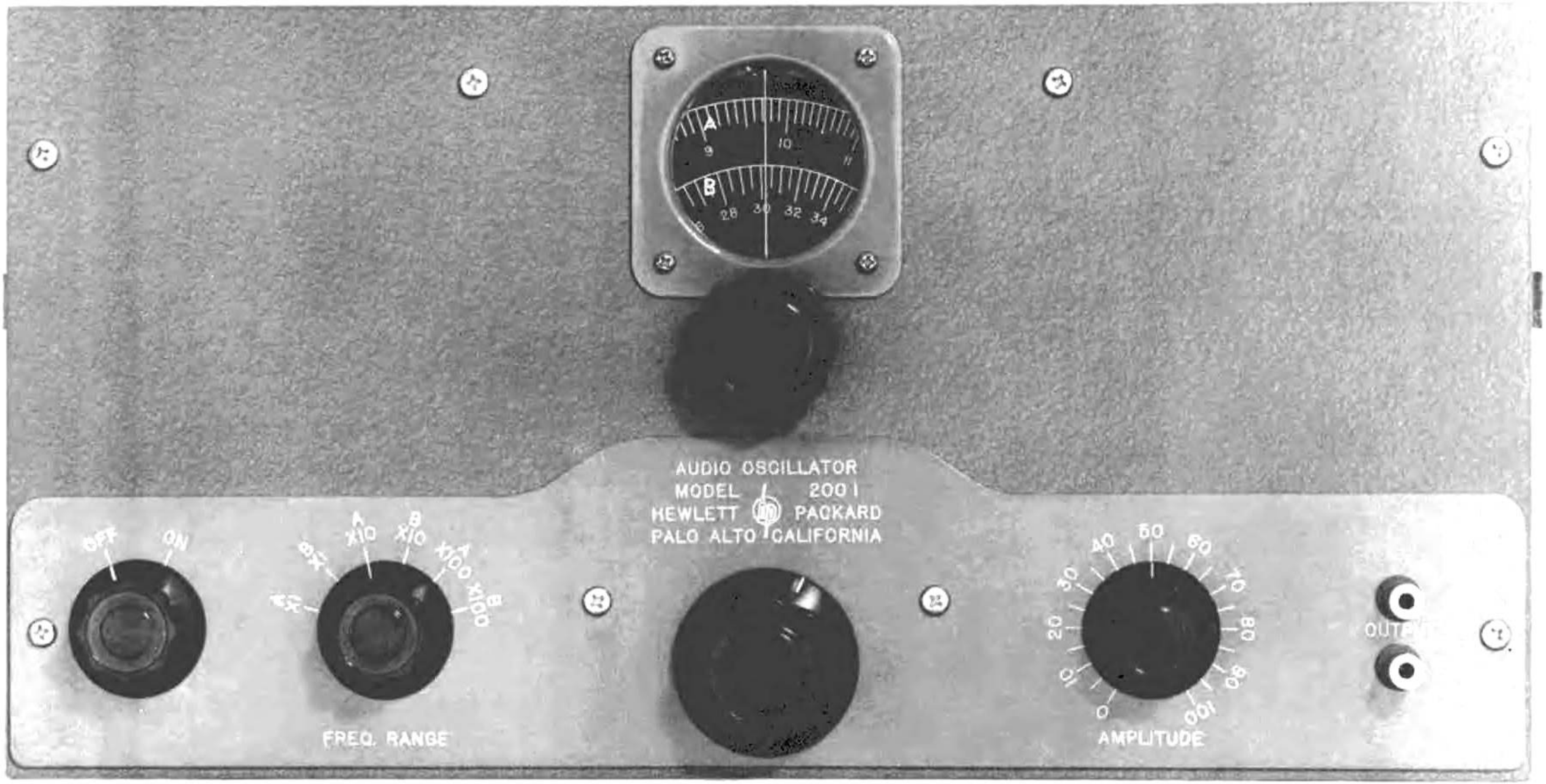


Fig. 3. Model 200I Audio Oscillator

HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

2001

AUDIO OSCILLATOR

2001

2001

INSTRUCTIONS

MODEL 200I

AUDIO OSCILLATOR

Specifications

Frequency Rating --

Frequency Range - 6 to 6,000 cycles/second.
Frequency Dial Calibration - two scales, A (top) scale 6 to 20, B (bottom) 20 to 60

Range	Frequency
Ax1	6 to 20 cycles/second
Bx1	20 to 60 cycles/second
Ax10	60 to 200 cycles/second
Bx10	200 to 600 cycles/second
Ax100	600 to 2,000 cycles/second
Bx100	2,000 to 6,000 cycles/second

Calibration Accuracy - ± 2% (± 1% with standardization)
Frequency Response - ± 1 db from 6 to 6,000 cycles/second (reference: 400 cycles/second).
Frequency Stability - ± 2% or .2 cycles/second (whichever is greater) under normal temperature conditions, including initial warm-up. An accuracy of ± 1% can be maintained by frequent standardization of the Model 200I against a suitable frequency standard. Line voltage variations up to 10% of rated voltage will have a negligible effect on the frequency stability of the instrument.

Power Output Rating --

Power Output - 100 milliwatts (10 volts) into 1000 ohms resistive load.
Distortion - Less than 1% at rated output from 10 to 6,000 cycles/second.
Hum and Noise - Less than .1% of rated output (at least 60 db below rated output).
Load Impedance - 1,000 ohms resistive.
Approximate Internal Impedance - 25 ohms, 50 to 6,000 cycles/second.

Power Supply Rating --

Voltage - 115/230 volts ± 10%
Frequency - 50 to 60 cycles
Wattage - 60 watts

Overall Dimensions --

Cabinet Model - 8-3/4" high x 18-3/4" wide x 11-5/8" deep.
Rack Model - 8-3/4" high x 19" wide x 12" deep.
Panel: 8-3/4" high x 19" wide.
Depth behind panel: 10-3/4".

Weight --

Cabinet Model - 26 pounds.
Rack Model - 26 pounds.

Operating Instructions

Inspection --

This instrument has been thoroughly tested and inspected before being shipped and is ready for use when received.

After the instrument is unpacked, it should be carefully inspected for damage received in transit. If any shipping damage is found, follow the procedure outlined in the "Claim for Damage in Shipment" section on the last page of this instruction book.

