Stock No. 154 Beat-Frequency Oscillator

ELECTRICAL CHARACTERISTICS

Frequency Range .... 30 to 15,000 cycles

Power Output .... 125 milliwatts

Voltage Output:

Load Impedance	Output Voltage
Open Circuit	37.5 volts
5,000 ohms	25.0 volts
500 ohms	7.5 volts
250 ohms	5.2 volts

Response Characteristics:

Load Impedance	* Output Variation 30—10,000 cycles	30—15,000 cycles
5,000 ohms ...	±1 db	+1, −2 db
500 or 250 ohms.	±1 db	+1, −3 db

* Volume control maximum.

Distortion .. Under 5% (r-m-s) over entire frequency range

Hum .. 60 db below maximum output (approximate)

Tube Complement:

Function	Type
R-F Oscillators	2 RCA-6J7
Detector	1 RCA-6C5
A-F Output Amplifier	1 RCA-6J5
Rectifier	1 RCA-5W4

Power Supply Requirements .. 110-120 volts, 50-60 cycles, 35 watts.

Protective Fuse Rating .... 1 ampere

MECHANICAL SPECIFICATIONS

Dial .. Full-vision type (approximately 8″ diameter)

Dimensions .... 13¾″ length x 9¼″ height x 6½″ depth, overall

Weight .... 15 pounds

Finish .... Baked lacquer, fine blue-gray wrinkle

IMPORTANT

Upon unpacking this instrument, remove the chassis from the case and inspect the tubes, grid-cap connections and fuse. The chassis may be withdrawn after removing the three screws in the back of the case. Replace the chassis and tighten the three screws before operating.

DESCRIPTION

The Stock No. 154 Beat-Frequency Oscillator is a portable, self-contained instrument for generating voltages in the audio-frequency range of 30 to 15,000 cycles. It operates entirely from an a-c source of 110-120 volts, 50-60 cycles and requires only 35 watts. Provision is made for calibrating against the power-supply frequency, which method affords exceptional accuracy and utmost convenience. No calibration meter or dial is employed, a neon lamp indicator serving to register synchronization with the supply frequency. At multiples or sub-multiples of the latter frequency, it is possible to check the oscillator frequency to better than one part in one hundred. The neon lamp also functions as a pilot lamp to indicate whether power is being applied to the instrument.

Another important feature is found in the output transformer, which enables optimum load matching between the oscillator output and the most frequently encountered impedances; namely, 5,000 ohms, 500 ohms and 250 ohms. This transformer is center-tapped for proper operation on balanced-to-ground lines. For unbalanced measurements, additional impedances of 1,250 ohms, 125 ohms and 62.5 ohms are obtainable from the center tap to either side of each winding.

Although adaptable to a wide variety of applications, this instrument is especially useful in measuring the fidelity of radio receivers, the frequency response of audio amplifiers, the frequency characteristics of audio transformers and filters, and the modulation characteristics of amateur transmitters. It also may be used to advantage in determining frequencies and mechanical speeds. Such applications and the respective methods of use are described under the section entitled "Applications."

CALIBRATION

Insert the power cord into an electrical outlet supplying power at the proper voltage and frequency (110-120 volts, 50-60 cycles). Turn the "POWER" switch to "ON" and the "INDICATOR" switch to "USE." The neon lamp should now be observed to glow, denoting that power is being applied.

Although the oscillator will be operative after the tubes are heated, which requires approximately one minute, a much longer delay is recommended to insure proper stability. Stable operation is possible, as in any equipment of this nature, only after the component parts of the unit have reached a steady operating temperature. The time to attain this condition will vary, depending upon the ambient temperature of the room, and may be from one-quarter to one-half hour.

It is necessary that the calibration of the oscillator be checked and adjusted as required before each operating period. To calibrate, turn the "INDICATOR" switch to "CAL." and advance the "OUTPUT" control to its maximum clockwise position. Set the main tuning control to the frequency of the power supply and rotate the "CAL. ADJ." knob back and forth until a point is found where the neon lamp ceases to glow. *This setting is used as a reference position only.* Now turn the "CAL. ADJ." knob slowly clockwise from this reference position, observing the action of the neon lamp. Normally, the lamp will flicker slowly at first, then will speed up and finally slow down to a very few brilliant flashes per second with both plates of the lamp glowing at simultaneous intervals. The proper setting is that where flashing occurs at a minimum rate and will be found approximately 1/16 inch from the *reference* position, as measured at the outer circle of the scale.

To check this calibration, advance the main tuning control to a setting corresponding to twice the power-supply frequency. The neon lamp should glow steadily, but the plates of the lamp should start to flash alternately (first one plate and then the other) upon moving the main tuning control slightly above or slightly below this setting if the calibration is correct. These flashes will not be as bright as for the calibration (fundamental supply frequency) position. The "OUTPUT" control should be reduced during this check.

A cathode-ray oscillograph, such as the RCA Stock No. 9545 (Type TMV-122-B) or the RCA Stock No. 151, may be employed to advantage in calibrating this beat-frequency oscillator. Connect the 5,000-ohm terminals of the oscillator to the vertical input terminals of the oscillograph. Using the Stock No. 9545 oscillograph, set the synchronizing switch to the central (60-cycle) position and adjust the sweep oscillator to 60 cycles; with the Stock No. 151 oscillograph, it will be necessary to connect an external 60-cycle source (approximately, 2 volts r. m. s.) to the "HORIZ." and "GND." binding posts and adjust the sweep oscillator to 60 cycles. Set the main tuning control of the oscillator to the power-supply frequency and rotate the "CAL. ADJ." knob back and forth until a point is found where the oscillographic trace appears as a straight horizontal line. *This setting is used as a reference position only.* Now turn the "CAL. ADJ." knob slowly clockwise until a single cycle of a sine wave appears on the oscillograph screen. The proper setting should occur at approximately 1/16 inch from the *reference* position, as measured at the outer circle of the scale.

To check this calibration, advance the main tuning control to a setting corresponding to twice the power-supply frequency. Two cycles of the sine wave should be observed on the oscillograph screen at this setting if the calibration is correct.

> NOTE: It is possible to obtain an indication of correct calibration when the "CAL. ADJ." knob is turned *counterclockwise* from the reference position. Such an adjustment is erroneous as will be revealed by the check at twice the power-supply frequency since the neon lamp will cease to glow. If the cathode-ray oscillograph is being employed, the trace will appear as a straight horizontal line.

When correctly calibrated, the frequency will increase upon turning the main tuning control clockwise from the 30-cycle mark. Incorrect calibration will be evidenced by a condition of decreasing frequency from the 30-cycle mark to a dial setting of twice the power-supply frequency beyond which the frequency increases. *The latter is to be avoided.* With a little practice, the correct calibration point will be readily distinguished. A pair of headphones connected across the 5,000-ohm terminals may be used to listen to the signal while becoming familiar with the calibration process.

After calibrating, the "INDICATOR" switch should be turned to the "USE" position, which renders the oscillator ready for operation.

EXTENDED RANGE

This beat-frequency oscillator may be used to produce frequencies below 30 cycles by calibrating with the main tuning control set 20 cycles higher than the power-supply frequency. When so operated, all frequencies below that point will be 20 cycles less than the scale reading.

CONNECTIONS

In connecting the oscillator to the apparatus under test, select that pair of output terminals whose marking (5,000, 500, or 250) is comparable to the load impedance. It is desirable that the load impedance shall be equal to that of the instrument, but if an exact match cannot be obtained, use the terminals of next *lower* impedance than the load.

The output transformer of this oscillator is center-tapped for use with lines or circuits which are balanced to ground. Since the center tap is not grounded, it will be advisable, in the event that hum is encountered, to try various grounding combinations—that is, from the case of the instrument or center-tap, or both, to the grounded side of the device being tested. If, in the latter equipment, one side of the input circuit is grounded, the oscillator output center-tap should be left ungrounded unless it is employed for connection to the ground side. On balanced input lines, where the center-tap of the device under test is grounded, best results usually will be obtained by connecting the center-tap of the oscillator to the same ground point as the former.

