BEAT FREQUENCY OSCILLATOR

TYPE TMV-134-A

INTRODUCTION

These instructions cover description, operation, maintenance, and servicing of the Type TMV-134-A Beat Frequency Oscillator; a portable, self-contained instrument for generating audio frequencies from 30 to 15,000 cycles. In general, this instrument may be used wherever it is desired to obtain audio frequencies between the ranges given above and is applicable for measuring the fidelity of radio receivers, the frequency response of audio amplifiers, transformer characteristics, filter characteristics, the frequency characteristics of amateur transmitters, frequency measurements, speed measurements, hearing tests, etc. It operates entirely from an a-c source of 110-120 volts, 50-60 cycles. The Radiotrons used, and the type circuits in which each is employed are thoroughly described in the section entitled "Circuit description."

Another important feature is the output transformer which provides for perfect load matching between the oscillator output and the most frequently encountered impedances; namely, 5,000 ohms, 500 ohms, and 250 ohms. This transformer is also center-tapped for proper operation on balanced-to-ground lines. The output signal is continuously controllable.

A very accurate means of checking the oscillator frequency against the power-supply frequency, for calibration purposes, is provided by means of a neon lamp. At multiple or sub-multiple frequencies of the power-supply frequency, it is possible to check the oscillator frequency to better than one part in a hundred. This neon lamp acts as a pilot lamp when not used for calibrating purposes, indicating whether or not power is being applied to the instrument.

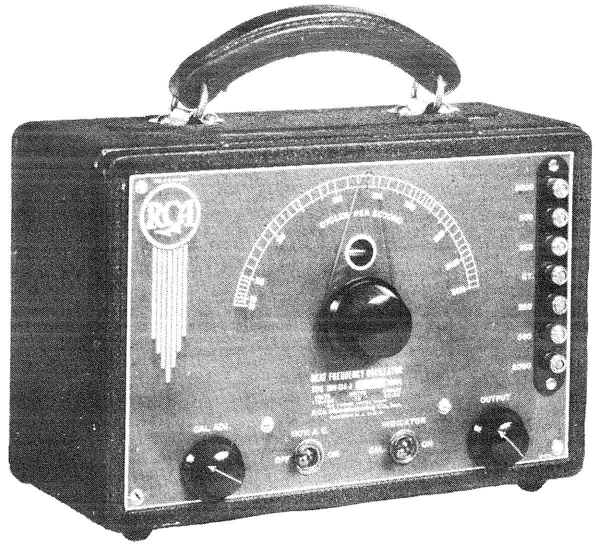

Figure 1—Beat Frequency Oscillator

A number of applications and methods of use of this Beat Frequency Oscillator are outlined under the section entitled "Applications."

OPERATION

Insert the power cord into a convenient power-supply outlet of 110-120 volts, 50-60 cycles. Turn the 110-volt a-c switch "On" and turn the indicator switch "On." The neon lamp should glow, indicating that power is applied to the instrument. After approximately one minute, the tubes will be heated and the oscillator will be in operating condition. For best stability, as with any equipment of this nature, it is advisable to allow the component parts of the unit to reach a steady operating temperature. The time will vary with the ambient temperature of the room and may require from one-quarter to one-half hour. Turn the indicator switch to "Cal." and advance the output control to its maximum clockwise position. Set the main frequency control to the frequency of the power supply (60 cycles for 60-cycle supply or 50 cycles for 50-cycle supply). Rotate the "Cal. Adj." knob back and forth and stop at the point where the neon lamp goes out entirely. **This setting is used as a reference position only.** Now, slowly move the "Cal. Adj." knob in a clockwise direction from this reference position. The neon lamp will flicker slowly at first, then speed up, and then slow down to a very few brilliant flashes per second with both neon lamp plates flashing on and off together. This setting should be made so as to obtain the longest time between flashes, thus indicating zero beat and proper calibration. The movement of the "Cal. Adj." knob (at the outer rim) to obtain this condition will be approximately 1/16-inch clockwise from the reference position.

To check this calibration, advance the main control to a frequency setting twice that of the power-supply frequency. The neon lamp will glow steadily and by moving the main frequency control slightly above or slightly below this setting, the plates of the neon lamp will flash alternately one plate and then the other plate. These flashes will not be as bright as for the calibration position. The output control should be reduced for this check.

When using the TMV-122-B Cathode-Ray Oscillograph, connect the 5,000-ohm terminals of the TMV-134-A to the vertical input terminals on the oscillograph and set the oscillograph synchronizing switch to its 60-cycle (center) position. Set the main frequency control of the TMV-134-A to the frequency of the power supply and rotate the "Cal. Adj." knob back and forth and stop at the point where the oscillograph image appears as a straight horizontal line. **This is the reference position only.** Now, advance the "Cal. Adj." knob clockwise until a single sine wave appears on the oscillograph screen. To check, advance the main frequency control to a setting of twice the power-supply frequency. At this setting, two sine waves should appear on the screen.

