiers.

1.02 This section is reissued:

(a) To change the title of the section.

(b) To add the information covering silicon rectifying elements.

(c) To amplify the information covering the CHARGE-FAILURE ALARM relays.

(d) To add the information for the L30 rectifier.

1.03 The KS-15661 rectifiers and the associated charge-failure alarm relays are covered by list numbers to suit different power supplies. The rectifiers were intended for use in the 102G power plant, in plants for charging engine starting batteries, and in plants for PBX equipment.

1.04 The rectifying element in the rectifiers consists of selenium cells or of silicon diodes assembled as a 3-phase, full-wave bridge rectifier. The rectifying element assemblies are electrically and mechanically interchangeable.

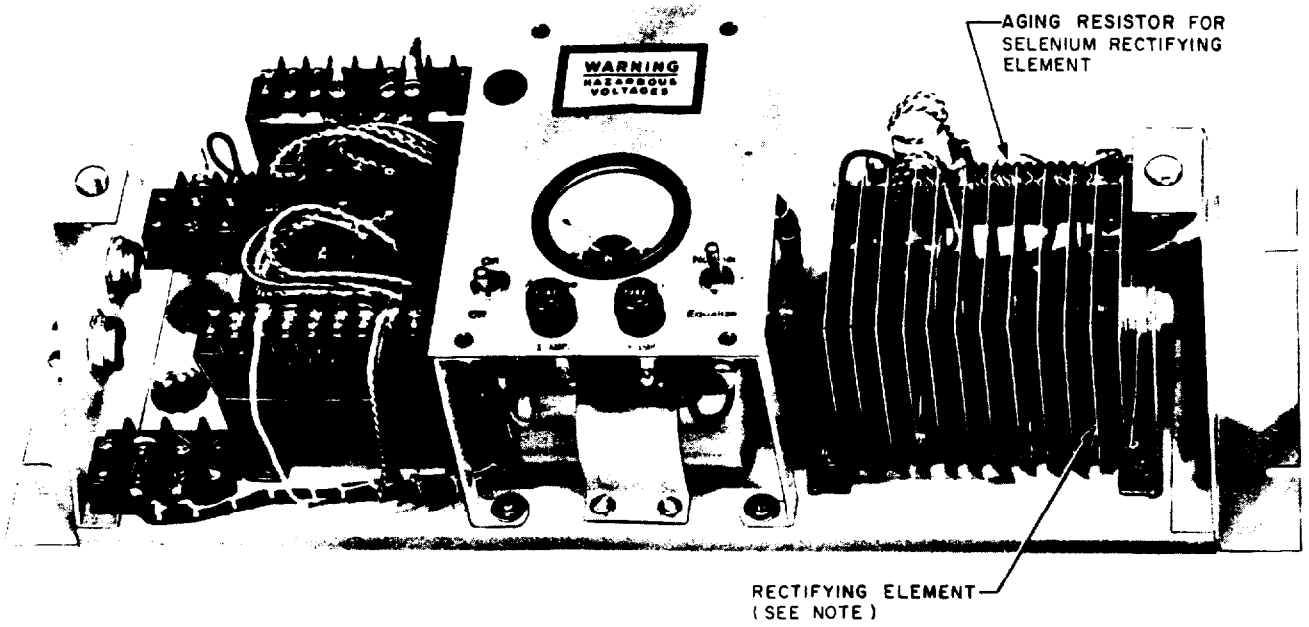
1.05 All the KS-15661 rectifiers, except L28, require single-phase, 60-cycle input power supplies with some rectifiers having 115-volt and others having 230-volt nominal inputs. The L28 rectifier requires a 3-phase, 3-wire, 60-cycle, nominal input power supply and the nominal output is 25 amperes at 54 volts dc.