Shielded and twisted leads ordinarily are advantageous when protection against hum pickup is necessary, or when the leads must be run over a considerable distance from the oscillator.

APPLICATIONS

Several general applications in which this beat-frequency oscillator can be employed are outlined below. Figures 2 to 6 show methods of connection and means of measurement for these applications. The two meters used for audio-frequency measurements may be vacuum-tube voltmeters or rectifier-type a-c meters capable of measuring high audio frequencies. The same type meters should be used in each position for greatest accuracy.

RADIO RECEIVER FIDELITY CHARACTERISTICS

The over-all electrical fidelity characteristic of a radio receiver may be determined by applying a modulated r-f signal to the antenna stage and measuring the output voltage (at various modulating frequencies) across the loudspeaker voice coil.

Connect the 250-ohm output terminals of the beat-frequency oscillator to an r-f test oscillator which is capable of being externally modulated. The RCA Stock No. 153 Test Oscillator has a jack provided for this purpose. Connect the output terminals of the test oscillator to the antenna and ground terminals of the receiver under test. Turn the receiver volume control to its *minimum* position. Connect a suitable a-f voltmeter. across the 250-ohm terminals of the beat-frequency oscillator and another similar meter across the loudspeaker voice coil. The arrangement is shown by Figure 2.

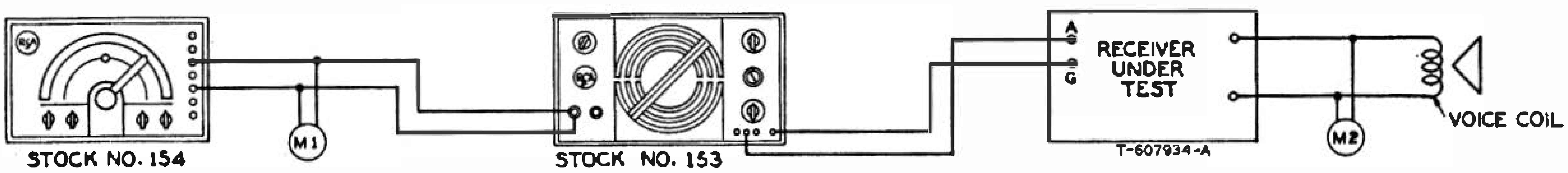

Figure 2—Connections for Radio Receiver Fidelity Measurements

Set the test oscillator to 1,000 kc and adjust its output to deliver approximately 2 millivolts into the receiver antenna stage. With the Stock No. 153 Test Oscillator, this output will be obtained using the "LOW" output terminal and setting the "OUTPUT" control approximately at "1." Set the beat-frequency oscillator to a frequency between 3,500 and 5,000 cycles to give best indication on the meter as explained below, and adjust its output to 1.5 volts (required for 30% modulation of the Stock No. 153 Test Oscillator). Tune the radio receiver to the 1,000-kc signal and advance its volume control until the meter across the voice coil shows an observable indication. Tune the receiver back and forth through the signal, noting that two peaks will be observed on the meter. These peaks indicate the side-band responses. The receiver then should be carefully tuned to the lowest meter reading between the peaks, at which point it will be precisely tuned to the test-oscillator frequency. Now, shift the audio-frequency to 400 cycles, maintaining the oscillator output at 1.5 volts. Adjust the receiver volume control until the power delivered to the loudspeaker voice coil is 0.1 watt. Knowing the voice-coil impedance, the voltage (E) required across the voice coil to obtain this power may be calculated by the formula:

$$E = \sqrt{WZ} \qquad (1)$$

where W is the desired output in watts and Z is the impedance of the voice coil in ohms.

Example: If the desired output is 0.1 watt and the voice-coil impedance is 3 ohms, the voltage (E) would be:

$$\sqrt{0.1 \times 3} = \sqrt{0.3} = 0.55 \text{ volt.}$$

By rearranging the above formula (1), the power (W) in watts delivered to the voice coil may be derived as follows:

$$W = \frac{E^2}{Z} \qquad (2)$$

and using the same values as above, the power (W) would be:

$$\frac{0.55^2}{3} = \frac{0.3}{3} = 0.1 \text{ watt.}$$

After setting the volume control to obtain the specified output at 400 cycles, vary the beat-oscillator frequency through the desired audio range, keeping the oscillator output at 1.5 volts, and record the variations of the voltage across the loudspeaker voice coil.

AUDIO AMPLIFIER FREQUENCY RESPONSE

In measuring the frequency response of an audio amplifier, the test procedure is generally the same as for the fidelity of a radio receiver except that no r-f test oscillator is used. Figure 3 shows the general arrangement. The output of the beat-frequency oscillator may be fed directly into the input of the audio amplifier, or, when the input voltage required for the amplifier is so low that it is practically impossible to measure it with an ordinary voltmeter, an attenuator should be used. This will establish a definite ratio between the output voltage of the beat-frequency oscillator and the input voltage fed to the amplifier.

Normally, either of two types of attenuators may be used, and each type has its particular advantage. If one side of the amplifier input is grounded, the arrangement shown at the left may be used. The value of $R_1 + R_2$ should be equal to or greater than the impedance across the output terminals of the beat-frequency oscillator to which they are connected (i. e., 250 ohms total for 250-ohm taps, 500 ohms

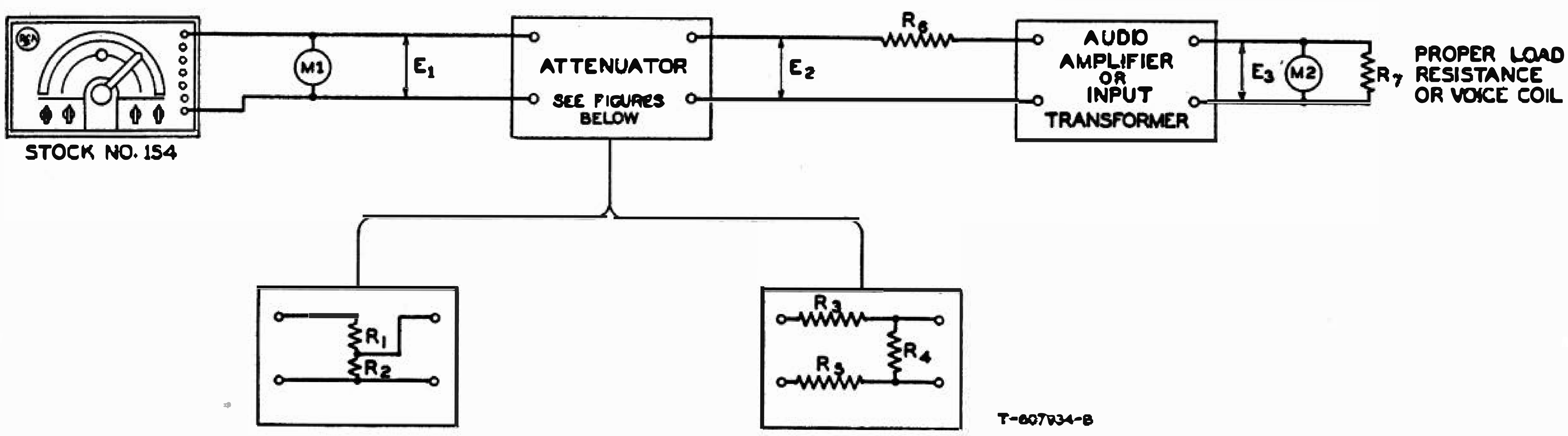

Figure 3—Connections for Measurement of Audio Amplifier Frequency Response

total for 500-ohm taps, or 5,000 ohms total for 5,000-ohm taps). The ratio of resistance R_2 to the total resistance $(R_1 + R_2)$ will determine the voltage (E_2) which is applied to the amplifier when the oscillator output voltage (E_1) is known. Resistance R_2 always should be less than one-twentieth of the input impedance of the amplifier.

