

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TM 11-5044

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TO 16-35TS174-5

FREQUENCY METER
TS-174B/U

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

AUGUST 1951

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FREQUENCY METER

TS-174B/U



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DEPARTMENTS OF THE ARMY AND
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WARNING

When the frequency meter is out of its cabinet, do not touch the plugs mounted on the rear of the cabinet if the batteries are connected. A severe shock may result. Do not short-circuit the plugs.

When using the frequency meter to calibrate a transmitter, never make any direct connection between the meter and the transmitter.

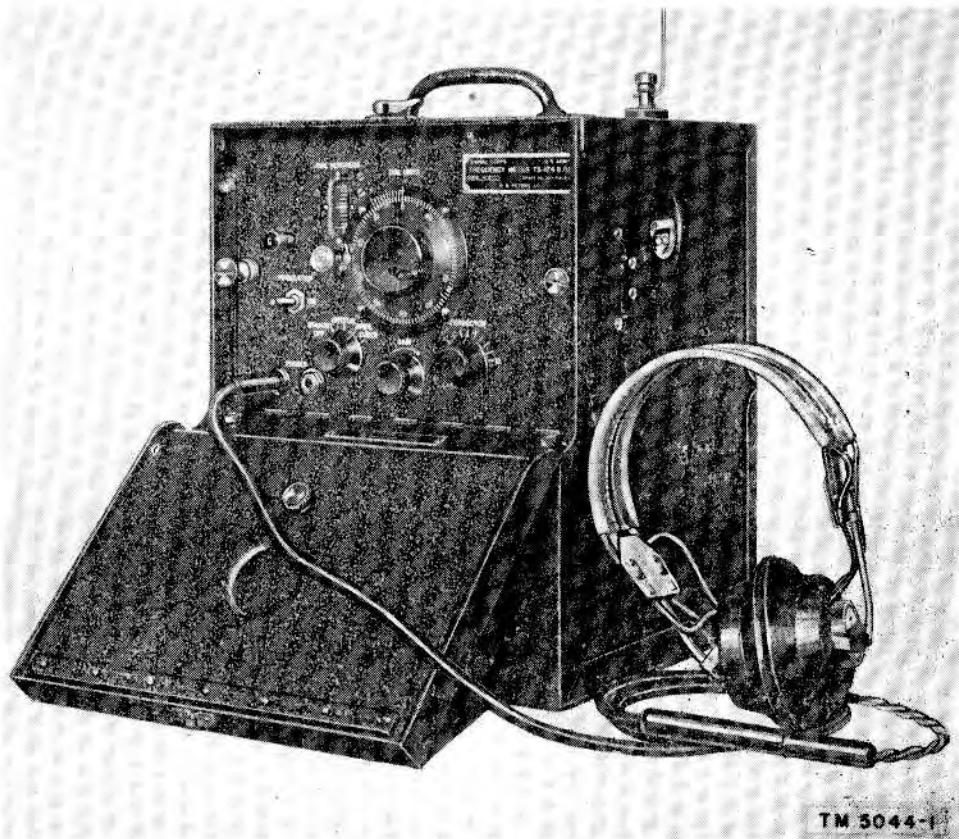


Figure 1. Frequency Meter TS-174B/U in operation.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

This technical manual contains instructions for the installation, operation, theory, maintenance, and repair of Frequency Meter TS-174B/U (fig. 1). In addition to these instructions, there are two appendixes covering a list of references and an identification table of parts.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army matériel and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forward-

ed as prescribed in SR 745-45-5 (Army), and AFR 71-4 (Air Force).

b. DA AGO Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700-45-5.

c. USAF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AFR 65-26.

d. DA AGO Form 419, Preventive Maintenance Checklist for Signal Corps Equipment, will be prepared in accordance with instructions on the back of the form.

e. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Frequency Meter TS-174B/U (fig. 1) is a precision instrument designed to measure or radiate r-f (radio-frequency) energy between 20 and 250 mc (megacycles). It is a portable, self-contained instrument used mainly to calibrate field radio receivers and transmitters by direct comparison with the calibrated vfo (variable-frequency oscillator) of the frequency meter. The frequency meter contains a 1,000-kc (kilocycle) crystal-controlled oscillator circuit which is used in calibrating the instrument at a number of frequencies. These points of frequency calibration are called *crystal check points*.

b. The equipment is mounted in a black wrinkle-finished aluminum-alloy cabinet (fig. 2). The upper and largest compartment of the cabinet contains the frequency meter chassis and the spare parts. The next smaller compartment, at the bottom rear, contains the batteries. The smallest compartment, at the bottom front, provides space to store a headset. The batteries and the headset are required for the operation of the equipment but are not supplied with it. A carrying handle and one snap latch are mounted on the top surface of the cabinet. Two small rings to which Strap ST-19-A can be hooked are mounted at the sides of the cabinet.

4. Technical Characteristics

Frequency range..... 20 to 250 mc.

Oscillator:

Variable..... 20 to 40 mc
(fundamentals).

Crystal..... 1,000 kc.

Modulation..... 900 cycles (when used).

Number of tubes..... 3.

Types of tubes..... Oscillator, 6SJ7-Y;
mixer, 6K8; and
audio, 6SJ7.

Power input:

6.0 volts d-c (di- 1.0 ampere.
rect current).

135 volts d-c..... .025 ampere.

Crystal type..... Crystal Unit DC-9-AJ.

Calibration accuracy.... .04 percent over a tem-
perature range of
-40°C. to +55°C.
with 10 percent varia-
tion in voltages when
corrected to nearest
crystal check point
(.02 percent average
under normal condi-
tions).

Frequency drift after warm-up. After a 15-minute warm
up, should not drift
more than .005 per-
cent in next 5 min-
utes.

R-f output..... 15,000 μ v (microvolts)
at any fundamental
frequency in the cali-
brated range and 300
 μ v at any point from
40 to 250 mc.

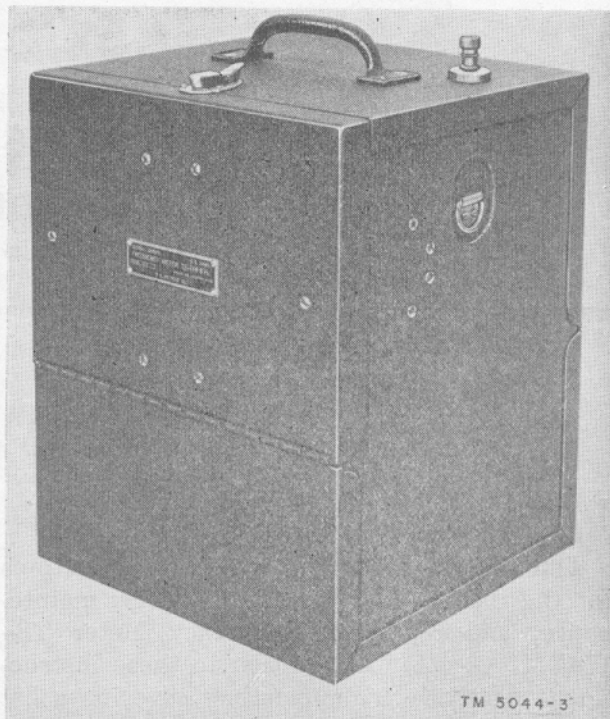


Figure 2. Frequency Meter TS-174B/U, cover closed.

Audio power output..... Minimum of .5 mw
(milliwatt).

Weight..... Approximately 171½
pounds with neither
batteries nor headset.

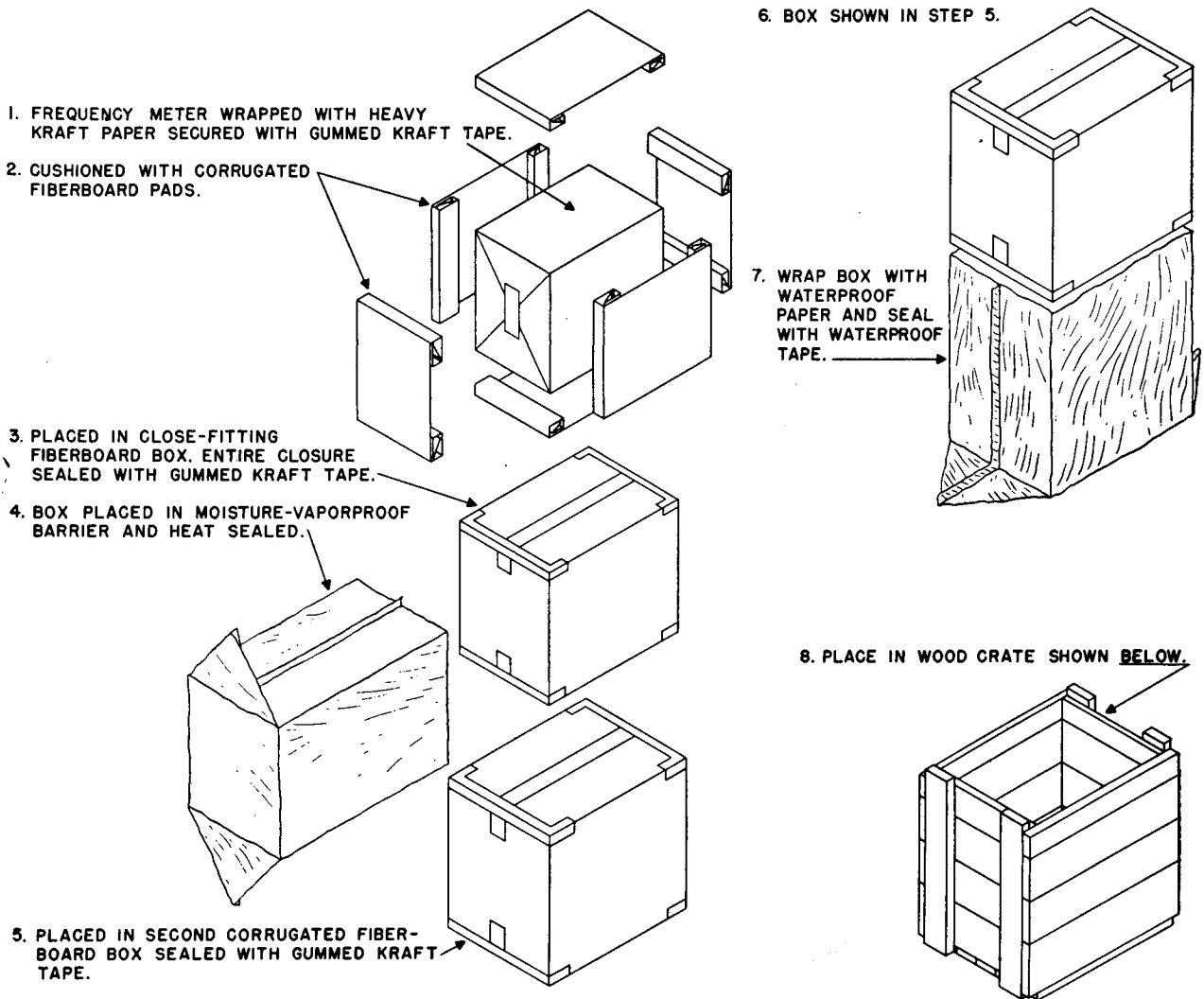
5. Packaging Data

When packaged for export shipment, the components of Frequency Meter TS-174B/U are placed in moistureproof-vaporproof containers and are packed in a wooden export crate. Figure 3 shows a typical method of packing. The size, weight, and volume of the crate are indicated in the following chart.

Note. Items may be packaged in a manner different from that shown, depending on the supply channel.

Number of crates	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Unit weight (lb)
1	22	18	16	4	70

NOTE: FOLLOW PROCEDURE OUTLINED IN STEPS 1 THROUGH 5 ONLY FOR DOMESTIC SHIPMENTS. ADD STEPS 7 AND 8 FOR OVERSEAS SHIPMENTS.



TM 5044-7

Figure 3. Packing and packaging of Frequency Meter TS-174B/U.

6. Table of Components

Component	Required No.	Height (in.)	Depth (in.)	Length (in.)	Volume (cu ft)	Unit weight (lb)
Frequency Meter TS-174B/U.	1	13 $\frac{13}{16}$	9 $\frac{11}{16}$	10 $\frac{1}{4}$.793	25
Calibration book-----	1	5 $\frac{5}{8}$	4 $\frac{7}{8}$	$\frac{1}{2}$.00794	
Bristo wrench-----	1	$\frac{9}{16}$	$\frac{1}{16}$	1 $\frac{3}{4}$	-----	
Technical manual, TM 11-5044.	1	9 $\frac{1}{8}$	5 $\frac{7}{8}$	$\frac{1}{4}$.0103	

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts.