CAUTION. **It is possible to obtain an indication of correct calibration when the "Cal. Adj." knob is turned in a counter-clockwise direction from the reference point. This will be detected in a check at twice the power-supply frequency as the neon lamp will go out entirely, or, if the cathode-ray oscillograph is used, the image will appear as a horizontal line.**

A pair of headphones connected across the 5,000-ohm terminals may be used to listen to the signal when becoming familiar with calibration. When correctly calibrated, the frequency should increase when the main frequency control is turned clockwise from its 30-cycle mark. **When incorrectly calibrated, the frequency will decrease when this control is rotated from its 30-cycle mark to a dial reading of twice the frequency of the power supply, then increases beyond that point. The latter is to be avoided.** With a little practice the correct calibration point will be readily distinguished. After calibration, the indicator switch should be turned to its "On" position. The instrument is then ready for operation.

When connecting the output terminals to the device being tested, connect the 250-, 500-, or 5,000-ohm terminals to a load which has an impedance comparable to 250, 500, or 5,000 ohms respectively. It is preferable to have the load impedance equal to that of the terminals to which it is connected; however, if an exact match cannot be obtained, select the terminals which have the next lower impedance than that of the load.

The output transformer has a center-tap for feeding lines or circuits which are balanced to ground. This center-tap is not grounded to the case (chassis) of the TMV-134-A. If hum is encountered, it is advisable to try various grounding combinations from the TMV-134-A case, or center-tap, or both, to the ground of the instrument under test. If one side of the input of the equipment being tested is grounded, do not ground the center-tap of the output transformer unless it is used as the terminal to the grounded side. For balanced input lines where the center-tap of the equipment under test is grounded, best results will normally be obtained by connecting the center-tap of the output transformer to the same point of ground as the center-tap of the instrument under test. Shielded and twisted leads will normally be advantageous when protection against hum pickup is necessary, or, when running the leads a considerable distance from the TMV-134-A.

APPLICATIONS

Several general applications to which this Beat Frequency Oscillator can be applied 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 a-c meters capable of measuring high audio frequencies. The same type meters should be used in each position for greatest accuracy.

Fidelity Characteristics of Radio Receivers

An over-all electrical fidelity characteristic of a radio receiver consists of applying a modulated r-f signal into the antenna stage and measuring the audio output voltage (at various modulating frequencies) across the loudspeaker voice coil.

Connect the 250-ohm output terminals of the TMV-134-A to a test oscillator capable of being externally modulated. The RCA TMV-97-C 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 TMV-134-A and another similar meter across the loudspeaker voice coil. The arrangement is shown by figure 2. Set the test oscillator to 1,000 kc and adjust its output to deliver approximately 2 millivolts into the receiver antenna stage. This output will be obtained from the TMV-97-C test oscillator with its Hi-Lo switch set to "Lo" and its output control set to maximum. Adjust the frequency of the TMV-134-A 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 5.4 volts. 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 response. The receiver should then be carefully tuned to the lowest meter reading between the peaks. The receiver is then precisely tuned to the test oscillator frequency. Now, shift the TMV-134-A frequency to 400 cycles and adjust its output to 5.4 volts. Adjust the receiver volume control until the power delivered to the loudspeaker voice coil is 0.1 watt. Knowing the voice coil

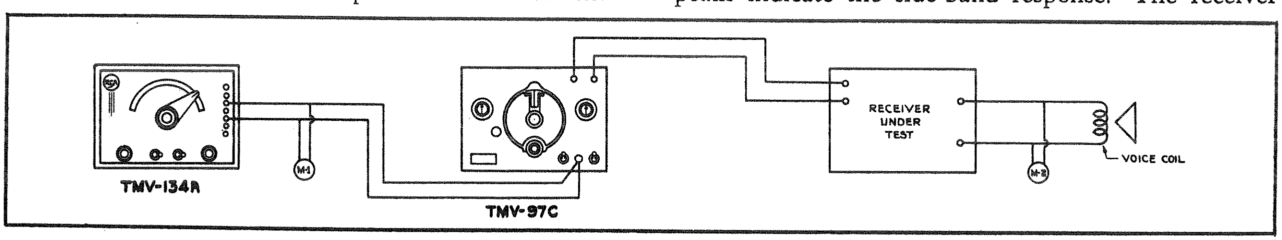

Figure 2—Receiver Fidelity Measurements

impedance, the voltage required across the voice coil to obtain this power may be calculated by use of the formula:

$$E \text{ (volts)} = \sqrt{W \times Z_{VC}}$$

Where W is the desired output in watts and Z_{VC} is the impedance of the voice coil in ohms.
Example: The desired output is 0.1 watt and the voice coil impedance is 3 ohms, the voltage is

$$E = \sqrt{0.1 \times 3} = \sqrt{0.3} = 0.55$$

By rearranging this formula, the power in watts delivered to the voice coil may be calculated by

$$W \text{ (watts)} = \frac{(E)^2}{Z_{VC}}$$

using the same values as above

$$W = \frac{(0.55)^2}{3} = \frac{0.3}{3} = 0.1$$

After setting the volume control to obtain the specified output at 400 cycles, vary the frequency of the TMV-134-A through the desired audio range, keeping its output at 5.4 volts (this gives approximately 30% modulation of the TMV-97-C) and record the variations of the voltage across the loudspeaker voice coil.

