KS-5789 RECTIFIER
OPERATING METHODS

GENERAL

1.01 This section covers the operation of series tube controlled rectifier unit KS-5789 which was designed to provide a closely regulated d-c output that can be adjusted by remote control to any value between 1000 and 1600 volts for loads up to 30 milliamperes for use originally in the TD-2 radio relay system. The unit will carry continuously a load of 40 milliamperes at 1500 volts. The instantaneous regulation should be within ± 0.3 per cent for power service voltages from 105 to 125 volts at 58 to 62 cycles for load changes of 20 milliamperes. The mean regulated voltage however may change as much as five volts. The rectifier unit is suitable for use in room temperatures from zero to 104F.

Caution: Voltages inside the rectifier case are higher than those usually encountered in telephone power plants. Avoid all contact with terminals as high voltages are present. Do not allow a test pick to touch two metal parts at the same time or destructive and dangerous short circuits may occur. The door switch, when open, disconnects only one side of the power supply, so that some a-c terminals may be alive or at service voltage to ground. The door switch is provided for the protection of personnel and must not be made inoperative. Disconnect a-c supply before removing cover to work inside of rectifier.

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

1.03 In this section the term capacitor is used for apparatus coded either as a capacitor or a condenser, and the term resistor is used for apparatus coded either as a resistor or a resistance.

1.04 Information in this section is arranged under the following headings:

1.05 List of Tools and Test Apparatus (Equivalents may be substituted)

Screwdriver, cabinet, 3"
Meter, M9B

2. OPERATION

How the Rectifier Unit Works
(See Fig. 1 - Functional Schematic)

2.01 Full-wave rectification of the 60-cycle a-c power from the secondary 5-6-7 of transformer T1 is obtained through rectifying tubes V1 and V2. The rectified voltage is considerably in excess of the output voltage of the rectifier unit to provide for filtering and regulating. The filter consists of capacitor C1. Regulation is obtained by varying the plate to cathode resistance of series tube V3. This resistance is controlled by the grid 1 to cathode 2 voltage which in turn is governed by a 2-stage amplifier using tube V4. In the amplifier stages slight changes in the rectifier output voltage are amplified in such a way as to cause an increase or decrease in the plate to cathode resistance of series tube V3 and in this way correct for or minimize the output voltage changes.

2.02 For example, if the load connected to output terminals 2 and 3 increases, it will tend to decrease the voltage due to the increased internal losses in the rectifier unit. Since the potentiometer consisting of the external rheostat connected between terminals 1 and 2, and resistors R10, R11, R17,and R18 is connected across the output terminals 2 and 3, only a part of the decrease in output voltage will occur across resistors R11, R17,and R18.

2.03 The potentiometer consisting of resistors R14, R15, R12,and R13 is also across the output terminals 2 and 3. However, voltage reference tubes V5 and V6, which are connected across resistors R14 and R15, tend to hold the voltage across these resistors constant and cause changes in output voltage to occur almost entirely as voltage changes across resistors R12 and R13.

2.04 The grid to cathode bias voltage in the 4-5-6 half of tube V4 is continuously a comparison of the voltage across resistors R11, R17, and R18 with the voltage across resistors R12 and R13. Any decrease in output voltage will therefore result in a decrease in the grid to cathode bias voltage. This will tend to increase the plate to cathode current and therefore the voltage drop across resistor R9. This will increase the grid to cathode bias in the 1-2-3 half of tube V4, the cathode being