7. Description

a. Frequency Meter TS-174B/U is a three-tube heterodyne frequency meter designed to operate over a range of 20 to 250 mc. The front panel (fig. 4) contains a calibrated tuning dial; a ground connection marked G; a MODULATION OFF-ON switch; a selector switch marked OFF, STANDBY, CRYSTAL, OPER., and CHECK; an audio GAIN control; and a CORRECTOR control marked from 0 to 10 divisions. In the lower left-hand corner of the panel are two PHONES jacks.

b. The chassis can be removed by turning the two large slotted knobs on the front panel a quarter-turn to the left (either by hand or with the aid of a screw driver) and pulling the chassis out of the cabinet.

c. A four-contact plug (PI in fig. 5) in the rear of the cabinet mates with receptacles in the rear of the chassis when the chassis is placed in the cabinet. At the same time, a clip on the upper right side of the chassis engages the antenna stud mounted in the top of the cabinet.

8. Running Spares

Running spares supplied with each frequency meter are stored on the back of the cabinet (fig. 5). Spares are reached by removing the chassis, as described in paragraph 7b. The following is a list of running spares.

1 tube type 6SJ7-Y.

1 tube type 6K8.

1 tube type 6SJ7.

Note. A 6SJ7-Y tube may be substituted for a type 6SJ7, but a 6SJ7 tube must not be substituted for a type 6SJ7-Y.

9. Additional Equipment Required

The following equipment is *not* supplied as part of Frequency Meter TS-174B/U but is required for its operation:

1 Headset HS-30.

1 Battery BA-411/U.

1 Battery BA-420/U.

1 antenna, stiff copper wire about 18 inches long.

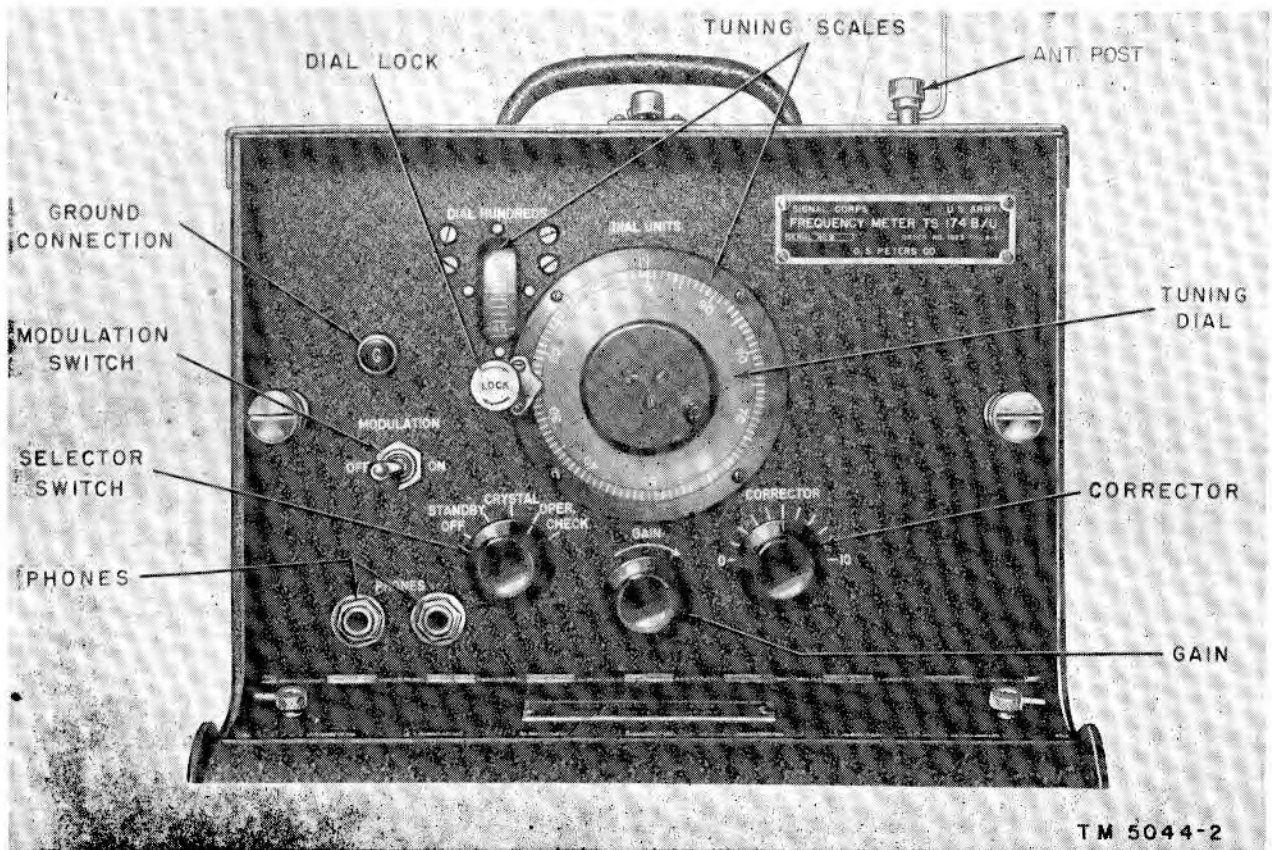


Figure 4. Front panel of Frequency Meter TS-174B/U.

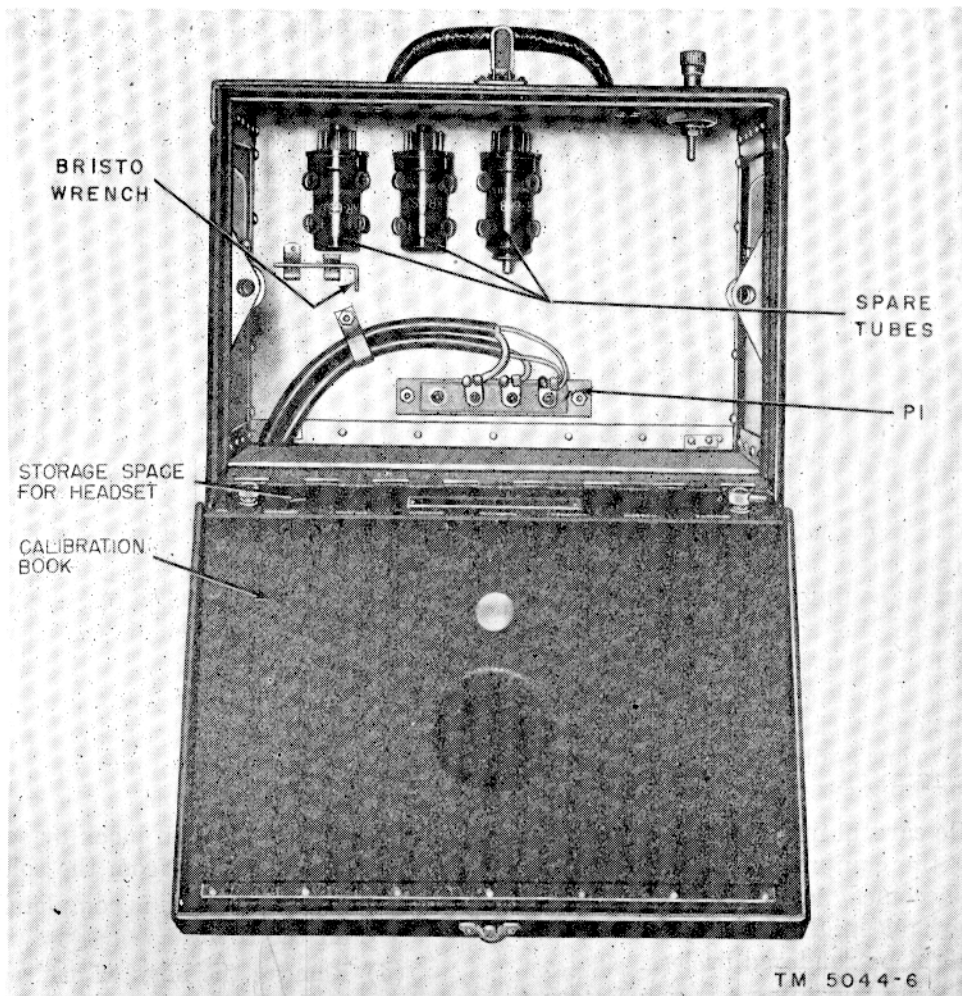


Figure 5. Frequency Meter TS-174B/U, chassis removed to show spare parts.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE ON RECEIPT OF EQUIPMENT

10. Uncrating, Unpacking, and Checking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 12.

a. GENERAL. Equipment may be shipped in oversea packing cases or in domestic packing cases. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements. The instructions in *b* below apply to equipment shipped in export packing cases, and the instructions in *e* below apply to equipment shipped in domestic packing cases.

Caution: Be careful in uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged or exposed, a complete overhaul might be required or the equipment might be rendered useless.

b. STEP-BY-STEP INSTRUCTIONS FOR UNCRATING AND UNPACKING EXPORT SHIPMENTS.

- (1) Place the packing case in a convenient position.
- (2) Cut and fold back the steel straps.
- (3) Remove the nails with a nail puller. Remove the top and one side of the packing case. Do not attempt to pry off the sides and top; the equipment may become damaged.
- (4) Remove the waterproof metal container or moistureproof barrier and any excelsior or corrugated paper covering the equipment inside the case.
- (5) Remove the equipment from its inner case and place it on a workbench or in some other convenient location.
- (6) Inspect the equipment for possible damage incurred during shipment.
- (7) Check the contents of the packing case against the master packing slip.

c. OPENING CARDBOARD CARTON AND WATER-PROOF BARRIER. No special instructions are needed for opening the waterproof paper barrier and removing the equipment from the cardboard carton.

d. INSTRUCTIONS FOR OPENING METAL CONTAINERS. The top of the metal container is soldered to the sides. To open, break the soldered seam by prying the side of the container away from the soldered seam as follows:

- (1) Wipe off the excess solder with a soldering iron. Never use a torch because the contents of the container are inflammable.
- (2) With a wooden block or screw driver, pry the sides from the soldered seam.
- (3) When the seam is completely open, pry off the cover.
- (4) Remove the bags of desiccant and the protective cardboard packing and lift or draw out the packages within.

e. UNPACKING DOMESTIC PACKING CASES. Radio equipment may be received in domestic packing cases. The instructions given in *b* above also apply to unpacking domestic shipments. Cut the metal bands if they are used. Open the cartons that protect the equipment, or, if heavy wrapping paper has been used, remove it carefully and take out the contents. Check the contents of the packing case against the master packing slip.

Note. Save the original packing cases and containers for both export and domestic shipments. They may be used again when the equipment is repacked for storage or shipment.

11. Installation of Equipment

a. GENERAL. The frequency meter is supplied with all the tubes in their sockets and with the crystal installed. However, batteries are not supplied with the equipment. Use caution in

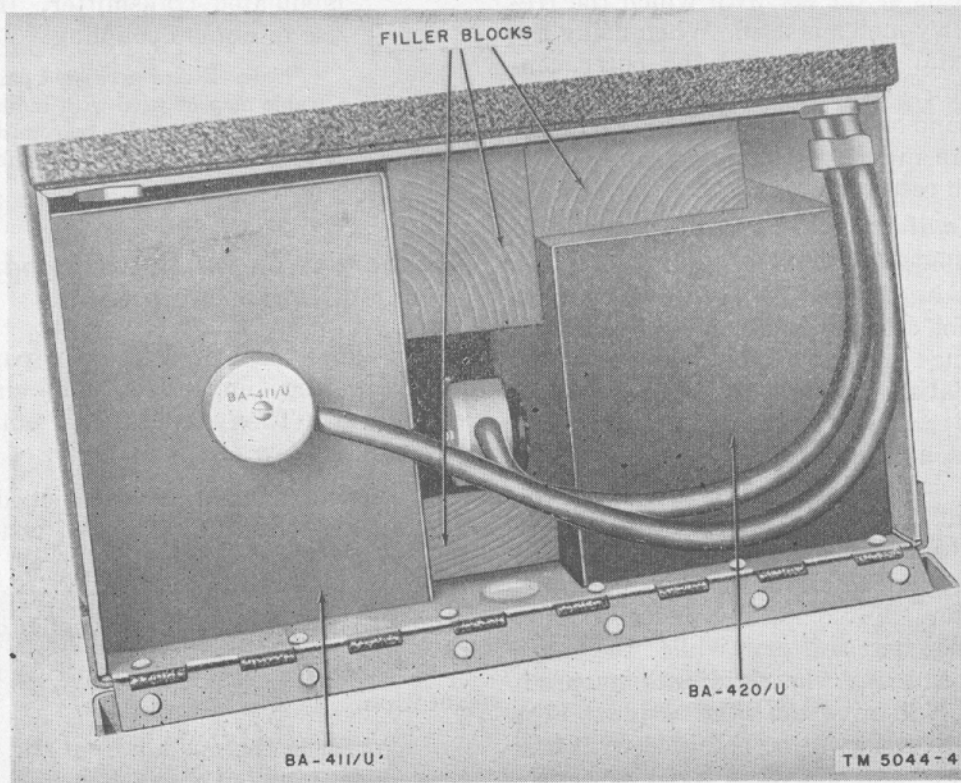


Figure 6. Installation of batteries.

handling the equipment since it is a precision instrument.

b. **INSTALLATION OF BATTERIES.** Remove the frequency meter chassis from the cabinet as a precaution while installing the batteries.