Audio Amplifier Frequency Response

In general, audio amplifier frequency response is taken the same way as the fidelity of a radio receiver except that no test oscillator is used. Figure 3 shows the general arrangement. The output of the TMV-134-A 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 provide a definite ratio between the output voltage of the TMV-134-A 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 of the terminals of the TMV-134-A to which they are connected (i.e., 250 ohms total for 250-ohm taps, 500 ohms total for 500-ohm taps, or 5,000 ohms total for 5,000-ohm taps). The ratio of R_2 to the total resistance $R_1 + R_2$ will determine the voltage E_2 which is applied to the amplifier when the output voltage E_1 of the TMV-134-A is known. R_2 should always 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 TMV-134-A, $R_1 + R_2$ should be 5,000 ohms. A convenient value to adjust the TMV-134-A output for these terminals is 10 volts. The voltage ratio between the output of the TMV-134-A and the input of the amplifier will then be 100 to 1. R_2 should then be $\frac{1}{100}$ of $R_1 + R_2$ or 50 ohms. 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 and reading the two meters in the circuits of figure 3, knowing the values of R_1 and R_2, the

$$\text{Gain} = \frac{E_3 (R_1 + R_2)}{R_2 \times E_1}$$

(This formula with R_6 or R_3 omitted.)

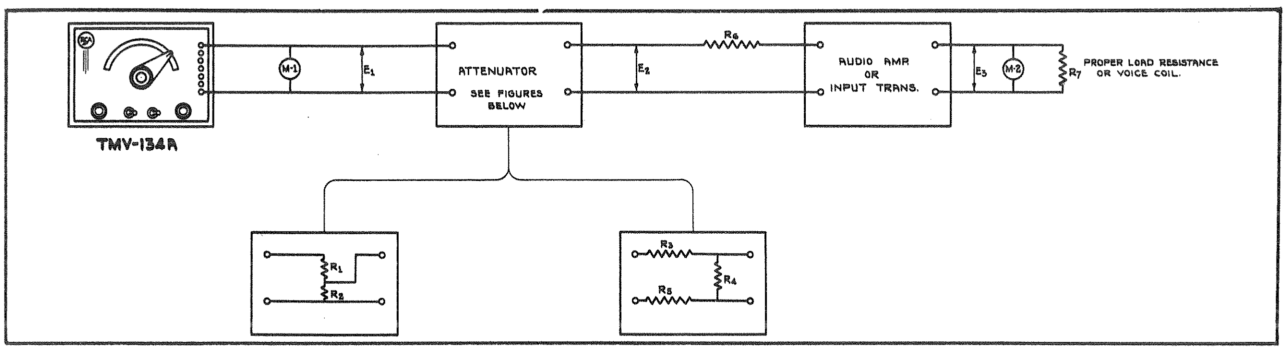

Figure 3—Audio Amplifier Frequency Response

Assume E_3 to be 5 volts and using the constants in the above example

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

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 shown at left or R_4 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 resistor 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 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 above arrangement for audio amplifiers will apply to input transformers. The value of 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.

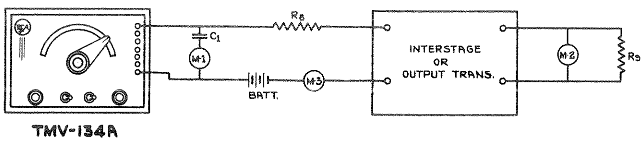

Figure 4—Audio Transformer Characteristics

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. The battery voltage should be such that the current is equivalent to the normal current under operating conditions. Figure 4 shows the arrangement. This current is measured by a d-c milliammeter M-3 inserted in series with the primary. Resistor R_8 should be equal to the plate impedance of the tube from which the transformer works, and R_9 should be equivalent to the secondary loading—normally the capacity between tube elements—and a vacuum-tube voltmeter will approximate this load. Likewise, if R_9 is high, a vacuum-tube voltmeter should be used. Any special loading on either the primary or 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 which would otherwise give false readings. The battery polarity should be such as to give the highest reading on M-1 at 60 cycles. For interstage transformers, the 250-ohm terminals on the TMV-134-A should be used; for output transformers the 5,000-ohm terminals should be used.

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

For transformers having push-pull primaries, 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) R_9 should be equal to the voice coil impedance of the speaker for which it was designed.