1.06 ***Caution: Voltages inside some rectifier cases are higher than 250 volts to ground. Avoid all contact with terminals as high voltages may be present. Do not allow a test pick to touch two metal parts at the same time or destructive and dangerous short circuits may occur. Any open or reversed windings on the saturable reactors may cause dangerously high voltages on the other windings. Disconnect the alternating current supply before working on the unit except when necessary to make tests.***

1.07 Keeping the ventilating passages and rectifying elements clean is especially important to avoid excessive heating.

1.08 Routine checks are intended to detect defects particularly in infrequently operated parts of the equipment and, insofar as possible, to guard against circuit failures which interfere with service. Checks and adjustments, other than those required by trouble conditions, should be made during a period when there will be a minimum interference with service.

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



NOTE: THE RECTIFYING ELEMENT CONSISTS EITHER OF SELENIUM CELLS OR SILICON DIODES. SELENIUM CELLS ARE SHOWN IN THE ILLUSTRATION.

Fig. 1 – KS-15661 L1 (FLOTROL Model U24A) Rectifier — Front View — Cover Removed

2. TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch C Screwdriver
TEST APPARATUS	
KS-8039	Volt-Milliammeter
KS-14510 L1	Volt-Ohm-Milliammeter

3. OPERATION

Description

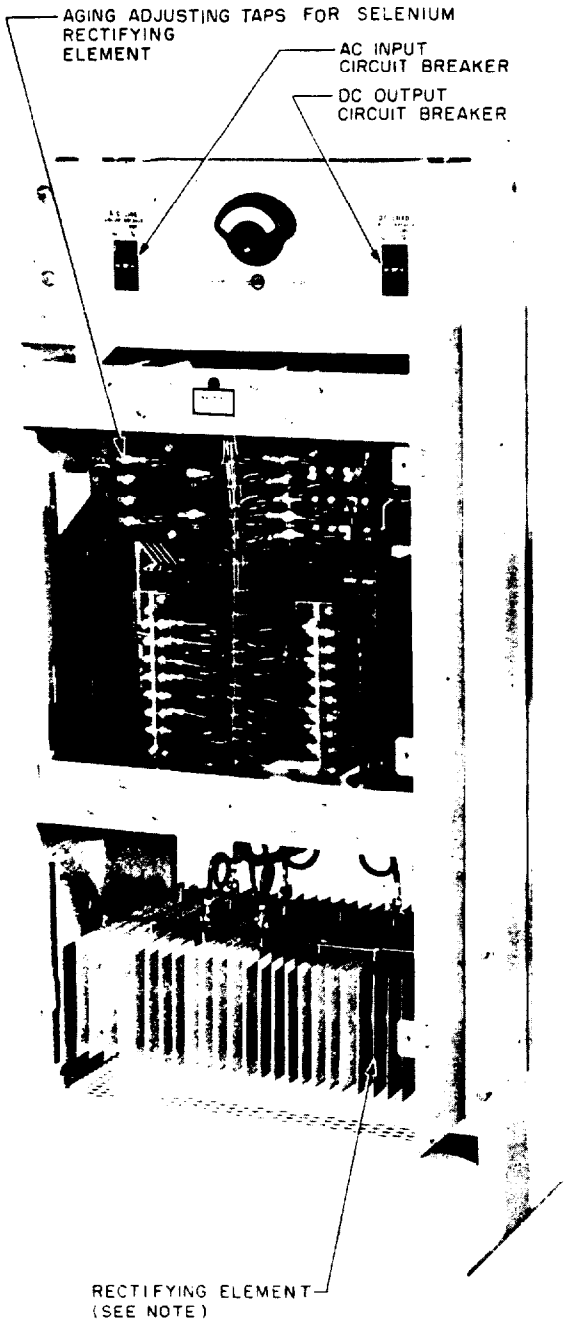
3.01 ***KS-15661 L1 Through L17, L22 Through L27, and L30 Rectifiers (single-phase input)***

(a) These rectifiers operate from a single-phase power supply and consist of a saturable-reactor-type transformer with a phase-shifting capacitor, selenium or silicon rectifying elements arranged in a 3-phase, full-wave configuration, current limiting droop circuit, and a filter coil. L10 and L22 rectifiers are provided with additional filtering. An ammeter is provided to indicate the output current in all rectifiers except L25 which is equipped with two pin jacks for measuring the output voltage. L24, L26, and L30 rectifiers are equipped with both the ammeter and pin jacks. Some of the rectifiers are provided with input and output circuit breakers, some with only an input switch or fuse, and some with an input switch and fuses. The rectifiers, except L25 and L27, may be equipped with a relay to cause an alarm when there is a failure of the charging current. (See 3.04.)

