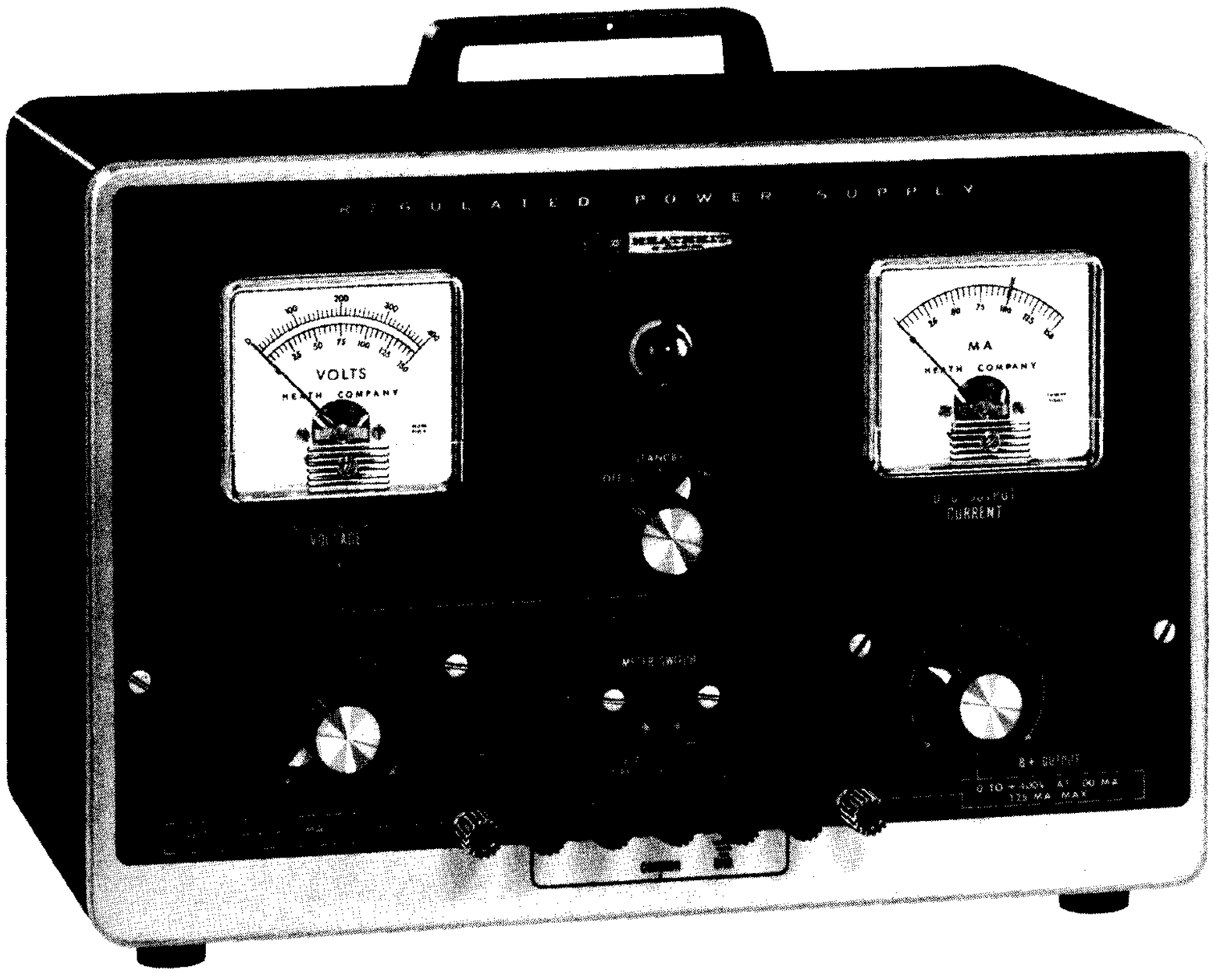
ASSEMBLY AND OPERATION OF THE HEATHKIT REGULATED POWER SUPPLY

MODEL IP-32



SPECIFICATIONS

Power Requirements:	105 to 125 volts AC, 50/60 cycle, 150 watts maximum
Output:	
B+ Voltage:	0 to 400 volts DC regulated; 0 to 100 ma continuous (125 ma intermittent)
Bias Voltage:	0 to -100 volts DC at 1 ma
Filament Voltage:	6.3 volts AC at 4 amps (Insulated to withstand 1500 volts DC)
B+ Regulation:	Output variation less than 1% from no load to full load, for outputs of 100 to 400 volts Output variation less than ±0.5 volt for a ±10 volt variation in the 117 volt AC input
B+ Ripple:	Less than 10 mv RMS ripple, jitter and noise
B+ Output Impedance:	Less than 10 Ω from DC to 1 mc (See output impedance curve.)