Example: Assume the input voltage (E_2) to an audio amplifier for rated output is 0.1 volt. Using the 5,000-ohm terminals of the oscillator, $R_1 + R_2$ should be 5,000 ohms. A convenient value of output for these terminals is 10 volts. The voltage ratio between the output of the oscillator and the input of the amplifier will then be 100 to 1. Resistance R_2, therefore, should be $R_1 + R_2/100$ or 50 ohms, and resistance R_1 should be 5,000—50 or 4,950 ohms. This example is given as a guide for calculating the values of resistance needed. Any combination of resistance values may be worked out to give the required input voltage.

The voltage gain of an amplifier is the ratio of the output voltage to the input voltage. Using the attenuator, in which the values of R_1 and R_2 are known, the gain (G) may be calculated from the readings of the two meters in the circuits of Figure 3 by the formula:

$$G = \frac{E_3}{E_1} \times \frac{R_1 + R_2}{R_2} = \frac{E_3 (R_1 + R_2)}{E_1 R_2} \qquad (3)$$

NOTE: In this formula, the matching impedances (R_6 and R_8) are not considered, and the result is therefore only approximate.

Example: Assuming E_3 to be 5 volts and using the constants in the above example, the gain would be:

$$\frac{5\ (4{,}950 + 50)}{10 \times 50} = \frac{5 \times 5{,}000}{500} = 50$$

When the input circuit to the amplifier is balanced-to-ground, the attenuator shown at the right should be used. The values of R_3 and R_5 should be equal, and for the calculations above, $R_3 + R_5$ should be equal to R_1, so that the ratio of R_4 to the total resistance $(R_3 + R_4 + R_5)$ is the same as the ratio of R_2 to the total resistance $(R_1 + R_2)$.

The value of the resistance feeding the input of the amplifier (R_2 as shown at left, or R_4 as shown at right) should always be less than one-twentieth the value of the input impedance of the amplifier. The amplifier input may consist of a transformer, resistor, or tube load.

When an input transformer is incorporated in the amplifier, a resistance (R_6), equal to the input impedance of the amplifier, should be placed in series with the amplifier input to provide proper impedance matching. The output of the audio amplifier should be connected to the speaker voice coil, or to an equivalent load resistor (R_7). The decrease in the output load impedance caused by the meter should be taken into consideration for best accuracy.

AUDIO TRANSFORMERS AND FILTER CHARACTERISTICS

The arrangement of Figure 3 for audio amplifiers also is applicable to input transformers. In such cases, the value of resistance (R_6) should be equal to the input impedance of the transformer, and the load on the secondary should be equal to the load into which it works. Where it connects directly to a tube, a vacuum-tube voltmeter will approximate the tube load and will be the only loading required. Normally, the step-up ratio is high, and an attenuator should be used. Calculations for gain will be the same as for amplifiers.

For audio interstage and output transformers (except push-pull), it may be necessary to pass current through the primary winding, using a battery as shown in Figure 4. The battery voltage should be

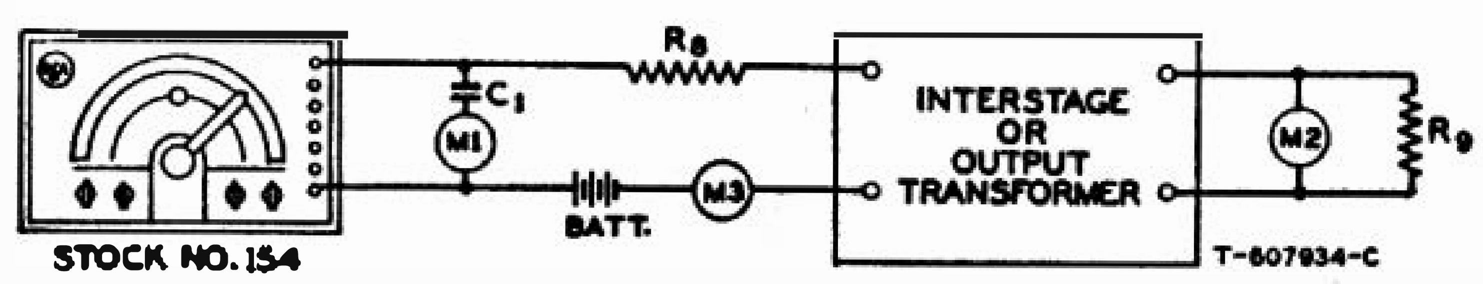

Figure 4—Audio Transformer Test Connections

such that the current is equivalent to the normal current under operating conditions. This current is measured by a d-c milliammeter (M-3) inserted in series with the primary. Resistance R_8 should be equal to the plate impedance of the tube from which the transformer works, and resistance R_9 should be equivalent to the secondary loading (normally, the capacity between tube elements). A vacuum-tube voltmeter will approximate this load and must be used in cases where resistance R_9 is high. Any special loading on either the primary or the secondary should be duplicated if the performance in a particular circuit is to be measured. A capacitor (C_1) should be connected in series with the meter (M-1) to block out the d-c current which would otherwise introduce error. The battery polarity should be such as to give the highest reading on meter M-1 at 30 cycles. For interstage transformers, the 250-ohm terminals on the oscillator should be used; for output transformers the 5,000-ohm terminals should be used.

For filters, the resistances R_8 and R_9 should be equal respectively to the characteristic impedances of the input and output circuits of the filter, or the impedances which the filter works from and into. Where resistance R_9 is high, meter M-2 should be a vacuum-tube voltmeter. For lower impedance values, the resultant resistance of M-2 and R_9 in parallel must be equal to the output impedance of the filter.

For transformers having push-pull primaries, resistance R_8 should be equal to the sum of the plate resistances of the tubes from which the transformer works and the total primary connected to the circuit. When the transformer has a push-pull secondary, the voltmeter and load should be connected across the total winding.

For output transformers (not push-pull) resistance R_9 should be equal to the voice-coil impedance of the speaker for which it was designed.

AMATEUR TRANSMITTER MODULATION CHARACTERISTICS

When taking the modulation characteristics of an amateur transmitter, some type of modulation indicator is necessary. The most convenient device for this purpose is a cathode-ray oscillograph such as the RCA Stock No. 9545 (Type TMV-122-B), or the RCA Stock No. 151. Connect the beat-frequency oscillator to the transmitter microphone transformer (one 5,000-ohm terminal to high side, and center-tap to transmitter ground) as indicated in Figure 5. Also, connect the oscillator as shown to the oscillograph, using the "EXT. SYNC." terminals of the Stock No. 9545, or the "HORIZ." and "GND." terminals of the Stock No. 151. Place a pickup coil near the output of the power amplifier stage of the transmitter and connect it to the vertical input of the oscillograph.

The audio voltage from the beat-frequency oscillator should then be held constant to give the desired percentage modulation at a given audio frequency, normally 1,000 cycles. The sweep-frequency oscillator in the oscillograph should be adjusted to give approximately three patterns on the screen. Data is then taken on the deviation in percentage modulation with variation in audio frequency. The procedure for measuring the percentage modulation is fully covered in the instructions on each oscillograph.

FREQUENCY MEASUREMENTS

Frequencies from a few cycles up to 150 kilocycles may be measured with this instrument in conjunction with a cathode-ray oscillograph. This information is completely explained in the instruction books for the RCA Stock No. 9545 and Stock No. 151 Oscillographs.