Controls and Terminals --

OFF-ON - This rotary switch controls all the power supplied to the instrument from the power line. When this switch is turned on the frequency dial window will be illuminated.

FREQ. RANGE - This rotary switch inserts various values of resistance in the frequency determining circuit of the oscillator. The position of this switch indicates the frequency dial scale in use and the multiplying factor to be used with this scale.

Frequency Dial - This dial, located in the middle of the control panel, has two scales both calibrated in cycles per second. This dial is controlled by two knobs, one above and one below the name plate on the control panel. The top knob is a direct drive for the frequency dial and the bottom knob is a vernier drive knob.

AMPLITUDE - This variable resistor controls the amount of oscillator signal applied to the output amplifier and thus the voltage appearing at the OUTPUT terminals. This control is calibrated from "0" to "100" in arbitrary units.

FUSE - The fuseholder, located on the back of the instrument, contains a 1 ampere cartridge fuse. To replace the fuse, unscrew the fuseholder cap and remove the blown fuse, insert a new fuse of the same type and replace the fuseholder cap. For 230 volt operation this fuse should have a 1/2 ampere rating. Replacement fuses must be of the "Slo-Blo" type as specified in the Table of Replaceable Parts in this instruction manual.

Power Cable - This instrument is equipped with a special three conductor power cable with a standard two prong male plug moulded on one end. The third conductor (green) protrudes from the cable near the plug and may be used to connect the instrument chassis to an external ground.

OUTPUT - These two binding posts are the output terminals of the instrument. These binding posts will accept bare wire, phone tips, banana plugs, or the standard dual banana plugs with 3/4" spacing. The bottom binding post is connected directly to the instrument chassis.

Operation of the Instrument --

The procedure for correct operation of the Model 200I is as follows:

1. Connect the power cable to a suitable power source.

2. Turn the power switch to ON and allow about five minutes for the instrument to reach its normal operating temperature. This warm-up period should be thirty minutes when maximum accuracy is desired.

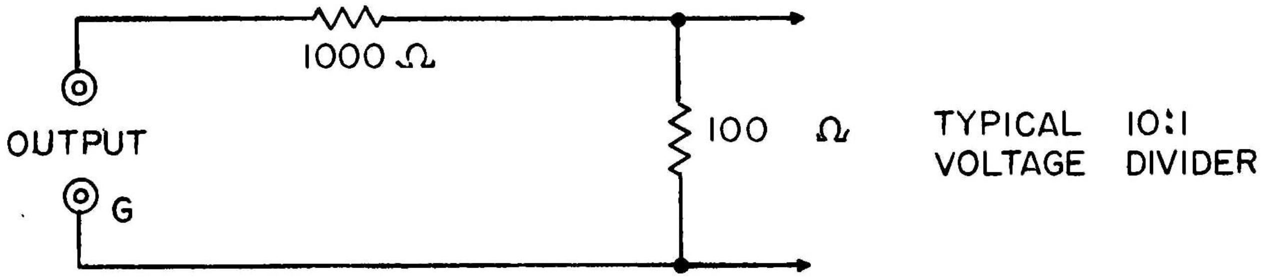
3. Set the Frequency Dial and the FREQ. RANGE switch for the desired output frequency. For example: If the desired output frequency is 1,000 cycles/second, set the frequency dial to 10 (A scale) and the FREQ. RANGE switch to Ax100 (10 x 100 = 1,000). If the desired output frequency is 440 cycles/second, set the frequency dial to 44 (B scale) and the FREQ. RANGE switch to Bx10 (44 x 10 = 440).

4. Connect the Model 200I output terminals to the proper points in the test set-up. The instrument has an unbalanced output and for best operation should be connected to a load of not less than 1,000 ohms.

CAUTION

The output of the Model 200I should not be connected to a high quality audio transformer. Because of the type of output circuit used in this instrument, there is a small amount of direct current present at the output terminals. This direct current might damage a high quality audio transformer.

5. Set the AMPLITUDE control for the desired output voltage from the Model 200I. If a small output voltage with minimum noise is desired, best results will be obtained by externally attenuating the instrument output rather than by decreasing the AMPLITUDE control. A simple voltage divider will be a satisfactory attenuator in many cases, the total resistance of this voltage divider should not be less than 1,000 ohms.



Circuit Description

The circuit of the Model 200I consists of an oscillator section, an output amplifier section, and a power supply section that includes a voltage regulator to stabilize the oscillator portion of the instrument.

The oscillator section consists of a 6SJ7 (V1) and a 6V6 or 6F6 (V2) and is basically a two stage resistance coupled amplifier. Two feedback loops are used around this amplifier, positive feedback to set up oscillations and negative feedback to reduce distortion and keep the amplitude of oscillation constant. The positive feedback loop contains fixed resistance values and a variable capacitor (See Fig. 1) is proportioned such that $R_1C_1 = R_2C_2$. With this circuit arrangement the ratio between the voltage appearing at the grid of the first stage and the voltage applied to the network will vary with frequency as shown by Fig. 2. This curve also illustrates the phase relation ship that exists between the voltage applied to the frequency determining network (E_{out}) and the portion applied to the grid (E_{in}) of the first stage. Oscillations will take place at the point on the curves where the phase shift through the network is 0^o and the amplitude of the grid signal is maximum. The frequency of oscillation will be equal to $1/2 \sqrt{R_1C_1R_2C_2}$ or $1/2$ RC since $R_1 = R_2$ and $C_1 = C_2$. The cathode by-pass capacitor (C8) in the second oscillator stage (V2) is to correct phase shift at the higher operating frequencies of the instrument.

The negative feedback network in the oscillator section minimizes changes in oscillator amplitude with changes in frequency. The incandescent lamp used as a cathode bias resistor, and also part of the negative feedback voltage divider, in the first stage of the oscillator (V1) has a temperature-resistance characteristic such that its resistance will increase in direct proportion to the voltage applied to it. Changes in the resistance of this lamp will change the percentage of negative feedback in the oscillator circuit. When the oscillator voltage rises more voltage is applied to the lamp (R19), the increased voltage will raise the temperature and resistance of the lamp which in turn increases the percentage of negative feedback in the oscillator circuit. Increasing the percentage of negative feedback will tend to decrease the oscillator output voltage to its normal operating point. The action will be reversed if the oscillator output voltage decreases, the negative feedback voltage will decrease lowering the voltage across the lamp (R19) which will lower its resistance thus lowering the percentage of negative feedback and tending to raise the oscillator output to its normal operating point. The thermal inertia of the lamp is great enough so that its resistance will not vary in accordance with the sine wave voltage at the lowest frequencies involved.

