AC VOLTAGE REGULATOR

KS-5655

OPERATING METHODS

1. GENERAL

1.01 This section covers the operation of line voltage regulator KS-5655 which was designed for use on the output of a 30-volt, 20-cycle rotary converter type of machine to provide regulated a-c power for ringing. It is rated 84-88 volts at 0.5 ampere of regulated output. Unregulated output of 80-95 volts, 0.25 ampere and 100-120 volts, 0.25 ampere may also be obtained provided the regulated output current is reduced so that the total current (regulated and unregulated) does not exceed 0.5 ampere. The regulator is suitable for use in room temperature between 32F and 104F.

> Caution: Voltages inside the regulator case are over 150 volts to ground and between terminals. 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 a-c supply before working on regulator except as necessary to make tests.

1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 Instructions are based on a-c voltage regulator circuit SD-80998-01. For detailed description of the operation, see the corresponding circuit description.

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

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

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

1.07 List of Tools and Gauges
(Equivalents may be substituted if desired)

Screwdriver, cabinet, 3 in.
Meter, M9B or Volt-ohm-milliammeter, KS-14510

2. OPERATION

How the Regulator Works (See Fig. 1, Functional Schematic)

2.01 Regulation of the a-c output voltage is obtained by varying the saturation of a reactor L1 in series with the a-c supply. The loss in voltage in the reactor is overcome by a step-up in transformer T1. The reactor has both a-c and d-c windings, the impedance of the a-c windings being dependent on the degree of saturation produced by the d-c windings. The impedance decreases as the saturation increases and conversely the impedance increases as the saturation decreases. The saturating current is from taps 12, 13, and 14 of transformer T2 through the grid-controlled rectifier tubes V2 and V3. The control for the grids of V2 and V3 is obtained from the plate current of amplifier tube V1, the grid bias of V1 being the difference between the voltage across thermistor RV1 (practically constant due to inherent characteristics) and the voltage from terminal 6 of T2 to terminal 2 of the potentiometer P1 (proportional to output voltage of T1 or the input of T2).

2.02 For example, if the input voltage on T1 decreases, it will also tend to decrease on T2 so that the drop from terminal 6 of T2 to terminal 2 of P1 will decrease, while the voltage across RV1 remains constant. This makes the grid bias of V1 less negative thus increasing the plate current during the conducting half cycle. Increased plate current increases the drop across resistance R5 thereby reducing the grid bias on tube V2 (voltage 10-11 of T2 minus drop over R5). This reduced grid bias causes an increase in V2 plate current during the conducting half cycle of V1. During that half cycle, capacitor C2 charges, the voltage being dependent on the grid voltage of V2. During the other half cycle, the voltage across C2 provides the grid bias for tube V3 and the plate current of V3 tends to follow the output of V2. The increased plate currents of V2 and V3 mean an increased saturation in L1 (a reduced impedance in L1) and an increased voltage applied to the primary of T1, thus correcting for the drop in the input voltage and