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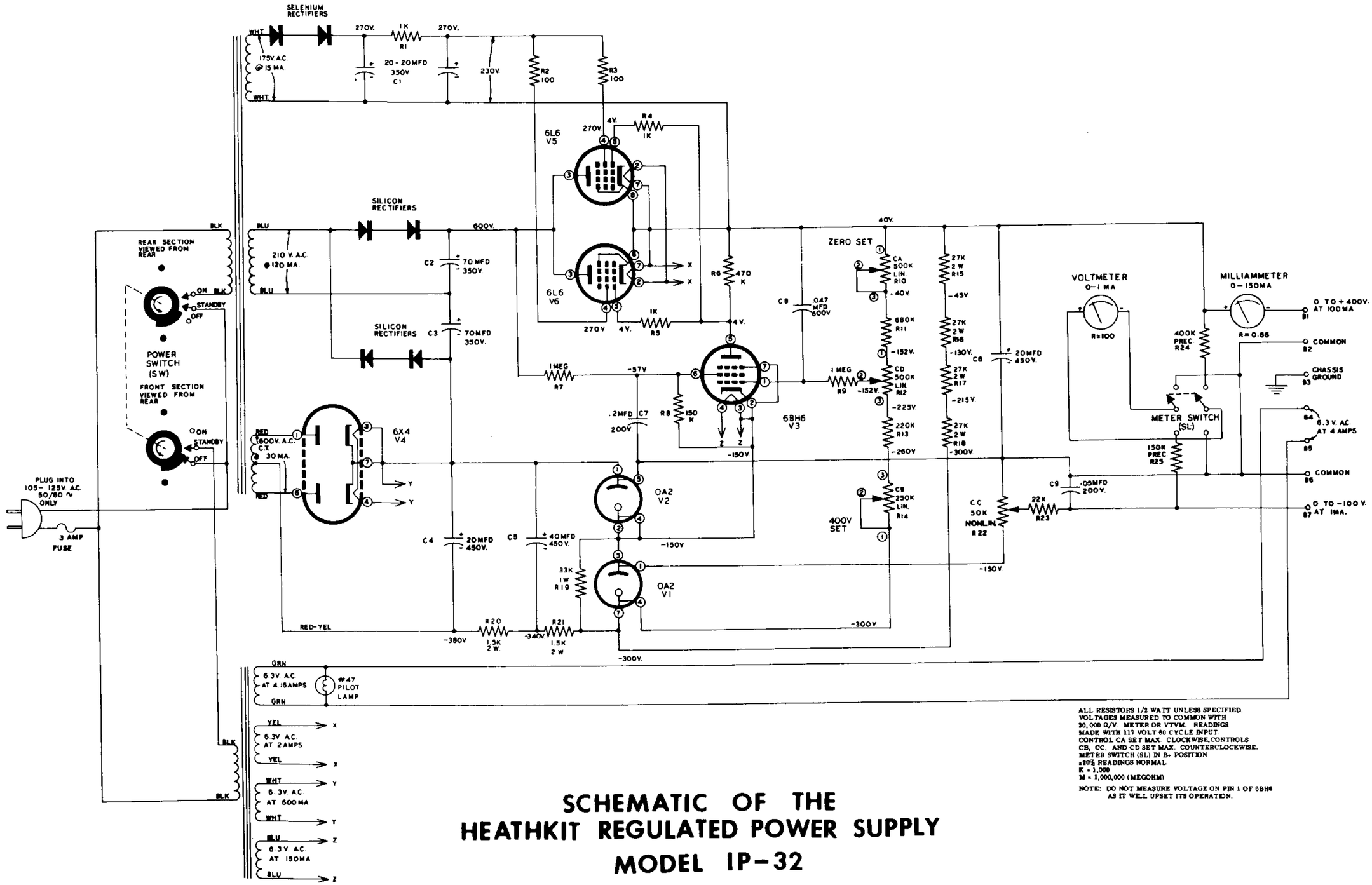