The amplifier section of the instrument consists of two stages (V3 and V4) with a large amount (35 db) of negative feedback for stability and low distortion. The negative feedback may be divided into three sections,

1. Overall (from the plate of V4 to the cathode of V3), 16 db.
2. Un-bypassed cathode resistor in input stage (V3), 11 db.
3. Un-bypassed cathode in the output amplifier (V4), 8 db.

The plate of the output amplifier is coupled through C12 to the OUTPUT terminals of the instrument. The 10,000 ohms resistor across the OUTPUT terminals serves to keep C12 charged and thus preventing surges of direct current through the external load when the load is first connected.

The power supply section of the instrument consists of a conventional full wave rectifier (V8) followed by a pi-section filter. Following the filter there is an electronic regulator to supply the direct current to the oscillator section of the instrument. The voltage regulator circuit consists of V5, V6 and V7. The 6L6 (V5) acts as a variable resistance unit with a 6SQ7 (V6) controlling its resistance. The voltage regulating tube (V7) keeps the cathode potential of the 6SQ7 (V6) constant. When the regulator output voltage rises, the grid of the 6SQ7 (V6) will become more positive, this will allow it to conduct more current through its plate load (R39). Increased current through R39 will increase the bias on the 6L6 (V5) which will raise its resistance and decrease the output voltage of the regulator. If the output voltage of the regulator drops below its normal operating point, this action will be reversed with a resulting decrease in resistance of V5 and an increase in regulator output voltage. A hum balancing potentiometer (R44) is included to minimize the effects of heater to cathode leakage.

Maintenance

Cover and Bottom Plate Removal --

The bottom plate is removed by unscrewing the four screws, one in each corner of the bottom plate, which fasten the plate to the chassis.

The cover is removed by unscrewing the eight screws which fasten the cover to the back and top of the instrument.

Tube Replacement --

After replacing any of the oscillator or amplifier (V1 - V4) tubes in the instrument, distortion measurements should be made to determine wheter or not the instrument still meets the specifications set forth in the front of this instruction manual. Selected tubes are not required for proper operation of this instrument, but defective tubes may cause excessive noise in the output waveform. When replacing tubes, it may be necessary to readjust the hum balancing control (R44) on the back of the instrument. (See HUM BAL. Adjustment, R44) After replacing any of the tubes in the power supply section of this instrument (V5 - V8), refer to the "Voltage Regulator Adjustment" section.

Replacement of Lamp R19 --

This lamp operates well below its rating and should have an infinite life. The lamp may be damaged by severe mechanical vibration. If the lamp is damaged it may result in excessive oscillator voltage or no oscillations if the lamp opens. If the lamp is replaced, the oscillator voltage should be checked to make certain it falls within the range specified on the schematic diagram (26 - 28 volts RMS at 1000). This voltage may be measured between the case of C9 and ground with a 1000Ω/volt or better AC meter (See Fig. 5 for the location of C9). If the oscillator voltage is not correct, adjust R25 (Above C9 and RB2) until the correct voltage is obtained. If the correct oscillator voltage cannot be obtained with adjustment of R25, reject the new lamp and try another.

HUM BAL. Adjustment, R44 --

The HUM BAL. control is located on the back of the instrument and may be adjusted as follows:

1. If a distortion analyzer is available, the HUM BAL. control should be adjusted for minimum distortion in the output waveform with the instrument operating from 5 to 20 cycles above or below the power line frequency (60 in most cases).

2. If a distortion analyzer is not available, the HUM BAL. control may be adjusted for minimum variation in the instrument output amplitude when the instrument is operating near the power line frequency. This amplitude variation may be observed on an oscilloscope or a sensitive AC voltmeter.

Voltage Regulator Adjustment --

The voltage regulator output voltage must be 240 volts. This voltage may be measured between pin 8 of V5 and the chassis (See Fig. 5 for location of V5). If this voltage is not 240 volts, adjust R41 to obtain this value (R41 is located on RB1). If adjustment of R41 will not return the voltage to its proper value, it is an indication of trouble in the regulator circuit or an excessive load due to a defect in another section of the instrument. Line voltage variations from 105 to 125 (210 to 250) volts should not affect the output voltage of the regulator.

Power Transformer Primary Connections --

The power transformer of this instrument is connected for 115 volt operation at the factory. If 230 volt operation is desired, it will be necessary to reconnect the power transformer primaries as indicated in the transformer detail on the schematic diagram. The power line fuse should also be replaced with the value indicated for F1 (for 230 volt operation) in the "Table of Replaceable Parts" in this instruction manual.

Lubrication of Tuning Capacitor Drive Assembly --

The tuning capacitor drive assembly should be oiled once a month if the instrument is in constant use, or every six months if the instrument has only occasional use. Before lubricating the instrument, all dust and dirt that has collected on the tuning mechanism should be removed. The following need lubrication:

1. Vernier drive shaft bearing, one drop on each end.
2. Idler pulley (below the pilot lamp socket), one drop.
3. Spring loaded take-up pulley (on the back of the main tuning control shaft), one drop each end.

The most satisfactory oil for this purpose is Lubriplate #3, manufactured by the Fiske Brothers Refining Co., Newark, New Jersey

Calibration and Frequency Response Adjustment --

CAUTION

Do not attempt to calibrate this instrument unless you have the use of a secondary frequency standard such as the Hewlett-Packard Model 100C or 100D Secondary Frequency Standard or the Hewlett-Packard Model 524 or 522 Frequency Counter.

If a secondary frequency standard is used for calibration, it will be necessary to compare the instrument output with that of the frequency standard on an oscilloscope. If a frequency counter is used for calibration, it will indicate the frequency directly. A voltmeter that is accurate over the range of 200 to 600 cycles/second (such as the Hewlett-Packard Model 400 A, B, or C or Model 410B) will also be necessary to adjust the frequency response of the instrument.