(b) The saturable reactor-type transformer has primary taps to adapt the unit to various power service voltages. When used for a nominal input voltage of 115 volts, taps are available for operation from either 100 to 120 volts or from 110 to 130 volts. When used for a nominal input voltage of 230 volts, taps are available for operation from either 190 to 230 volts or from 210 to 250 volts.

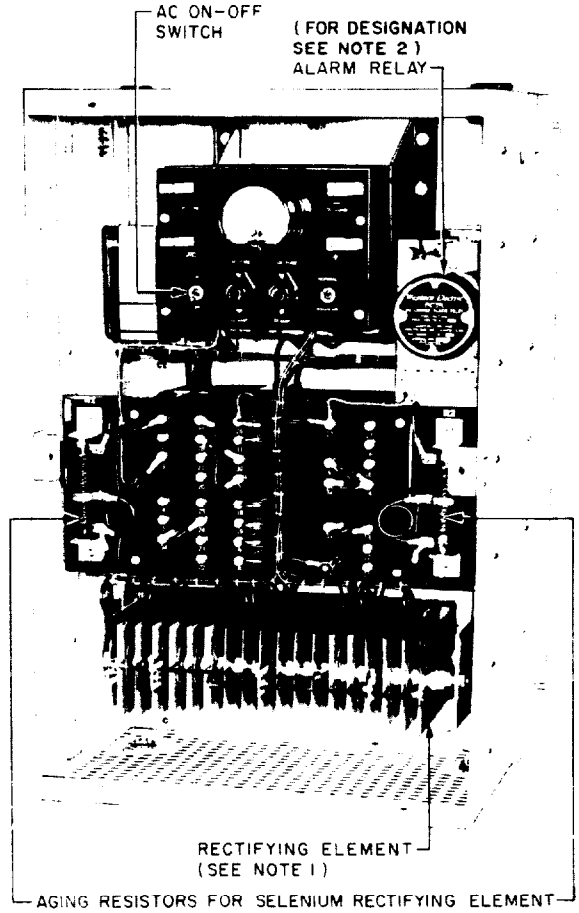
(c) The saturable reactor is provided with coarse taps which may be selected for the particular number of cells in the battery to be charged.

(d) Except on the L25 rectifier, fine taps are provided in the saturable reactor circuit so that the regulated output voltage may be adjusted in ten approximately equal steps over a range of at least ±3 percent but not more than ±6 percent of the output voltage.



NOTE: THE RECTIFYING ELEMENT CONSISTS EITHER OF SELENIUM CELLS OR SILICON DIODES. SELENIUM CELLS ARE SHOWN IN THE ILLUSTRATION.

Fig. 2 – KS-15661 L7 (FLOTROL Model U600A) Rectifier — Front View — Cover Removed — Mounted on KS-15661 L21 Relay Rack



NOTE 1: THE RECTIFYING ELEMENT CONSISTS EITHER OF SELENIUM CELLS OR SILICON DIODES. SELENIUM CELLS ARE SHOWN IN THE ILLUSTRATION.

NOTE 2: DESIGNATION OF EARLY DESIGN KS-15661 L20 NO CHARGE ALARM RELAY
DESIGNATION OF LATER DESIGN KS-15661 L20 CHARGE-FAILURE ALARM RELAY.

Fig. 3 – KS-15661 L14 (FLOTROL Model U300B) Rectifier — Front View — Cover Removed — Equipped With KS-15661 L20 No-Charge Alarm Relay

(e) The rectifier, where provided with a selenium rectifying element, is equipped with a variable resistor which is used to compensate for eventual aging of the rectifying element and to adjust load regulation.

