INSTRUCTIONS

—

AUDIO OSCILLATOR

Specification #7176

MODEL 200C
MODEL 200CR

HEWLETT-PACKARD COMPANY

Laboratory Instruments for Speed and Accuracy

395 PAGE MILL ROAD • PALO ALTO • CALIFORNIA

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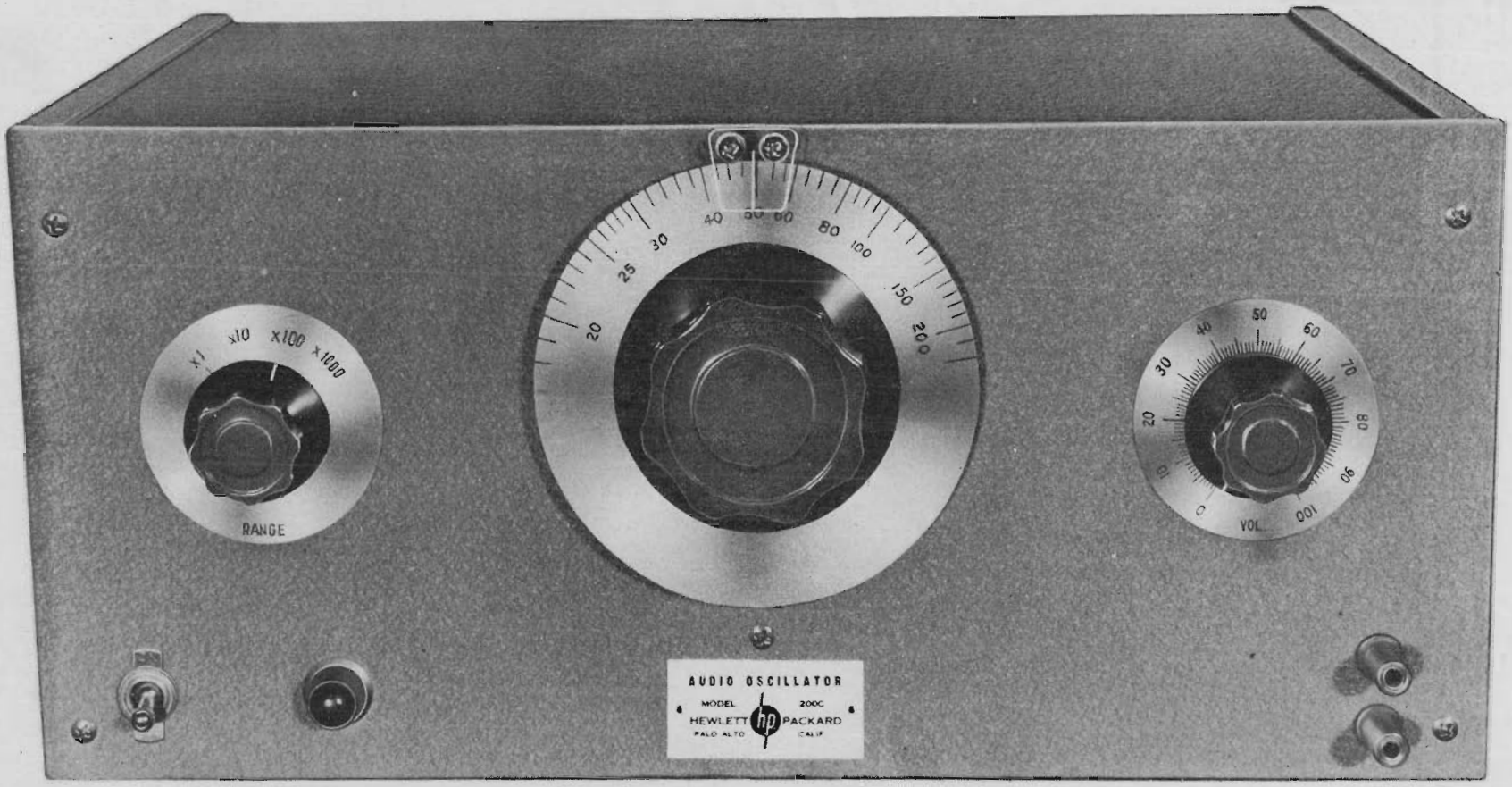

Figure 1—Audio Oscillator Model 200C

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AUDIO OSCILLATOR

MODEL 200C and 200CR

SPECIFICATION #7176

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ELECTRICAL SPECIFICATIONS

Frequency . . . . . 20 to 200,000 cps

Calibration: Main dial 20-200

Freq. Range	Mult. Factor	Frequency
X1	1	20-200 cps
X10	10	200-2000 cps
X100	100	2000-20,000 cps
X1000	1000	20,000-200,000 cps

Power Output . . . . . 100 milliwatts into 1000 ohm load

Output Impedance . . . . . 50 ~~1000~~ ohms (grounded)

Frequency Response (ref.—400 cps—10V into 1000 ohm load) . . . . 20 cps . . approx. ± 1 db

150,000 cps . . approx. ± 1 db

Stability (Frequency) . . . . . Within ±2% under normal temperature conditions

Distortion (Rated output) . . . . . Less than 1% 20 cps to 20,000 cps

Hum . . . . . 60 db below rated output

Power Supply . . . . . 230 volts, 50 cps, ~~xxxxxxxxxxxxxx~~ 68 watts

Fuse Rating . . . . . 1 amp

MECHANICAL SPECIFICATIONS

Cabinet Model 200C

Panel Size . . . . . 15¼" x 6⅞"

Over-all Dimensions . . . . . 15¾" x 10⅝" x 7"

Finish . . . . . Grey Wrinkle Enamel

Relay Rack Model 200CR

Panel Size . . . . . 19" x 7"

Cover . . . . . 15¾" x 10⅝" x 6⅞"