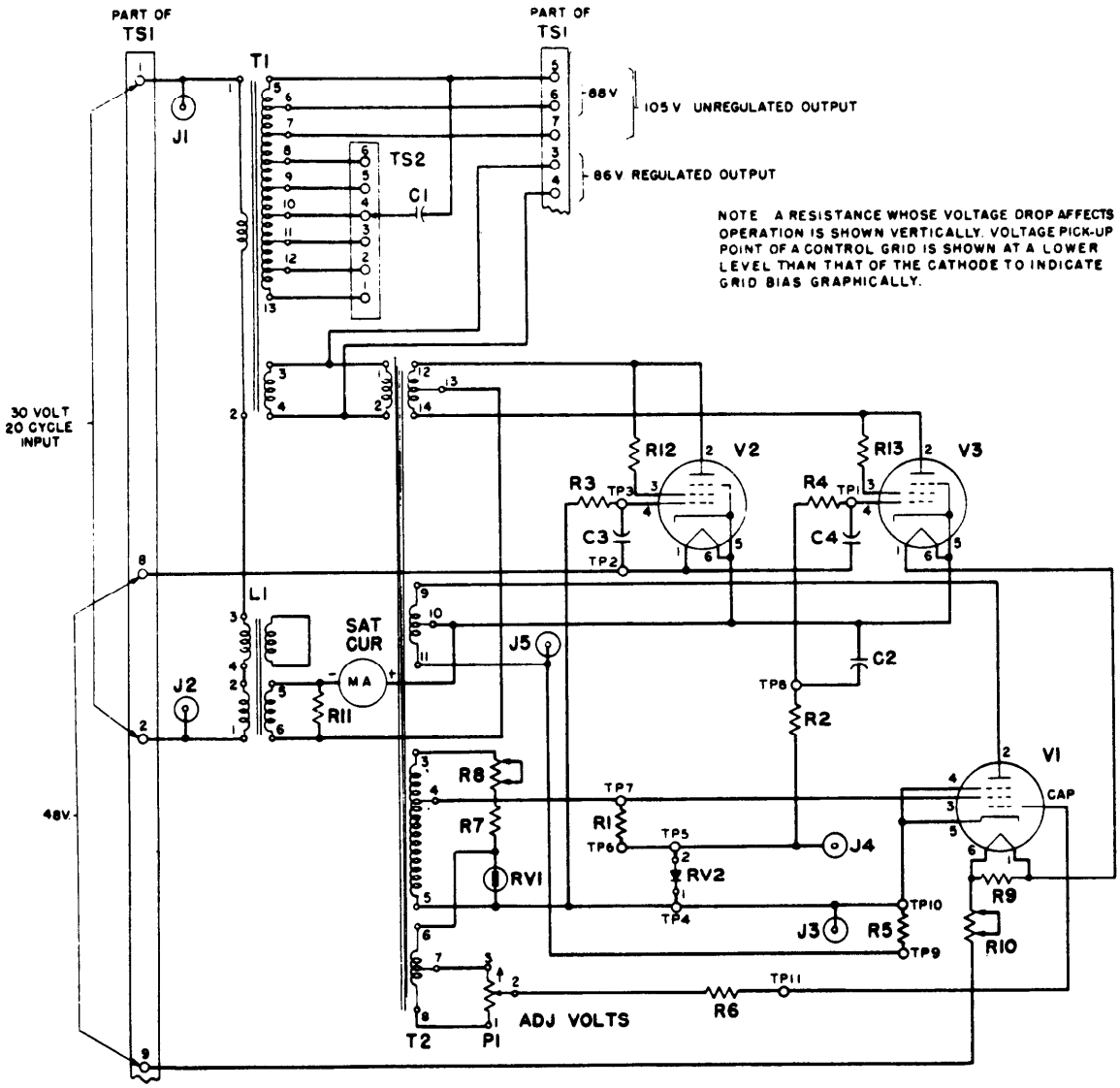

Fig. 1 - Functional Schematic

holding the output voltage within the regulated range. If the load increases, the action and correction are the same as above, since increased load decreases the output voltage (input to T2). Increased supply voltage or reduced load, of course, produces the opposite reactions to make corrections again and hold the output voltage within the regulated range.

2.03 The regulated voltage is adjusted by means of potentiometer P1 (ADJ VOLTS), turning it clockwise to raise the voltage. Unregulated output is obtained from another winding 5-6-7 on the T1 transformer. A capacitor C1 is provided with tap adjustments so that its effectiveness can be varied depending on the amount of capacity in the connected PBX or other feeders connected to terminals 5 and 7 of TS1. It is used as a filter to reduce harmonics introduced by the saturable reactor.

Testing Facilities

2.04 Pin jacks J1 to J5 are provided to facilitate testing, making it possible to check certain critical voltages without removing the cover. A milliammeter mounted in the regulator indicates the saturating current when the MA key is operated to the TEST position. With the key in the NOR position, the ammeter is short circuited.

Preparing to Start

2.05 When putting the regulator into service initially, with the power supply off, check the equipment against the circuit drawing to see that:

(a) Correct tubes are in the sockets.

(b) ADJ VOLTS rheostat is turned completely counterclockwise.

(c) Capacitor C1 is connected to terminal 4 of TS2.

Initial Adjustments

2.06 Connect nominal 48-volt battery for the heaters to terminals 8 and 9 of TS1 and nominal 30-volt, 20-cycle power to the a-c input terminals 1 and 2 of TS1. Check power supply voltage by measuring voltage from pin jack J1 to J2.

2.07 With 50 volts across terminals 8-9 of TS1, adjust resistance R10 to give 29.7 volts, minimum, 30.3 volts, maximum, across the heaters of the three tubes V1, V2, and V3 in series (junction R9 and R10 to terminal 8 of TS1).

2.08 Adjustment of resistance of R8 is made at the factory and normally should need no further check unless some element in the circuit has been replaced because of damage.