STROBOSCOPIC SPEED MEASUREMENTS

The speed of rotating shafts, motors, etc., may be readily measured with this instrument, using an arrangement as shown in Figure 6. A stroboscopic disc, consisting of alternate and equally divided black and white spaces, should be placed on the rotating member. The number of black spaces required will vary inversely with the speed, and can be readily chosen by trial in the formula for speed (S):

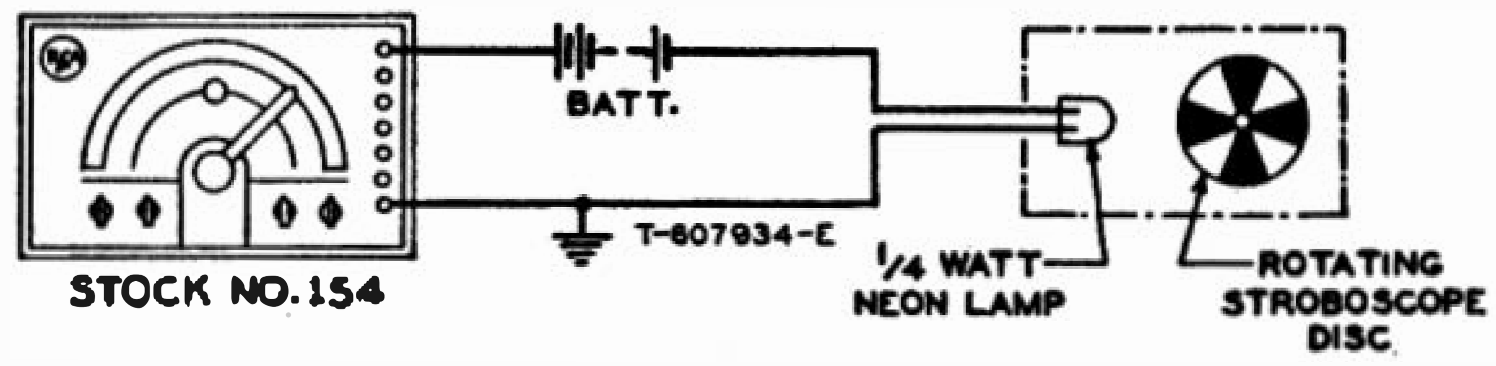

Figure 6—Speed Test Connections

$$S = \frac{60 \times f}{n} \text{ r.p.m.} \qquad (4)$$

where f = frequency in cycles,
n = number of black sections.

Example: If n = 4 sections and f = 60 cycles, the speed (S) would be:

$$\frac{60 \times 60}{4} = 900 \text{ r.p.m.}$$

The additional equipment required for these measurements is a battery of about 45 volts and a ¼-watt neon lamp. The neon lamp should be held close to the disc and the frequency of the oscillator varied until the segments appear motionless and normal in width.

In some cases, more than 45 volts may be used. This can best be determined by turning the oscillator output control to its minimum position and connecting enough battery so that the neon lamp just glows. Then reduce this battery potential by approximately 10 volts and the desired results are obtained.

When the rotating members are wheels, with spokes or gears, this can be done directly if the teeth or spokes are painted white. Then the number of spokes or teeth is "n" in the formula.

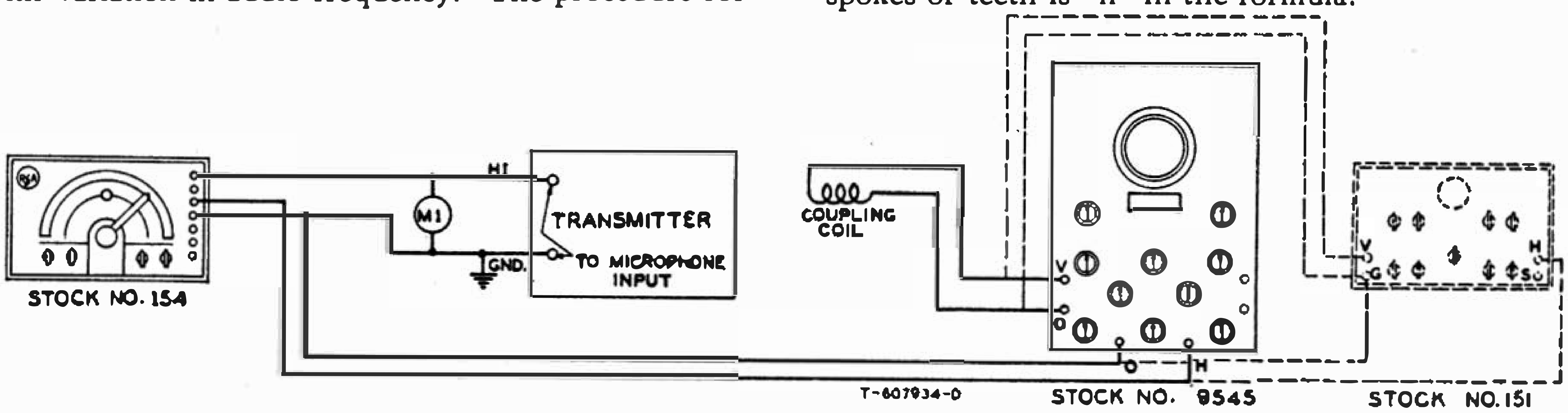

Figure 5—Connections for Measurement of Modulation Characteristics

CIRCUITS

Schematic and wiring diagrams for the Stock No. 154 Beat-Frequency Oscillator are shown in Figures 7 and 10, respectively. The instrument relies for operation upon the heterodyne or beat-frequency principle, incorporating two r-f oscillators—one fixed and the other variable. The outputs of these oscillators are combined in a heterodyne detector to produce the desired audio frequency, which signal is amplified and fed to a load-matching output transformer.

The fixed r-f oscillator stage, consisting of a self-biased RCA-6J7 tube and its associated circuit elements, oscillates at a frequency of 350 kc; the second and third grids of this tube operate as the oscillator plate. The plate (termed "work plate") is electron coupled to the oscillation-generating portion of the tube and feeds into the primary of the i-f transformer. The secondary of this i-f transformer is connected in series with the cathode of the self-biased RCA-6C5 detector tube, which provides detector-cathode modulation at the frequency of the fixed oscillator.

The variable r-f oscillator stage utilizes a circuit similar to that of the fixed oscillator, except that the main tuning control (C-12) is connected across coil L-6 and provides the required variation of capacitance to change the frequency from 30 to 15,000 cycles below that of the fixed oscillator. The electron-coupled work plate is resistance-capacitance coupled to the grid of the RCA-6C5 detector tube. This provides detector-grid modulation at the frequency of the variable oscillator.

Use of electron coupling in each oscillator circuit provides good stability and effectually prevents external circuit effects reflecting to the oscillator circuits, which would otherwise have a tendency to cause frequency drift, instability, and non-uniform output.

The two r-f oscillator signals entering the detector, one at the cathode circuit and the other at the grid circuit, are thus combined to produce the desired audible (beat) frequency. The detector output is fed to the control grid of the RCA-6J5 fixed-bias amplifier through a two-stage r-f filter. This filter allows only the detected audio voltage to be applied to the amplifier grid. The output control (R-11) is connected in the grid circuit of the amplifier stage, and allows continuous control of the output voltage. The output of the amplifier stage is then fed into a statically-shielded output transformer. This transformer is designed to work into loads of 250, 500, or 5,000 ohms. A center-tap is provided so that lines or circuits of these impedances may be balanced to ground.

The power supply consists of an RCA-5W4 full-wave rectifier working into a capacitor-input filter circuit. The output of this filter circuit supplies the d-c voltages required for the various circuits of the apparatus.

A neon lamp is incorporated for use either as a pilot lamp or as a calibration indicator, depending on the position of the "INDICATOR" switch. In the "CAL." position, a portion of the a-c voltage from