Finish . . . . . Grey Wrinkle Enamel

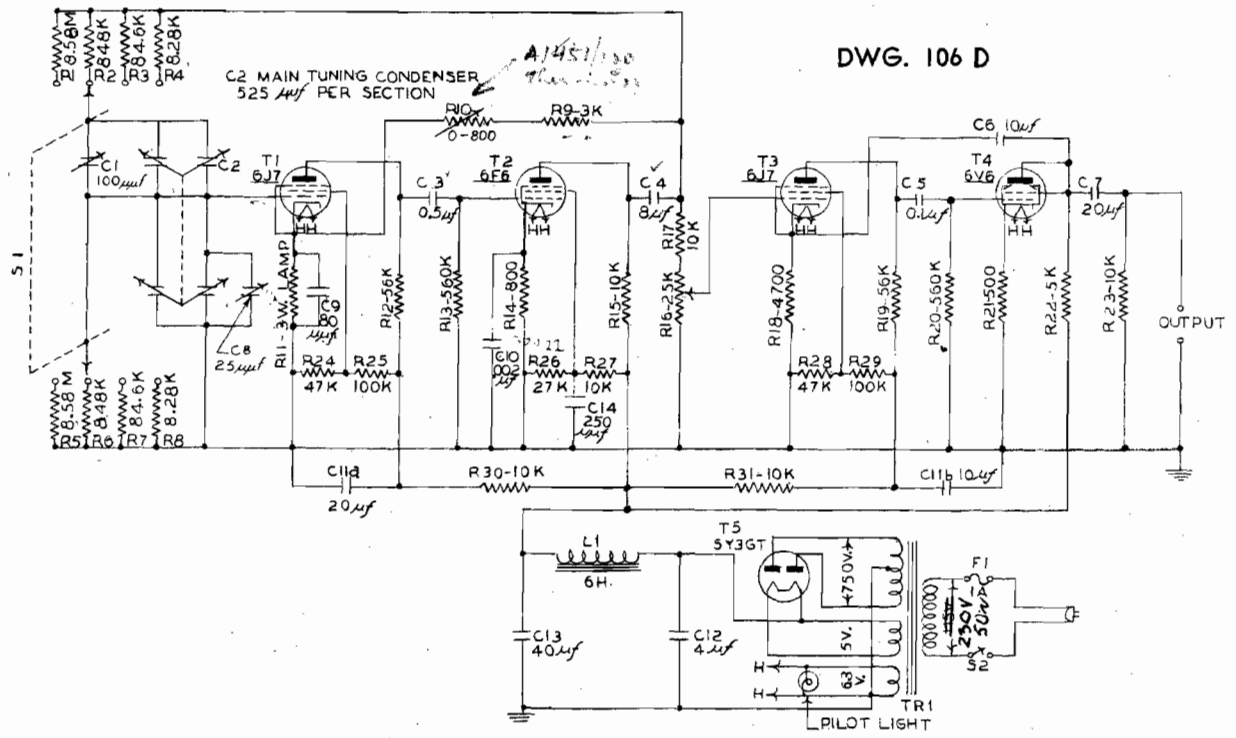

Figure 2—Schematic Diagram for Models 200C and 200CR

CIRCUIT DESCRIPTION

The Oscillator Section is a two stage resistance-coupled amplifier over which both positive and negative feedback are applied. The positive feedback network is a frequency selective, resistance-condenser combination which is used to control the frequency of oscillation. Negative feedback is used to stabilize the operation of the circuit. The amount of negative feedback is determined by a resistance network which contains a non-linear element in the form of a 3 watt Mazda lamp. This element controls the amount of feedback in accordance with the amplitude of oscillation and consequently maintains the proper operating point in the system.

The Amplifier Section is a two stage resistance-coupled output amplifier. Feedback is used in this amplifier to eliminate distortion and to provide a good frequency response over the wide frequency range. This amplifier is designed to deliver 100 milliwatts into a 1000 ohms resistance load over the major portion of the frequency range. The internal impedance of this amplifier is approximately 50 ohms at 400 cps and therefore the output is not critical with load. Load resistances less than 1000 ohms will tend to increase the distortion when the volume control is set for full output and will, at the same time, decrease the maximum output obtainable.

OPERATION

Ordinarily a warm-up period is not required. However, when the unit is first put into operation or when it has been standing idle for a long time the oscillator should be allowed to run for ten or fifteen minutes before it is used.

The Output Frequency is selected by the main dial located in the center of the panel and is calibrated directly in cycles per second for the lowest frequency range.

The Frequency Range switch on the left side of the panel indicates the proper multiplying factor to be used. See Figure 1 for front panel view of the Model 200C. Model 200CR is identical to Model 200C except in the rackmount panel.

The Output Voltage is controlled by the volume control at the right side of the panel. This control is ahead of the output amplifier. When very small audio voltages are required, it is good practice to use an attenuator between the oscillator and the equipment being driven. This will help keep the hum level far enough below the audio signal.

The Model 200C is designed to operate on 230 volts at 50-60 cps and has been adjusted to deliver more than rated power into the rated load. Because of this adjustment the output wave may show some distortion when the volume control is adjusted to give maximum output. This condition is normal and when low distortion is required the oscillator should be operated at rated output or slightly below.

MAINTENANCE

Figure 3 shows the tube socket layout and voltages from the socket connections to ground. Figures 4 and 5 show the top and bottom views respectively. See Figure 6 for instructions on how to remove cover and bottom plate.

The Frequency Calibration will ordinarily remain correct without adjustment. Should it be necessary, however, to adjust the tracking of the main frequency selecting dial, an **accurate source** of frequency must be used for comparison. Set dial to 20 and range switch to X10. Note output of oscillator at 20 on dial (200 cps) then set to 200 on dial. Adjust oscillator frequency to 2000 cps by means of C1 (see Figure 5), at the same time adjust the voltage output to be equal to that obtained at 20 on the dial by the compensating condenser C8 (see Figure 5). This requires some maneuvering as the settings are interdependent. Check output at 20 again to make sure it has not changed. If it has changed, readjust output and frequency at 200 to match. NOTE: These adjustments are all made from the bottom because the final calibration **is correct only** when the dust cover is in place. If the instrument still does not track properly the resistors have probably changed value. Return oscillator to the factory for range switch replacement and recalibration.