Amateur Transmitter Over-all Frequency Characteristics

When taking over-all frequency characteristics of an amateur transmitter, some type of modulation indicator is necessary. The most convenient device for this use is a Cathode-Ray Oscillograph such as the Type TMV-122-B. Connect the TMV-134-A 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 TMV-134-A to the "Ext. Sync." terminals of the Cathode-Ray Oscillograph. Place a pickup coil near the output of the power amplifier stage of the transmitter and connect it to the vertical input of the Cathode-Ray Oscillograph.

The audio voltage from the TMV-134-A 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 for variation in percentage modulation with variation in audio frequency. Measuring the percentage modulation is fully covered in the instructions on the TMV-122-B Oscillograph.

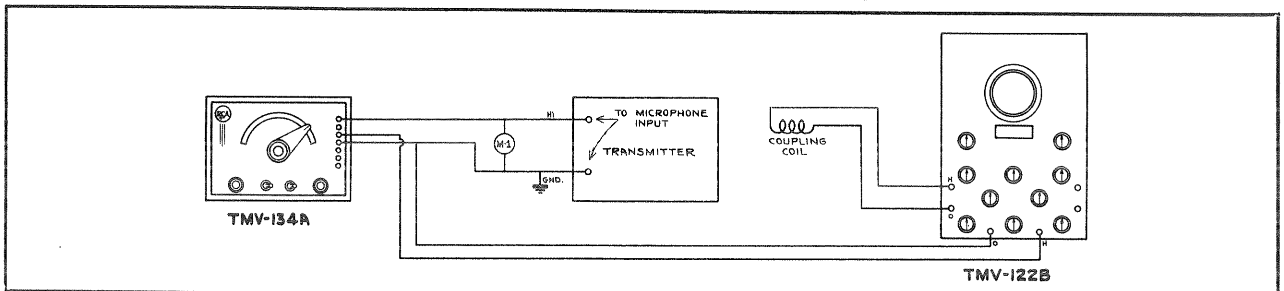

Figure 5—Amateur Transmitter Frequency Characteristics

Frequency Measurements

Frequencies from a few cycles per second up to 150 kilocycles per second may be measured with this instrument in conjunction with the TMV-122-B Cathode-Ray Oscillograph. This information is completely explained in the instruction book for the TMV-122-B.

Stroboscopic Speed Measurements

The speed of rotating shafts, motors, etc., may be readily measured with this instrument. Figure 6 shows the arrangement. A disc, made up in equally divided black and white spaces, should be placed on the rotating member. The number of sections varies inversely with the speed.

The number of black spaces can be readily chosen by trial in the formula

$$RPM = \frac{60 \times f}{N}$$

where 60 = seconds per minute,
f = frequency in cycle per second,
N = number of black sections.

Example: N = 4 sections, f = 100 c.p.s.

$$RPM = \frac{60 \times 100}{4} = 1,500$$

The additional equipment required for these measurements is a battery of about 45 volts and a 1/4-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 of the same width as the original size of the segments.

In some cases, more than 45 volts may be used This can best be determined by turning the TMV-134-A output control to its minimum position and

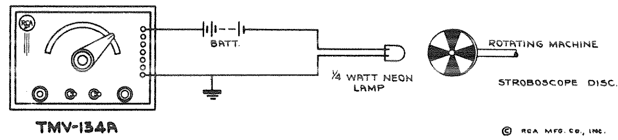

Figure 6—Stroboscopic Speed Measurements

connecting enough battery so that the neon lamp just lights. 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.

SERVICE DATA

Electrical Specifications

Power-Supply Rating:	
Voltage	110-120 A.C.
Frequency	50-60 Cycles
Power Consumption	15 Watts
Fuse Protection	1/2 Ampere
Range and Applications:	
Frequency	30-15,000 Cycles
Output:	
With Open Circuit	25 Volts
At 5,000-Ohm Load	18 Volts
At 500-Ohm Load	6 Volts
At 250-Ohm Load	4 Volts
Power Output	60 Milliwatts
Radiotrons Used, and Functions:	
1 RCA-954	Fixed R-F Oscillator
1 RCA-954	Variable R-F Oscillator
1 RCA-955	Detector
1 RCA-955	Audio Amplifier
1 RCA-84	Full-Wave Rectifier

Mechanical Specifications

Over-all Dimensions:	
Height	6½ inches
Width	9¾ inches
Depth	4½ inches
Weights:	
Net	10¾ pounds
Shipping	13 pounds

Circuit Description

The RCA TMV-134-A Beat Frequency Oscillator consists of two radio-frequency oscillators whose outputs are combined in a detector to produce the desired audio beat-note or difference frequency which is amplified and fed to the output transformer. Referring to the schematic circuit diagram (figure 7) the following action takes place.