- (1) Select one Battery BA-411/U, which measures 5.5 volts or higher between pins 1 and 5, and one Battery BA-420/U, which measures 121.5 volts or higher between pins 1 and 6. Test the batteries as outlined in paragraph 36.

Note. If there is any choice of batteries, use those with the highest voltages, because they will give longer service. Do not install batteries which measure lower than the abovementioned voltages except in an emergency.

- (2) Release the two small catches at the lower rear of the set by revolving them a half-turn with a screw driver. Open the door to the battery compartment.
- (3) Place the batteries partly in the battery compartment in the location shown in figure 6, but leave the connection sockets exposed.

- (4) Insert the proper plug into the proper battery socket. One plug has alignment keys different from those on the other. Do not try to force the wrong plug into a socket.

- (5) After the plugs are inserted in the sockets, slide the batteries back into their compartment. Insert the filler blocks as shown in figure 6.

- (6) Close the compartment door and rotate the catches to hold the door closed. Replace the frequency meter chassis and make certain that it is fastened securely in place.

c. **INSTALLATION OF ANTENNA.**

- (1) *Coaxial and twisted-pair antennas.* In most cases, especially where noise or high-power interference is present, a coaxial or twisted-pair antenna is preferable for work with receivers. When either of these is used, one of the conductors must be grounded to the frequency meter ground terminal on the chassis of the set and to the

chassis of the set with which the frequency meter is used. When using the coaxial cable, ground the outer conductor. When using the twisted pair, ground one of the leads. Either a direct or an inductive coupling may be used with receivers.

Caution: Never directly connect the frequency meter to a radio transmitter.

- (2) *Rigid antennas.* When close coupling is not desired, or when using the frequency meter with a transmitter, a radiating antenna is preferable. In this case, a rigid antenna may be used. Attach about 1 foot of No. 12 wire to the antenna terminal of the meter. Bend the wire so that it will be free and will run parallel and close to the antenna lead of the receiver or transmitter. For checking installed airborne transmitters while they are transmitting, the rigid antenna probably will give the best results. Best results also will be obtained with this type of antenna when testing a noise-

modulated transmitter. In this case, use minimum coupling.

Note. Either a twisted pair or a coaxial cable may be used with inductive coupling when working with transmitters if a pick-up loop is attached to the ungrounded conductor.

12. Service on Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 10 for uncrating, unpacking, and checking the equipment. Then proceed as outlined in *b* through *d* below.

b. Check the used or reconditioned equipment for tags or other indications of changes in the wiring of the equipment. If any changes in wiring have been made, note the change in this manual, preferably on the schematic diagram.

c. Check the operating controls for ease of rotation.

d. Perform the installation and connection procedures given in paragraph 11.

Section II. CONTROLS AND INSTRUMENTS

13. General

Haphazard operation or improper setting of the controls can cause damage to electronic equipment. For this reason, it is important to know the function of every control. The actual operation of the equipment is discussed in section III of this chapter.

14. Operating Controls

(fig. 4)

The following table lists the operating controls of Frequency Meter TS-174B/U and indicates what they do:

Control	Function
Selector switch (S1) (labeled OFF, STANDBY, CRYSTAL, OPER., and CHECK).	<p>In the OFF position, power to the instrument is turned off.</p> <p>In the STANDBY position, the vfo filament is turned on.</p> <p>In the CRYSTAL position, the crystal oscillator may be used to produce an accurate 1,000-kc signal. The vfo does not operate in this position.</p> <p>In the OPER. position, the vfo may be used to determine the frequency of a received signal or to radiate a signal from the meter at the frequency to which the meter is set. The crystal oscillator does not operate in this position.</p> <p>In the CHECK position, both the crystal oscillator and the vfo may be used so that the vfo may be adjusted accurately.</p>

Control	Function
MODULATION OFF-ON switch (S2)-----	This switch is used to apply modulation to the frequency meter for use as a signal generator. In the ON position, a 900-cycle (approximately) audio note is applied to the frequency meter.
GAIN control (R5)-----	This control adjusts the volume of sound in the headsets.
DIAL HUNDREDS-----	This is a drum dial on the shaft of the main tuning capacitor. It is graduated into 50 equally spaced divisions.
DIAL UNITS-----	This is a disk type dial graduated into 100 divisions used to read DIAL HUNDREDS more accurately. One complete revolution of DIAL UNITS moves DIAL HUNDREDS through one division. In order to improve still further the accuracy of reading the frequency meter, a vernier scale is provided to split the individual divisions of the DIAL UNITS into tenths.
PHONES JACKS (J1 and J2)-----	Two PHONES jacks are provided for plugging in the headset. Plugging in the headset connects the filament supply to the selector switch so that, if the set is on and operating, removal of the headset will cause the set to shut down.
ANT (E2)-----	The ANT (antenna) post, used in connecting the antenna, is located on the top of the cabinet.
G (ground) (E1)-----	This terminal, for connection to ground, is located on the front panel.
LOCK (dial lock) -----	The dial lock is supplied on the DIAL UNITS disk to lock the dial in position.

Section III. OPERATION UNDER USUAL CONDITIONS

15. Starting Procedure

a. Plug the headset into one of the PHONES jacks.

Note. The headset must always remain plugged in; otherwise, the frequency meter will be rendered inoperative.

b. Turn the selector switch to the CHECK position and allow the tubes to heat for 15 minutes.

Note. Make sure the set is warmed up under the same temperature conditions it will encounter in actual use.

16. Use of Dials

a. DESCRIPTION. The following three separate scales are provided in order to obtain accurate readings:

(1) A *hundreds scale* (DIAL HUN-

DREDS). This is the drum dial behind the small window (fig. 4). The lines across the window act as the index.

(2) A *tens and units scale* (DIAL UNITS). This is the scale printed around the edge of the main tuning dial. The fixed arrow directly above the dial serves as the index.

(3) A *vernier scale*. This scale, which is immediately to the left of the dial index line, consists of 10 lines, each line representing a tenth of a unit.

b. SETTING THE DIAL. To set the tuning dial, loosen the dial LOCK screw and proceed as follows:

(1) Turn the tuning dial until the proper hundreds graduation is directly under the line marked on the window.

- (2) From this point, turn the tuning dial clockwise until the *tens and units graduation* is directly under the index.
- (3) Continue turning very slowly. Stop at the point where the tenths unit desired, as read from the *vernier* (counting counterclockwise from the index), coincides directly with a unit on the dial. Figure 7 shows the vernier set at .7. Note that, between these two points (the index and vernier readings), there are a similar number of graduations (seven) on the dial.

Caution: To eliminate errors caused by backlash in the gears of the dial mechanism, always approach the final setting of the dial by turning it in a clockwise direction.

- (4) To keep the setting fixed, close the friction lock. This lock is especially valuable when the instrument is subjected to vibration.

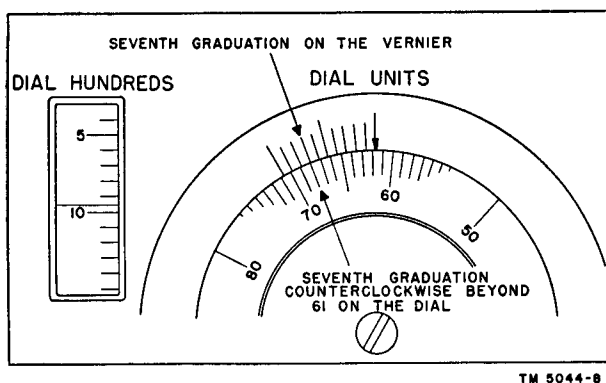


Figure 7. Frequency Meter TS-174B/U, main tuning dial.

c. READING THE DIAL. Before using the frequency meter for actual measurements, it is a good idea to practice reading dial settings until they can be read quickly and accurately. By using the three scales, in turn, it is easy to take a reading.

- (1) *Hundreds scale.* The number above the horizontal line on the window is the hundreds reading (9 in fig. 7).
- (2) *Tens and units scale.* The number to the right of the index represents the tens and unit digits (61 in fig. 7).
- (3) *Vernier scale.* The point where the vernier graduation coincides directly

with any dial graduation represents the tenths unit (.7 in fig. 7). The complete reading of the example in figure 7 is 961.7.

17. Calibration Book

(fig. 8)

The calibration book is kept inside the cover of the meter control panel. The book is exposed by pulling a small knob on its own metal cover. In addition to a list of dial settings, with their associated frequencies, the book contains instructions for making common measurements.

Note. The values listed in the calibration section refer only to the meter the serial number of which is printed on the fly leaf. The calibration book must be protected. It is a valuable part of the equipment.

a. FUNCTION. The table of dial settings with their corresponding frequencies (fundamental and harmonics) may be used to—

- (1) Find the exact frequency for a certain dial setting of the meter.
- (2) Find the dial setting needed to set the meter at a certain frequency.

b. INDEXING. Various indexes are provided. The main indexes are on the large pages. In addition, each page has figures which simplify the use of the book.

- (1) *Large pages.* These pages contain—
 - (a) Table of pages versus dial settings.
 - (b) Table of pages versus frequency settings.
 - (c) Table of *crystal check points*.
 - (d) A *guide to dial settings* (on top).
 - (e) A *guide to frequencies—megacycles* (on top).
- (2) *Smaller pages.* These pages contain—
 - (a) *Page tabs.* The *guide to dial settings* and the *guide to frequencies—megacycles* can always be seen projecting above the other pages. The page number on the tabs appears beneath the guide numbers and indicates on what page a certain range of settings and the frequencies they represent can be found. For instance, in figure 8 the tab marked $\frac{1}{3}$ falls between 1000 and 1250 in the *guide to dial settings* and between 23.00

and 24.00 in the *guide to frequencies*—megacycles. Look at page $\frac{1}{3}$. The dial readings run between 1173.5 to 1288.0, approximately within the range of 1000 to 1250, and the fundamental frequencies run between 24.00 and 24.50.

- (b) *Frequency range and dial readings.* These are found above the table and give, at a glance, the range of frequencies and the dial settings to be found on that page.
- (c) *Crystal check point.* This is printed in red at the bottom of the page.
- (d) *Av. dial div. per 10 kc.* This is at the bottom of the right-hand column of each page.

c. FINDING THE FREQUENCY FROM A GIVEN DIAL READING.

- (1) Find the number of the page on which the desired tuning dial setting can be found by referring to the index for

calibration range either in the front of the book or on the long middle page. A better way is by using the *guide to dial settings* at the top of the long pages (b(2)(a) above), which enables the operator to open the book to the desired page by the use of the proper thumb tabs.

- (2) After the page has been found, locate the dial setting in the left-hand column. The frequencies (fundamental and harmonics) which this dial setting represents are in the right-hand columns.
- (3) If the dial reading falls somewhere between two other readings, a midpoint frequency should be used. For greater accuracy, use interpolation, as described in e below.

d. FINDING A DIAL READING FOR A GIVEN FREQUENCY.

- (1) Using the *guide to frequencies—megacycles* at the top of the long page, find

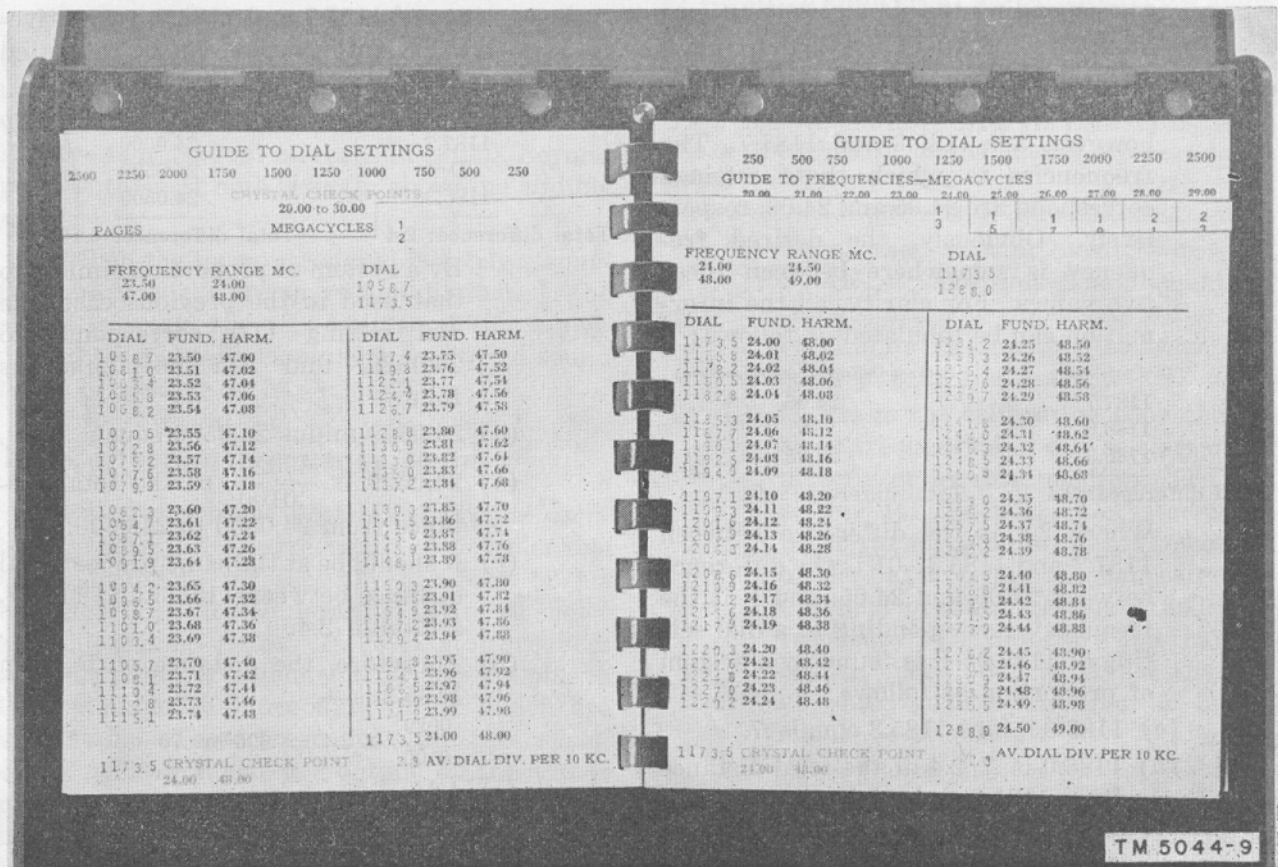


Figure 8. Frequency Meter TS-174B/U, calibration book.

the proper page on which the frequency is listed.