Total Harmonic Distortion is less than one-half of 1 per cent if the instrument is operating properly. When tubes are changed the distortion should be measured, because a poor tube will increase the distortion without otherwise affecting the operation of the instrument.

Instability of the output voltage is sometimes caused by a defective tube in the oscillator section T1 or T2 or by a defective coupling condenser which places a positive voltage on the grid of T2.

3 W Mazda Lamp failure. Should it be necessary to change this lamp (R11) (see Figure 4) because of unstable output or failure to oscillate, adjust the output voltage of the oscillator section to approximately 20-22 volts. Procedure: set dial to 20 on the X10 frequency range; connect a high impedance voltmeter from the junction of C4 and R17 (see Figures 2 and 5) to ground: vary the padding resistor R10 on the negative feedback resistor R9. Add resistance to raise voltage and vice versa. The distortion of the oscillator section should be 0.3% (50 db) or less at 400 cps.

The Fuse is a 1 ampere cartridge located on the under side of the chassis next to where the power cord enters. If fuse fails, the instrument should be carefully checked to ascertain the cause of the overload. Do not replace with a fuse of higher amperage or short the clips on the fuse block.

In General, the frequency calibration and the distortion level in the output should be periodically checked. Clean the unit thoroughly and apply a drop of light oil to the bearing on the main dial shaft every six months.