Note: Some of the rectifiers are equipped with two variable resistors.

(f) Except as noted in (g), the rectifiers are designed so that the output voltage should not vary more than average voltage ±1 percent with ac input voltage variations of ±8-1/2 percent from the nominal value and dc load

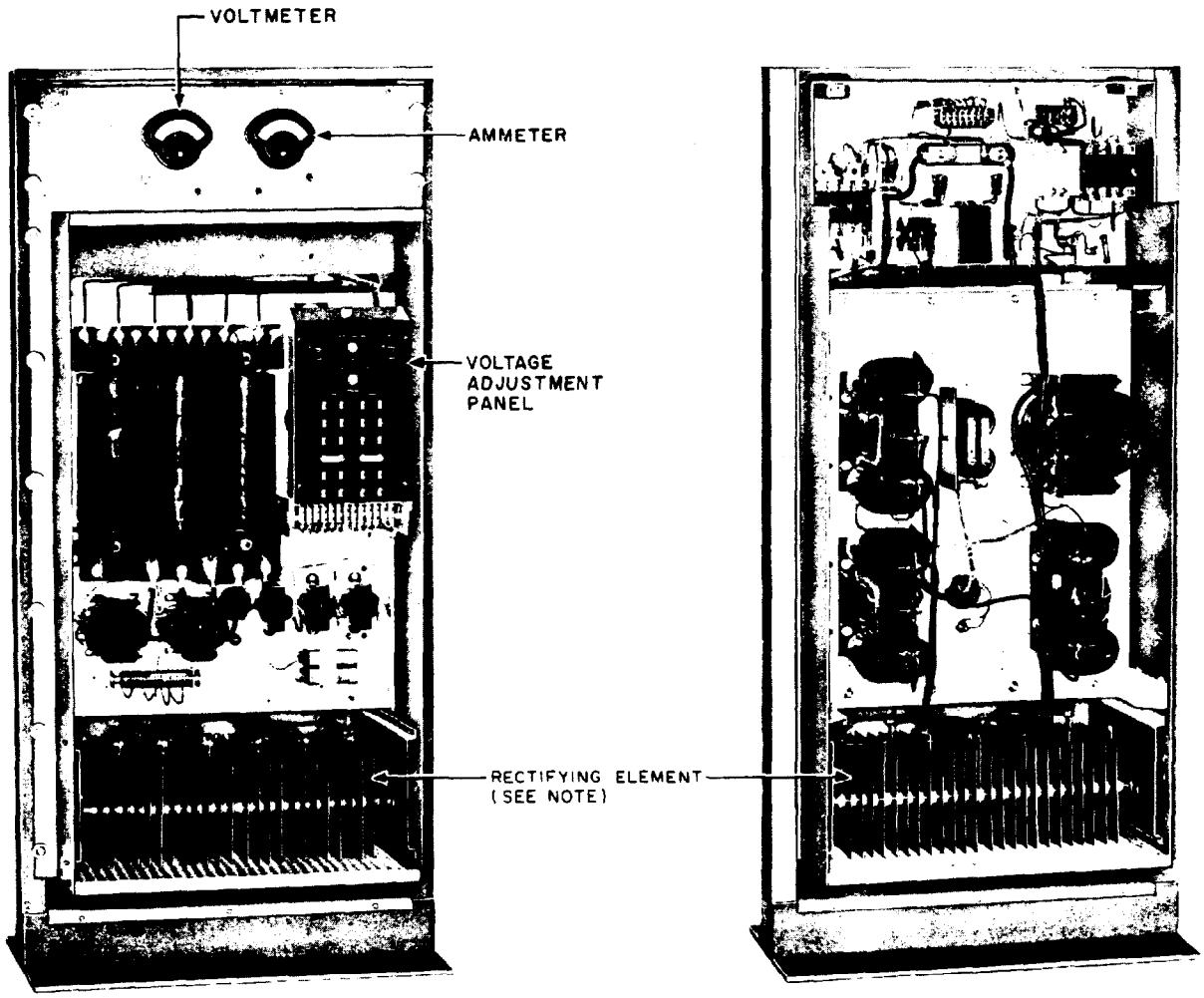


FIG. 4A FRONT VIEW— COVER REMOVED

FIG. 4B REAR VIEW— COVER REMOVED

NOTE: THE RECTIFYING ELEMENT CONSISTS EITHER OF SELENIUM CELLS OR SILICON DIODES. SELENIUM CELLS ARE SHOWN IN THE ILLUSTRATION.