A fixed r-f oscillator stage, consisting of a self-

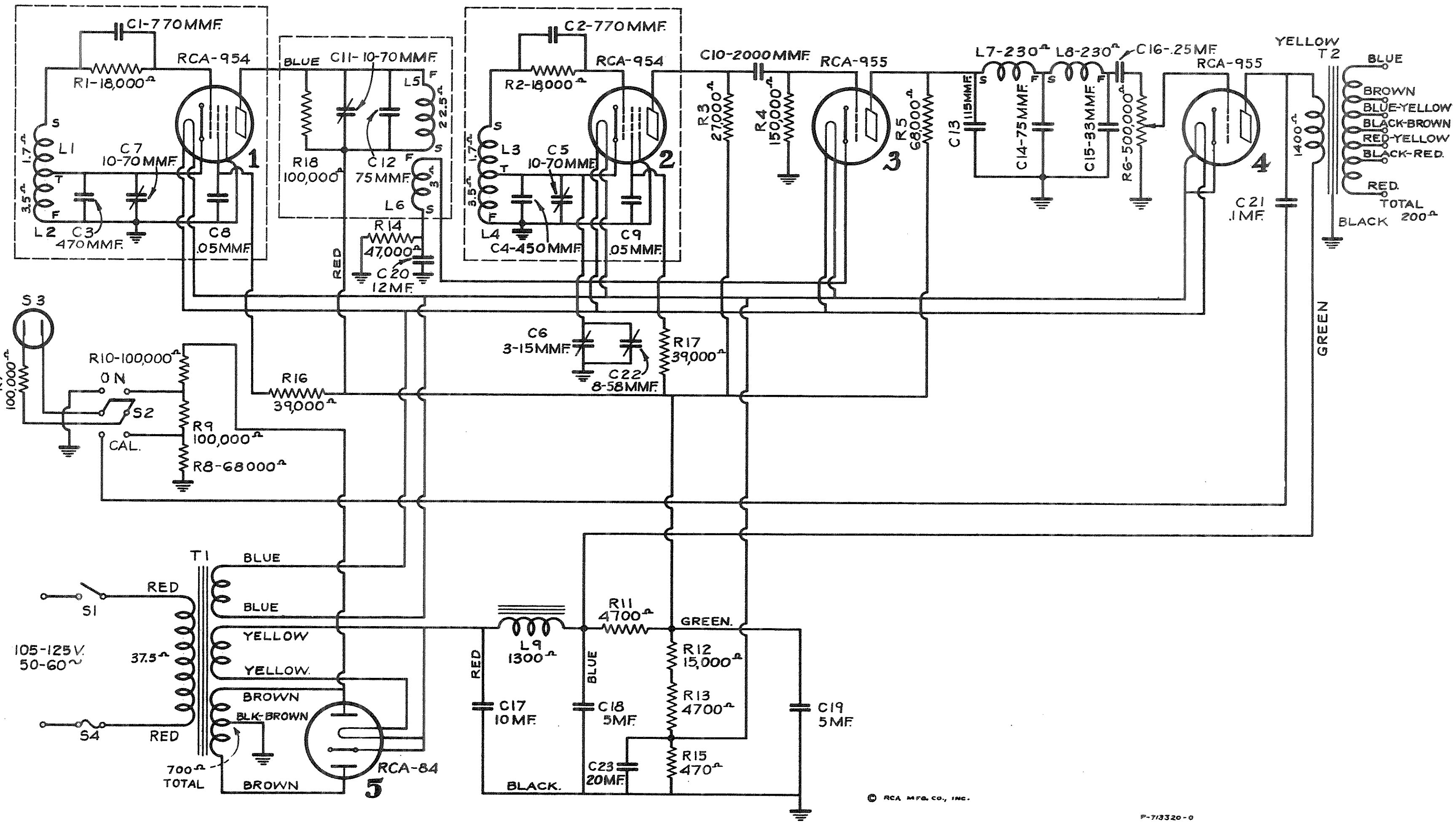

Figure 7—Schematic Circuit Diagram

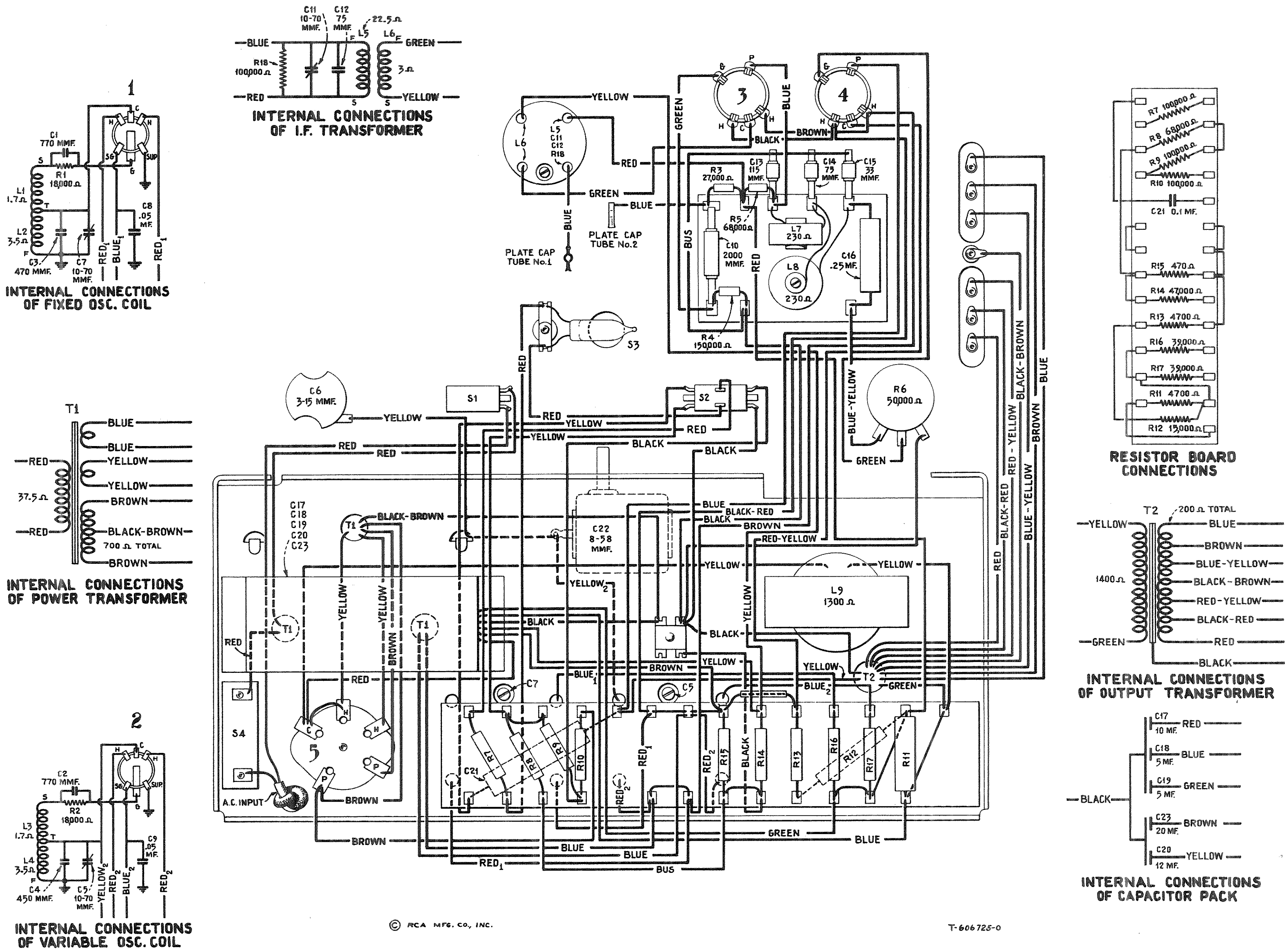

Figure 8—Chassis Wiring Diagram

biased RCA-954 acorn-type pentode Radiotron and its associated capacity and inductance, oscillates at a frequency of 350 kc; the second grid of this tube operates 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-955 acorn-type detector tube which provides detector-cathode modulation at the frequency of the fixed oscillator.

The variable r-f oscillator stage consists of a similar circuit to that of the fixed oscillator except that the main frequency control C-22 is connected across L-4 and provides the required variable capacity 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-955 detector tube. This provides detector-grid modulation at the frequency of the variable oscillator.

The method of electron coupling of 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, one entering the cathode circuit and one entering the grid circuit, are detected by the RCA-955 Radiotron. The output of this stage is fed to the control grid of the RCA-955 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-6 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-84 full-wave rectifier working into a condenser input-filter circuit. The output of the filter circuit supplies the d-c voltages required for the various circuits of the apparatus.