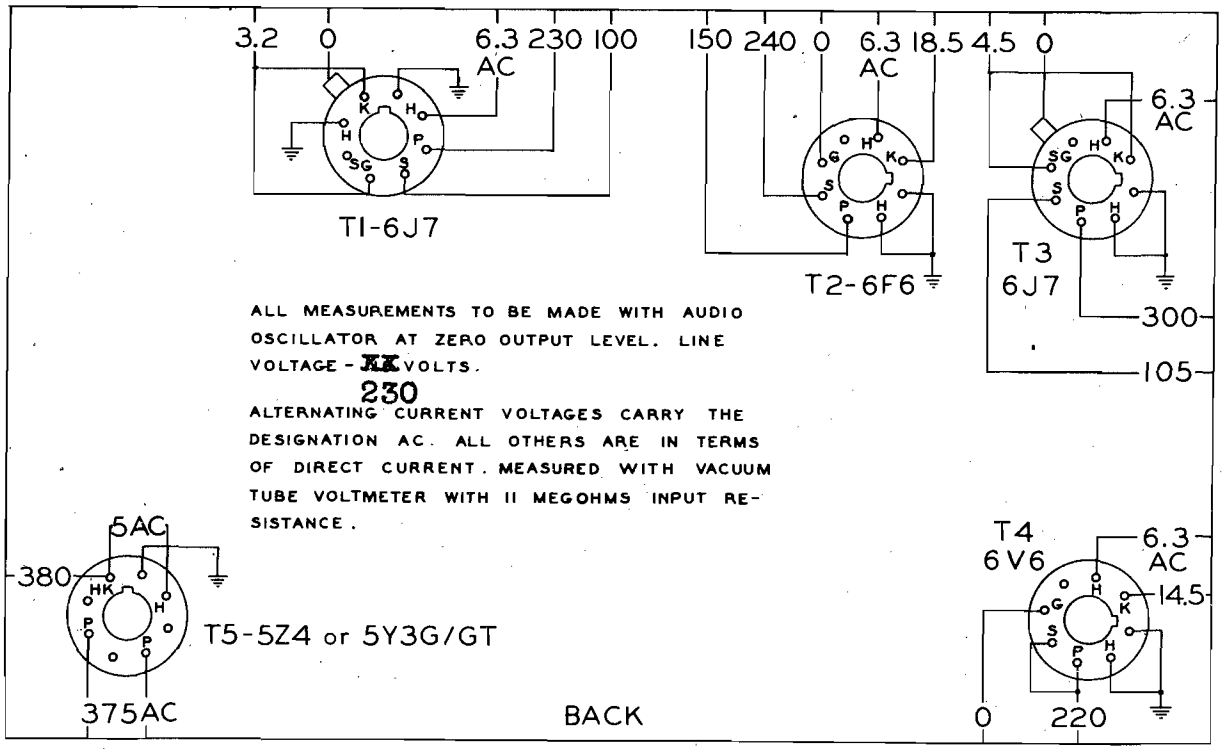

Figure 3—Tube Layout and Voltage Diagram—Model 200C and 200CR

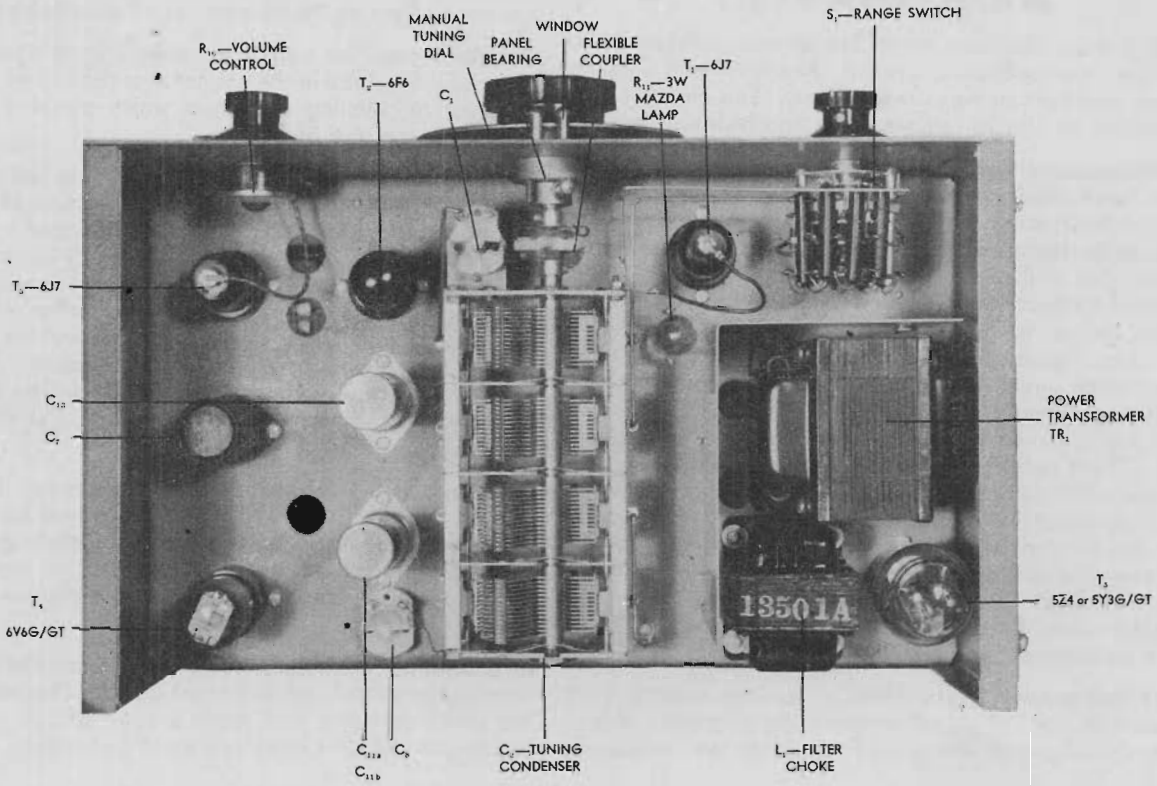

Figure 4—Top View of the Model 200C

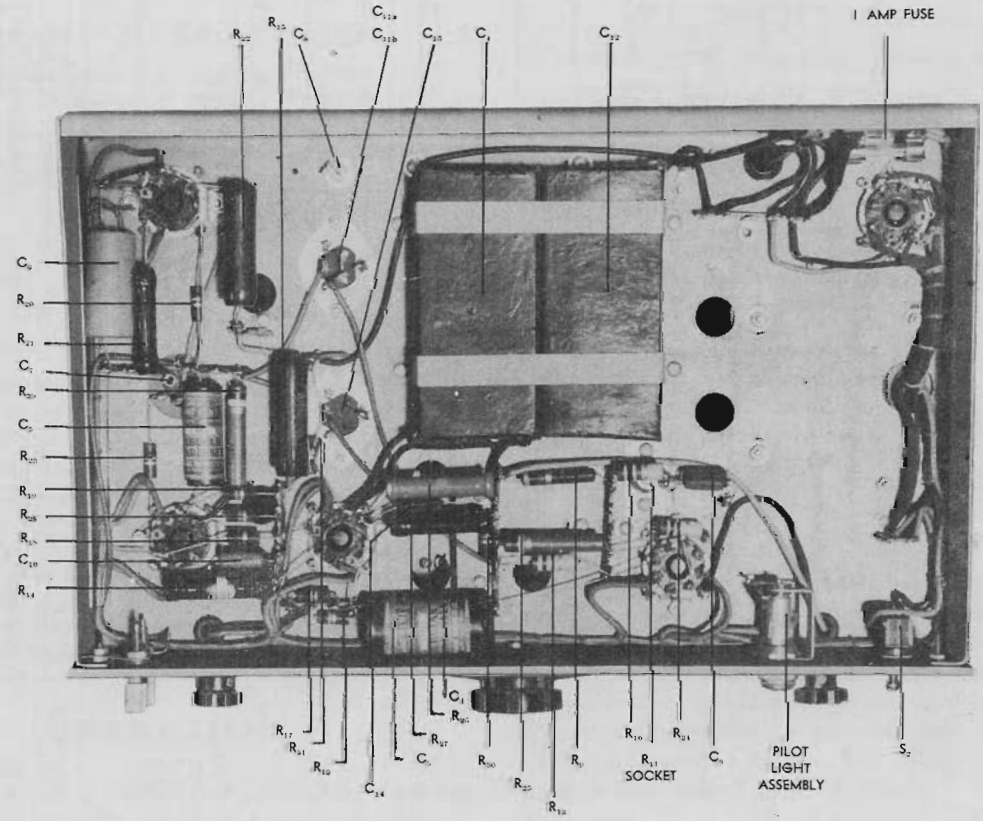

Figure 5—Bottom View of the Model 200C

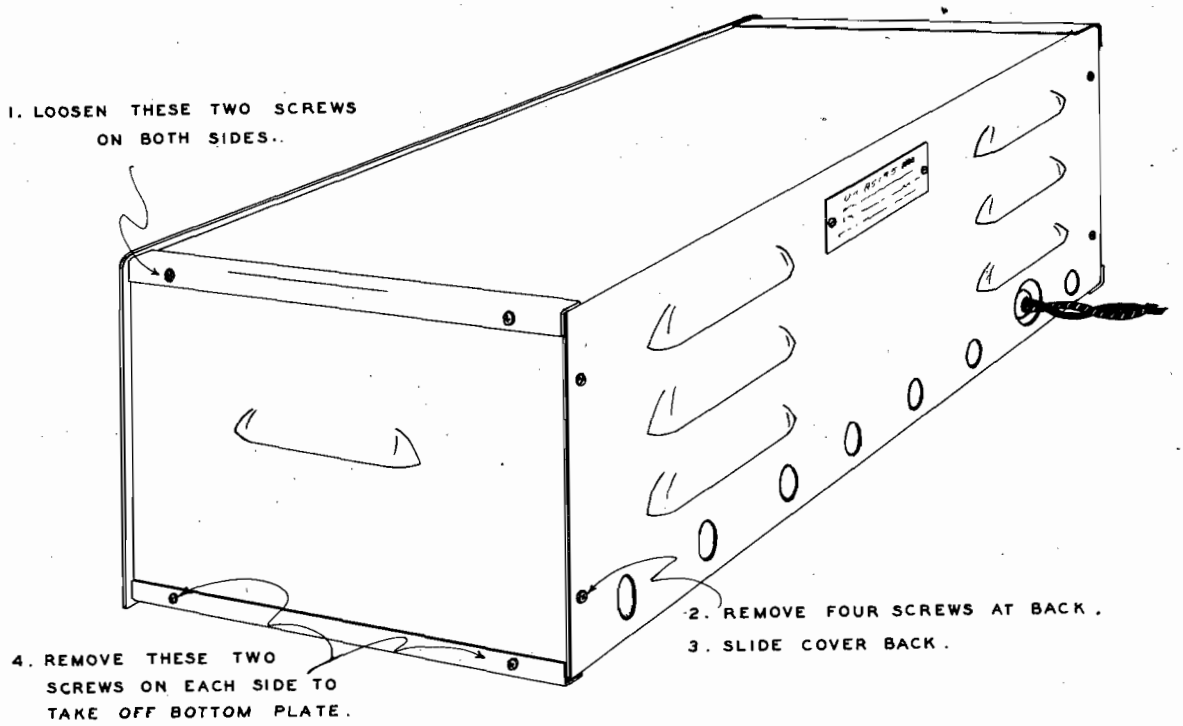

Figure 6—Instructions for Removing Cover and Bottom

LIST OF COMPONENT PARTS

AUDIO OSCILLATOR—MODEL 200C and 200CR

Diagram Reference Symbol	Name of Part and Description	Function	Hewlett-Packard Stock No.	Mfg. Ref. Code
S_1 R_1, R_5 R_2, R_6 R_3, R_7 R_4, R_8	Resistor—Range Switch Assembly comprising two 8.58 megohm (R_1, R_5); two 848,000 ohms (R_2, R_6); two 84,600 ohms (R_3, R_7); two 8,280 ohms (R_4, R_8); 1 watt precision carbon—Matched to dial.	Frequency range selector switch and frequency determining resistors	C-19	H.P.
R_9	Resistor—3000 ohms 1 watt wirewound (±10%)	Feedback control T_1 (6J7)	26-3K	I.R.C.
R_{10}	Resistor—0-800 ohms 1 watt carbon (±10%)	Padder resistor for R_9	24-(value of resistor)	B. or E.
R_{11}	Resistor—non-linear 3 watt 120V Mazda lamp	Automatic amplitude control T_1 (6J7)	211-3W	G.E.
R_{12}	Resistor—50,000 ohms 1 watt carbon (±10%)	Plate load resistor T_1 (6J7)	24-50K	B. or E.
R_{13}	Resistor—500,000 ohms 1 watt carbon (±10%)	Grid resistor T_2 (6F6)	24-500K	B. or E.
R_{14}	Resistor—800 ohms 10 watt wirewound (±10%)	Cathode resistor T_2 (6F6)	26-800	L.