Fig. 4 – KS-15661 L28 (FLOTROL Model 1250B) Rectifier Mounted on KS-15661 L2i Relay Rack

current variations from 10 percent load to full load. The average voltage is considered as 1/2 the sum of the voltages at 10 percent and full load. The regulation is measured after the rectifier has been initially adjusted, using nominal line voltage at 60 cycles and a load consisting of a variable resistance in parallel with 6000 microfarads of capacitance to give an output voltage of 2.15 to 2.19 volts per cell at rated full load for lead-acid-type batteries and 1.40 to 1.45 volts per cell at rated full load for nickel-cadmium-type batteries.

Note: The combination of capacitance and resistance simulates a battery load.

(g) For the 11-cell connection on the L4, L6, and L9 rectifiers and for the L10, L22, L25, and L27 rectifiers, the output voltage should not vary more than ±2 percent.

3.02 *KS-15661 L28 Rectifier (3-phase input)*

(a) This rectifier operates from a 3-phase power supply and consists of an insulating transformer, saturable reactors, three full-wave selenium or silicon rectifying units, current limiting droop circuit, and a power circuit filter. An ammeter and voltmeter are provided to indicate the output current and voltage. The rectifier is equipped with an ac input 3-wire

contactor and a dc output contactor. A battery operated remote control relay is provided in the unit to enable starting and stopping the rectifier from a remote location. The rectifier may be equipped with a relay to cause an alarm when there is a failure of the charging current. (See 3.04.)

(b) The insulating input transformer in the rectifier has primary taps to adapt the unit to various power service voltages. When intended for a nominal input voltage of 230 volts, taps are available for operation from 180 to 253 volts, 185 to 260 volts, or 190 to 269 volts.

Note: The ac input voltage adjustment depends on both the ac power service and the number of cells in the battery to be charged.

(c) The rectifier is equipped with a voltage adjustment panel provided with coarse and fine taps so that the regulated output voltage may be accurately adjusted.

Note: The taps adjust the reference voltage standard which controls the rectifier output voltage.

(d) An equalizing voltage adjustment potentiometer is provided so that the equalizing voltage can be adjusted independently of the floating voltage.

(e) The rectifier is designed so that its output voltage should not vary more than ±1 percent with ac input voltage variation of ±8 percent from the nominal value and dc load current variations from 2 percent load to full load. The regulation shall be measured after the rectifier has been initially adjusted using nominal line voltage at 60 cycles and a load consisting of a variable resistance in parallel with 120,000 microfarads of capacitance to give an output voltage of 2.15 to 2.19 volts per cell at rated full load for lead-acid-type batteries and 1.40 to 1.45 volts per cell at rated full load for nickel-cadmium-type batteries.

Note: The combination of capacitance and resistance simulates a battery load.

3.03 *All KS-15661 Rectifiers Except L25 and L30*

(a) These rectifiers are equipped with a toggle switch connected to taps on the saturable reactor so that, when the switch is moved from the NORMAL position to the EQUALIZE position, the output voltage of the rectifier will be increased by 5 to 10 percent (from about 2.17 to 2.33 volts per cell for lead-acid-type batteries and from about 1.425 to 1.53 volts per cell for nickel-cadmium-type batteries).

(b) When the switch is operated to the EQUALIZE position, the above values provide for a fast boost charge. In some cases, the values may be excessive and the fine taps on the saturable reactor should be adjusted as required.