A neon lamp is used either as a pilot lamp or as a calibration indicator depending on the position of the indicator switch. In the "calibration" position a portion of the a-c voltage from the high-voltage winding of the power transformer is impressed on one plate of the neon lamp from the junction of resistors R-8 and R-9 through a 100,000-ohm resistor R-7. The other plate of the neon lamp is connected through C-21 to the output of the RCA-955 amplifier. Proper calibration is indicated when the two frequencies applied to the neon lamp are the same. The lamp will then stay lit continuously or stay 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 "on" position, the neon lamp is connected from the junction of resistors R-9 and R-10 to ground and acts as a pilot lamp. A small air condenser C-6 is connected in parallel with the main frequency control to change the frequency of the variable oscillator for setting the calibration point.

Maintenance

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, and C-1, etc., are provided for reference between the illustrations and the Replacement Parts List. These identifications are in a sequence which begins at the left of the diagram and increases numerically from left to right, thus facilitating the location of such parts on the schematic diagram.

The coils, reactors, and transformer windings are rated in terms of their d-c resistance. This method of rating provides ready means for checking continuity of circuits. Suspected faulty circuits or parts may be checked and their resistances compared with the value 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.

Low output or improper calibration may result from:

(1) Improper alignment of the various circuits.
(2) Oscillator coil shields loose or removed.
(3) Defective tubes.
(4) Improper setting of control knobs on shafts.
(5) Defects within the instrument itself.