To compare the output frequency of the instrument with that of the secondary frequency standard an oscilloscope is used to obtain Lissajous figures. If the known frequency is connected to the horizontal input of the oscilloscope and the instrument output is connected to the vertical input of the oscilloscope, the frequency of operation of the instrument can be determined as follows:

1. Adjust the frequency of the instrument until a stable pattern is obtained on the oscilloscope.

2. Count the number of points that are tangent to a horizontal line on top of the pattern.

3. Count the number of points that are tangent to a vertical line along the right hand edge of the pattern.

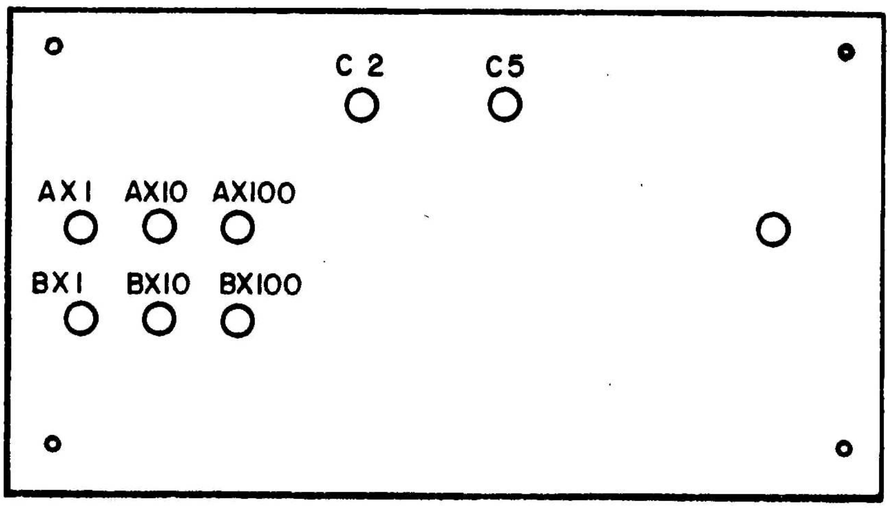
4. The instrument operating frequency is then obtained from:

$$\frac{\text{Horizontal Tangencies}}{\text{Vertical Tangencies}} = \frac{\text{Unknown (instrument) Frequency}}{\text{Known (standard) Frequency}}$$

For example: If the pattern on the oscilloscope is a figure 8, and the secondary frequency standard is operating at 100 cycles/second, the instrument will be operating at exactly 50 cycles/second because:

$$\frac{\text{1 (Horizontal Tangency)}}{\text{2 (Vertical Tangencies)}} = \frac{50}{100}$$

Before attempting calibration, the instrument should be allowed to warm up for at least thirty minutes. All adjustments should be made with the cover and bottom plate fastened in place. All calibration controls may be reached through holes in the bottom plate as indicated below.



Bottom Plate Showing Location of Calibration Controls

The procedure for calibration and adjusting the frequency response of the Model 200I is as follows:

1. Terminate the instrument with a 1000 ohm resistive load. Set the FREQ. RANGE switch to the Bx10 position and the frequency dial to 20 (B scale). Set the AMPLITUDE control for 10 volts RMS output.

2. Adjust the Bx10 control (R16) so that the instrument is operating at exactly 200 cycles/second as indicated by comparison of the instrument output with that of the secondary frequency standard.

3. Change the frequency dial to 60 (B scale) and leave the FREQ. RANGE switch on Bx10. By means of C2 or C5 (It may be necessary to adjust both C2 and C5 if the instrument is badly out of calibration.) set the operating frequency of the instrument to exactly 600 cycles/second as indicated by comparison with the secondary frequency standard. Adjustment of C2 and C5 should be made with a non-metallic screwdriver.

4. Return the frequency dial to 20 (B scale) and adjust the AMPLITUDE control until the instrument output is exactly 10 volts RMS.

5. Move the frequency dial to 60 and note the variation in instrument output voltage. This variation should be corrected if the change in output voltage is greater than 1/4 volt.

6. Correct changes in output amplitude as follows: If the 600 cycle output was higher than the 200 cycle reference, decrease the capacity of C2 to correct for half the output amplitude variation and increase the capacity of C5 to return the frequency of oscillation to exactly 600 cycles/second. The adjustment of C5 will usually correct the remaining output amplitude variation but if this is not the case again adjust C2 for half the remaining output amplitude variation and bring the output frequency back with C5. If the output amplitude is low at the 600 cycle point it will be necessary to increase C2 to compensate for half the variation and decrease C5 to bring the frequency of oscillation back to 600 cycles/second.

7. Return the frequency dial to 20; if the output amplitude has shifted from 10 volts, repeat steps 4, 5, and 6.

8. Repeat steps 1 and 2 to make certain that the 200 cycle point is still in correct calibration after adjustment of C2 and C5.

9. If it was necessary to change the calibration of the 200 cycle point in step 8 it will also be necessary to repeat steps 4, 5, and 6.

10. Now calibrate the remaining ranges of the instrument by means of their calibration controls. (Location of these controls indicated on bottom plate drawing.) The following table lists the remaining ranges and a preliminary point

for calibration on each range. Rather than exact calibration at one frequency it is best to calibrate the instrument for minimum error over the whole frequency dial on each range. If one end of a range is 1% high the other end of the range should be 1% low, in this way the highest degree of accuracy will be obtained over the whole frequency range of the instrument.