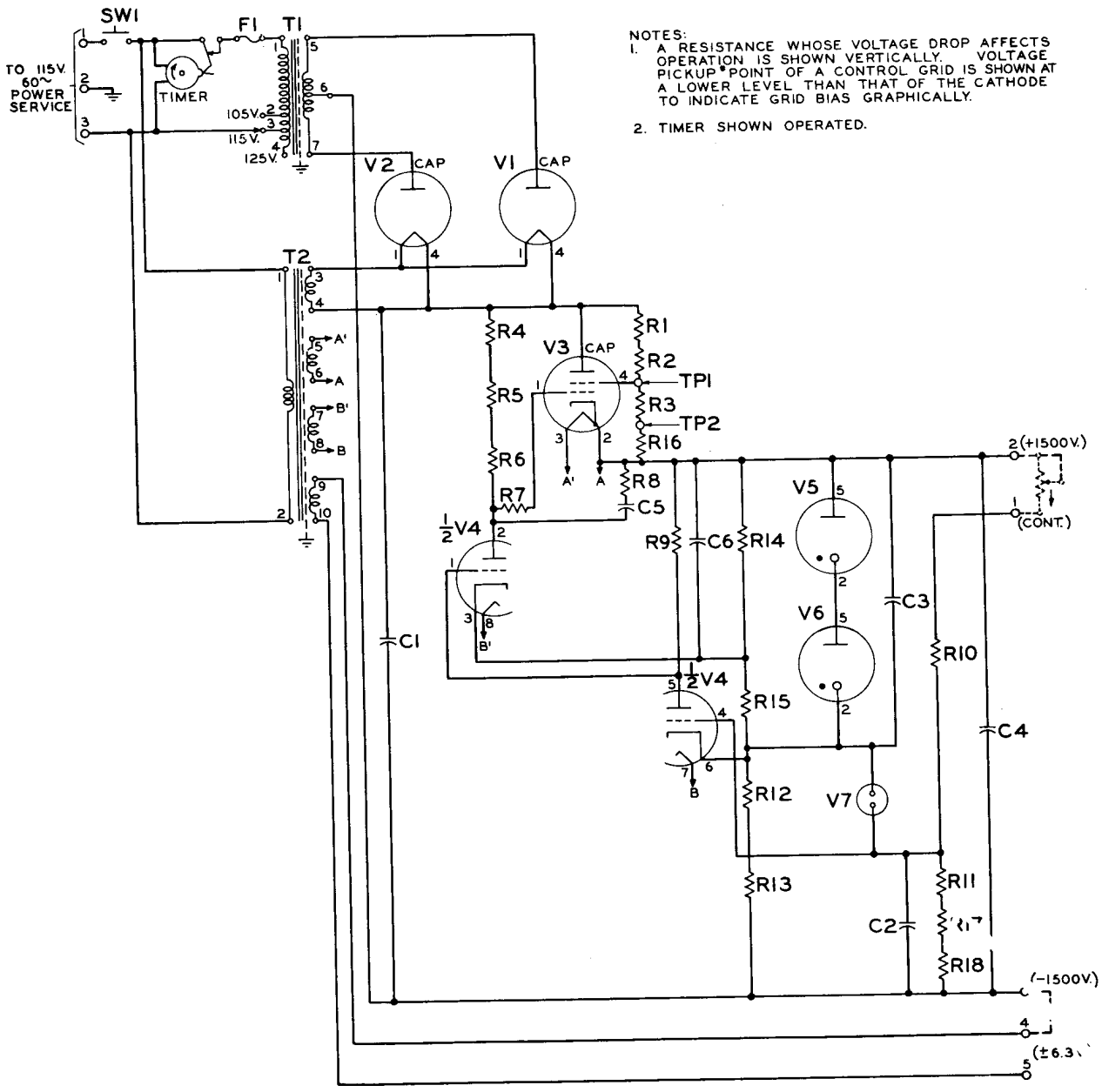

Fig. 1 - Functional Schematic

connected to the partially stabilized voltage across R14 and reduce the plate to cathode current and the voltage across resistors R4, R5, and 6.

2.05 A decrease in the voltage across resistors R4, R5, and R6 decreases the grid to cathode bias voltage of tube V3, reduces the plate to cathode resistance and increases the output voltage to practically correct for the output voltage drop caused by the assumed increase in load. If the load decreases similar but opposite effects are produced.

2.06 The external rheostat connected to terminals 1 and 2 provides the means for adjusting the rectifier output voltage by increasing or decreasing the current through the resistors R10, R11, R17, and R18. As the current is increased (clockwise operation of external rheostat if connected as shown in Fig. 1.) the grid bias of the 4-5-6 half of tube V4 is decreased which will increase the output voltage as explained above for an increase in load.

2.07 At starting with capacitor C2 discharged, grid 4 of tube V4 is practi-

cally at the potential of terminal 3 which produces a high grid to cathode bias voltage until capacitor C2 becomes charged. To limit this voltage and protect the grid, tube V7 is bridged across from the grid to cathode of tube V4 and fires during starting. As capacitor C2 becomes charged, the voltage across tube V7 becomes less than its so it firing no longer affects the operation. Actually it fires only for an instant.

2.08 Resistor R8 and capacitor C5 connected between the cathode and grid of tube V3 tend to oppose changes in the grid bias voltage and form an antihunting device for the rectifier unit.

2.09 Either the positive or negative output terminal may be grounded. Transformer T2 provides power for heating the filaments of the tubes in the rectifier unit and in addition furnishes a 6.3-volt 1-ampere a-c supply which may be grounded or operated at plus or minus 1600 volts to ground.