CAUTION.—Disconnect power supply before removing case.

Care in removing the case will prevent damage to the internal parts, especially the acorn-type Radiotrons. After the four screws around the front panel are removed, the panel should be tilted forward and the case carefully slipped off. **DO NOT PLACE THE INSTRUMENT IN SUCH A POSITION AS TO REST ON OR DAMAGE THE ACORN TUBE TOP (PLATE) CONTACTS.**

Alignment Procedure

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 or immediately after any repairs or replacements have been made which affect the oscillator circuits. If either or both of the RCA-954 oscillator tubes have been interchanged or replaced, these circuits should also 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 and place it on one side so that all trimmer adjustments are accessible. Make sure that the two oscillator shields are securely screwed in place and that all tubes are in secure contact with their socket terminals. Make sure that both oscillator plate leads are making good contact with the top connections on these tubes. Reset the control knobs, as explained in section below, if necessary.

Fixed Oscillator Alignment

Place the instrument in operation with both the power and indicator switches to their "On" positions, the output control to its maximum (clockwise) position, and the main 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 TMV-133-A Crystal Calibrator. The crystal calibrator should be connected for d-c plate operation, using 22½ volts or more with its output switch to its "Lo" position. This gives the seventh harmonic for the 700-kc signal. Connect a lead from any one of the output terminals of the Beat Frequency Oscillator 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 Crystal 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-7 of the fixed oscillator (see figure 10 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 Alignment

After proper alignment of the fixed oscillator, as explained above, set the main frequency control to its 30-cycle position. Set the "Cal. Adj." pointer to its vertical position and place "indicator" switch to "Cal.", leaving the output control set to maximum. Adjust trimmer C-5 of the variable oscillator (see figure 10 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 "Operation."

Output Calibration

Connect a 0—25-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. Properly calibrate the instrument as described under "Operation." Place indicator switch to "On" and advance the output control to maximum. Set the main frequency control to its 1,000-cycle position. Adjust trimmer C-11 on the i-f transformer (see figure 9 for location) for 18 volts output. This is accomplished by screwing the trimmer all the way in and then unscrewing it to obtain the correct voltage. This places the transformer tuning on the lower side of resonance.

Resetting Controls

The main frequency control pointer should coincide exactly with the 15,000-cycle mark when the variable condenser is set to its 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 set screws in the collar to which the main pointer is attached. Turn the condenser shaft clockwise until the condenser plates are in their full-mesh (maximum-capacity) position. Set the pointer of the main frequency control exactly on the 15,000-cycle mark and tighten the set screws, making sure that neither the condenser 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 both the calibration-adjustment (Cal. Adj.) knob and the output knob 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.

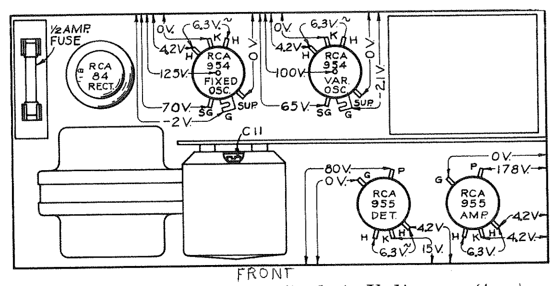

Figure 9—Radiotron Socket Voltages (top)

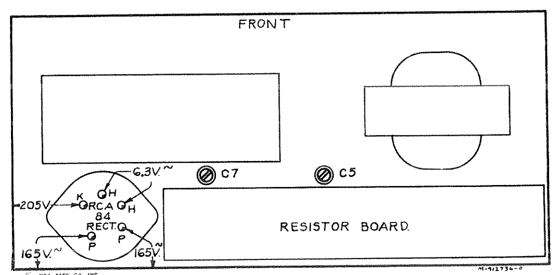

Figure 10—Radiotron Socket Voltages (bottom)

Radiotron Socket Voltages

Operating conditions of the basic circuits of this instrument may be determined by measuring the voltages applied to the tube elements. Figure 9 shows the voltage values from the socket contacts to ground and also those appearing across the heater contacts H-H on the four acorn-type Radiotrons on the top side of the chassis. Figure 10 shows the rectifier Radiotron voltages on the bottom side of the chassis. Each value as specified should hold within ±20% when the instrument is normally operative with all tubes intact and rated voltage applied. Variations in excess of this limit will usually be indicative of trouble.

The voltages given on this diagram 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 1,000-ohm-per-volt a-c/d-c voltmeter having ranges of 10, 50, and 250 volts. Use the nearest range above the voltage to be measured. The two oscillator shield cans must be unscrewed and removed to measure the voltages of the oscillator tubes.

Radiotrons

Under ordinary usage, within the ratings specified for voltage supply, tube life should be consistent with that obtained in other applications. Low output, inability to calibrate, or total failure of operation may be indicative of tube trouble. Caution should be taken to make sure that all tubes are in proper contact with their socket terminals.