Range	Preliminary Calibration Point
A x 1	15 cps
B x 1	50 cps
A x 10	150 cps
A x 100	1500 cps
B x 100	5000 cps

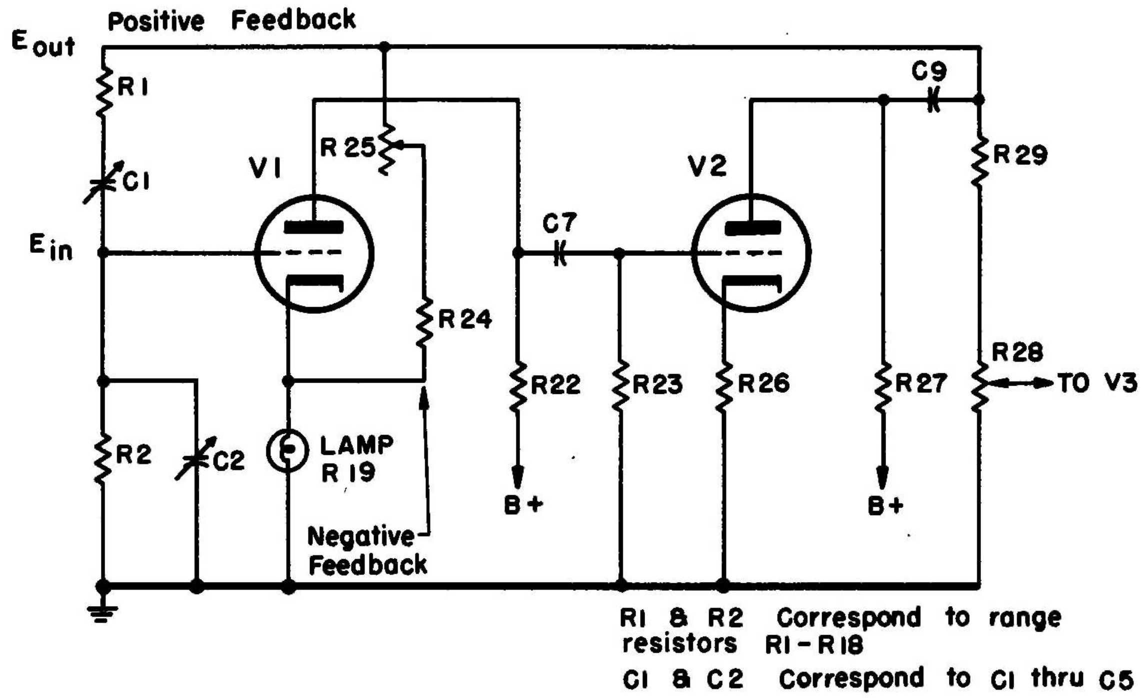