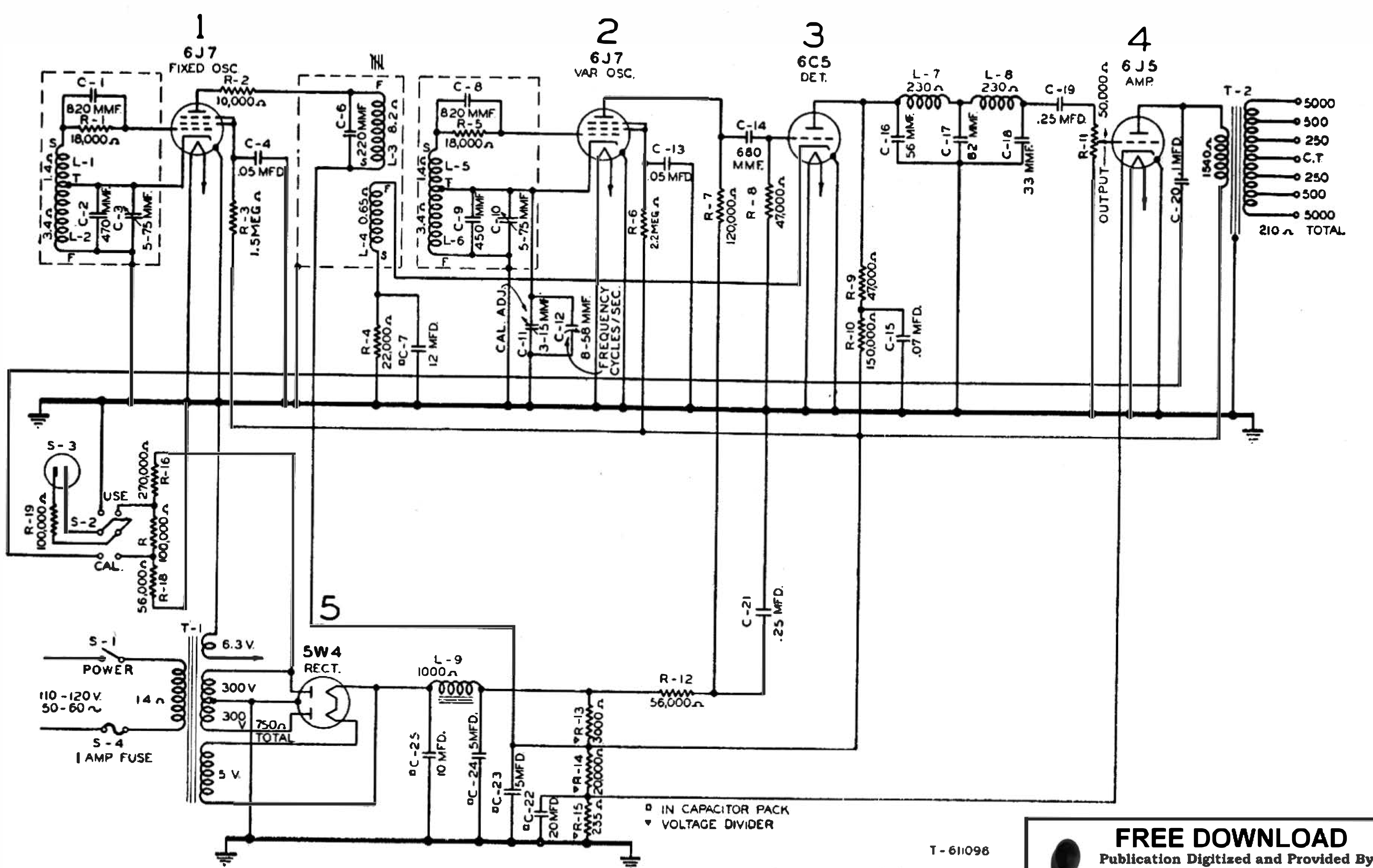

Figure 7—Schematic Circuit Diagram

the high-voltage winding of the power transformer is impressed on one plate of the neon lamp from the junction of resistors R-17 and R-18 through a 100,000-ohm resistor (R-19). The other plate of the neon lamp is connected through capacitor C-20 to the output of the RCA-6J5 amplifier. Proper calibration is indicated when the two frequencies applied to the neon lamp are the same. The lamp will then remain lighted continuously or remain out continuously, depending on the phase relation of the applied voltages. When the frequencies are nearly the same, both plates of the lamp will flash together at the difference frequency. In the "USE" position, the neon lamp is connected from the junction of resistors R-16 and R-17 to ground and acts as a pilot lamp. A small air condenser (C-11) is connected in parallel with the main tuning control to change the frequency of the variable oscillator for setting the calibration point.

MAINTENANCE

Caution: Disconnect the power supply before removing the instrument case to replace tubes or make service adjustments.

TUBE SOCKET VOLTAGES

Operating conditions of the basic circuits of this instrument may be determined by measuring the voltages applied to the tube elements. Figure 8 shows the voltage values from the socket contacts to ground,

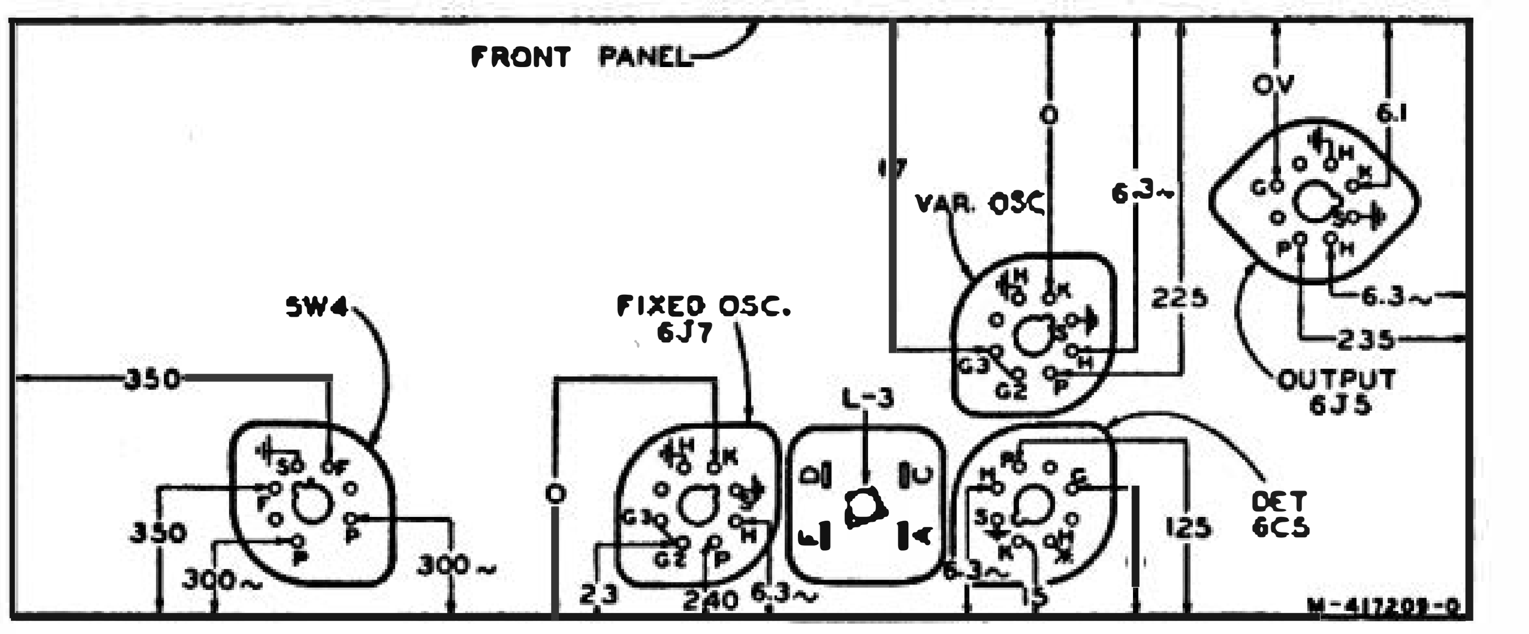

Figure 8—Tube Socket Voltage Diagram

while Figure 9 shows the oscillator grid voltages as measured to chassis ground. Each value as specified should hold within ±20% when the instrument is normally operative with all tubes intact and rated