- (2) Locate the desired frequency in one of the right-hand columns. The dial setting will be in the left-hand column on the same line.
- (3) If the frequency is somewhere between two frequency readings in the column, use a midpoint dial setting. For greater accuracy, use interpolation, as described below.

e. FINDING ACCURATE FREQUENCY READINGS BY INTERPOLATION. The observed dial setting (when the frequency meter is being used to measure an unknown frequency) may often fall between two values listed in the calibration book. To aid in the calculation of the exact frequency corresponding to this intermediate value, interpolation should be used. The process of interpolation can best be explained by an example:

- (1) *Problem.* The observed dial setting is 1186.0. Find the unlisted frequency corresponding to this dial setting.
- (2) *Solution.* 1186.0 is not listed in the calibration book. The two listed numbers between which 1186.0 would fit, however, are 1185.3 and 1187.7. The frequencies to which these settings correspond are 24.05 and 24.06, respectively. Obviously, the desired frequency is somewhere between these two values. For clarity, all the information can be tabulated as follows:

Dial settings	Corresponding frequencies (mc)
1187.7	24.06
1186.0	F
1185.3	24.05

Total difference: 2.4

Total difference: .01

Where 2.4 is the difference between 1187.7 and 1185.3, .01 is the difference between 24.06 and 24.05, and F is the frequency corresponding to a dial setting of 1186.0. F is found by a system of proportion as follows:

- (a) 1186.0 minus 1185.3 equals .7.
- (b) 1186.0 is $.7/2.4$ of the total distance from 1185.3 to 1187.7.
- (c) F should be at the same proportional distance between 24.05 and 24.06, a total of .01 mc.

- (d) Therefore, the distance of F from 24.05 is—

$$\frac{.7}{2.4} \times .01 = .0029$$

- (e) Add:

$$\begin{array}{r} 24.05 \\ .0029 \\ \hline \end{array}$$

$$24.0529 = F$$

f. FINDING ACCURATE DIAL SETTINGS BY INTERPOLATION. The desired frequency (when the frequency meter is being used to calibrate a radio transmitter) often may fall between two values listed in the calibration book. Interpolation may be used in this case also to find the exact dial setting.

- (1) *Problem.* Suppose it is desired to set the frequency meter to a frequency of 24.0529 mc. What should the dial setting be?
- (2) *Solution.* As shown in the calibration book, 24.0529 falls between the two listed values: 24.0600 and 24.0500. These values correspond to dial settings of 1187.7 and 1185.3, respectively. The information can be tabulated as follows:

Dial settings	Corresponding frequencies (mc)
1187.7	24.0600
D	24.0529
1185.3	24.0500

Total difference: 2.4

Total difference: 0.100

By a system of proportion similar to that used in the previous case, the dial setting (D) corresponds to 24.0529, and can be found as follows:

- (a) 24.0529 minus 24.0500 equals .0029.
- (b) 24.0529 is $\frac{.0029}{.0100}$ of the total distance from 24.0500 to 24.0600.
- (c) D should be at the same proportional distance between 1185.3 and 1187.7, a total of 2.4.
- (d) Therefore, the distance of D from 1185.3 is—

$$\frac{.0029}{.0100} \times 2.4 = .696 \text{ or } .70$$

- (e) Add:

$$\begin{array}{r} 1185.3 \\ .70 \\ \hline \end{array}$$

$$1186.0 = D$$

18. Zero-Beat Detection

When two frequencies are present in the input of a mixer circuit, the difference between the two will appear in the output circuit (PHONES) as a third frequency. This difference is called the beat frequency. If this beat frequency is in the a-f (audio-frequency) range, it can be heard in the headset.

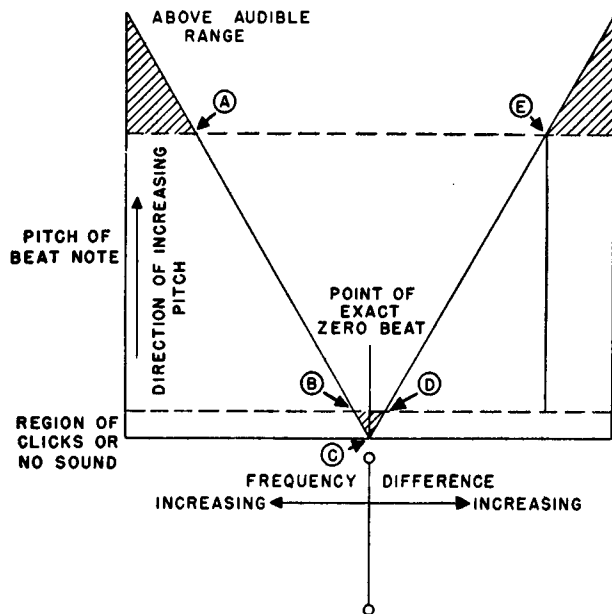
a. Figure 9 shows what happens to the beat note as one of the input frequencies is varied. The shaded region to the left of point A indicates an area where the beat frequency is above the a-f range. This is due to the fact that the two input frequencies are far apart. At point A a very high-pitched beat note can be heard in the headset. As one frequency is brought closer to the value of the other, the tone decreases in pitch down to point B. At this point, the tone is replaced by a series of clicks which decrease in rapidity until they stop (or are heard at very infrequent intervals) at point C. This is the point at zero beat, the point where the two original frequencies are exactly equal.

b. Changing the variable frequency still further in the same direction causes the clicks to increase in rapidity until they stop at point D, where a low-pitched tone is heard. From D to E there is a gradual increase in pitch. Beyond point E the best note is again above the audible range.

c. When the incoming signal is fairly strong, the tone or clicks are sharp and distinct. If the signal is weak, the zero-beat condition is evidenced by a slowly changing low-pitched sound in the headset.

19. Correcting Frequency Meter

a. CRYSTAL CHECK POINTS. A crystal oscillator is built into the frequency meter to enable the operator to increase the accuracy of his readings. The block diagram in figure 10 shows how this is done. The crystal oscillator produces a fundamental frequency of 1,000 kc plus a large number of harmonics, all of which are very stable. These frequencies are the *crystal check points*. When the output of the vfo is made equal to a check point frequency, zero beat is produced in the mixer and no sound is heard in the headset. If zero beat is not obtained at the correct dial setting as indicated



TM 5044-10

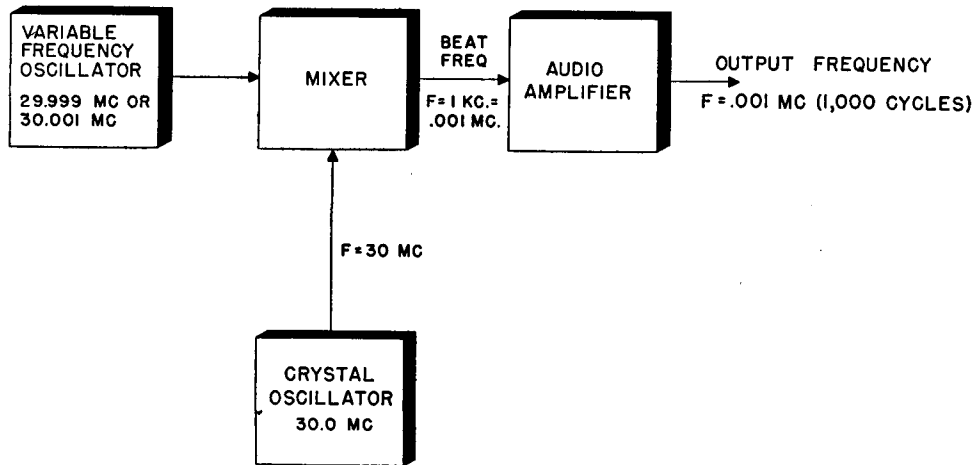
Figure 9. Beat-frequency detection.

by the calibration book, the CORRECTOR knob, which is a fine control of vfo frequency, can be varied until zero beat is obtained.

Note. If, when calibrating the dial against a crystal check point, two or more beats are heard in the range of the CORRECTOR control, *always* zero-beat on the stronger of the two.

b. TYPICAL CORRECTION PROCEDURES.

- (1) Turn the selector switch to the STANDBY position. The filaments of the vfo are now connected to the battery, allowing the tube to warm up. Also, plug in the headset.
- (2) Locate in the calibration book the desired frequency and dial setting either directly or by interpolation. The dial setting for the nearest crystal check point (printed in red) is at the bottom of the page. Using the figures of the previous problem, setting 1186.0 and frequency 24.0529 mc, we find that our crystal check point is 1173.5 (fig. 8), at which point a frequency of 24 mc should be produced.
- (3) After the set has warmed up for 15 to 20 minutes, turn the selector switch to CHECK. Both the crystal oscillator and the vfo circuits are now in operation.



TM 5044-12

Figure 10. Block diagram of meter in CHECK position and 30-mc check point.

- (4) Set the tuning dial at the selected *crystal check point*, 1173.5. At this point, the vfo produces a frequency close to 24 mc. The vfo output beating against the crystal oscillator output produces an audible tone.
- (5) If no tone is heard, its absence may be due to one of the following conditions:
 - (a) The meter is in exact calibration. If this is the case, turning the CORRECTOR control slightly in either direction will produce a sound of increasing pitch in the headset.
 - (b) The two frequencies are so far apart that no sound is heard; that is, their beat frequency is above the audible range. A change of the CORRECTOR control in the proper direction will produce an audible sound.
 - (c) The set is defective. In this case no sound will be heard at any point within the range of the CORRECTOR control.
- (6) After a tone is heard, turn the CORRECTOR knob until zero beat is obtained. This is the point where the vfo and one of the harmonics of the crystal oscillator are at the same frequency, 24 mc.
- (7) Check the accuracy of the meter further, as follows: Rotate the tuning dial to the next check point. The point where this zero beat is obtained should be within two dial divisions of the setting listed in the calibration book. If it is not, check the batteries.
- (8) Turn the selector switch to OPER. Place the dial at the desired setting. In this example it is 1186.0. Now the frequency meter is producing a frequency which is very close to that obtained from the calibration book, 24.0529 mc.

20. Frequency Measurements

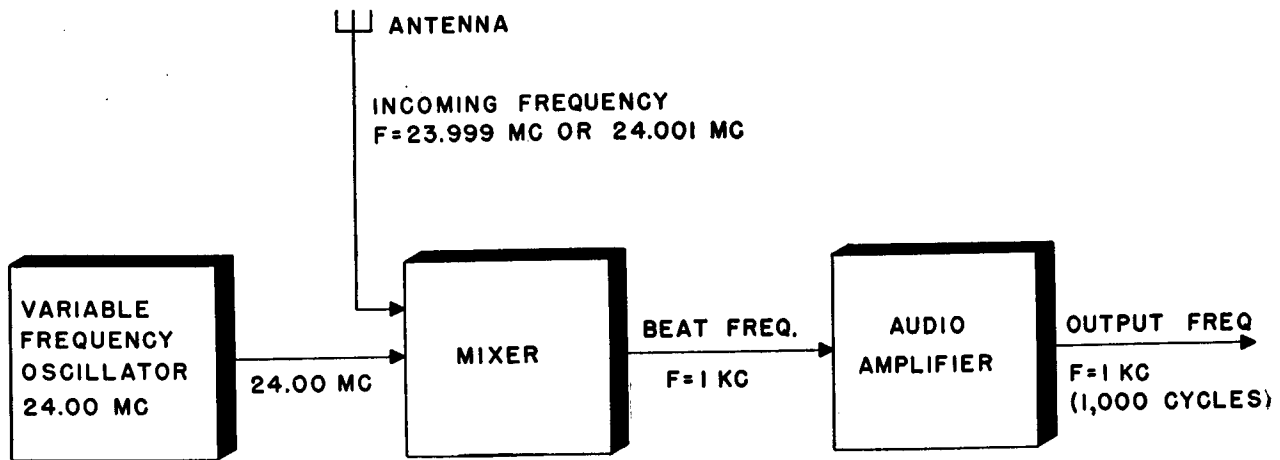
a. GENERAL. Frequency Meter TS-174B/U may be used for measuring accurately a frequency emitted from an outside source of local or remote origin. Since many harmonics are produced by the meter, the approximate frequency of the source should be determined first in order to avoid errors. Once this is done, the incoming frequency can be determined by the method shown in figure 11. Assume that the unknown frequency is approximately 24 mc. The vfo is set at the approximate frequency of 24 mc. Also assume that the unknown frequency applied to the mixer produces a beat note of 1 kc. This means that it is either 24.999 mc or 24.001 mc. If the dial, which controls the vfo, is now moved in the direction of decreasing pitch, the vfo frequency gets closer to the unknown

Caution: Once it is set, do not touch the CORRECTOR knob unless a new crystal check point is used.

frequency. When zero beat is obtained, the two are equal and the dial tells us the frequency of the unknown. If the dial setting is not found in the calibration book, interpolation is necessary to find the exact frequency (par. 17e).

d. MEASUREMENT OF A SIGNAL OF REMOTE ORIGIN. To measure accurately the frequency of a signal of remote origin—

- (1) Tune the signal in on a radio receiver and note the frequency from the receiver calibration.