Fig. 1. Simplified Oscillator Circuit

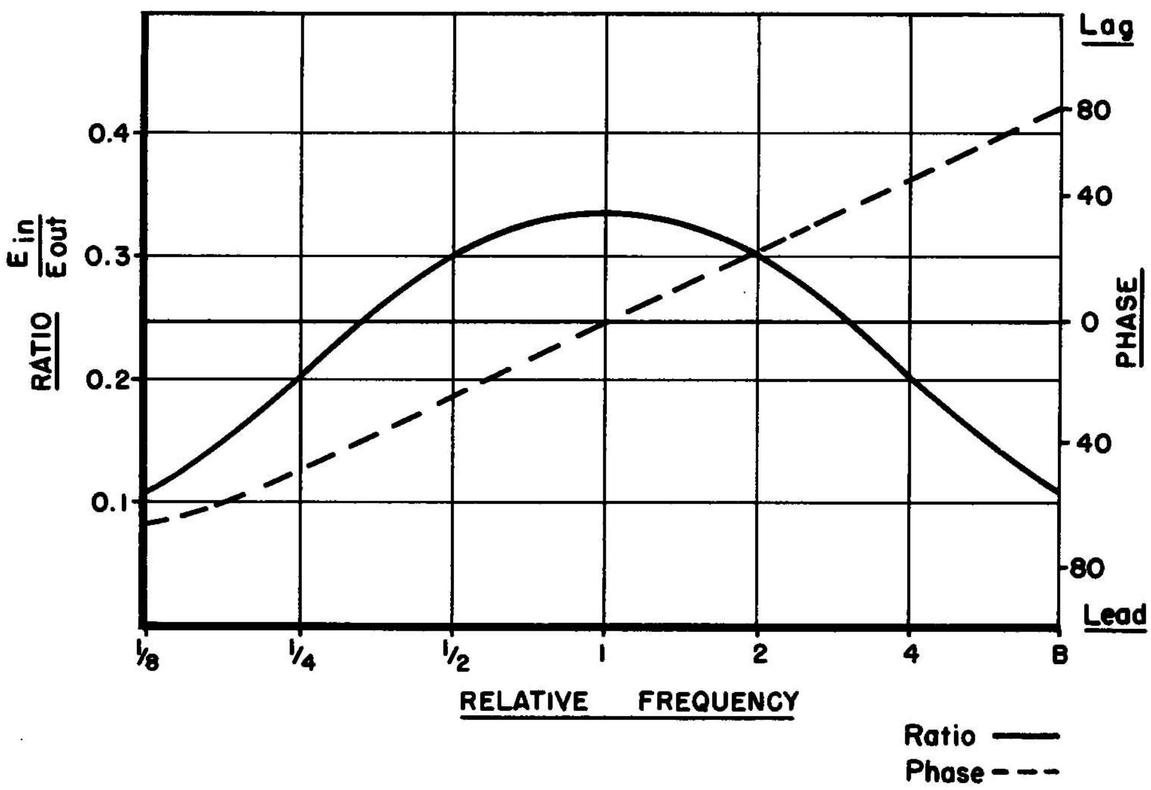


Fig. 2. Positive Feedback Network Characteristics