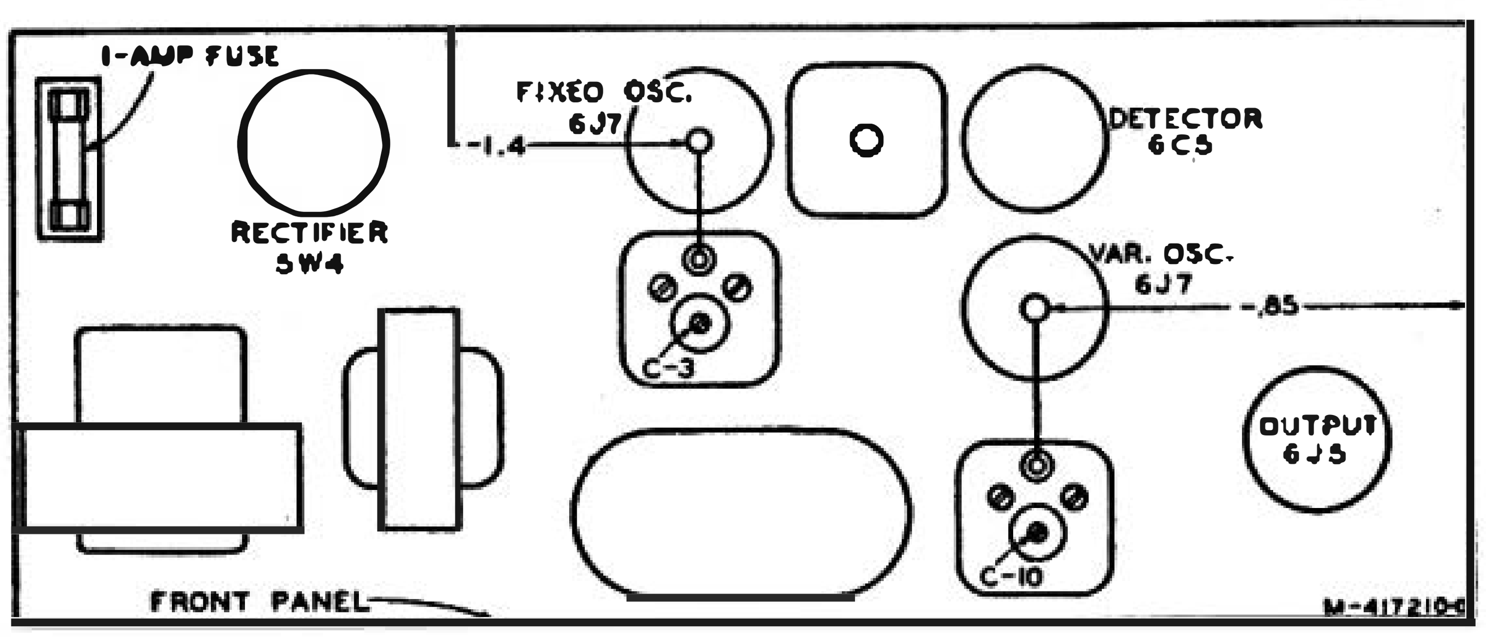

Figure 9—Chassis Layout Diagram

voltage applied. Variations in excess of this limit will usually be indicative of trouble.

The voltages given on these diagrams are actual measured values and are the results obtained after the loading of the circuit (by the voltmeter) has taken place. To fulfill the conditions under which these voltages were measured requires a 20,000-ohm-per-volt, a-c/d-c voltmeter having ranges of 10, 50, 100 and 500 volts. Use the nearest range above the voltage to be measured.

FUSE

A small 1-ampere cartridge fuse is employed to protect the power-supply system, and is located adjacent to the RCA-5W4 rectifier tube on the top side of the chassis. In the event of failure, this fuse should not be short-circuited or replaced by one of a higher rating. Fuse failures should be carefully investigated before replacement, since a fuse of good quality will fail only under conditions of overload. The fuse clips should be kept clean and in secure contact with the fuse at all times.

RESISTANCE AND CONTINUITY

The various diagrams given in this booklet contain such information as will be needed to locate causes for defective operation if such develops. The values of the various resistors, capacitors, and inductances are indicated adjacent to the symbols signifying these parts on the diagrams. Identification titles, such as R-3, L-2, C-1, etc., are provided for reference between the illustrations and the Replacement Parts List. These identifications, in general, progress in numerical order from left to right on the schematic diagram, and thus are readily located.

The coils, reactors, and transformer windings are rated in terms of their d-c resistance. This method of rating provides a ready means for checking the continuity of circuits. Suspected faulty circuits or parts may be checked and their resistances compared with the values given on the schematic diagram. Failure of operation may result from:

(1) Power supply being "off."
(2) Open fuse within the instrument.
(3) Defective tubes.
(4) Defects within the instrument itself.

R-F ALIGNMENT

Correct alignment of both oscillator circuits is necessary for proper frequency calibration, and correct adjustment of the i-f transformer primary trimmer is essential for proper output. All of these circuits should be properly adjusted every six months,

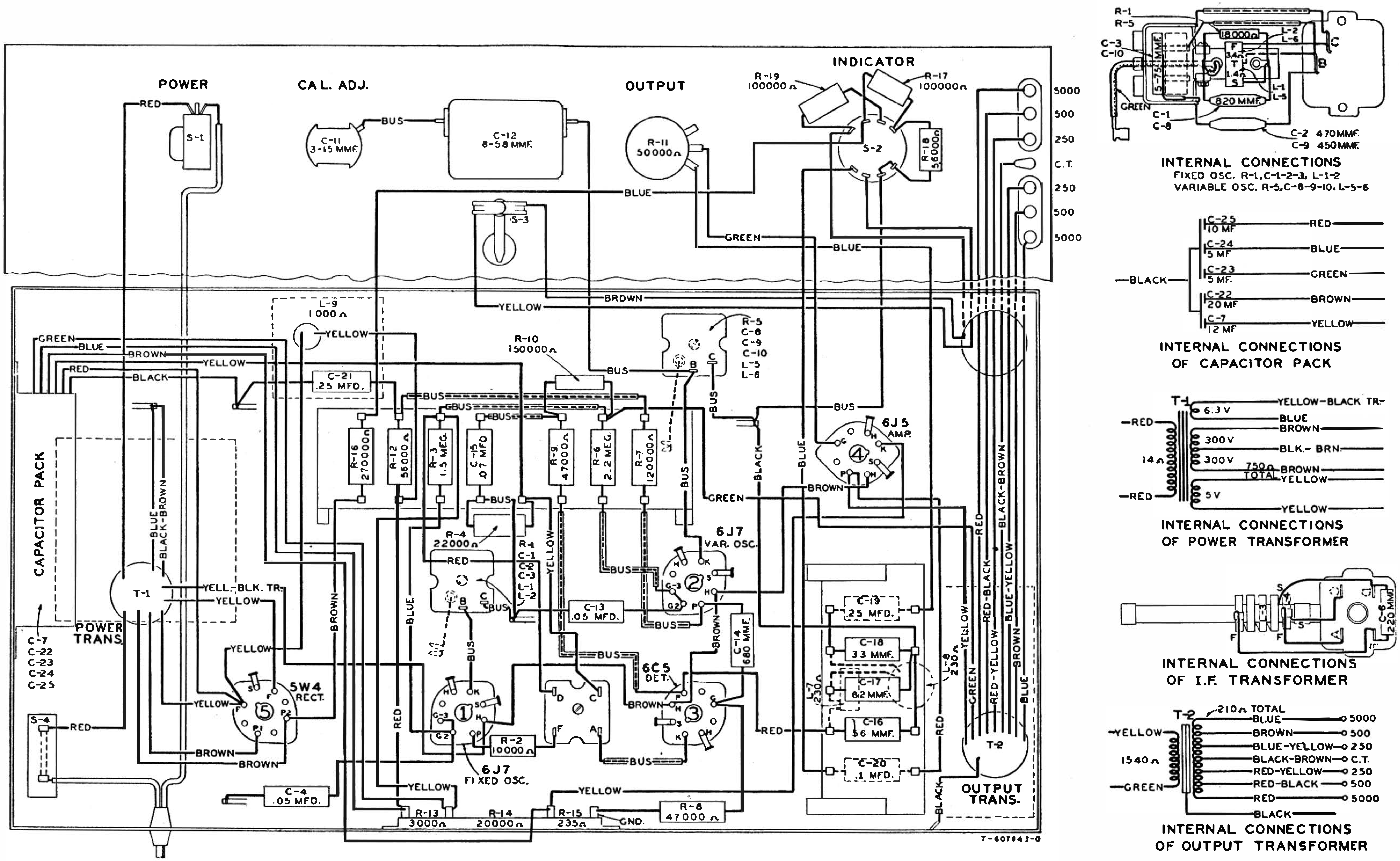

Figure 10—Chassis Connection Diagram

or immediately after any repairs or replacements have been made which affect the oscillator circuits. If either or both of the RCA-6J7 oscillator tubes have been interchanged or replaced, these circuits should be aligned since correct alignment depends on the tube characteristics. Adherence to these points will assure continued accuracy of calibration and output. Proceed as follows:

Remove the instrument from its case. Make sure that the two oscillator shields are securely mounted on the chassis and that all tubes make good contact with their socket terminals. Reset the control knobs, as explained below, if necessary.