R_{15}	Resistor—10,000 ohms 20 watt wirewound (±10%)	Plate load resistor T_2 (6F6)	27-10K	L.
R_{16}	Potentiometer—25,000 ohms 1 watt carbon (±10%)	Volume control potentiometer	ABC 15	H.P.
R_{17}	Resistor—10,000 ohms 1 watt carbon (±10%)	Output voltage limiting resistor	24-10K	B. or E.
R_{18}	Resistor—5,000 ohms 1 watt carbon (±10%)	Cathode resistor T_3 (6J7)	24-5K	B. or E.
R_{19}	Resistor—50,000 ohms 1 watt carbon (±10%)	Plate load resistor T_3 (6J7)	24-50K	B. or E.
R_{20}	Resistor—500,000 ohms 1 watt carbon (±10%)	Grid resistor T_4 (6V6)	24-500K	B. or E.
R_{21}	Resistor—500 ohms 10 watt wirewound (±10%)	Cathode resistor T_4 (6V6)	26-500	L.
R_{22}	Resistor—5000 ohms 20 watt wirewound (±10%)	Plate load resistor T_4 (6V6)	27-5K	L.
R_{23}	Resistor—10,000 ohms 1 watt carbon (±10%)	Leakage resistor for plate blocking condenser	24-10K	B. or E.
R_{24}	Resistor—50,000 ohms 1 watt carbon (±10%)	Screen bleeder resistor T_1 (6J7)	24-50K	B. or E.
R_{25}	Resistor—100,000 ohms 2 watt carbon (±10%)	Screen dropping resistor T_1 (6J7)	25-100K	I.R.C.
R_{26}	Resistor—27,000 ohms 3 watt carbon (±10%)	Screen bleeder resistor T_2 (6F6)	25-27K	G.
R_{27}	Resistor—10,000 ohms 10 watt wirewound (±10%)	Screen dropping resistor T_2 (6F6)	26-10K	L.
R_{28}	Resistor—50,000 ohms 1 watt carbon (±10%)	Screen bleeder resistor T_3 (6J7)	24-50K	B. or E.

