AC LINE VOLTAGE REGULATOR
KS-5650
OPERATING METHODS

1. GENERAL

1.01 This section covers the operation of ac line voltage regulator KS-5650. This regulator was designed for use with testing equipment where a stable ac supply is essential. It is rated at 115-volt, 250-volt-ampere ac output and 105- to 125-volt, 50- to 60-cycle ±2 per cent ac input and has output voltage regulation of ±0.75 per cent with either a fixed load and varying ac input within rated limits or with fixed input and varying load from no load to rated full load. Under favorable conditions of load, it is also satisfactory at lower input voltages, example, 90-volt, 60-cycle input with 113-volt output and with not over 250 volt-amperes of resistance load or over 200 volt-amperes of load at 0.9 power factor. A voltmeter and key are provided for checking input and output voltages. The regulator is suitable for use in room temperatures from 32F to 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 ac supply before working on regulator except as necessary to make tests.

1.02 The section is reissued to add point-to-point voltages and to make minor changes.

1.03 Instructions are based on drawing SD-80999-01, ac line voltage regulator circuit. 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 Information in this section is arranged under the following headings:

1.06 List of Tools, Gauges, and Materials (Equivalents may be substituted if desired)

Screwdriver, cabinet, 3 inch
Test set, 35 type
Volt-ohm-milliammeter, KS-14510 ←

2. OPERATION

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

2.01 Regulation of the ac output voltage is obtained by varying the saturation of a reactor L1 in series with the ac supply. The loss of voltage in the reactor is overcome by a step-up in transformer T1. The reactor has both ac and dc windings, the impedance of the ac windings being dependent on the degree of saturation produced by the dc windings. The impedance decreases as the saturation increases and conversely. The saturating current is from taps 15, 16, and 17 of transformer T1 through 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 3 of T1 to terminal 2 of potentiometer P1 (proportional to input voltage of T1) less the voltage induced in winding 3-4 of transformer T3 (proportional to output current or load). For example, if the supply voltage decreases, the drop from terminal 3 of T1 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 R6 thereby reducing the grid bias on tube V2 (voltage 7-8 of T1 minus drop over R6). 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 the difference between the voltage across R6 and the voltage from terminal 7 to 8 of T1. 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