TM 5044-13

Figure 11. Block diagram of meter in OPER. position, external signal applied to antenna.

b. MEASUREMENT OF LOCAL TRANSMITTER, APPROXIMATE FREQUENCY KNOWN.

- (1) Correct the vfo to the *crystal check point* nearest the approximate known frequency.
- (2) Throw the selector switch to OPER.
- (3) Loosely couple the frequency meter antenna to the source.
- (4) Move the frequency meter tuning dial until zero beat is obtained.
- (5) Refer to the calibration book to obtain the frequency corresponding to the dial setting obtained.

c. MEASUREMENT OF LOCAL TRANSMITTER, APPROXIMATE FREQUENCY UNKNOWN. To measure accurately the emitted frequency of an adjacent transmitter or oscillator, the frequency of which is unknown, determine first the approximate frequency with the aid of an absorption type wavemeter or a radio receiver, then the actual frequency as described in *b* above. If the receiver is used to determine the approximate transmitter frequency, make sure that it is not tuned to a harmonic of the transmitter under measurement.

- (2) Correct the vfo at the *crystal check point* nearest this approximate frequency.
- (3) Turn the selector switch to OPER.
- (4) Loosely couple the frequency meter to the receiver antenna.
- (5) Turn the meter tuning dial until a signal is heard in the headset.

Note. To be sure that the output of the frequency meter is being heard, tap the ANT post with the finger. A change in tone will be heard in the headset.

- (6) Tune the frequency meter for zero beat against the receiver signal. If the receiver signal is blanked out by the frequency meter signal, place the receiver in operation for c-w (continuous-wave) reception; zero-beat the receiver to the incoming signal, then zero-beat the frequency meter to the receiver. If this cannot be done, reduce the coupling of the frequency meter.
- (7) Refer to the calibration book to obtain the frequency corresponding to the dial setting obtained.

21. Precautions During Operation

a. ACCURACY. For most accurate results, allow the frequency meter to warm up for about 15 to 20 minutes before giving the CORRECTOR control its final adjustment. This control corrects the accumulated errors due to temperature, humidity, battery voltage variations, warm-up drift, and rough handling. Therefore, always adjust the CORRECTOR at the same temperature at which the instrument is to be used. If the meter is taken from a heated building to the cold outdoors, it is best to allow the meter to stand for 30 minutes or more before turning it on for the warm-up period. If this cannot be done, readjust the CORRECTOR at the *crystal check point* used before each reading. It is also a good idea to recheck the CORRECTOR in ordinary use, especially if measurements are made over a long period of time.

b. FALSE BEAT NOTES. Many harmonics of the vfo are present but are not listed in the calibration book. These unlisted harmonics can cause false beat notes which may lead to errors in frequency measurement or frequency adjustments. To be sure of the correct beat note, it is

essential that the operator know the approximate calibration of the equipment being measured or adjusted.

c. BATTERY LIFE. In most instances, the 15-minute warm-up periods far exceed the actual periods of measurement; consequently, any reduction in warm-up time prolongs the useful battery life. Therefore, in the early stages of the warm-up period, set the selector switch at CHECK and adjust the CORRECTOR control for a beat note at the *crystal check point* used. If the beat note drifts very slowly, the meter may be used. However, readjust the CORRECTOR control immediately before each reading.

Caution: High temperatures shorten the life of the batteries. Always store spare batteries, particularly B batteries, in a cool, dry place.

22. Stopping Procedure

When the work with the frequency meter is completed, perform the following steps:

- a. Turn the selector switch to the OFF position.
- b. Remove the headset from the jack.
- c. Close the front cover of the cabinet.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

23. General

The operation of Frequency Meter TS-174-B/U may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. In the following paragraphs instructions are given for procedures minimizing the effect of these unusual operating conditions.

24. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

- a. Handle the equipment carefully.
- b. Keep the equipment warm and dry. If a good supply of batteries is on hand, keep the selector switch in the STANDBY position to help keep the set warm.

c. Locate the equipment inside a heated inclosure where there is no danger of a cold draft striking the cabinet when a door is opened. A sudden draft of cold air is often sufficient to cause a considerable shift in frequency. If the inclosure is so constructed that this precaution is impossible, place a blanket or some other barrier between the source of the draft and the equipment.

d. Wear a knitted woolen cap over the earphones of the headset when operating in the open air with headsets that do not have rubber earpieces. Frequently, when headsets without rubber earpieces are worn, the edges of the ears may freeze without the operator's being conscious of this condition. Never flex rubber earcaps, since this action may render them useless. If water gets into the receivers, or if moisture condenses within them, it may freeze and impede the actuation of the diaphragm. When this happens, remove the bakelite caps and remove the ice and moisture from the receiver.

e. When equipment which has been exposed to the cold is brought into a warm room, it will start to sweat and will continue to do so until it reaches room temperature. When the equipment has reached room temperature, dry it thoroughly. *Do not overheat.* This condition also arises when equipment warms up during the day after exposure during a cold night.

f. Use any improvised means to protect dry batteries, since they will fail if they are not protected against the cold. Preheat the batteries. To prevent heat loss, place them in bags lined with kapok, spun glass fiber materials, animal skins, or woolen clothing.

25. Operation in Tropical Climates

When operated in tropical climates, radio equipment may be installed in tents, huts, or, when necessary, in underground dugouts. When equipment is installed below ground or when it is set up in swampy areas, moisture conditions are more acute than normal. Ventilation is usually very poor, and the high relative humidity causes condensation or moisture on the equipment whenever the temperature of the equipment becomes lower than that of the ambient air. To minimize this condition, place lighted electric bulbs under the equipment.

26. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem which arises with equipment operation in desert areas is the large amount of sand or dust and dirt which enters the moving parts of radio equipment, such as gear trains, etc. The ideal preventive precaution is to house the equipment in a dustproof shelter. Since, however, such a building is seldom available and would require air conditioning, the next best precaution is to make the building in which the equipment is used as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and, with sand, secure the side walls of tents to prevent their flapping in the wind.

c. Take care to keep the equipment as free from dust as possible. Make frequent preventive maintenance checks. Pay particular attention to the condition of the lubrication of the equipment. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit, which will damage the equipment.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. PREVENTIVE MAINTENANCE SERVICES

27. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that break-downs and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring. See AR 750-5.

28. Tools and Materials Required

The following tools and materials may be required for the organizational maintenance of this equipment.

a. **TOOLS.** Tool Equipment TE-41 or TE-113. There is a special wrench located in the case (fig. 5) that is used to tighten the setscrews that hold the control knobs. Do not use this wrench for any other purpose.

b. **MATERIALS.**

Item	Signal Corps stock No.
Orangestick -----	6Z7360
Brush, hair, 10 inches long*-----	6Z1401
Cheesecloth, bleached, lint-free*-----	6Z1989
Carbon tetrachloride*-----	6G184.1
Paper, sand, flint No. 000*-----	6Z7500-000
Solvent, dry-cleaning (SD) (Fed spec No. P-S-661a).	6G1914
Brush, paint-----	6Z1504

* Part of Tool Equipment TE-113.

29. General Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

c. If necessary, except for electrical contacts, moisten the cloth or brush with solvent (SD); then wipe the parts dry with a cloth.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

30. Performing Preventive Maintenance

The following preventive maintenance operations should be performed by organizational personnel at the intervals indicated, unless these intervals are reduced by the local commander.

Caution: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken. Elements of the frequency-determining circuits should not be touched, because disturbance of these elements may necessitate complete recalibration of the frequency meter.

Daily
Clean the exterior of the cabinet.
Weekly
<ol style="list-style-type: none"> 1. Remove the chassis from the cabinet and clean the dust from the interior of the cabinet and from the chassis. Be careful not to disturb any parts. An air jet at low pressure is the best system for removal of light dust and dirt. 2. Check tubes for tight seating in their sockets. Tighten loose tube clamps if necessary. 3. Inspect the bottom of the chassis for loose wiring, hardware, etc. 4. Reassemble the meter, check the battery voltages, and test for proper operation.
Monthly
Make visual inspections of the following; tighten and/or clean <i>if necessary</i> :

1. Tubes and crystal sockets and pins for loose contacts, dirt, and corrosion. Check vacuum tubes; replace if necessary with running spares. Note that tubes including final letters W or Y in their nomenclature can replace tubes of the same type without the W or Y; this is not advisable except in cases of emergency. Vfo tube 6SJ7-Y can be replaced with a type 6SJ7 tube, but the accuracy of the instrument may be changed if this is done.

2. Resistors for blistering, discoloration, and other evidence of overheating.

3. Switches S1 and S2 for dirt, corrosion, loose contacts, and unsatisfactory mechanical operation.

4. Terminal boards for cracks, dirt, and loose connections.

5. GAIN control R5 for unsatisfactory electrical and mechanical operation.

6. Mountings, machine screws, and nuts for mechanical looseness.

7. All visible terminals and connections for loose connections and corrosion.

8. Moisture-fungiproof coatings for breaks. (Re-

touch with a brush if necessary.)

9. Finish for scratches and bare spots. (Retouch if necessary.)

10. Unshielded variable capacitor C7 for dirt, corrosion, and bent plates.

11. PHONES jacks J1 and J2 for proper contact, dirt, corrosion, etc.

31. Lubrication Instructions

a. The gear train of the main tuning capacitor drive has been lubricated by the manufacturer with grease, lubricating, special (GL) and should need no further lubrication. If the frequency meter should be completely recalibrated, this lubrication may be checked.

b. A very small amount of a white grease such as petroleum jelly may be used on the Dzus fasteners that hold the chassis in the cabinet. This will make it much easier to remove and return the chassis.

Section II. WEATHERPROOFING AND PAINTING

32. Weatherproofing

a. GENERAL. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. TROPICAL MAINTENANCE. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13 and TB SIG 72.

c. WINTER MAINTENANCE. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66. Further instructions for operation at low temperatures are contained in TB SIG 219.

d. DESERT MAINTENANCE. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

e. LUBRICATION. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat. Refer to paragraph 31 for lubrication instructions.

33. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 000 sandpaper to clean the surface down to the bare metal; obtain a bright smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and sandpaper to complete the preparation for painting. Only authorized paint will be used.

Section III. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

34. Scope

a. The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is necessarily limited in scope by the tools, test equipment, and replaceable parts issued and by the existing tactical situation. Accordingly, trouble shooting is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out tubes, discharged batteries, etc.

b. The following paragraphs in this section help in determining which of the components, such as the oscillator or the audio section, is at fault and in localizing the fault in that component to the defective item, such as a tube or a resistor.

35. Visual Inspection

a. Failure of this equipment to operate properly will usually be caused by one or more of the following faults:

- (1) Improperly connected batteries.
- (2) Weak batteries.
- (3) Defective tubes.
- (4) Worn, broken, disconnected headset cord.
- (5) Contacts on selector switch damaged.
- (6) Wires or parts broken because of excessive vibration.
- (7) Inactive crystal.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred.

36. Battery Check

During normal service, check the battery voltages under normal load at weekly intervals. Also check them after periods of idleness of more than 1 week. Use a battery tester if available; otherwise, make the test as follows:

a. Open the battery compartment door to expose the batteries.

b. Remove the plug from Battery BA-420/U and connect the wires to pins 1 and 6 by wrapping a small piece of wire once around the pin. Replace the plug in the battery. Be careful not to short these two wires together or to the chassis. Using these two wires and a 20,000-ohm-per-volt voltmeter with a full scale range of at least 150 volts, measure the voltage of Battery BA-420/U with the frequency meter in the CHECK position. If this voltage is below 120 volts, replace Battery BA-420/U (par. 11b).

c. Remove the wires from the plug in Battery BA-420/U after turning the selector switch to the OFF position. Place the wires on pins 1 and 5 of the plug in Battery BA-411/U.

d. Using a 20,000-ohm-per-volt voltmeter with a full scale range of at least 6 volts and the two wires connected to the plug of Battery BA-411/U, measure the voltage with the meter in the CHECK position. If this voltage is below 5.4 volts, replace Battery BA-411/U (par. 11b).

e. Remove the wires used for measurements after turning off the set. Replace the plugs in their batteries, replace the batteries in their compartment, and close the compartment door.