Diagram Reference Symbol	Name of Part and Description	Function	Hewlett-Packard Stock No.	Mfg. Ref. Code
R_{29}	Resistor—100,000 ohms 2 watt carbon (±10%)	Screen dropping resistor T_3 (6J7)	25-100K	I.R.C.
R_{30}	Resistor—10,000 ohms 1 watt (±10%)	Filter resistor	24-10K	B. or E.
R_{31}	Resistor—10,000 ohms 1 watt (±10%)	Filter resistor	24-10K	B. or E.
C_1, C_2	Condenser—variable condenser assembly consisting of C_1—27 plate 100 uufd variable air trimmer; C_2—4 gang variable air tuning condenser (each section— min. capacity 13 uufd; max. capacity 538 uufd); four 1" x 3/8" ceramic pillars, and flexible ceramic coupler	Main variable tuning condenser; calibration adjustment trimmer condenser	ABC 7	H.P.
C_3	Condenser—0.5 ufd, 600 volts, tubular paper	Plate blocking condenser T_1 (6J7)	16-5	S. or M.
C_4	Condenser—8 ufd, 600 volts, paper wound	Plate blocking condenser T_2 (6F6)	17-44	G.H.
C_5	Condenser—0.1 ufd, 600 volts, tubular paper	Plate blocking condenser T_3 (6J7)	16-1	S. or M.
C_6	Condenser—10 ufd, 450 volts, tubular electrolytic	Feedback condenser T_4 (6V6)	18-10	M.
C_7	Condenser—20 ufd, 450 volts, tubular electrolytic	Plate blocking condenser T_4 (6V6)	18-20	M.
C_8	Condenser—25 uufd variable air trimmer (adjusted at factory)	Output voltage compensating condenser	13-25A	S.P.
C_9	Condenser—80 uufd, 600 volts, molded mica	Frequency compensating condenser (high frequency)	14-(value of condenser)	Mica.
C_{10}	Condenser—.002 ufd, 600 volts, molded mica	Frequency compensating condenser (high frequency)	14-2000	Mica.
$C_{11}{}^a$, $C_{11}{}^b$	Condenser—3 section electrolytic. Each section 10 ufd, 450 volts. C11a—20 ufd (2 sections)	Filter condensers	18-310	M.
C_{12}	Condenser—4 ufd, 800 volts, paper wound	Filter condensers	17-4-800	G.H.
C_{13}	Condenser—40 ufd, 450 volts, electrolytic	Filter condensers	18-40	M.
C_{14}	Condenser—250 uufd, 600 volts, molded mica	Frequency compensating condenser (high frequency)	14-(value of condenser)	Mica.
T_1	Tube—6J7	Oscillator tube	212-6J7	RCA
T_2	Tube—6F6	Oscillator tube	212-6F6	RCA
T_3	Tube—6J7	Amplifier tube	212-6J7	RCA
T_4	Tube—6V6	Output tube	212-6V6	RCA
T_5	Tube—5Z4 or 5Y3G/GT	Rectifier tube	212-5Z4 or 212-5Y3G/GT	RCA RCA
Tr_1	Transformer— Primary—~~105 to 125~~ 230 volts, 50 cps Secondary—750 volts, 75 ma (CT) 6.3 volts—3 amp 5 volts—2 amp Electrostatic shield between primary and secondary	Power transformer	ABC 8	H., P., T.E.

Diagram Reference Symbol	Name of Part and Description	Function	Hewlett-Packard Stock No.	Mfg. Ref. Code
L	Choke—12h @ 125 ma DC resistance 240 ohms	Filter choke	ABC 10	H.P.
S_2	Switch—S.P.S.T. Toggle Switch, 3/8"	To switch power (AC)	310-11	A.H.H.
F	Fuse—1 amp, 3AG	Protection against overload	211-1	Buss
	Fuse block	Fuse mounting	312-Fc3	F.S.
	Window—50/1000" cellulose acetate	Frequency dial indication	M2	H.P.
	Sockets—Octal tube sockets	Vacuum tube mounts	38-8	Cinch
	Sockets—candelabra socket	3 watt Mazda lamp mount	M1	H.P.
	Dial—frequency 20-200, 4 5/8" diameter	Designates frequency to which oscillator is tuned	35-FBC	Crowe
	Dial—range X1, X10, X100, X1000—2 1/2" diameter	Designates frequency multiplying factors	35-4R	Crowe
	Dial—volume 0-100, 2 1/2" diameter	Designates setting of volume potentiometer	35A-2	Crowe
	Knob—frequency dial knob 3" black bakelite	To allow manipulation of frequency dial	37-3	K.K.
	Knob—pointer knobs 1 1/2" black bakelite	To allow manipulation of frequency range switch and volume	37-112	K.K.
	Binding posts	To allow for external connection to output of oscillator	312-BP	H.P.
	Bearing—Panel bearing assembly consisting of 1 shaft, 2 collars, and phosphor bronze washer	Provides axis of rotation for, and controls degree of rotation of, main frequency dial	ABC 14	H.P.
	Chassis—1 deck plate 2 gusset plates 18GA		C1*	H.P.
	Shield—wing overall 9 1/4" x 4 1/2" 20GA 3 spade lug	To isolate oscillator from power supply	ABCD 6	H.P.
	Strap—2-Condenser bank straps 7 5/8" x 1/2" 20GA	To secure condensers (C_4, C_{12}) to bottom of chassis	ABC 16	H.P.
	Cord—Power cord 6 ft. Cotton braid	AC power supply to instrument	812-6	W.I.W.
	Clamp—Power cord clamp 3/8" x 3/4" overall—1/4" clamp	To secure power cord to instrument	312-14	F.S.
	Cover	Covers chassis	ABC 3*	H.P.
	Panel—Model 200C 15 1/4" x 6 7/8" x .078 cold rolled steel		ABC 2*	H.P.
	Bottom plate 14 7/8" x 9" 20GA, 2 angles, 9" x 1 1/8" and 4 felt feet	Covers underside	ABC 4*	H.P.
	Socket—Pilot light socket assembly consisting of jewel, bayonet socket, bracket, and locking device	Pilot lamp mount	312-P	S.I.
	Lamp—Pilot lamp—bayonet base—6.3 volts, .15 amps, Mazda #47	Panel indicator denoting instrument in operation	211-47	G.E.
	MODEL 200CR			
	Panel—19" x 7" x 1/8" cold rolled steel		ABC2R*	H.P.
	Bottom plate, 18-20 GA 14 7/8" x 9", incl. 2 angles, 9" x 1 1/8"	Covers underside	ABC4R*	H.P.

*Specify when black.