Preparing to Start Initially

2.10 When putting the rectifier unit into service initially, check to see that,

(a) The correct tubes are in the sockets as indicated by the stamping near the sockets.

(b) The connection at transformer T1 is correct for the power service voltage.

(c) Fuse F1 is correct size.

(d) The external control rheostat is set in the maximum resistance position.

(e) The cover is properly in place, operating the door switch.

(f) A fuse (5 ampere unless otherwise specified) is provided in the power supply.

Initial Adjustments

2.11 Connect power to the rectifier unit. After a delay of about one minute voltage should be indicated on the voltmeter of the associated equipment. Clockwise rotation of the external control rheostat when connected as shown in Fig. 1, should raise the voltage to the desired value between 1000 and 1600 volts.

Routine Adjustments

2.12 For routine starting and stopping it is only necessary to turn on or off the a-c supply. When starting, adjust the output voltage to the desired value using the external control rheostat. After about 30 minutes check and if necessary readjust the voltage.

3. ROUTINE CHECKS

3.01 Routine checks of the electron tubes should be made periodically with the electron tube tester available in the office, in accordance with the standard information on that tester. For this rectifier unit, the grid current test of tube V4 is particularly important.

4. TROUBLES

4.01 Should any of the following troubles develop, check the possible causes and if the trouble is not found, look for open connections.

Caution: The output voltage and voltage within the rectifier unit are dangerous and may be over 1500 volts to ground. The door switch must not be disabled. When it is necessary to work inside the rectifier unit or make test connections inside the cover, first disconnect the power supply, then remove the cover, make any adjustments or measurements, replace the cover and connect the power supply. Do not attempt to work on the unit with the a-c supply connected.

Trouble	Possible Cause
No d-c voltage	Power failure Blown a-c supply fuse or fuse F1 Shorted capacitor C1 or C4 Cover not properly closed, door switch SW1 open Timer failure Short in connected load
Low d-c voltage	External control rheostat incorrectly se Tube V5 or V6 failed Overload Low a-c line voltage Shorted capacitor C2 or C3 Failure of tube V3 Tube V4 defective (see 3.01) Low emission in rectifier tubes V1 and/or V2 if line voltage is low and output current is 20 milliamperes or more External control open
High d-c voltage	External control rheostat incorrectly set High a-c line voltage Shorted capacitor C6 Tube V5 and/or V6 aged, high voltage drop Tube V3 or V4 defective (see 3.01) Insufficient load Tube V5 or V6 failed

Trouble	Possible Cause
Erratic d-c voltage	Loose connection at external control rheostat Variable arc drop tube V5 or V6 Excessive line voltage variations Tube V5 or V6 failed
V7 lit	C2 or C6 shorted
Loss of voltage range 1000 to 1600 V.	Defective V3, V5, or V6

4.02 If a check of the tubes V4, V5, and V6 in a vacuum tube tester (see 3.01) does not indicate a poor tube, change all the other tubes. When the trouble has been cleared replace these tubes one at a time with the old tubes until the defective tube is found.

5. POINT-TO-POINT RESISTANCE MEASUREMENTS

5.01 As long as the rectifier operates satisfactorily, point-to-point resistance values are not needed and are not operating requirements to be checked in routine. In case the rectifier output cannot be secured they may be useful in locating defective conditions.

5.02 High voltages are present within the rectifier and every precaution should be observed to avoid any contact which exposed metal parts or terminals when the rectifier is in operation.

5.03 The readings given in the table are approximate and typical. The readings are measured with an M9B meter which is provided with test leads. The door switch does not disconnect both sides of the input power so that the terminals of the door switch and fuse, if provided, as well as the transformer primary terminals may be at voltage-to-ground. Disconnect the a-c supply before removing the cover to make resistance measurements or to do any work inside the unit. All load should be disconnected when making resistance measurements.

5.04 The procedure for making measurements is outlined in the caution note of 4.01.

Caution: See caution in 4.01

5.05 Table of Resistance Measurements, all load disconnected.

Resistance Across	Measurements Taken from App.	Term.	to App.	Term.	M9B Meter Reading Megohms
R1 & R2	V3	Cap	TP1	-	0.3
R3 & R16	TP1	-	Term	2	0.4
R4, R5, & R6	V3	Cap	V4	2	1.0
R9	Term	2	V4	5	0.5
R10	Term	1	V4	4	0.15
R11, R17, & R18	V4	4	Term	3	0.9
R12 & R13	V4	6	Term	3	0.06
R14	Term	2	V4	3	0.22
R15	V4	3	V4	6	0.043