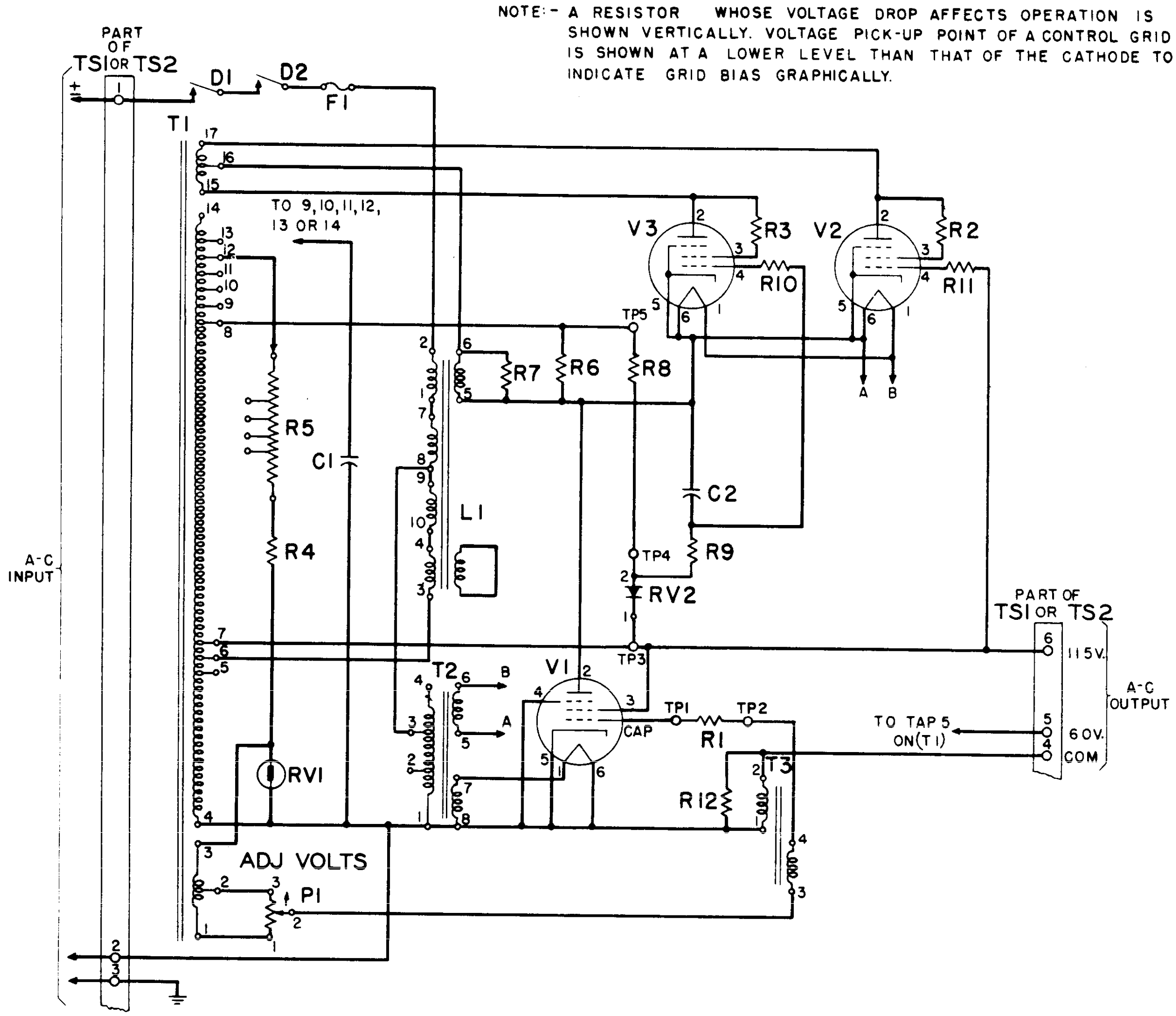

Fig. 1 - Functional Schematic

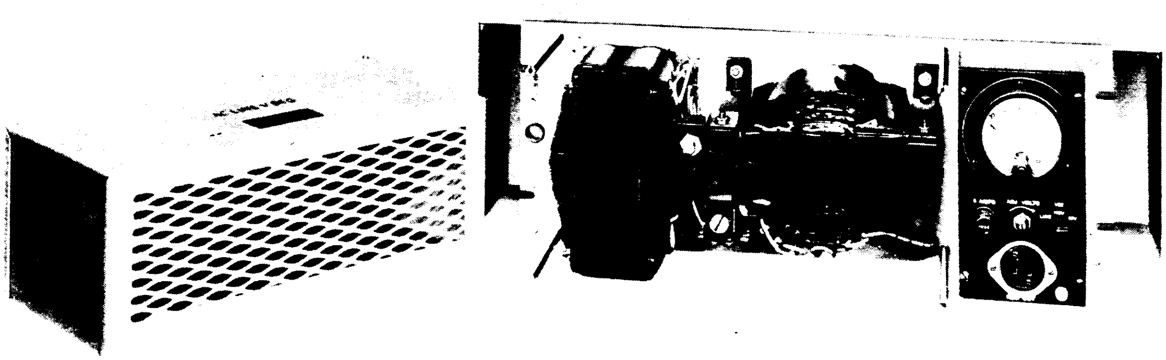

Fig. 2 - Regulator - Front View

saturation in L1 (a reduced impedance in L1) and an increased voltage applied to the primary of T1 thus correcting for the drop in supply voltage and holding the output voltage practically constant. If the load increases, the action and correction are the same as above, since increased load increases the voltage across terminals 3-4 of T3, which being opposed to the voltage from terminal 3 of T1 to terminal 2 of P1, reduces the grid bias on V1. Increased supply voltage or reduced load, of course, produces the opposite reactions to again correct the output voltage. The regulated output voltage is adjusted by means of ADJ VOLTS potentiometer P1, turning it clockwise to raise the voltage. Tap adjustment for capacitor C1 is provided and is dependent on the value of C1 and also the frequency of the power service.

Preparing to Start

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

(a) Correct tubes are in the sockets.

(b) Proper fuse F1 is provided.

(c) If power service is grounded, ground side is connected to terminal 2 of TS1 or TS2.