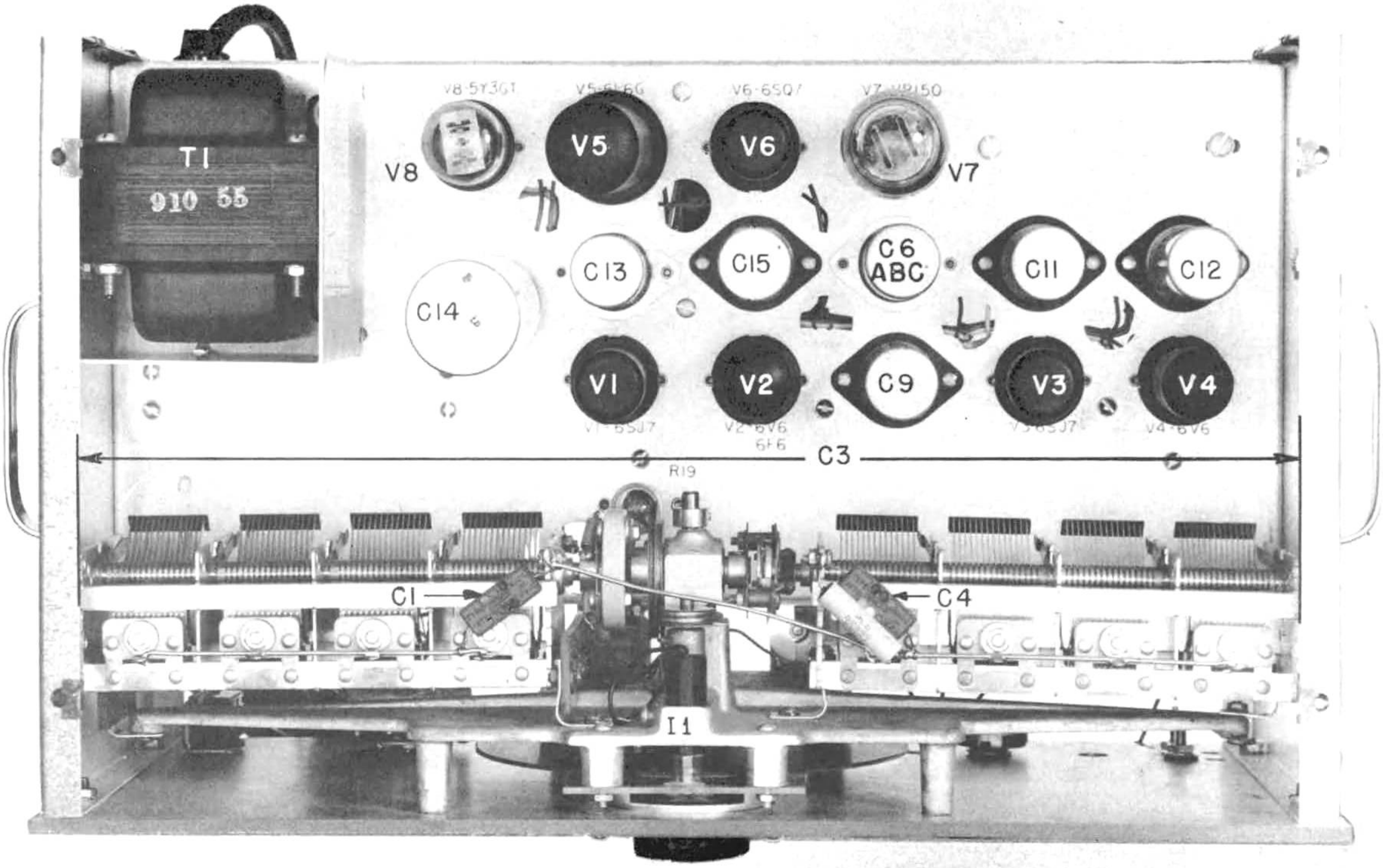


Fig. 4. Model 200I Top View Cover Removed

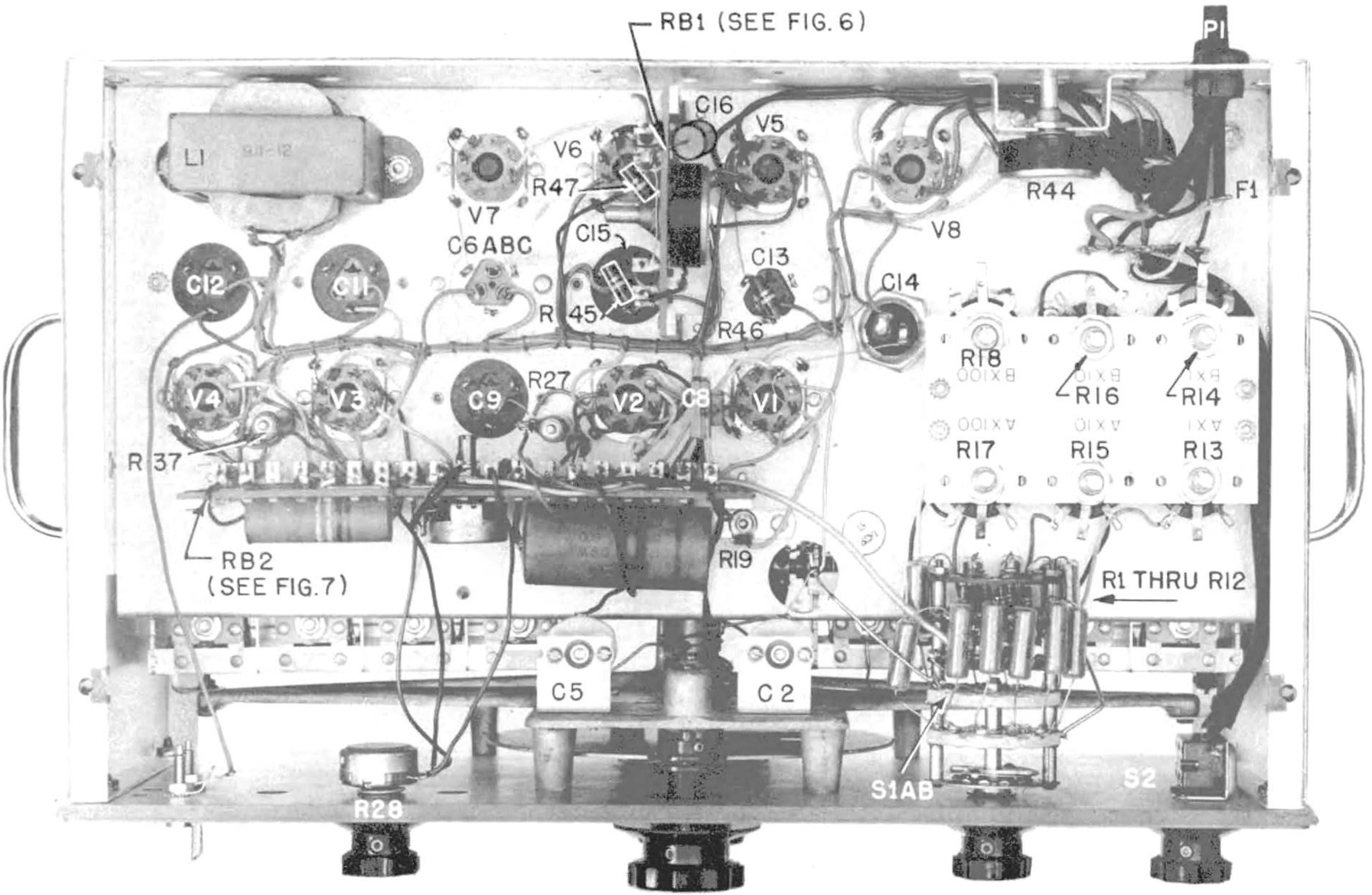
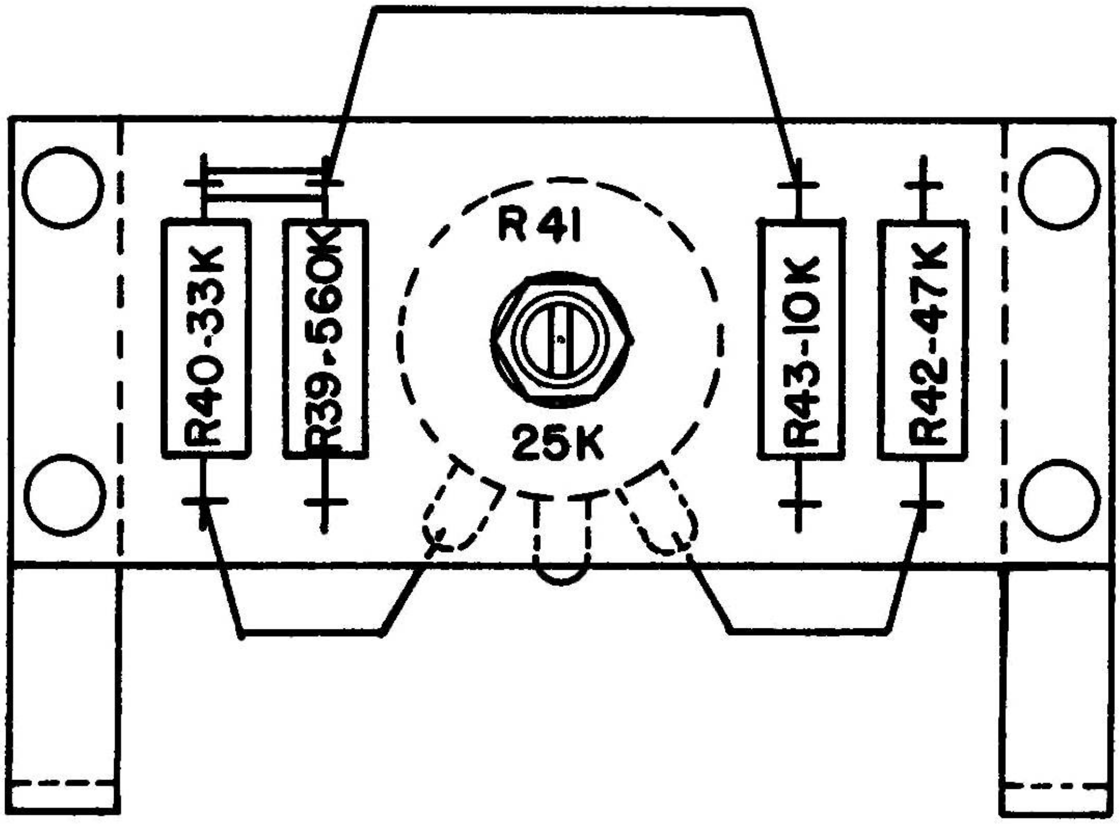