37. Trouble Shooting by Using Equipment Performance Checklist

a. GENERAL. The equipment performance checklist (par. 38) will help the operator to locate trouble in the equipment that may be corrected by the operator. The list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective measures the operator can take. To use this list, follow the items in numerical order.

b. ACTION OR CONDITION. For some items, the information given in the action or condition column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indication given in the normal indications column.

c. NORMAL INDICATIONS. The normal indications listed include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. CORRECTIVE MEASURES. The corrective measures listed are those the operator can make

without turning the equipment in for repairs. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. However, if the tactical situation requires the use of the frequency meter, the operator must maintain the set in operation as long as it is possible to do so.

38. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
P R E P A R A T O R Y	1	Phones-----	Plugged into PHONES jack.		
	2	Selector switch--	Set at OFF position-----		
	3	GAIN control---	Set to maximum position---		
	4	MODULATION OFF-ON switch.	Set to OFF position-----		
S T A R T	5	Selector switch--	Turn to CHECK position--	Noise heard in headset and beat note heard if tuning dial is set near a crystal check point.	Check battery plugs and voltages. Check headsets and headset cord. Check tubes for proper seating and warmth. Be sure tube clamps are in position and tight.
S T O P	6	Selector switch--	Turn to OFF position-----		

CHAPTER 4 THEORY

39. Block Diagram

Frequency Meter TS-174B/U consists of an electrical circuit composed of four principal parts. Figure 12 shows these parts in block outline. The functions of the circuits are as follows.

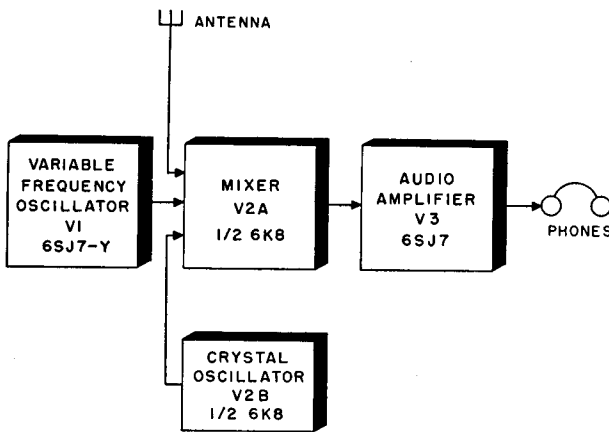


Figure 12. Frequency Meter TS-174B/U, block diagram.

a. VARIABLE-FREQUENCY OSCILLATOR (V1). This oscillator generates a signal the frequency of which (including harmonics) can be adjusted accurately to any value between 20 and 250 mc.

b. CRYSTAL OSCILLATOR (V2B). The crystal oscillator generates a signal the frequency of which is set accurately at 1,000 kc. The signal also contains many strong harmonics.

c. MIXER (V2A). This circuit mixes two signals together to produce a beat-frequency signal at the output. The two signals may be either—

- (1) The vfo signal and any signal received by the frequency meter antenna (as in the OPER. position of the selector switch).
- (2) The vfo signal and the crystal oscillator signal (as in the CHECK position of the selector switch).

d. AUDIO AMPLIFIER (V3). This stage amplifies the beat-frequency signal produced in the mixer circuit so that it may be heard in the headset. When the MODULATION OFF-ON switch is in the ON position, the audio stage functions as an audio oscillator with a frequency output of approximately 900 cycles.

40. Variable-Frequency Oscillator (fig. 13)

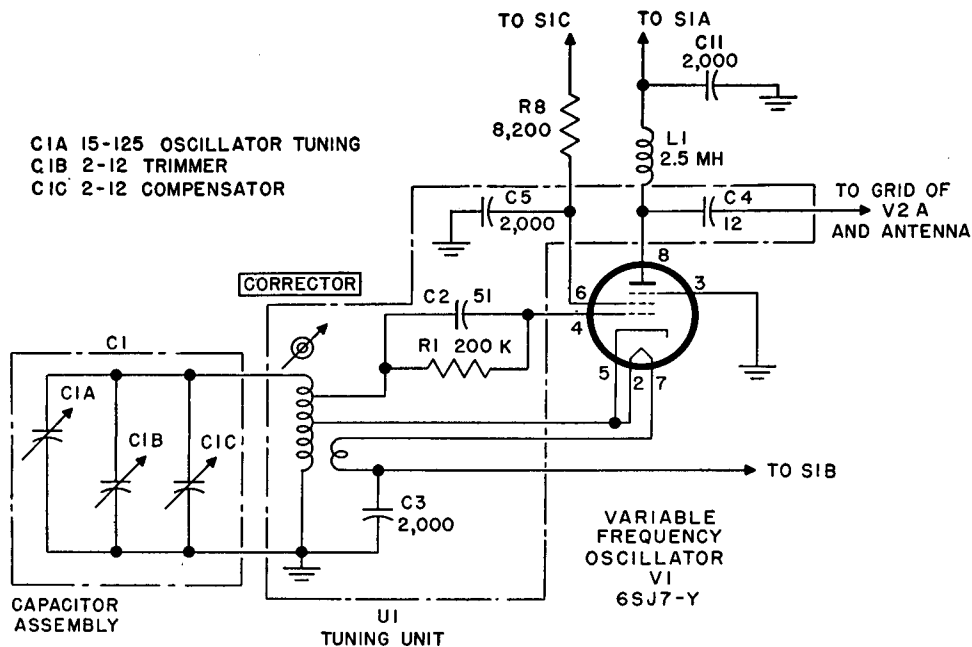
The vfo stage, V1, consists of three essential elements: the tuning capacitor, the coil assembly (tuning unit with CORRECTOR), and oscillating tube 6SJ7-Y, connected as an electron-coupled oscillator.

a. TUNING CAPACITOR. Capacitor C1A controls the frequency of the oscillator. This capacitor has a straight-line frequency operating curve and the tuning element is rotated by a precision worm wheel and a hardened stainless steel worm. The frequency selector dial attached to the worm shaft can be locked at any setting by means of the dial LOCK.

b. TUNING UNIT (U1). The tuning unit mounted in a metal inclosure, consists of the coil and corrector, four capacitors, one resistor, and the socket for the oscillating tube.

c. CIRCUIT CORRECTOR. The small disk which is mounted on the insulated top of the corrector shaft to which the knob labeled CORRECTOR on the front panel is fastened, acts as a short-circuiting turn on the coil. This disk enables the operator to alter the frequency of the adjustable frequency oscillator circuits independently of the dial, and thereby corrects the circuit for effects of temperature, voltage variations, etc., to insure the accuracy of the meter at all times.

d. TRIMMING CAPACITOR. Capacitor C1B, accessible through the hole in the side of the chassis, is in shunt with the main tuning capacitor C1A, and insures, by carefully controlling the fixed capacitance in the resonant cir-



TM 5044-16

Figure 13. Variable-frequency oscillator, simplified schematic diagram.

cuit, a straight-line frequency operating curve and a frequency range that virtually covers the entire dial. This control is preset for the main tuning capacitor and should not be changed except during calibration. It is an integral part of the main tuning capacitor assembly.

e. COMPENSATING CAPACITOR. Capacitor C1C, in shunt with the main tuning capacitor C1A, compensates for capacity variation in the oscillating circuit caused by changes in temperature. The correct setting has been determined by the manufacturer and should not be changed at any time. The compensating capacitor is an integral part of the main tuning capacitor assembly.

f. OSCILLATOR HARMONICS. The circuit of the meter is designed to give the largest possible dial space of frequency increment per unit. This design necessitates the use of a circuit radiating a large amount of harmonic energy. For example, if the frequency tuning dial is turned to produce a frequency of 22 mc, harmonics will be emitted at 44, 66, 88, 110, 132, 154, and 176 mc. The principal harmonics of each frequency are listed in the calibration book, on the same line as the fundamental frequency. The operation of the instrument is unchanged without regard to the column in which the particular frequency appears.

41. Crystal Oscillator

a. The crystal oscillator circuit (fig. 14) uses the triode section of tube 6K8. It can be switched in and out of operation without affecting the rest of the circuit. This is done by applying or removing the plate potential.

b. The natural frequency of the crystal oscillator is 1,000 kc. The crystal oscillator emits a constant frequency of 1,000 kc with additional harmonic frequencies. These additional frequencies are integral multiples of the 1,000-kc frequency, that is 2,000, 3,000, etc., kc, and have the same percentage accuracy as the fundamental. They may be used as reference frequencies throughout the range of the meter.

c. The crystal is mounted in a holder which is designed to minimize the effects of vibration and shock. It is mounted in a standard metal tube envelope, and is provided with an octal base. It is hermetically sealed and contains an inert gas, so that variations in barometric, thermal, and humidity conditions cannot greatly affect the frequency. Crystal Unit DC-9-AJ has an output of 1,000 kc. In order to use any Crystal Unit DC-9-AJ in Frequency Meter TS-174B/U and obtain exactly 1,000-kc output, a variable capacitor, C7, is provided in shunt with

the crystal. The variable capacitor provides an adjustment range from 3 to 25 $\mu\mu\text{f}$ (micro-microfarads). The exact setting of variable capacitor C7 is determined at the time of installation of the crystal.

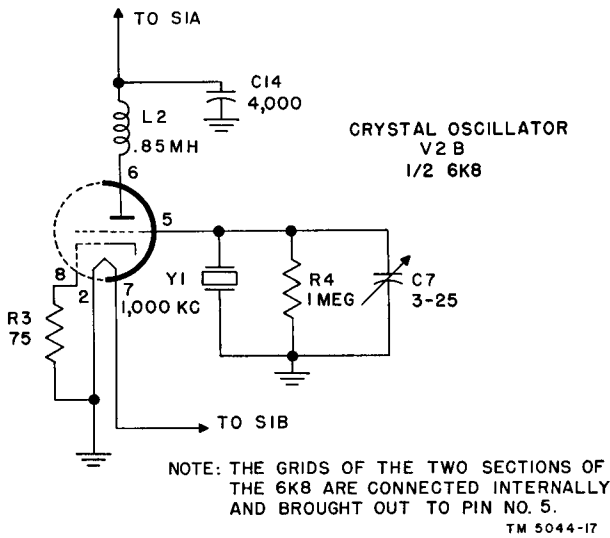


Figure 14. Crystal oscillator, simplified schematic.

42. Mixer

a. The mixer circuit (fig. 15), when in the CHECK position, combines the r-f potentials that are applied to the two operating grids of tube V2. If potentials with identical frequencies are applied to the grid of the mixer section of tube 6K8, the combined energy is rectified, and a steady nonvarying plate current, lacking an audio signal, results. If the two frequencies differ, even slightly, the plate current will increase and decrease at a rate depending on the frequency difference of the two input signals; that is, the tube mixes the vfo frequency with the crystal frequency.

b. When the selector switch is at OPER., an incoming frequency is compared with the oscillator frequency and produces a signal that is equal to the mathematical difference between them.

c. The beat frequency signal variations in plate current are coupled through capacitor C9 to the audio-amplifier tube, 6SJ7. Here the beat-frequency tone is amplified and transferred