Fixed Oscillator.—Place the instrument in operation, setting the "POWER" and "INDICATOR" switches respectively to the "ON" and "USE" positions, the "OUTPUT" control to its *maximum*

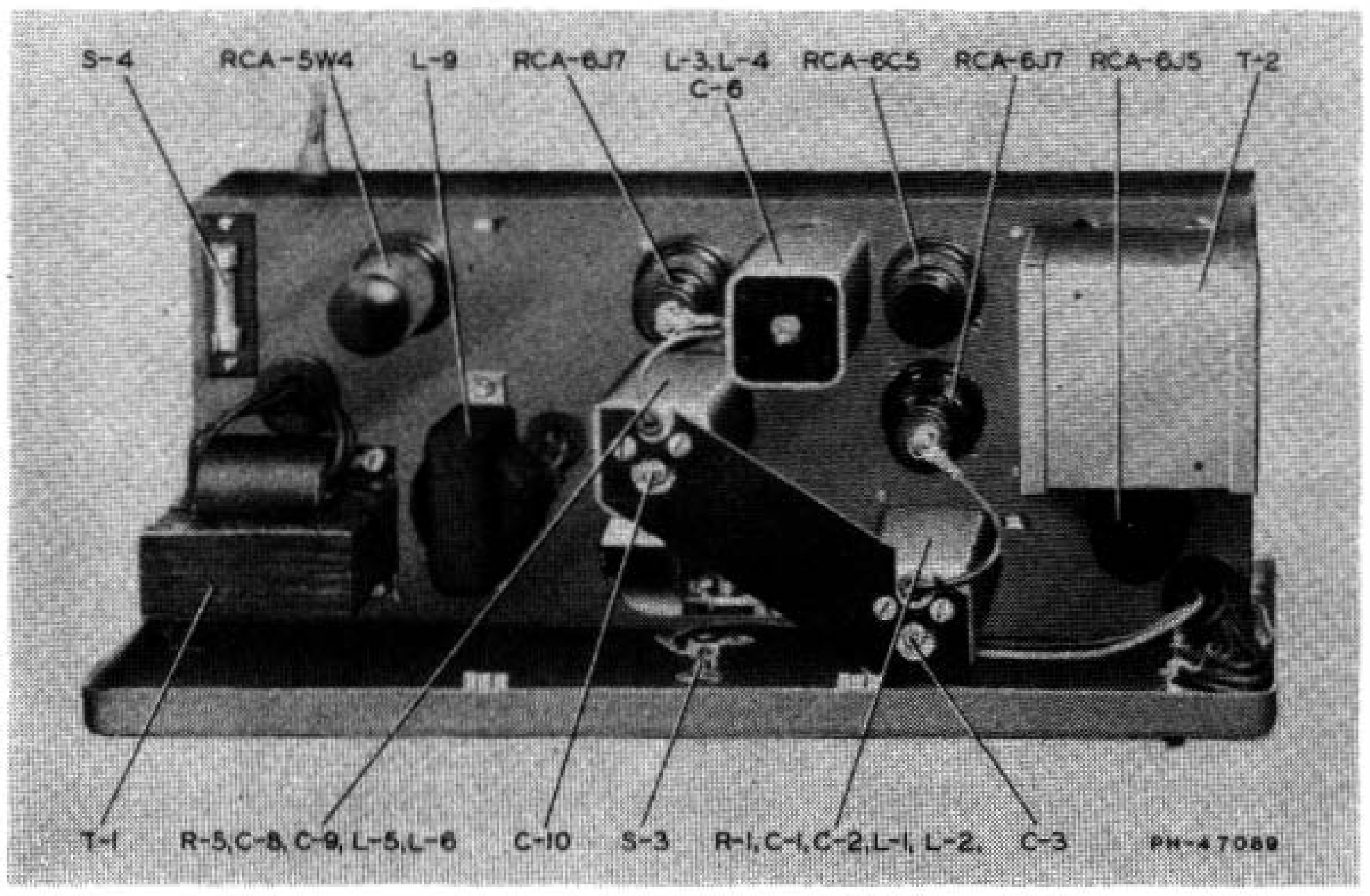

Figure 11—Top View of Chassis

(clockwise) position, and the main tuning control to its 15,000-cycle position. Tune in a radio receiver accurately to 700 kc—either to a broadcast station or to an RCA Stock No. 9572 Piezo-Electric Calibrator. The latter calibrator should be connected for d-c plate operation using at least $22\frac{1}{2}$ volts. With the calibrator output switch at the "LO" position, the seventh harmonic will be a 700-kc signal. Place a lead about two inches away from the grid lead of the fixed oscillator tube and connect the other end of this lead to the antenna terminal on the receiver, leaving the receiver antenna connected.

These operations will feed two signals into the receiver: (1) The broadcast station carrier or the calibrator frequency, and (2) the fixed oscillator frequency from the beat-frequency oscillator. The second harmonic of the fixed oscillator will be used for indication, since its fundamental is 350 kc. Adjust trimmer C-3 of the fixed oscillator (see Figure 11 for location) until zero beat is heard in the receiver loudspeaker, indicating that the fixed oscillator is correctly tuned to 350 kc. Disconnect the lead to the receiver antenna connection.

Variable Oscillator.—After proper alignment of the fixed oscillator, as explained above, set the main tuning control to its 30-cycle position. Set the "CAL. ADJ." pointer to its vertical position and place the "INDICATOR" switch to "CAL.," leaving the "OUTPUT" control set at maximum. Adjust trimmer C-10 of the variable oscillator (see Figure 11 for location) until zero beat occurs between the two oscillators. This point will be indicated when the neon lamp goes out entirely. A pair of headphones may be connected across the 5,000-ohm output terminals to obtain the same indication of zero beat. The oscillators are now properly aligned, but the "CAL. ADJ." setting is not correct for operation and must be adjusted as described under "Calibration."

POINTER ADJUSTMENTS

The main tuning control pointer should coincide exactly with the 15,000-cycle mark when the variable capacitor is set to the position for maximum capacity. If, for any reason, this pointer does not stop at this position, remove the bakelite knob by loosening its set screw and loosen the two sets screws in the collar to which the main pointer is attached. Turn the capacitor shaft clockwise until the capacitor plates are in their full-mesh (maximum-capacity) position. Set the pointer of the main tuning control exactly on the 15,000-cycle mark and tighten the set screws, making sure that neither the shaft nor the pointer shifts as these screws are tightened; then replace the bakelite tuning knob. This setting must be exact for accurate frequency calibration.

The pointers on the "CAL. ADJ." and "OUTPUT" knobs should be in a vertical position when the controls are set midway between their stops. These knobs may be reset by loosening their set screws and resetting the knobs to their correct positions.