2.09 Turn ADJ VOLTS rheostat clockwise until the regulated output voltage is 87 volts. Put MA key in the TEST position. With no load except the frequency generator, the SAT CUR milliammeter should indicate 4 to 6 ma (approximately 4 ma which is normally connected continuously to produce audible ringing tone for 50-volt battery and 6 ma for 45-volt battery). Allow the equipment to operate for an hour to warm up. Readjust the ADJ VOLTS rheostat, if necessary, to 87 volts and connect office load. If, with minimum load and maximum battery voltage, the SAT CUR milliammeter indicates less than 2 ma, reconnect C1 to terminal 5 or 6 of TS2 to obtain at least 2-ma current. If the milliammeter indicates more than 3 ma, reconnect C1 to terminal 3, 2, or 1 until the meter indicates the minimum value obtainable which is not less than 2 ma. Due to a low value of PBX feeder capacity or to the magnitude of the minimum load on the machine and regulator, the saturating current may exceed 3 ma after terminal 1 has been selected. In this case, leave the connection on terminal 1. Restore the MA key to the NOR position. This adjustment is affected particularly by the capacity of the PBX ringing feeders and should be readjusted whenever that load is materially changed. In normal operation, the saturating current should be in the range of 2 to 25 milliamperes.

Routine Adjustments

2.10 Routine starting and stopping is done by the control of the machine supplying the power.

3. ROUTINE CHECKS

3.01 Routine checks of the vacuum tubes can be made with a vacuum tube tester which should indicate when a tube is poor and needs to be replaced.

4. TROUBLES

4.01 Should any of the following troubles develop, it is suggested that the possible causes be checked in the order listed.

Trouble	Possible Cause
No output voltage.	No input voltage.
Low output voltage.	ADJ VOLTS rheostat out of adjustment. Defective V1, V2, or V3 tube. Defective RV1, one element short-circuited. No or low filament voltage. SAT CUR ammeter out of calibration. SAT CUR reading high. (a) Low input voltage. (b) Output overloaded. SAT CUR reading low. (a) Defective tube V2 or V3 (J3-J4 volts normal). (b) Defective tube V1 (J3-J4 volts low). (c) Output or capacitor C1 shorted.
High output voltage.	ADJ VOLTS rheostat out of adjustment. Cap off V1 tube. Capacitor C2 short-circuited or open. Defective RV1, open. SAT CUR ammeter out of calibration. SAT CUR reading high (a) RV2 shorted. SAT CUR reading low. (a) High input voltage. (b) Incorrect adjustment of taps on TS2. (c) Capacitor C1 open.

4.02 If the trouble is not found, look for open connections.

4.03 Some troubles may be best located by checking point-to-point voltage or resistances (See part 5).

4.04 In case the regulator does not function properly and the troubles listed above have been checked, the current through the RV1 thermistor should be determined. Since the current in R7 and RV1 is the same, this can be done by measuring the voltage drop across R7. Measure the resistance of resistor R7. Multiply this by the allowable current, taking separately the maximum (0.0255-ampere) and minimum (0.0245-ampere) current. This will give the maximum and minimum voltage drops across the resistor R7. With the output voltage adjusted to 86 volts at terminals 3-4 on TS1, adjust R8 to give a voltage drop across the resistor R7 within the calculated maximum and minimum drops within the limits.

4.05 Whenever any tube is replaced, the initial adjustments should be checked.

4.06 ADJ VOLTS rheostat is totally enclosed and should be replaced if it becomes defective in any respect.

5. POINT-TO-POINT VOLTAGES AND RESISTANCES

Caution: When using any portable instrument, the leads should be connected at the instrument before making contact with an energized circuit. The leads should be disconnected from the energized circuit before removing them from the instrument.

5.01 Approximate transformer voltages between taps are shown for no load on the circuit drawing and may be checked with an a-c voltmeter.

5.02 Resistance values are shown on the circuit drawing and may be checked approximately with an ohmmeter.

5.03 The thermistor RV1 is made in two parts. If one becomes short-circuited, the voltage across the terminals will be about half the value stamped on the unit. If the thermistor becomes open, the full transformer voltage of about 300 volts across terminals 3 to 5 will be on the thermistor terminals.

5.04 Typical voltages across certain parts of the regulator are shown in the table to assist in locating defects in operation. Measurements are those with an M9B meter.

Regulator Parts	Meter Jacks	Volts	Voltage Measurement
J1 to J2	-V and 150V	A-C	25-35
J3 to J5	-V and 150V	D-C	10-30
J3 to J4	-V and 150V	D-C	25-35
Terminals C2	-V and 150V	D-C	2-25
Terminals RV1	-V and 150V	A-C	Stamped on RV1
Junction R9 and R10 to 8 of TS1	-V and	30V D-C	30