INDEX OF MANUFACTURERS

Ref. Code	Name and Address
A.H.H.	Arrow-Hart & Hegeman Electric Company Hartford, Connecticut
B.	Allen-Bradley Company Milwaukee, Wisconsin
Buss	Bussman Manufacturing Company St. Louis, Missouri
Cinch	Cinch Manufacturing Company 2335 W. Van Buren St., Chicago, Illinois
Crowe	Crowe Nameplate & Manufacturing Company 3701 Ravenswood Ave., Chicago, Illinois
E.	Erie Resistor Corporation Erie, Pennsylvania
F.S.	Federal Screw Products 224 W. Huron St., Chicago, Illinois
G.E.	General Electric Company Schenectady, New York
G.H.	Girard-Hopkins Oakland, California
G.	Globar Div., Carborundum Co. Buffalo Ave., Niagara Falls, N. Y.
H.	Robert M. Hadley Company 711 East 61st St., Los Angeles, California
H.P.	Hewlett-Packard Company 395 Page Mill Road, Palo Alto, California
I.R.C.	International Resistance Company 401 N. Broad St., Philadelphia, Pennsylvania
K.K.	Kurz Kasch Dayton, Ohio
L.	Lectrohm Inc. 5125 W. 25th St., Cicero, Illinois
M.	P. R. Mallory & Co. 3029 E. Washington St., Indianapolis, Indiana
Mica.	Micamold Radio Corporation 1087-1095 Flushing Ave., Brooklyn, New York
P.	Peerless Electrical Products Company 6920 McKinley Ave., Los Angeles, California
RCA	RCA Manufacturing Company, Inc. Harrison, New Jersey
S.	Sprague Products North Adams, Massachusetts
S.I.	Signal Indicator Corporation 140 Cedar St., New York City, New York
S.P.	American Steel Package Company Defiance, Ohio
T.E.	Thermador Electric Manufacturing Co. 5119 S. Riverside Drive, Los Angeles, California
W.I.W.	Western Insulated Wire 1001 E. 62nd St., Los Angeles, California

WARRANTY

Our instruments are guaranteed to be free from defects in workmanship and material, except tubes, fuses and batteries, for one year from date of purchase. Our liability under this warranty is limited to repairs and adjustments or replacements of defective parts or instruments when the fault is a direct result of defective materials or workmanship in the manufacture of the apparatus. This warranty covers service for the first year without charge except for transportation to the factory.

If during subsequent service any fault develops in the equipment, the following steps should be taken:

1. Notify us, giving full particulars of the difficulty and include the serial number of the instrument in question. On receipt of this information we will give you service information or shipping instructions.

2. On receipt of shipping instructions, forward the apparatus to us prepaid and we will make repairs and adjustments immediately at the factory.

3. If the fault has been caused by misuse or abnormal conditions of operation as disclosed by our examination, repairs will be billed at cost. In this case an estimate of the cost will be submitted before the work is started.

DO NOT HESITATE TO CALL ON US

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SERVICE NOTES

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#200C-1

PROCEDURE TO FOLLOW WHEN REPLACING THE RANGE SWITCH OR WHEN REALIGNING THE FREQUENCY OF THE HEWLETT-PACKARD AUDIO OSCILLATOR MODEL 200C.

The schematic diagram on page 4 of this Service Note is to be used as the reference for all component numbers and circuit designations mentioned here. If this reference schematic diagram does not completely agree with the instrument in your possession, comparison cross-checking will usually enable you to make satisfactory identification of the necessary components. If difficulty is encountered, please write to the factory Service Department, describing your trouble and giving the model, serial, and type numbers of your instrument.

I. Remove the old range switch and install the replacement. The range switch should be turned so that the side with the black jumper is next to the 6J7 tube. Normally no further adjustments are necessary when a defective range switch has been replaced.

CAUTION

Avoid having the precision resistors touch the mounting lugs adjacent to them on the switch assembly.

II. The range switch R1-R16 inc., in conjunction with the tuning condenser assemblies (C1, C2, C3) determines the frequency of oscillation of the unit and also affects the amplitude. If the output frequency is not the same as indicated by the dial, or if the amplitude varies more than ±1/2 db from 200 to 2000 cps, the following procedure is recommended.

1. For Serial Numbers 1 to approximately 14, 500.

a. Check for proper setting of dial on shaft as follows: Set tuning condenser to minimum capacity and place a 20 mil thick flat piece of metal under the heel of the rotor plates, between the rotor and stator. Rotate condenser clockwise so that rotor seats gently against 20 mil gauge resting on stator. At this point the last mark on the dial after 200 (long line) should be directly under the hairline. If not, move hairline or dial so that this condition is obtained.

b. For serial Numbers 14,500 and above. Rotate the condenser completely clockwise. To do this it will be necessary to loosen the collar of the stop on the rear of the panel bearing. When the condenser is completely closed, set the main tuning dial so that the dot to the left of 20 on the main tuning dial is exactly under the hairline. Tighten the coupler with the tuning dial and tuning condenser in these relative positions. Then tighten the collar of the stop so that the tuning condenser rotor **cannot** strike the frame or the stator at either end of its arc.

70EA199

2. Close cover and tighten. The calibration will be correct only when the dust cover is firmly closed. Remove the bottom plate.

3. Turn on the oscillator and allow at least 30 minutes for it to warm up.

4. Set to X10 range and set output to some reference level at 20 on the dial, say 10 volts. Change the dial setting to 200 and note the output. It should be exactly 10 volts and the frequency should be within 1/2% of 2000 cps. If such is not the case, simultaneous adjustments of condensers C1 and C3 should be made to obtain the correct frequency at 200 on the dial at the same time that the output voltage is 10 volts. Use the non-metallic (bakelite, etc.) aligning tools to adjust the condensers. The two condenser settings are interdependent, and the adjustment for correct frequency and voltage requires some manipulation and skill.

5. Check the tracking of the rest of the dial. If the entire dial is off by a constant percentage, either proceed to step 7 or return to steps 1 and 4 and reset the dial to take into account the constant error. Which of these methods is followed will depend on the relative values of the other ranges on the instrument. Either method will produce the same results; the one to follow is that which will require the least number of adjustments on the range switch. If there is no constant error in tracking, proceed to step 6.

6. If on the X10 range there is not more than a 1% or 2% error in tracking across the dial, this may be corrected by bending the split rotor plates on the tuning condensers* C3. Start at the 200 mark on the dial and work toward the 20 end. Bend the plates in the front four sections the same amount as in the rear four sections. If 200 cps (the 20 end of the dial) is too far out to correct in this manner, it will be necessary to proceed to step 7.