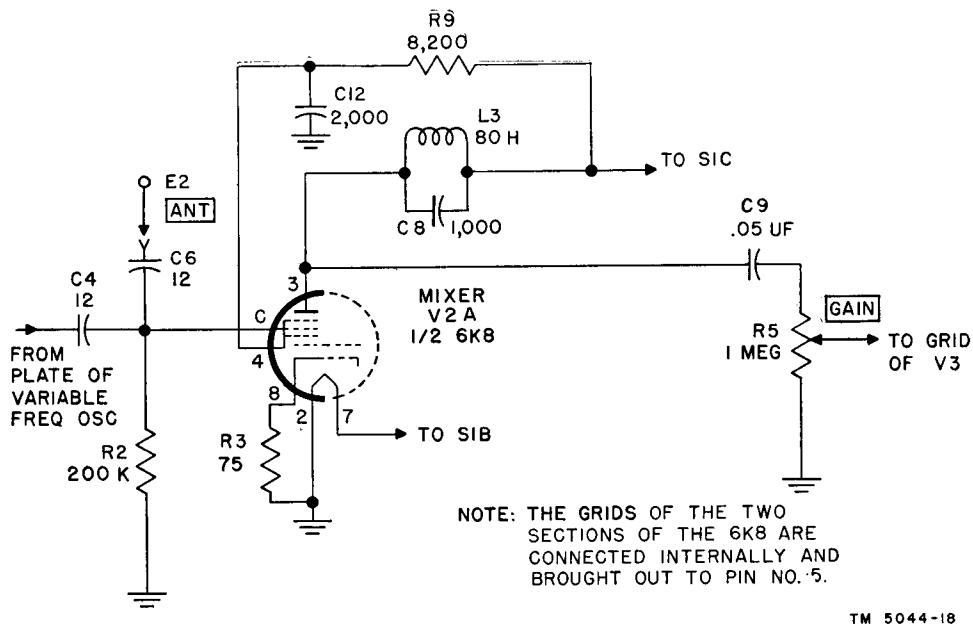
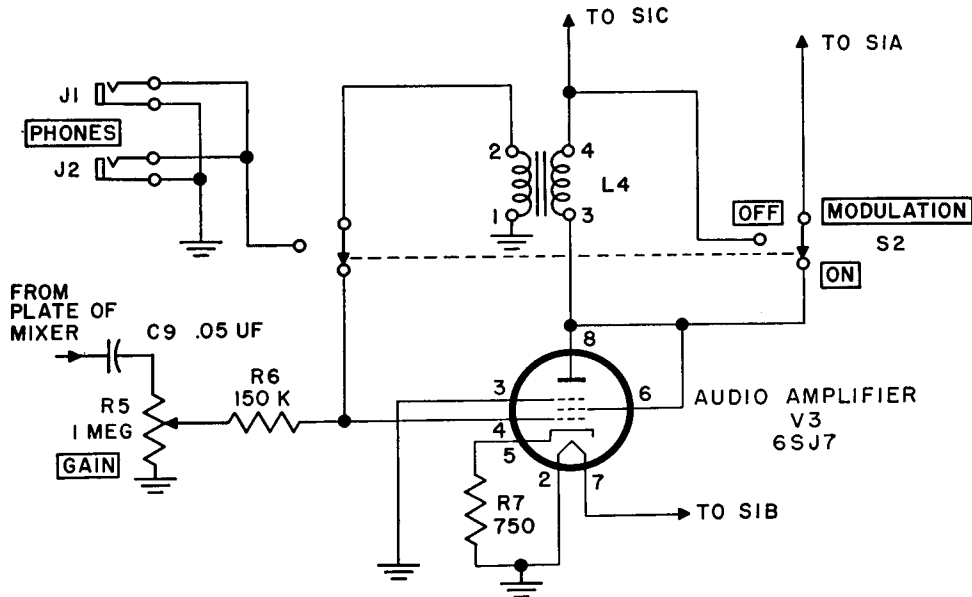


Figure 15. Mixer circuit, simplified schematic.

to the headset where the sound is heard. The transfer circuits from tube 6K8 work in conjunction with choke coil L3 which, together with shunt capacitor C8, provides a matching circuit between the tubes that is responsive to audio tones below a few hundred cycles. It is the ability of this circuit to handle extremely low frequencies that permits the zero-heat condition to be detected easily.

causing the circuit to oscillate at an audio frequency. A grid bias resistor (R6) is used to prevent the grid of the tube from becoming short-circuited to ground when the GAIN control is turned down. The frequency of modulation is approximately 900 cps (cycles per second). This 900-cycle note modulates either the vfo or the crystal oscillator, depending on the setting of the selector switch.



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Figure 16. Audio amplifier, simplified schematic.

43. Audio Amplifier

a. AMPLIFICATION. The audio amplifier, V3 (fig. 16), is a triode-connected tube 6SJ7. The audio signal level can be adjusted manually with the GAIN control (R5) to suit the operator's requirements. The headsets are operated at ground potential since the B+ potential has been removed by transformer L4.

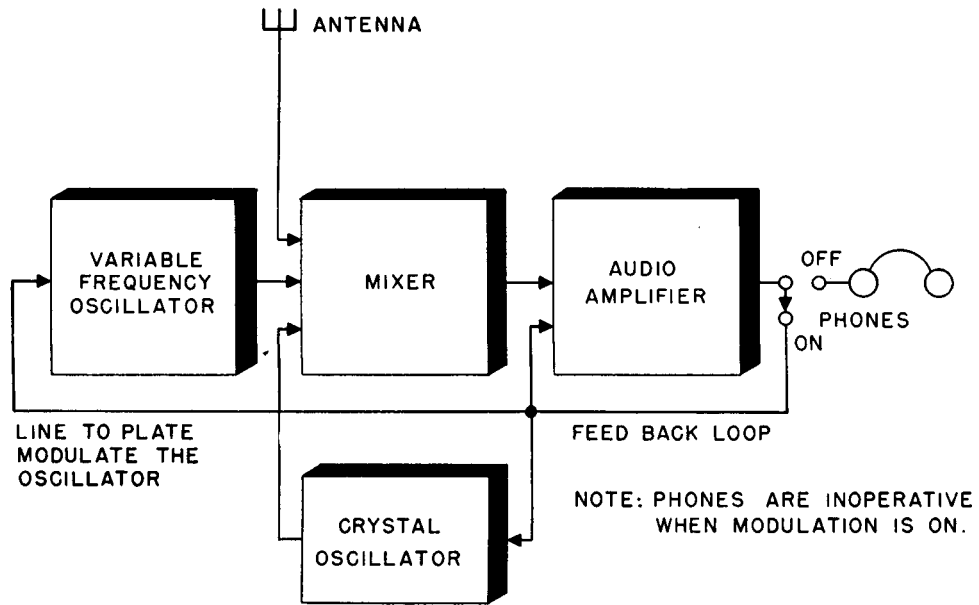
b. MODULATION. The amplifier is converted into an a-f oscillator by means of DPDT (double-pole, double-throw) switch, S2 (fig. 16). The secondary winding of the output transformer is disconnected from the phone jacks and connected to the input of the amplifier tube

44. Control Circuits

The selector switch on the front panel of Frequency Meter TS-174B/U, marked OFF, STANDBY, CRYSTAL, OPER., and CHECK, allows the operator to select the particular circuits of the frequency meter:

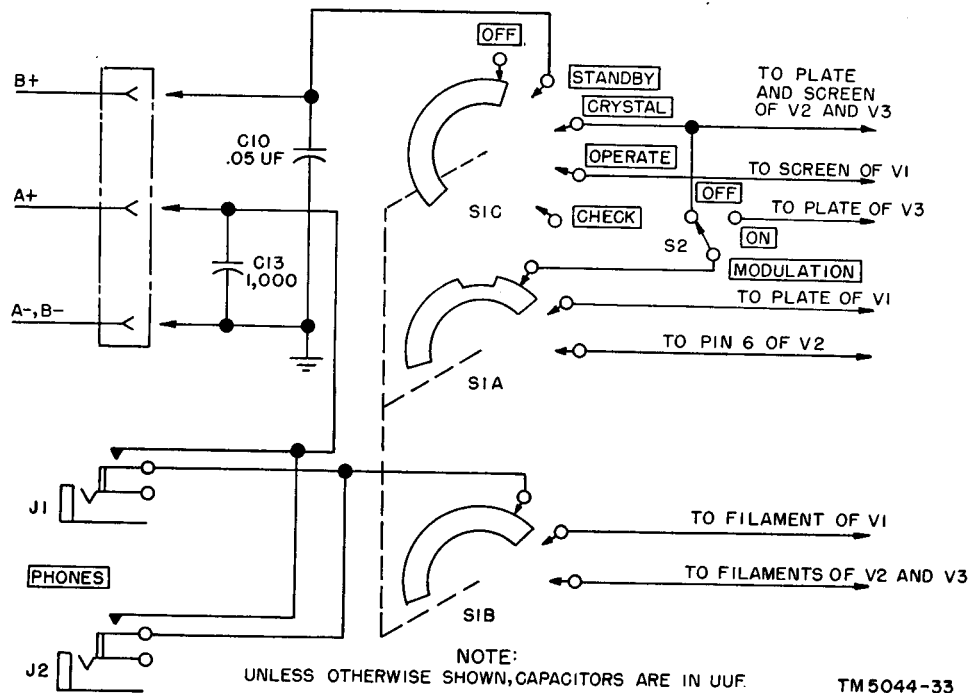
a. In the OFF position, the battery supply is disconnected from the chassis, making the set inoperative.

b. In the STANDBY position, with phones connected, filament power is applied to the vfo tube (V1) and B+ is applied to the mixer section to tube V2 and to audio tube V3. The



TM 5044-32

Figure 17. Modulation system, block diagram.



TM 5044-33

Figure 18. Control circuits.

STANDBY position allows the set to warm up and stabilize while using a minimum drain from the batteries.

c. In the CRYSTAL position, filament voltage is applied to all tubes and B+ is applied to the crystal oscillator section. The vfo does not operate in this position. The exact operation of the frequency meter depends on the position of the MODULATION OFF-ON switch:

- (1) With the MODULATION OFF-ON switch turned to OFF, tube V3 acts as an audio amplifier for the beat frequency.
- (2) With the MODULATION OFF-ON switch turned to ON, tube V3 acts as

an audio oscillator. The audio signal it produces modulates the output of the crystal oscillator.

d. In the OPER. position, B+ is removed from the crystal oscillator and is applied to the vfo mixer section of V2, and audio amplifier tube V3. With the MODULATION OFF-ON switch turned to ON, the audio signal from tube V3 modulates the output of the vfo.

e. In the CHECK position, power is applied to all tubes so that the vfo can be adjusted to one of the harmonics of the crystal oscillator. In this position, the output of both the vfo and the crystal oscillator are modulated when the MODULATION OFF-ON switch is ON.

CHAPTER 5

FIELD MAINTENANCE INSTRUCTIONS

Section I. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and by the skill of the repairman.

Warning: When servicing the frequency meter, be careful because of the high voltages exposed. While not often fatal, a severe shock may result.

45. Trouble-Shooting Procedures

The first step in servicing a defective frequency meter is to sectionalize the fault. Sectionalization means tracing the fault to the circuit responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned-out resistors, r-f arcing, and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltage and resistance.

46. Trouble-Shooting Data

Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Figures 13 through 16, 18 through 20, 27, and 28 will prove helpful when trouble shooting. See also paragraphs 4, 14, and 36.

47. Test Equipment Required for Trouble Shooting

Items of test equipment that are required for trouble shooting Frequency Meter TS-174 B/U are listed below. Similar items having equal characteristics may be used also.

Item	Signal Corps stock No.
Signal Generator TS-497/URR	3F4325-497
Signal Generator I-72 (range 1,000 kc to 20 mc).	3F3852
Audio Oscillator TS-382/U	3F4325-382
Oscilloscope BC-1060-A	-----
Oscilloscope OS-8A/U	-----
Battery Tester TS-183/U	3F4325-183
Electronic Multimeter TS-505/U	3F4325-505
Multimeter TS-352/U	3F4325-352
Tube Tester TV-2/U, or equal	3F3952-2
Frequency Calibrator-Meter Set AN/URM-18.	-----
Rectifier Power Unit RA-133-A	3H4691-133
Receiving Set AN/TRR-6, or an equal receiver having a range of 20 to 250 mc.	-----

48. General Precautions

Frequency Meter TS-174B/U is a precision instrument and must be handled carefully. If any repairs are necessary to the vfo or the crystal oscillator, the repairman must be prepared to check the calibration of the frequency meter and possibly to recalibrate the meter completely. Recalibration is a long procedure, and a considerable amount of equipment, which normally is available, is required. Section III of this chapter contains complete information on recalibration of the instrument. Repairs may be made on the audio amplifier without danger of disturbing the calibration.

a. For a lengthy job of repairing, the batteries normally used in the instrument may not hold up. Larger sized batteries may be substituted. An automobile type storage battery may be used for the filament power, and either large 45-volt B-batteries (three required) or a well

regulated power supply, capable of delivering 135 volts at .025 ampere, may be used.

b. Be careful when power is applied to the instrument when it is out of its cabinet.

c. Careless replacement of parts often makes new faults inevitable. Observe the following points:

- (1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of leads or connections, tag each of the leads.
- (2) Be careful not to damage other leads by pulling or pushing them out of the way.
- (3) Do not allow drops of solder to fall into the set, since they may cause short circuits.
- (4) A carelessly soldered connection may create a new fault. It is very important to make well soldered joints, since a poorly soldered joint is one of the most difficult faults to find.
- (5) Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring.
- (6) Do not disturb the adjustment of the trimmer capacitor C1B, compensating capacitor C1C, or capacitor C7 which is in shunt with the crystal.
- (7) Be careful not to move any of the wiring in the vfo or the crystal-oscillator circuits. This may destroy the calibration.

49. Checking Filament and B+ Circuits

Trouble in the equipment may often be detected by checking the resistance of the filament and B+ circuits before applying power to the equipment, thereby preventing excessive drain on the batteries. Make the following checks before attempting to put the set in operation. Be sure tubes are seated properly in their sockets.

a. Remove the chassis from the cabinet to expose the jacks on the rear where the power is applied to the instrument from the battery supply.

b. Plug a headset into the PHONES jack on the front of the panel to complete the filament circuit.

c. Connect a low-range ohmmeter from J6 to J4.

d. Turn selector switch to STANDBY. The ohmmeter should read approximately 6 ohms.

e. Turn selector switch to CRYSTAL, OPER., and CHECK positions, taking the reading at each position. The ohmmeter should read approximately 1.8 ohms at each switch position.