(d) Terminal 4 of TS1 or TS2 is grounded only when power service is ungrounded.

(e) ADJ VOLTS rheostat is completely counterclockwise.

(f) Capacitor C1 is connected to the proper terminal of TS3 for the power service frequency as shown on the SD circuit drawing.

Initial Adjustments

2.03 Connect power to the regulator, measure input voltage by putting voltmeter key in LINE position (see 1.01), put key in 115V position, and turn ADJ VOLTS rheostat until indicated output voltage is 115 volts. The adjustment may change somewhat as the regulator warms up and should be checked after a half hour's operation for exact value.

Routine Adjustments

2.04 For routine starting and stopping, it is only necessary to turn on or off the ac supply. Whenever the load is shifted from one voltage to the other, the output voltage should be checked and readjusted if necessary.

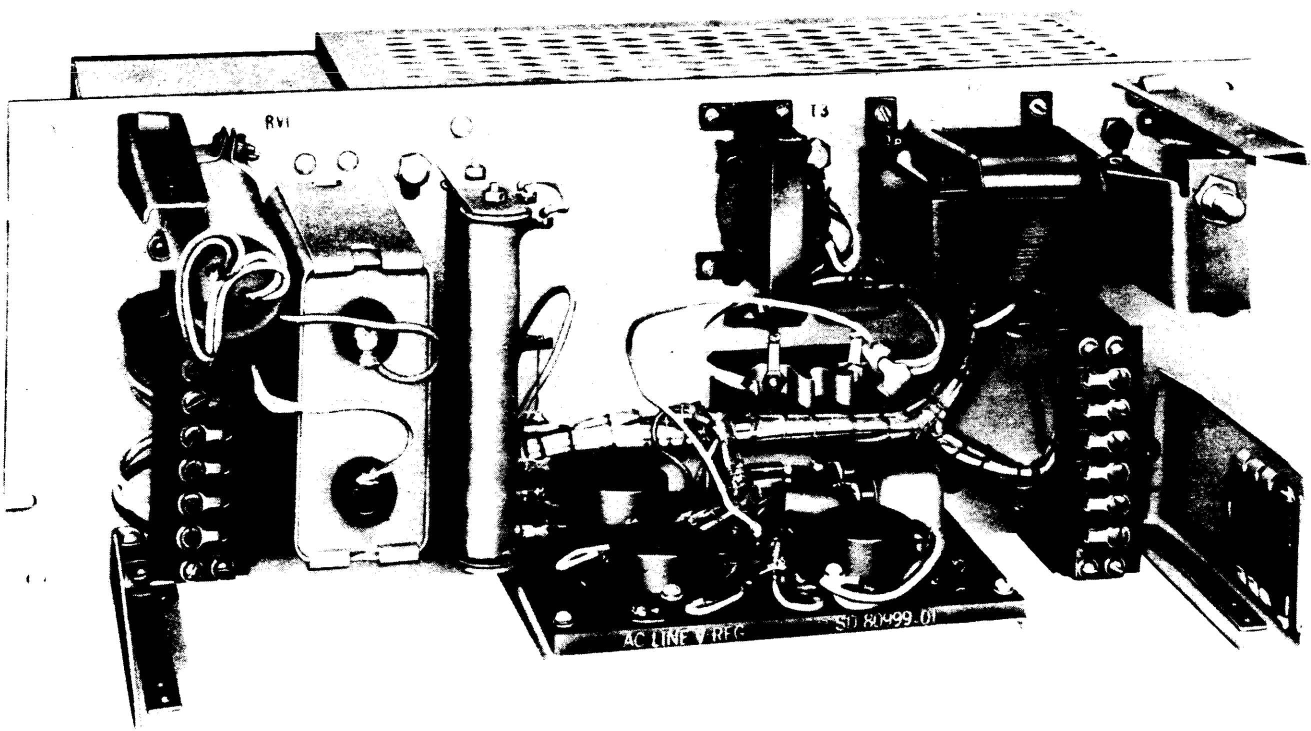

Fig. 3 - Regulator - Rear View

3. ROUTINE CHECKS

3.01 Routine checks of the electron tubes can be made with an electron tube tester to 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 Blown F1 fuse
Low output voltage	ADJ VOLTS rheostat out of adjustment Defective V1, V2, or V3 tube Regulator overloaded Low input voltage Voltage drop of thermistor RV1 low (see 4.05)
High output voltage	ADJ VOLTS rheostat out of adjustment Cap off V1 tube Capacitor C2 short-circuited or open RV2 varistor short-circuited or high resistance due to aging Voltage drop of thermistor RV1 high (see 4.05)

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 voltages or resistances (see Part 5).