3.04 *KS-15661 L18, L19, L20, and L29 Charge-Failure Alarm Relays*

Note 1: The designation used for early design alarm relays was NO CHARGE ALARM relay. For later design relays, the designation is CHARGE-FAILURE ALARM relay.

(a) The CHARGE-FAILURE ALARM relay is provided with two transfer contacts and is arranged to operate when the charging current exceeds 4 percent of the rated full-load current of the rectifier and remains operated as long as the charging current exceeds 3 percent of the rated full-load current.

Note 2: The relay operates from the ripple current in the output line in the rectifier circuit.

(b) The KS-15661 rectifiers, except L25 and L27, may be equipped with a CHARGE-FAILURE ALARM relay. The particular list number relay used with a rectifier is determined by the following.

(1) DC output voltage of the rectifier.

(2) Whether the rectifier ac input is single or 3-phase.

Note 3: The relay, where provided with the KS-15661 L1 rectifier, is mounted externally to the unit.

Preparing to Start Initially

3.05 When preparing to put the unit into service initially, check that:

(a) There is nothing in, on, above, or below the rectifier to interfere with operation or prevent free ventilation.

(b) The ac input power to the rectifier is disconnected.

(c) All external connections are made in accordance with the SD- drawing covering the associated circuit of which the unit is a part.

(d) Input and output fuses of the correct size, where required, are provided in the rectifier.

(e) Proper primary taps on the input transformer are connected for the input voltage to be used.

(f) Proper secondary taps on the input transformer or on the voltage adjustment panel (L28 rectifier) are connected for the particular load in accordance with the installation and adjustment instructions furnished with the rectifier.

Note 1: The tap connections are inside the rectifier and can be made by loosening a terminal screw and moving the tap lead as required. Instructions covering installation and adjustments, including a schematic diagram, are furnished by the Lorain Products Corporation with each rectifier.

Note 2: Use the KS-14510 meter for measuring the voltages.

Caution: When using any portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circiut to be tested. If connections are to be changed from one instrument range to another, the power should first be disconnected from the equipment being tested or, if test picks are being used, they should be removed from the equipment under test.

Initial Adjustments

3.06 Proceed as follows.

(a) ***All KS-15661 Rectifiers Except L28***

(1) If the batteries are not connected, connect capacitors totaling 6000 microfarads across the output. Use the office load or a variable resistor to load the rectifier and connect the KS-8039 voltmeter across the rectifier output. Operate the rectifier input switch or circuit breaker to the ON position and the NORMAL-EQUALIZE switch to NORMAL. Measure the voltage at 10 percent of full load and at full load.

Note: The L25 rectifier is equipped with an ac power input plug and a fuse in the ac input circuit.

(2) If the voltage at 10 percent of full load is not at the desired value, readjust the transformer secondary taps as required and check the voltage at full load.

(3) If the voltage at 10 percent of full load differs from the voltage at full load by more than the amount specified in 3.01(f), adjust the regulation resistor or resistors so that the requirements are met. Decreasing this resistance will increase the output voltage at full load and vice versa.

(b) ***KS-15661 L28 Rectifier***

(1) If the batteries are not connected, connect capacitors totaling 120,000 microfarads across the output. Use the office load or a variable resistor to load the rectifier. Operate the rectifier ac input contactor to the ON position and the NORMAL-EQUALIZE switch to NORMAL. Measure the voltage (indicated on the output voltmeter of the unit) at 2 percent of full load and at full load.

(2) If the voltage at 2 percent of full load is not at the desired value, readjust the taps on the voltage adjustment panel as required and check the voltage at full load.

(3) If the voltage at 2 percent of full load differs from the voltage at full load by more than the amount specified in 3.02(e), adjust the R4 regulation rheostat on the voltage adjustment panel so that the requirements are met. Decreasing the re-

sistance will increase the output voltage at full load and vice versa.

(4) Operate the NORMAL-EQUALIZE switch to EQUALIZE and adjust R9 equalize voltage potentiometer as required to obtain the desired overcharge voltage.