SCHEMATIC OF THE HEATHKIT REGULATED POWER SUPPLY MODEL IP-32

ALL RESISTORS 1/2 WATT UNLESS SPECIFIED.
VOLTAGES MEASURED TO COMMON WITH 20,000 Ω/V. METER OR VTVM. READINGS MADE WITH 117 VOLT 60 CYCLE INPUT.
CONTROL CA SET MAX. CLOCKWISE, CONTROLS CB, CC, AND CD SET MAX. COUNTERCLOCKWISE.
METER SWITCH (SL) IN B+ POSITION
±10% READINGS NORMAL
K = 1,000
M = 1,000,000 (MEGOHM)

NOTE: DO NOT MEASURE VOLTAGE ON PIN 1 OF 6BH6 AS IT WILL UPSET ITS OPERATION.

HEATHKIT by Daystrom

Meters:
Voltmeter:..... 0 to 400 volts or 0 to 150 volts
Milliammeter:..... 0 to 150 ma

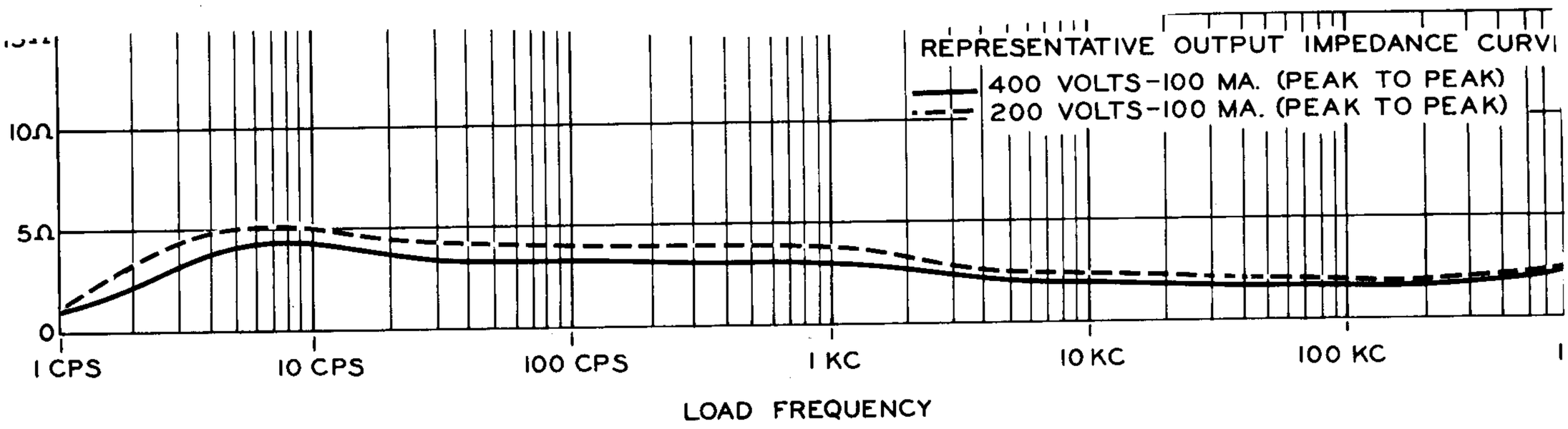
Tube and Diode Complement:..... 2 - 6L6 Series Regulators
1 - 6BH6 Control Amplifier
1 - 6X4 Bias Rectifier
2 - OA2 Bias Voltage Regulators
2 - 50 ma Selenium Screen Voltage Rectifiers
4 - 500 ma Silicon High Voltage Rectifiers

Output Terminals provided:..... B+ and common
C- and common
6.3 VAC filament
Chassis ground