Fig. 5. Model 200I Bottom View Bottom Plate Removed



RB1

Fig. 6. Model 200I Resistor Board Detail

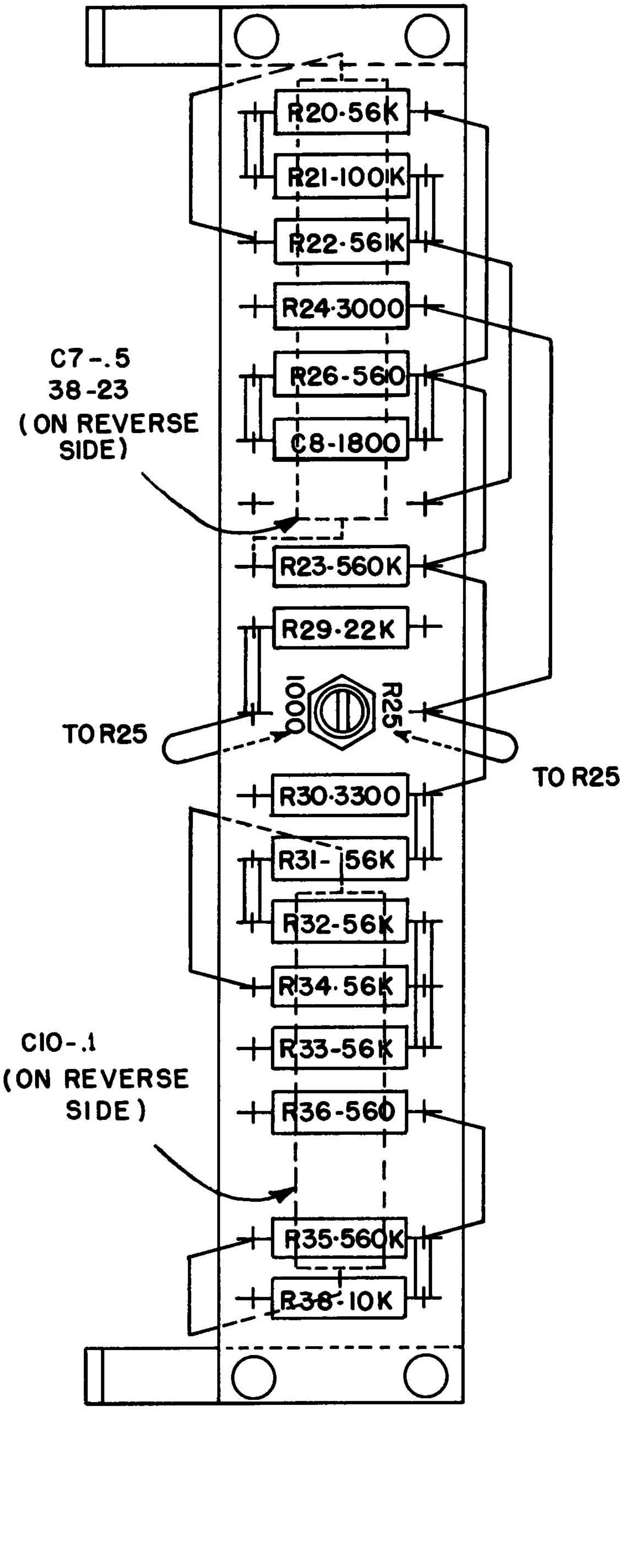
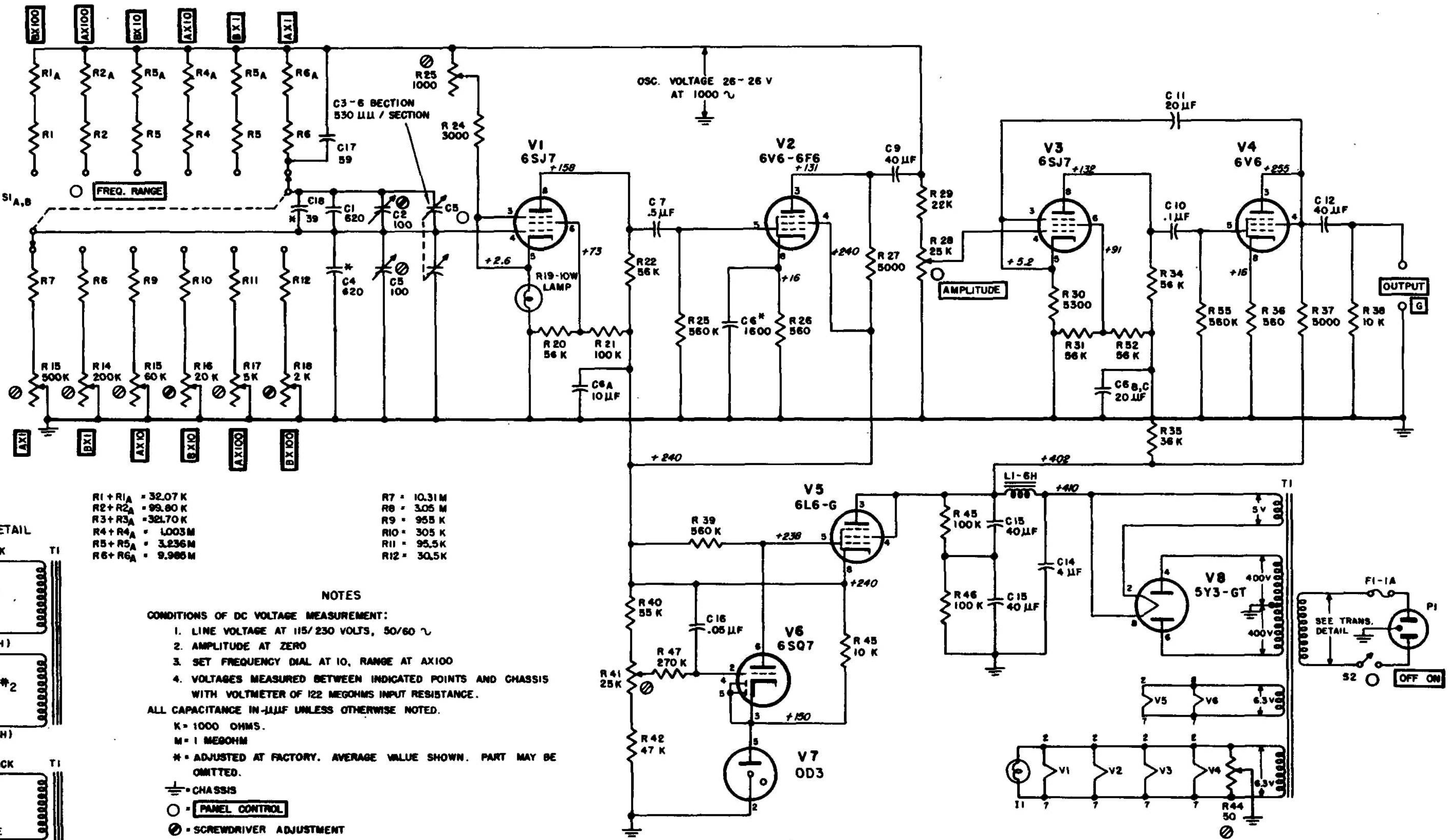


Fig. 7. Model 200I Resistor Board Detail



R1+R1A = 32.07 K
R2+R2A = 99.80 K
R3+R3A = 321.70 K
R4+R4A = 1.003 M
R5+R5A = 3.236 M
R6+R6A = 9.985 M

R7 = 10.31 M
R8 = 3.05 M
R9 = 955 K
R10 = 305 K
R11 = 95.5 K
R12 = 30.5 K

NOTES

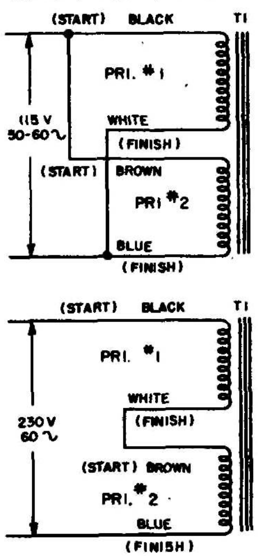
CONDITIONS OF DC VOLTAGE MEASUREMENT:

1. LINE VOLTAGE AT 115/230 VOLTS, 50/60 ∿
2. AMPLITUDE AT ZERO
3. SET FREQUENCY DIAL AT 10, RANGE AT AX100
4. VOLTAGES MEASURED BETWEEN INDICATED POINTS AND CHASSIS WITH VOLTMETER OF 122 MEGOHMS INPUT RESISTANCE.

ALL CAPACITANCE IN µµF UNLESS OTHERWISE NOTED.

K = 1000 OHMS.
M = 1 MEGOHM
* = ADJUSTED AT FACTORY. AVERAGE VALUE SHOWN. PART MAY BE OMITTED.
⏚ = CHASSIS
○ = PANEL CONTROL
⊘ = SCREWDRIVER ADJUSTMENT

TRANSFORMER DETAIL



SCHEMATIC DIAGRAM OF MODEL 200I
SERIAL 1145 & ABOVE