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

4.05 In case the regulator does not function properly and the possible causes of troubles listed above have been checked, the current through the RV1 thermistor should be determined. Since the current in R4 and RV1 is the same, this can be done by measuring the voltage drop across R4. Measure the resistance of resistor R4. 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 resistor R4. With the output voltage adjusted to 115 volts as indicated on the voltmeter with the key in the 115V position, adjust the tap connection to R5 resistor to give a voltage drop across R4 within the calculated maximum and minimum drops. When adjusting, the circuit should be allowed to stabilize after it has been opened to change connections.

4.06 If C1 capacitor has to be replaced, make connections between T1 transformer and TS3 terminal strip in accordance with capacity marked on the capacitor and the instructions in the note on the circuit drawing.

4.07 A strap connection on TS3 terminal strip is provided between terminals 6 and 7. The strap may be removed and milliammeter connected in place of the strap to measure the saturating current. At high power service voltage (125 volts) with no-load output, the saturating current should be in the order of 5 to 6 ma, and if the line voltage is low (100 volts) with full-load output (250 volt-amperes), the saturation current may be in the order of 35 milliamperes. Be sure to replace the strap when measurements are completed.

4.08 If short life of tubes is experienced and power service voltage usually is near the maximum 125 volts or the minimum 105 volts, some improvement can be secured by readjusting the T2 filament transformer primary tap connection to obtain heater voltages nearest to 10 volts measured at the tube sockets at the time of average line voltage conditions.

4.09 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. The door switch, when open, disconnects only one side of the power supply so that some terminals may be at voltage-to-ground. The door switch is for the protection of personnel and should not be made inoperative.

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

5.02 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 across terminals 4 to 12 (about 340 volts) will be on the thermistor terminals.

5.03 The volt-ohm-milliammeter is provided with both test clip leads and test pick leads. Wherever possible, the test clip leads should be used in making connections to leave the maintenance man free to observe the meter and operate the door switch. When it is necessary to use a test pick lead, the door switch should be operated with some insulating material to avoid grounding one hand. This insulating material may be a stick 5 or 6 inches long with a depression in one end into which the switch plunger fits. The depression is to prevent the stick from accidentally slipping off the switch plunger.

5.04 Point-to-point voltages are not operating requirements but are provided to help locate trouble in a defective regulator. As the voltages in a defective regulator may be higher than those shown in the table, it is suggested that a high voltmeter range be used when first measuring. Avoid contact with terminals or exposed metal parts as high voltages are present. Voltages shown in the following table are approximate and typical for a regulator in good working condition at full load.

Voltage Across	Measurements Made From (+) App	From (+) Term.	To (-) App	To (-) Term.	Voltage Reading
T1	T1	1	T1	2	44AC
T1	T1	1	T1	3	92AC
T1	T1	4	T1	5	61AC
T1	T1	4	T1	6	81AC
T1	T1	4	T1	7	122AC
T1	T1	4	T1	12	360AC
T1	T1	15	T1	16	362AC
T1	T1	16	T1	17	362AC
T2	T2	1	T2	3	102AC
T2	T2	5	T2	6	10AC
T2	T2	7	T2	8	10AC
L1	L1	3	L1	9	40AC
L1	L1	2	L1	9	21AC
RV1	T1	4	T1	3	60AC
Line	TS1	1	TS1	2	118AC
Output	TS1	4	TS1	5	60AC
Output	TS1	4	TS1	6	120AC
L1	L1	5	L1	6	76DC
R6		TP5	C2	Rear	26DC
R8		TP5		TP4	37DC
C2	C2	Rear	C2	Front	8DC
RV2		TP4		TP3	18DC
V1 Plate	V1	2	V1	6	22DC
V2 Plate	V2	6	V2	2	86DC
V3 Plate	V3	6	V3	2	88DC