Dimensions:..... 13" wide x 8 1/2" high x 7" deep

Net Weight:..... 12 pounds

Shipping Weight:..... 16 pounds



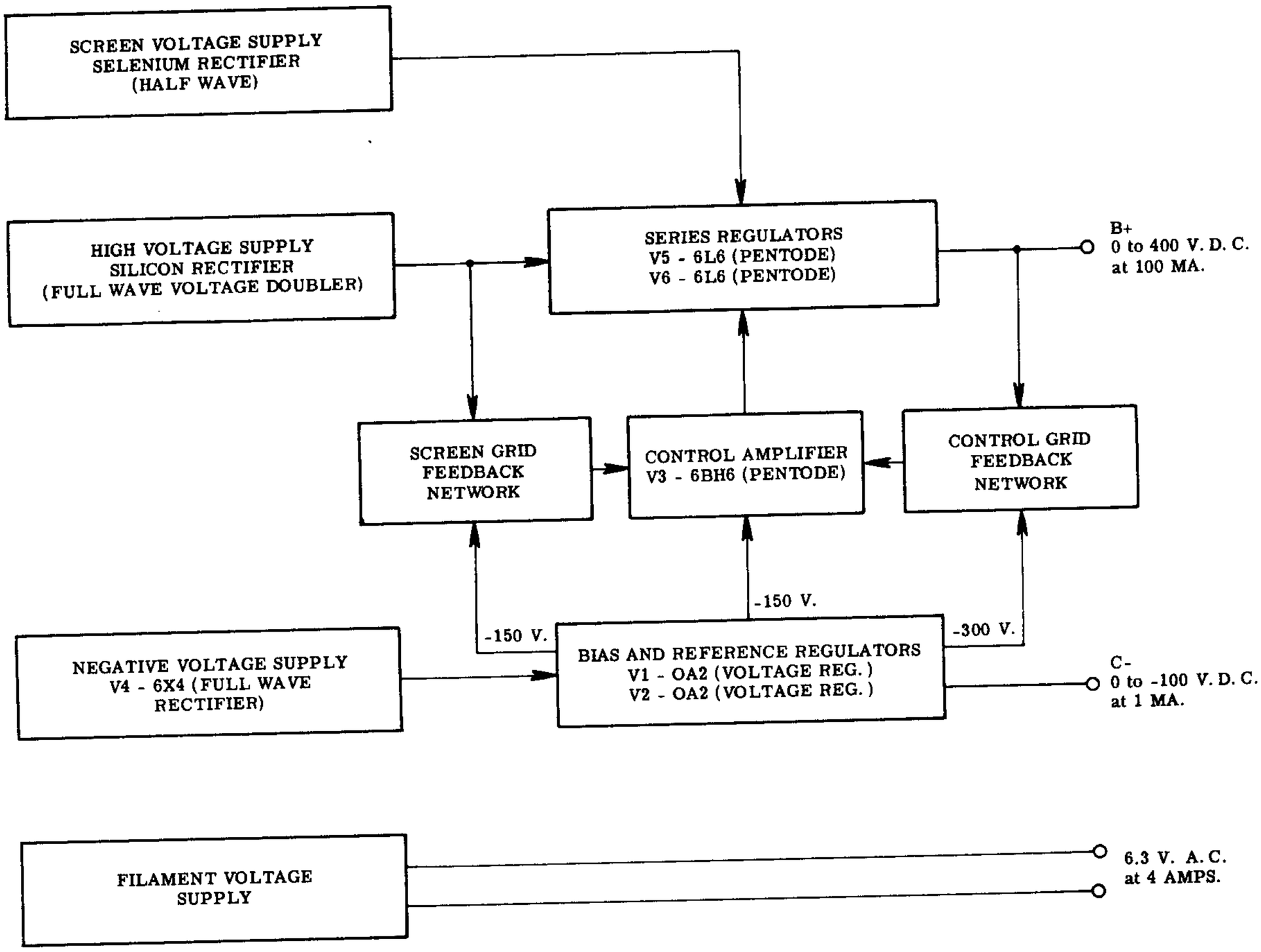
INTRODUCTION

The Heathkit Regulated Power Supply, Model IP-32, has been designed as a convenient source of variable regulated B+ voltage, variable bias voltage, and filament voltage for laboratories and workshops. This supply allows the designer, or experimenter, to develop and test his circuitry without having to construct a power supply each time. The output voltage and current are both continuously monitored by separate panel meters, allowing easy determination of power supply requirements for a particular piece of equipment.