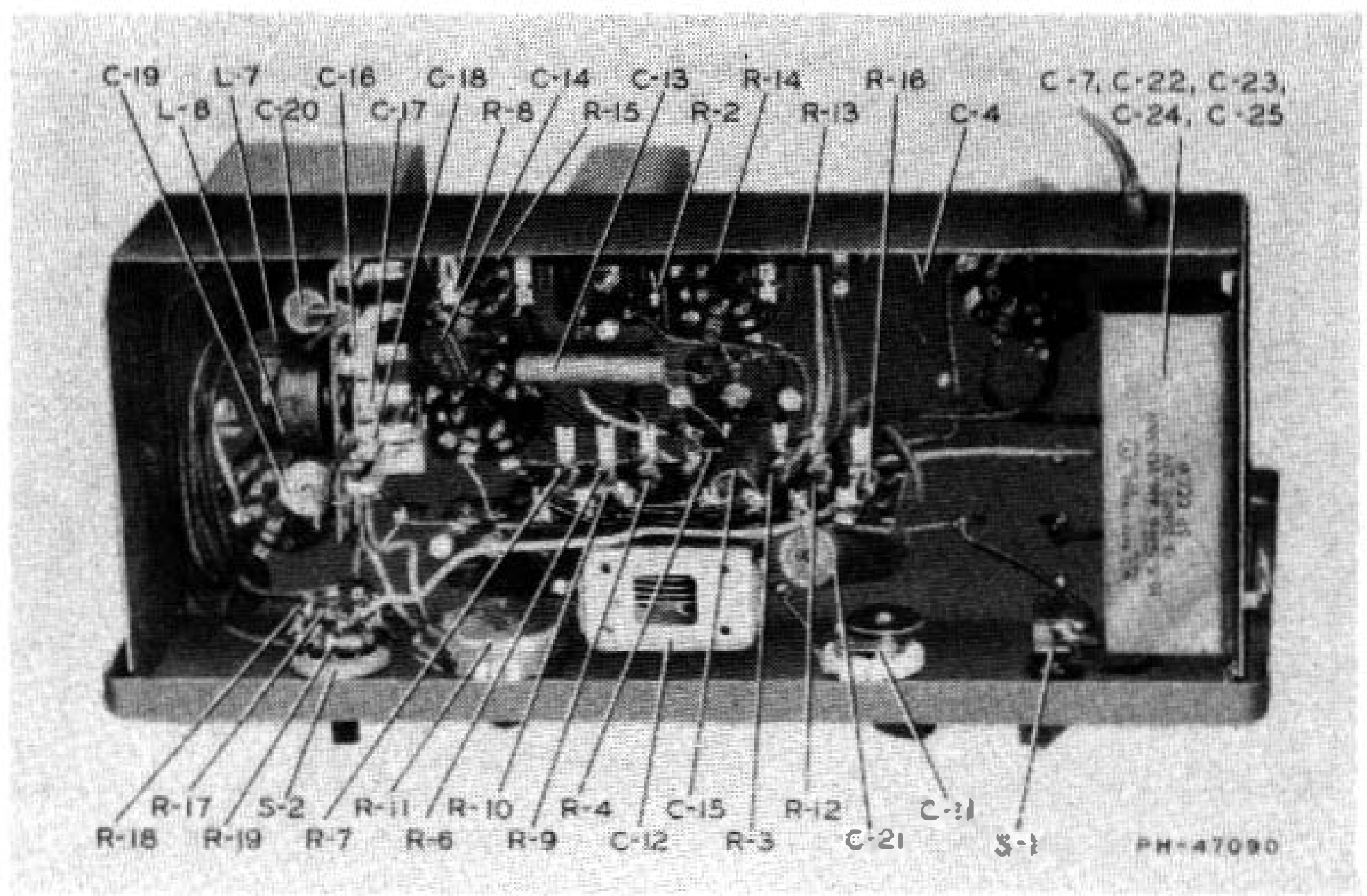

Figure 12—Bottom View of Chassis

OUTPUT CALIBRATION

Connect a 0–30 volt, a-c meter (equivalent load 5,000 ohms) across the two output terminals marked "5000." If a 1,000-ohm-per-volt meter is used, connect a carbon resistor of approximately 6,000 ohms in parallel with the meter to obtain the equivalent. 5,000-ohm load. Calibrate the instrument properly, as described under "Calibration." Place the "INDICATOR" switch at "USE" and advance the "OUTPUT" control to maximum. Set the main tuning control to its 1,000-cycle position. Adjust the magnetite core (L-3) on the i-f transformer (see Figure 11 for location) for maximum output.

REPLACEMENT PARTS

Insist on genuine factory-tested parts, which are readily identified and may be purchased from authorized dealers.

STOCK No.	DESCRIPTION	
12348	Capacitor—Calibration adjustment capacitor, 3-15 mmfd. (C-11)	
31330	Capacitor—Air trimmer capacitor, 5-75 mmfd. (C-3, C-10)	
31333	Capacitor—Variable tuning capacitor, 8-58 mmfd. (C-12)	
12948	Capacitor—Moulded toothpick capacitor, 33 mmfd. (C-18)	
12723	Capacitor—Moulded toothpick capacitor, 56 mmfd. (C-16)	
12813	Capacitor—Moulded toothpick capacitor, 82 mmfd. (C-17)	
12694	Capacitor—Moulded toothpick capacitor, 220 mmfd. (C-6)	
31332	Capacitor—Moulded toothpick capacitor (temperature compensated), 450 mmfd. (C-9)	
31329	Capacitor—Moulded toothpick capacitor (temperature compensated), 470 mmfd. (C-2)	
14498	Capacitor—Moulded toothpick capacitor, 680 mmfd. (C-14)	
12536	Capacitor—Moulded toothpick capacitor, 820 mmfd. (C-1, C-8)	
4886	Capacitor—Paper capacitor, 0.05 mfd. (C-4, C-13)	
14626	Capacitor—Paper capacitor, 0.07 mfd. (C-15)	
4839	Capacitor—Paper capacitor, 0.1 mfd. (C-20)	
12484	Capacitor—Paper capacitor, 0.25 mfd. (C-19, C-21)	
31331	Capacitor—Comprising one 5 mfd., 300 volts; one 5 mfd., 350 volts; one 10 mfd., 400 volts; one 12 mfd., 25 volts; and one 20 mfd., 25 volts electrolytic capacitors (C-23, C-24, C-25, C-7, C-22)	
4867	Coil—Filter choke coil (L-7, L-8)	
31343	Escutcheon—Dial escutcheon	
30926	Foot—Rubber foot	
14133	Fuse—1 amp. fuse (S-4)	
30925	Handle—Carrying handle	
7960	Knob—Bar-pointer knob	
31340	Knob—Red knob	
4161	Lamp—Neon glow lamp (S-3)	
13210	Mounting—Fuse mounting	
31341	Pointer—Pointer assembly	

STOCK No.	DESCRIPTION	
31327	Potentiometer—"OUTPUT," 50,000 ohms (R-11)	
6552	Reactor—Filter reactor	
31328	Resistor—Voltage-divider resistor, comprising one 235 ohms, one 3,000 ohms, and one 20,000 ohms sections (R-13, R-14, R-15)	
14559	Resistor—10,000 ohms, 1/4 watt (R-2)	
13045	Resistor—18,000 ohms, 1/4 watt (R-1, R-5)	
13998	Resistor—22,000 ohms, 1/4 watt (R-4)	
12412	Resistor—47,000 ohms, 1/4 watt (R-8, R-9)	
12286	Resistor—56,000 ohms, 1/4 watt (R-18)	
30650	Resistor—56,000 ohms, 1/2 watt (R-12)	
14560	Resistor—100,000 ohms, 1/4 watt (R-17, R-19)	
30180	Resistor—120,000 ohms, 1/2 watt (R-7)	
14020	Resistor—150,000 ohms, 1/4 watt (R-10)	
12199	Resistor—270,000 ohms, 1/4 watt (R-16)	
31449	Resistor—1.5 meg., 1/2 watt (R-3)	
30649	Resistor—2.2 meg., 1/2 watt (R-6)	
31251	Socket—Tube socket (RCA-5W4)	
11278	Socket—Tube socket (RCA-6J7)	
11280	Socket—Tube socket (RCA-6C5, RCA-6J5)	
31342	Strip—Output terminal strip	
31334	Switch, "POWER"—S.P.S.T. switch (S-1)	
31335	Switch, "INDICATOR"—D.P.D.T. switch (S-2)	
9556	Transformer—Power transformer (T-1)	
31336	Transformer—Output transformer (T-2)	
31337	Transformer—Fixed oscillator transformer (L-1, L-2, C-1, C-2, C-3, R-1)	
31338	Transformer—I-F transformer (L-3), L-4, C-6)	
31339	Transformer—Variable oscillator (L-5, L-6, C-8, C-9, C-10, R-5)