7. Change the values of the range switch resistors R2 plus R6 and R11 plus R15. One each of these resistors is a quarter-watt resistor in series with a precision resistor. Changing the value of one of these padder resistors by 10,000 ohms will change the frequency of the range by about 1/2%. Increasing the value of the resistor will lower the frequency of the range: decreasing the value of this resistor will raise the frequency of the range **.

---

* When bending condenser plates, it is necessary to open the dust cover to bend the plates and then to close the dust cover after each bending operation. The instrument changes frequency when the dust cover is open.

** Up to a 1% change in frequency on any range may be made by adjusting only one of the two range resistor padders on that range. If a greater frequency change is needed, adjust both padders. If this is not done, the relative amplitude between ranges will be affected.

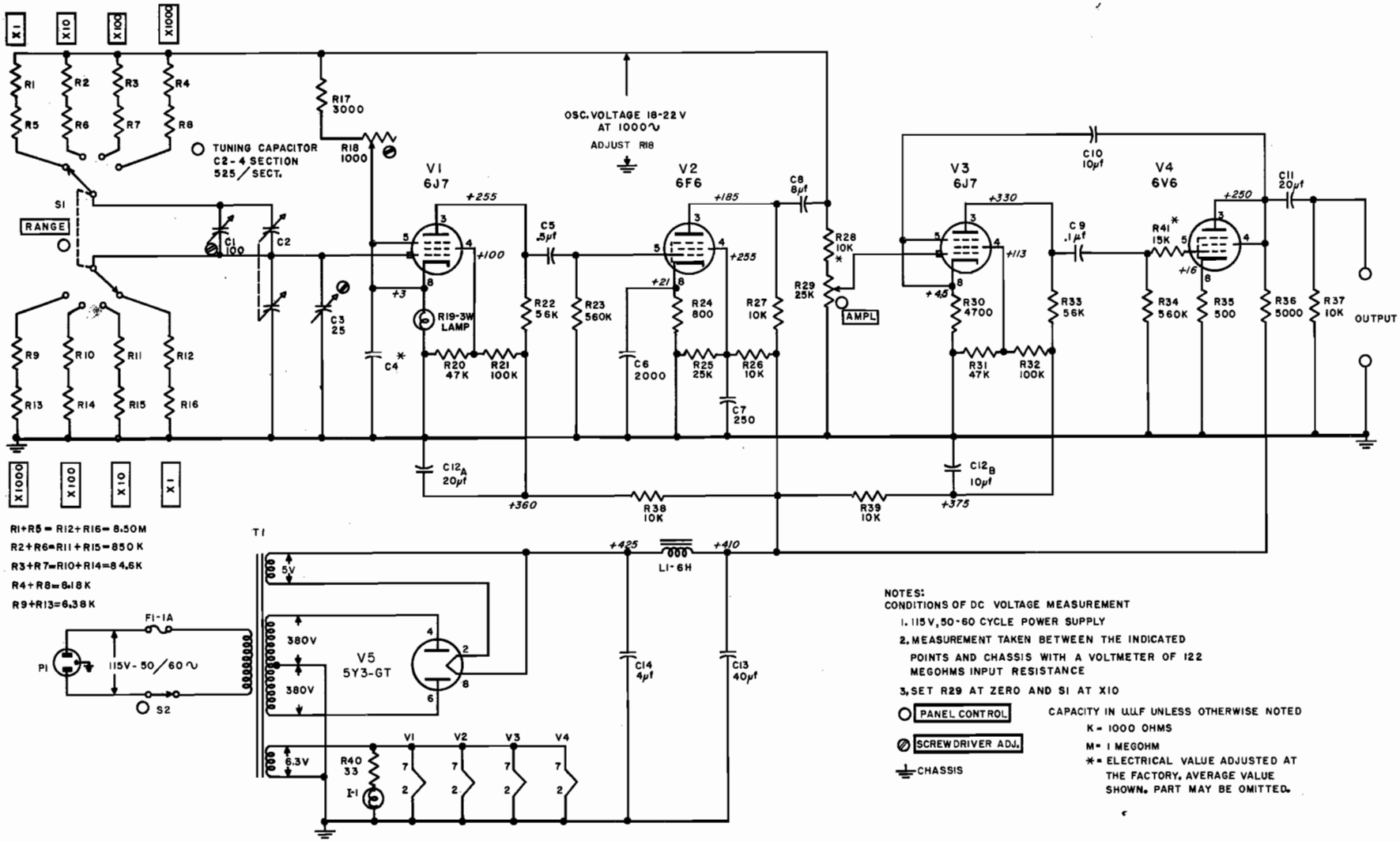
8. When the X10 range has been properly adjusted, the other ranges may be adjusted as follows:

a. X1000 range: Adjust the padding resistors in R4 plus R8 plus R13 bring 20 KC in at the proper point on the dial. A change in one padder of 100 ohms will change the frequency of the range by about 1/2%. If the extreme top of this band (200 KC) does not fall at the proper place on the dial, C4 may be changed. Increasing the value of this condenser will raise the frequency at the top of the band; decreasing the value will lower the frequency. Changes of from 25 to 50 μμfd are all that are usually required. If the X10 range has been properly adjusted, the X1000 range will now track properly.

b. X100 range: Adjust the padding resistors R3 plus R7 and R10 plus R14 to bring 2000 cycles in at the proper point on the dial. A change in one padder of 1000 ohms will change the frequency of the range by about 1/2%. If the X10 range has been properly adjusted, the X100 range will now track properly.

c. X1 range: Adjust the padding resistors in R1 plus R5 and R12 plus R16 to bring 100 cycles in at the proper point on the dial. A change in padders of 100,000 ohms will change the frequency by about 1/2%. There may be a small tracking error (less than 2%) at the top or bottom of the X1 band. This is normal to the instrument and cannot be eliminated.

9. Check calibration after the instrument is buttoned up.



SCHEMATIC DIAGRAM OF MODEL 200C - AUDIO OSCILLATOR

This circuit is basically correct, but small differences may exist for any particular instrument. Comparison and cross-checking will enable satisfactory identification of necessary parts.