The outputs are isolated from the chassis to allow the B+ to be used as either a positive or negative supply. Separate filament and high voltage transformers are employed so that all high voltage can be switched off, leaving only filament voltage available while changes in circuitry are made. This eliminates filament warmup time.

The bias voltage output control has a special taper for fine adjustment at low voltages and a meter switch is provided to read either the bias or B+ voltage. Built-in circuit protection prevents damage to the unit if the bias voltage output should accidentally be shorted. The supply is also fused for protection against overloads and short circuits.

CIRCUIT DESCRIPTION



The Heathkit Regulated Power Supply is, in essence, a power supply in which the output current may vary over a wide range (from 0 to 100 ma, depending on the load), while the output voltage remains constant at its original setting.

The high voltage (B+) is supplied from a full wave voltage doubler, using silicon diode rectifiers. This voltage is connected to the plates of the two paralleled 6L6 series regulator tubes, the cathodes of which are connected to the output through the milliammeter. To allow the 6L6's to operate as pentodes*, a separate power supply is employed to supply the screen grid voltage. This supply consists of a half-wave rectifier, using a pair of selenium diode rectifiers feeding a dual section capacity filter. A pair of 100Ω resistors (parasitic suppressors) couples the supply voltage to the screen grids. The common for this supply is returned to the 6L6 cathodes, thus maintaining a relatively constant voltage on the 6L6 screen grids.

Operating in this configuration, the paralleled 6L6's act as a large variable resistor, the value of which is controlled by a small voltage applied to the control grids. This voltage is produced by the 6BH6 control tube, which operates as a DC voltage feedback amplifier. Its grid is fed from a DC voltage divider connected to the B+ output, while its plate is direct coupled to the 6L6 grids by a pair of 1 KΩ (current limiting parasitic suppressor) resistors. In this manner, any voltage variation** at the B+ output is immediately amplified and fed back (with reverse polarity) to the grids of the paralleled 6L6 series regulator tubes. This produces a corresponding resistance change in the series regulators which is in opposition to the output variation, thus cancelling it out.

*Pentode operation is superior to triode operation in most wide range series regulator applications.
**Voltage variations - caused by changes in output load and/or input voltage.

Screen voltage for the control amplifier is taken from a DC voltage divider, connected between the high voltage supply and the regulated -150 volt supply. The high voltage varies inversely to changes in the output current, and this variation is fed into the screen grid through the divider network. The output impedance of the Power Supply can be made positive or negative by using different values in this divider. Actual values for this network are chosen to give substantially zero output impedance.

The negative output voltage is produced by a 6X4 full wave rectifier, feeding a two section capacity filter. The output of this filter feeds a pair of OA2 voltage regulators connected in series, to supply a stable -150 and -300 volts. These two voltages supply a reference for the 6BH6 control amplifier and its DC divider networks.

The bleeder resistor network, consisting of four 27 KΩ resistors in series, is connected between the B+ output and the -300 volt source. In this manner, current flow through the series regulators is maintained at all output voltage settings.

The 50 KΩ control, connected across the -150 volt source, provides the variable bias voltage, which is coupled to its output terminal through a 22 KΩ (current limiting) resistor. This resistor prevents damage to the unit in event the bias output should accidentally be shorted.

Heater voltage for the unit is supplied by a separate transformer. This transformer also supplies 6.3 volts at 4 amperes for the external filament voltage output.

PRELIMINARY CONSTRUCTION NOTES

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. If some shortage or parts damage is found in checking, please notify us promptly and include all inspection slips with your letter.

The large, fold-in pictorials are reproductions of pictorials appearing in the manual. They have been prepared in this manner to be attached to the wall above your work space, to help in the construction of your instrument.

The following instructions are presented in a logical, step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before you start to do it. When the step is completed, check it off in the space provided. This is particularly important as it may prevent omissions or errors, especially if your work is interrupted.

MOUNTING PARTS

( ) Locate the chassis and orient upside down as shown in Pictorial 1 on Page 6.