If tube trouble is suspected, the tubes should be removed from their sockets and tested in a reliable tube-testing device. Replacing a questionable tube with one known to be good is another sure and definite means of tracing tube trouble. After replacing either of the oscillator tubes, the circuits should be re-aligned as explained under "Alignment procedure."

Fuse Replacement

A small ½-ampere cartridge fuse provides protection of the power system. The fuse block is mounted beside the RCA-84 rectifier tube socket on the top side of the chassis. This fuse is intended to protect the entire power system of this instrument and, therefore, should not be replaced with one having a higher rating nor be shorted out. A fuse failure should be carefully investigated before making a replacement since fuses of good quality fail only under conditions of overload. The cause may originate from a surge in the power-supply line, but more likely the reason may be found in the apparatus protected, such as shorted rectifier elements, etc. Poor contact of the fuse clips may result in an open fuse due to the heat developed. These contacts should, therefore, be kept clean and in secure contact with the fuse.

REPLACEMENT PARTS

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

Stock No.	Description	List Price
4146	Block—Fuse block	.35
12334	Cap—Grid contact cap—Package of 5	.60
12338	Capacitor—Adjustable capacitor as in oscillator coil assembly (C5, C7)	.46
12345	Capacitor pack—Comprising two 5 mfd., one 10 mfd., one 20 mfd., and one 12 mfd., sections (C17, C18, C19, C20, C23)	3.84
12332	Capacitor—33 mmfd. (C15)	.28
11180	Capacitor—75 mmfd. (C14)	.16
8076	Capacitor—115 mmfd. (C13)	.20
12340	Capacitor—450 mmfd. (C4)	.34
12339	Capacitor—470 mmfd. (C3)	.34
12341	Capacitor—770 mmfd. (C1, C2)	.30
11812	Capacitor—2,000 mmfd. (C10)	.32
4836	Capacitor—.05 mfd. (C8, C9)	.30
4841	Capacitor—0.1 mfd. (C21)	.22
4840	Capacitor—.25 mfd. (C16)	.30
12346	Clip—Neon lamp clip, terminal, washer and rivets	.36
4867	Coil—Choke coil (L7, L8)	.70
12337	Coil—Oscillator coil—bobbin and coil only (L1, L2, L3, L4)	.98
12344	Condenser—Variable condenser (C22)	2.48
12348	Condenser—Variable condenser for calibration adjustment (C6)	.84
12351	Escutcheon—Name plate escutcheon for front panel	2.58
12350	Foot—Rubber foot—Package of 4	.22
3748	Fuse—½ ampere fuse (S4)—Package of 5	.40
3982	Handle—Carrying handle	.60
12479	Indicator—Frequency indicator pointer	.48
12349	Knob—Main frequency adjusting knob—Package of 5	1.60
3984	Knob—Variable calibrating condenser or volume control knob	.30
4161	Lamp—Neon lamp	.56
12477	Reactor—Filter reactor (L9)	2.78
5030	Resistor—470 ohms—Carbon type—¼ watt (R15)—Package of 5	1.00
5199	Resistor—4700 ohms—Carbon type—¼ watt (R13)—Package of 5	1.00
11987	Resistor—4700 ohms—Carbon type—½ watt (R11)—Package of 5	1.00
5114	Resistor—15,000 ohms—Carbon type—1 watt (R12)	.22
12070	Resistor—18,000 ohms—Carbon type—1/10 watt (R1, R2)—Package of 5	.75
11400	Resistor—27,000 ohms—Carbon type—¼ watt (R3)—Package of 5	1.00
11322	Resistor—39,000 ohms—Carbon type—¼ watt (R16, R17)—Package of 5	1.00
11646	Resistor—47,000 ohms—Carbon type—¼ watt (R14)—Package of 5	1.00
12333	Resistor—68,000 ohms—Carbon type—¼ watt (R5, R8)—Package of 5	1.00
3118	Resistor—100,000 ohms—Carbon type—¼ watt (R7, R9, R10)—Package of 5	1.00
12478	Resistor—150,000 ohms—Carbon type—1/10 watt (R4)—Package of 5	.75
4119	Screw—Set screw for indicator Stock No. 12479—Package of 20	.38
12342	Shield—Oscillator coil shield	.30
12336	Socket—954 or 955 Radiotron socket	.52
4814	Socket—5-contact rectifier Radiotron socket	.15
4750	Switch—Double pole double throw toggle switch (S2)	.94
7900	Switch—"ON-OFF" switch (S1)	.75
12335	Transformer — Intermediate frequency transformer, complete with shield (L5, L6, C11, C12, R18)	2.34
12343	Transformer—Output transformer (T2)	4.56
12135	Transformer—Power transformer 105-125 volts 50-60 cycle (T1)	7.10
12347	Volume Control—(R6)	1.22

The prices quoted above are subject to change without notice.

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