(c) ***KS-15661 Rectifiers Equipped With KS-15661 CHARGE-FAILURE ALARM Relays***

(1) Shut down the rectifier to check that the alarm operates satisfactorily. To do this, remove the ac input fuse or operate the ac input switch or circuit breaker as required.

(2) After making the check, restore the rectifier to service.

Routine Adjustments

3.07 For routine stopping (all rectifiers except L25), it is only necessary to operate the ac input switch, circuit breaker, or contactor, as provided on the rectifier, to the OFF position. The L25 rectifier is equipped with an ac power input plug and a fuse in the ac input circuit. To take this unit out of service, remove the ac plug or fuse.

4. ROUTINE CHECKS

4.01 The following should be performed.

(a) The dc output voltage should be checked periodically, using the KS-8039 voltmeter, to make certain that it is correct.

Note: The L28 rectifier is equipped with a voltmeter to indicate the dc output voltage.

(b) ***Selenium Rectifying Elements:*** As the selenium rectifying elements age, the rectifier output voltage may decrease beyond control of the regulating circuit. When this occurs, on all rectifiers except L28, adjust the variable resistor or resistors to raise the voltage. On the L28 rectifier, aging is automatically compensated for and no manual adjustment is required.

(c) Electrolytic capacitors should be maintained in accordance with Section 032-110-701.

5. TROUBLES

5.01 Where rectifier units have fuses, such fuses should be the first items of investigation if there is no output from the rectifier unit. If possible, the cause of the overload should be determined and corrected before replacing the fuse. A blown fuse may be due to trouble in a rectifying element. If a new fuse does not blow when the load is disconnected and does blow when the load is reconnected, the trouble is probably external to the unit.

5.02 Broken wires, particularly at terminals, may cause failures.

5.03 If the regulation requirements for the rectifier as stated in 3.01 or 3.02 are not met and the defective part cannot be located, notify the supervisor.

Rectifying Element Replacement

5.04 ***Selenium Stacks:*** Selenium rectifier cells in the stack may fail due to aging, which is an increase in the resistance of the cells. The replacement of only the defective stack in rectifying elements that consist of more than one stack may result in an unbalanced condition in the rectifying element. To avoid unbalance, replace the stacks as follows.

Note: Burned-out selenium rectifier stacks will show scorched spots or raised bumps on a cell disc and will emit an obnoxious odor.

(a) When replacing a defective stack or stacks in a multiple stack element, replace all other stacks in the element that have been in service 2 years or longer.

(b) Do not combine stacks of different list numbers or different manufacturers.

(c) Do not attempt to replace part of the rectifier cells in a stack or bolt assembly. Always replace the entire stack.

5.05 ***Silicon Diodes (see Section 032-173-301):*** When replacements are required, do not combine silicon diodes produced by different manufacturers.

Trouble Chart

5.06 Should any of the following troubles develop, it is suggested that the possible causes listed be checked. If the trouble is not found, look for loose or open connections or short circuits due to foreign matter lying across wiring terminals. A loose connection generally causes heating. Any one of the following troubles may be caused by an open or short cir-

cuit or by aging or drift in the constants of some faulty component.

Caution: The ac voltage across the terminals of the saturable reactor tuning capacitor in the unit exceeds 500 volts. When making tests inside the unit, take care to avoid any contact with the leads and terminals of this capacitor.

TROUBLE	POSSIBLE CAUSE
(a) No dc voltage	Failure or disconnection of the input power
	Blown or missing fuse
	Circuit breaker or contactor open
	Defective rectifying element
	Defective transformer or saturable reactor
(b) Low dc voltage	Low ac service voltage
	Defective capacitor across saturable reactor
	Aged or partially shorted selenium rectifying element
	Partially shorted transformer or saturable reactor
	High resistance connection
(c) High dc voltage	Defective transformer or saturable reactor
(d) Low charging current with normal voltage	High resistance in charging leads
(e) Erratic charging current	Regulation resistor set too low
	Rectifier overloaded
	High ambient temperature (over 104 F)
	Fluctuating ac service voltage
	Intermittent open or short in any component