( ) Mount a 1/2" grommet in hole GB.

( ) Mount 7-pin tube sockets in locations V1, V2, V3 and V4. Orient with blank spaces positioned as shown in Pictorial 1, and secure with 3-48 x 1/4" binder head machine screws and nuts.

( ) Mount octal tube sockets (8-pin) in locations V5 and V6. Orient with keyway positioned as shown in Pictorial 1, and secure with 6-32 x 3/8" binder head machine screws, lockwashers and nuts. Mount a 3-lug terminal strip under one lockwasher and nut on socket V5 in location TF. Note that there are two types of 3-lug terminal strips furnished in the kit. Be sure to use the correct one and orient as shown.

( ) Mount 1-lug terminal strips in locations TA and TB. Orient as shown in Pictorial 1, and secure with 6-32 x 3/8" binder head machine screws, lockwashers and nuts.

OPERATION AND ADJUSTMENT

( ) Set the power switch (SW) to the OFF position.

( ) Set the bias C- OUTPUT control (CC) and the high voltage B+ OUTPUT control (CD) maximum counterclockwise.

( ) Set the ZERO SET control (CA) maximum clockwise (from top of chassis).

( ) Set the 400 VOLT SET control (CB) maximum counterclockwise (from top of chassis).

( ) Set the meter slide switch (SL) to the B+ OUTPUT position.

NOTE: Do not connect any load to the Supply at this time.

( ) Connect the line cord to a 105-125 volt 50-60 cycle AC outlet.

CAUTION: This instrument will not operate, and may be seriously damaged, if connected to a DC or 25 cycle AC power source or to an AC line of more than 125 volts.

( ) Turn the power switch to STANDBY and allow a few minutes for the tube heaters to come up to operating temperature. Check to be sure that the heaters of the 6X4, 6BH6, and 6L6's are lit.

( ) Turn the power switch to ON. If the unit is functioning properly, the output current will be zero (0) and the voltage will be between zero (0) and 100 volts.

( ) Adjust the ZERO SET control (CA) counterclockwise until the output voltage reads zero (0).

( ) Now set the high voltage B+ OUTPUT control (CD) maximum clockwise.

( ) Adjust the 400 VOLT SET control (CB) clockwise until the output voltage reads 400 volts.

( ) Now set the high voltage B+ OUTPUT control (CD) back to its maximum counterclockwise position.

( ) Because the ZERO SET and 400 VOLT SET controls interact with each other, it will be necessary to repeat the above four steps about 3 or 4 times.

( ) This completes the adjustment of the unit. Unplug the instrument and insert it into the cabinet. Secure in the back with two 6-32 x 3/8" binder head machine screws.

( ) For normal operation, connect a jumper lead (piece of bare wire) from the chassis ground terminal (B3) to the adjacent common terminal (B2).

Regulated B+ Output:

Connect the load between the B+ OUTPUT and the COMMON terminals. Rotate the B+OUTPUT control clockwise to the desired output voltage. Read the output current and voltage (400 volt scale) on the two meters. Use care not to exceed the output ratings. Note the warning red line at 100 ma on the milliammeter.

Bias C- Output:

Connect the bias or other light load between the C- OUTPUT and COMMON terminals. Set the meter slide switch in the C- OUTPUT position. Rotate the C- OUTPUT control clockwise to the desired output voltage and read the output voltage (150 volt scale) on the voltmeter.

NOTE: The bias output current is not metered.

Filament Output:

Connect the filament load to the two filament voltage output terminals. This is a fixed 6.3 volts, with a maximum output of 4 amperes. Use care not to exceed this output rating.

NOTE: This output is insulated to withstand up to 1500 volts DC between it and common.

OUTPUT METER ACCURACY

Output Current (full scale)..... ±2%
Output Voltage (full scale)..... ±3%

NOTE: Both output meters have a full scale accuracy of ±2%, but because of the ±1% dropping resistor in series with the voltmeter, its total accuracy is ±3%. However, it is not likely that the meter and resistor tolerance would both be additive maximums. Therefore we would assume its total accuracy to be well within the specified ±3%.

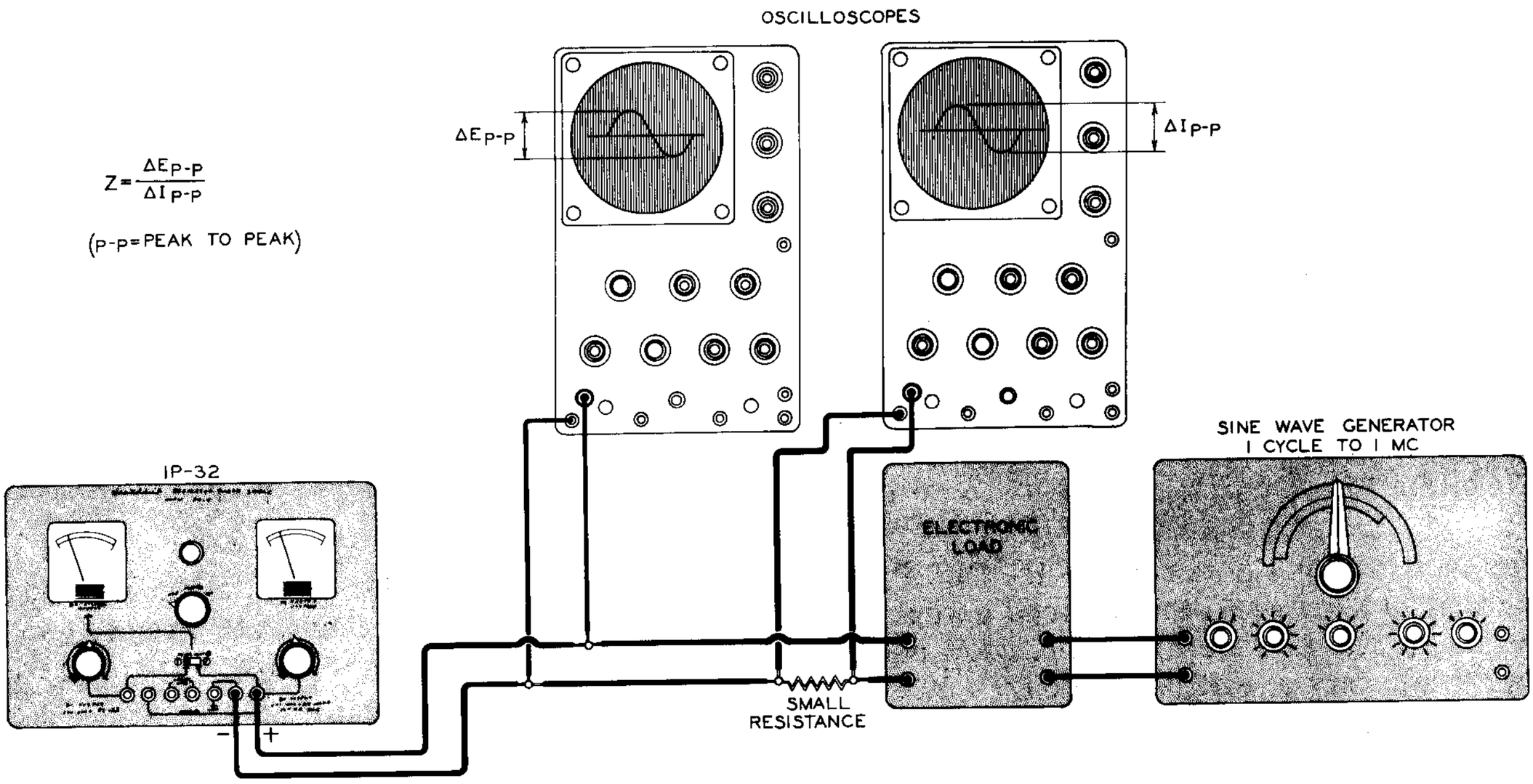
EQUIPMENT LIST

Test equipment used in making the specification measurements for the Heathkit Regulated Power Supply:

Generators:.....	Heathkit Audio Generators
Meters:.....	Hewlett-Packard Model 400D Audio Voltmeter
	Waveforms Model 520-A Audio Voltmeter
	Triplett Model 660 AC Wattmeter
	Heathkit Vacuum Tube Voltmeter
	Heathkit Multimeter
Oscilloscope:.....	Tektronix 515 Oscilloscope
Line Voltage Control:.....	General Radio Company Type W5MT Variac
Electronic Load:.....	Special design Static and Dynamic Load

$$Z = \frac{\Delta E_{P-P}}{\Delta I_{P-P}}$$

(P-P=PEAK TO PEAK)



DETERMINATION OF OUTPUT IMPEDANCE USING ELECTRONIC STATIC AND DYNAMIC LOAD

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-3	2	100 Ω (brown-black-brown)
1-9	3	1 KΩ (brown-black-red)
1-22	1	22 KΩ (red-red-orange)
1-27	1	150 KΩ (brown-green-yellow)
1-29	1	220 KΩ (red-red-yellow)
1-33	1	470 KΩ (yellow-violet-yellow)
1-34	1	680 KΩ (blue-gray-yellow)
1-35	2	1 megohm (brown-black-green)
1A-27	1	33 KΩ 1 watt (orange-orange-orange)
1B-14	2	1.5 KΩ 2 watt (brown-green-red)
1B-6	4	27 KΩ 2 watt (red-violet-orange)
2-86	1	150 KΩ precision
2-138	1	400 KΩ precision
Capacitors		
23-45	1	.047 μfd 600 V
23-59	1	.05 μfd 200 V
23-58	1	0.2 μfd 200 V
25-30	1	20-20 μfd 350 V
25-33	2	20 μfd 450 V
25-36	1	40 μfd 450 V
25-43	2	70 μfd 350 V
Controls-Switches		
10-26	1	500 KΩ control
10-59	1	250 KΩ control (Tab mount)
10-60	1	500 KΩ control (Tab mount)
10-89	1	50 KΩ control
60-2	1	DPDT slide switch
63-189	1	3-position rotary switch
Transformers-Rectifiers		
54-76	1	Filament transformer
54-77	1	Power transformer
57-13	2	50 ma selenium rectifier
57-27	4	500 ma silicon rectifier
Sheet Metal Parts		
90-239	1	Cabinet
200-M196	1	Chassis
203-166F806-807-808		
Meters-Tubes-Lamp		
407-56	1	Voltmeter
407-57	1	Milliammeter
411-8	2	6L6 tube

PART No.	PARTS Per Kit	DESCRIPTION
Meters-Tubes-Lamp (cont'd.)		
411-59	2	OA2 tube
411-64	1	6X4 tube
411-95	1	6BH6 tube
412-1	1	#47 lamp
Holders-Sockets-Terminal Strips		
423-1	1	Fuse holder
431-1	2	1-lug terminal strip
431-2	1	2-lug terminal strip
431-3	1	3-lug terminal strip
431-5	1	4-lug terminal strip
431-27	1	3-lug terminal strip
431-45	1	6-lug terminal strip
434-15	4	7-pin tube socket
434-58	2	Octal tube socket
Hardware		
100-M16B	5	Binding post cap (Black)
100-M16R	2	Binding post cap (Red)
250-18	8	8-32 x 3/8" RHMS
250-48	4	6-32 x 1/2" RHMS
250-49	8	3-48 x 1/4" BHMS
250-83	2	#10 x 1/2" screw
250-89	18	6-32 x 3/8" BHMS
252-1	8	3-48 nut
252-3	27	6-32 nut
252-4	8	8-32 nut
252-7	3	Control nut
252-22	2	6-32 speednut
253-9	12	#8 flat washer
253-10	3	Control flat washer
254-1	19	#6 lockwasher
254-2	8	#8 lockwasher
254-4	3	Control lockwasher
259-1	8	#6 solder lug
261-9	4	Cabinet feet
340-2	1	Length bare wire
344-1	1	Length hookup wire
346-1	1	Length sleeving
421-2	1	3 amp fuse
427-2	7	Binding post base
434-22	1	Pilot lamp assembly
Miscellaneous		
73-3	1	1/2" grommet
75-17	14	Insulator bushing
75-24	1	Line cord bushing
89-1	1	Line cord
211-15	1	Cabinet handle
462-139	3	Knob (black)
463-27	3	Knob pointer
331-6		Solder
595-579	1	Instruction manual