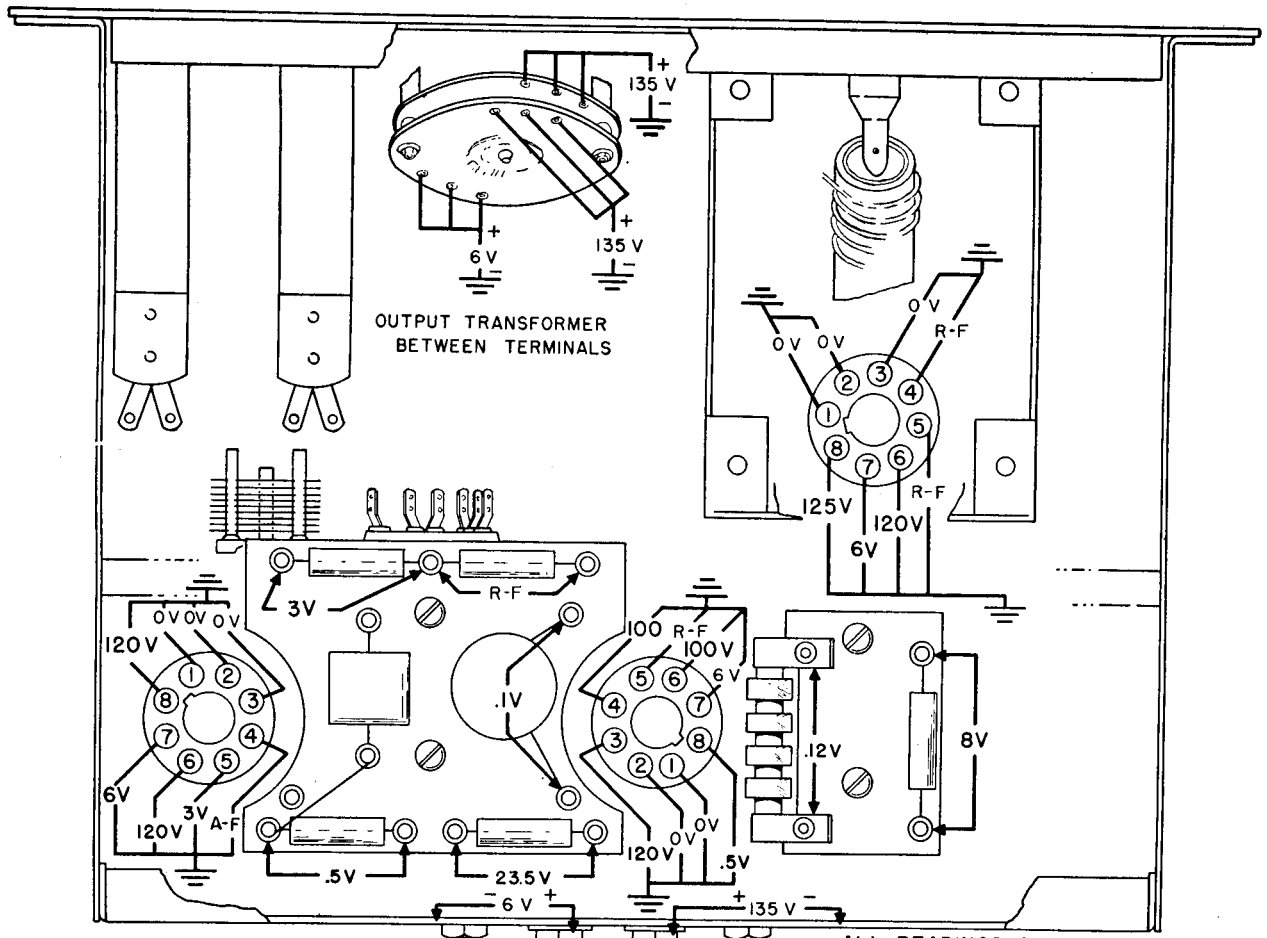
f. Reconnect the ohmmeter to J5 and J4 and use high range on the ohmmeter.

g. Rotate the selector switch through all its positions. The ohmmeter should read infinity at all settings of the selector switch.

h. The tests listed under *a* through *e* above indicate the condition of the filament circuit when the tubes are installed and in good condition. A short in the circuit or an open filament will change the readings materially. The tests listed under *f* and *g* above indicate the condition of the B+ circuit. A short circuit in the plate circuit will be readily apparent. If a low-resistance reading or short is indicated from B+ to ground (J5 to J4), check capacitor C10 for shorting. If C10 is in good condition, check capacitors C5, C11, C12, and C14 and the h-v wiring. To prevent possible damage to the batteries caused by excessive current drain, correct all abnormal conditions before applying high voltage to the frequency meter.

50. Operational Test

Install the frequency meter chassis in its cabinet. Check the batteries as described in paragraph 36. If the batteries are in good condition, operate the equipment as described in the equipment performance checklist (par. 38). This checklist is important because it frequently indicates the general location of trouble. Listen for crackling or buzzing noises in the headset which usually indicate h-v arcing. Check the instrument for the odor of burned or overheated parts.

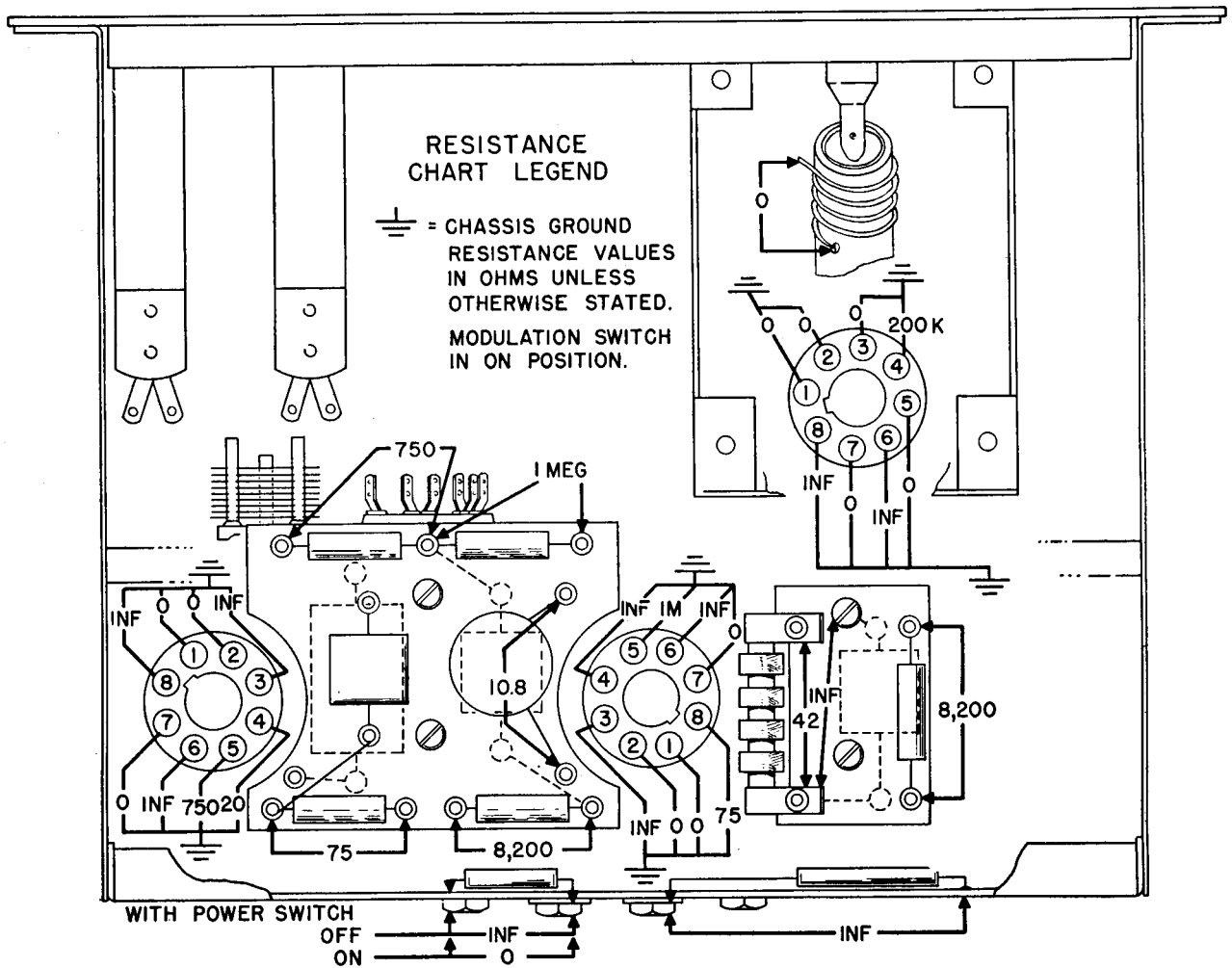


MEASUREMENTS TAKEN WITH 20,000 OHMS
 PER VOLT METER.
 S1 AT CHECK AND S2 AT OFF.

ALL READINGS ARE IN VOLTS DC
 EXCEPT: -R-F = RADIO FREQUENCY
 A-F = AUDIO FREQUENCY

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Figure 19. Frequency Meter TS-174B/U, voltage diagram.



TM 5044-23

Figure 20. Frequency Meter TS-174B/U, resistance diagram.

51. Trouble-Shooting Chart

The following chart is supplied as an aid in locating trouble in the frequency meter. This chart lists the symptoms which the repairman observes, either visually or audibly, while making a few simple tests. The chart also indicates how to localize trouble quickly to the audio,

mixer, or oscillator stage of the instrument. Once the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measurements of this stage or circuit ordinarily should be sufficient to isolate the defective part. Normal voltage and resistance measurements are given in figures 19 and 20.

Symptom	Probable trouble	Correction
1. Selector switch in STANDBY position, V1 does not warm up.	1. Defective tube-----	1. Check tube filament and replace with running spare, if necessary.
	Headset plug in PHONES jack not operating switch on jack.	Check switch on jack (J1 or J2) for dirty or damaged contacts.
	Selector switch contacts not operating.	Check selector switch (S1B) for dirty or damaged contacts.
	Defective jacks on rear of chassis.	Check J4 and J6 for proper contact.
2. Selector switch in CRYSTAL, OPER., or CHECK position. V1, V2, and V3 do not warm up.	Batteries improperly connected--	Check A-battery connections.
	2. Discharged batteries-----	2. Replace batteries.
3. Selector switch in CRYSTAL position. No signal picked up in adjacent receiver tuned to 1,000 kc.	3. V2 defective-----	3. Check tube in tube tester and replace if necessary or replace with tube known to be operating from another frequency meter.
	Plate voltage too low or non-existent.	Check B-batteries and h-v circuits for shorts.
	Crystal inoperative-----	Replace crystal.
4. Selector switch in OPER. position. No signal picked up from V1 in an adjacent receiver tuned to frequency of V1.	4. V1 defective-----	4. Check tube in tube tester and replace if necessary, or replace with tube, known to be operating, from another frequency meter.
	Plate voltage too low or non-existent.	Check B-batteries and h-v circuits for shorts.
	Defective tuning capacitor assembly.	Replace and recalibrate the instrument (sec. III of this chapter.)
	Defective tuning unit assembly--	Replace and recalibrate the instrument (sec. III of this chap.)
5. Selector switch in CHECK position. No signal heard in headset but crystal signal is heard on adjacent receiver.	5. Defective headset or cord-----	5. Replace headset with one known to be in good condition.

Symptom	Probable trouble	Correction
	Defective audio tube. MODULATION OFF-ON in ON position.	Check and replace tube V3. Turn MODULATION OFF-ON switch to OFF position.
	Defective output transformer L4	Check windings and replace if short or open circuited.
	Defective or dirty PHONES jacks J1 and J2.	Clean contacts on jacks and inspect for proper operation.
	Defective coupling capacitor C9	Replace C9.
	Defective GAIN control	Replace R5 if defective.
	Open grid circuit	Check R5 and R6 and replace if defective.
	Selector switch defective	Check contacts and clean or replace switch if defective.
6. Selector switch in CRYSTAL or OPER. position, MODULATION OFF-ON switch ON. No modulation heard on crystal or vfo signal in adjacent receiver.	6. MODULATION OFF-ON switch defective.	6. Replace MODULATION OFF-ON switch.
	Defective audio tube V3	Check and replace tube.
	Defective output transformer L4	Check windings and replace if shorted or open circuited.
	Selector switch S1A defective	Clean contacts and check for proper operation.
	Open grid circuit on V3	Check R5 and R6 and replace if necessary.
7. Selector switch in OPER. position, external signal coupled to ANT terminal. No beat note heard in headset.	7. Defective headset	7. Replace headset.
	Defective audio section	See step 5 above.
	Defective capacitor C6	Replace capacitor C6.
	Defective mixer tube	Check and replace if defective.
	Shorted grid circuit V2	Check R2 and replace if defective.
	V1 defective	See step 4 above.

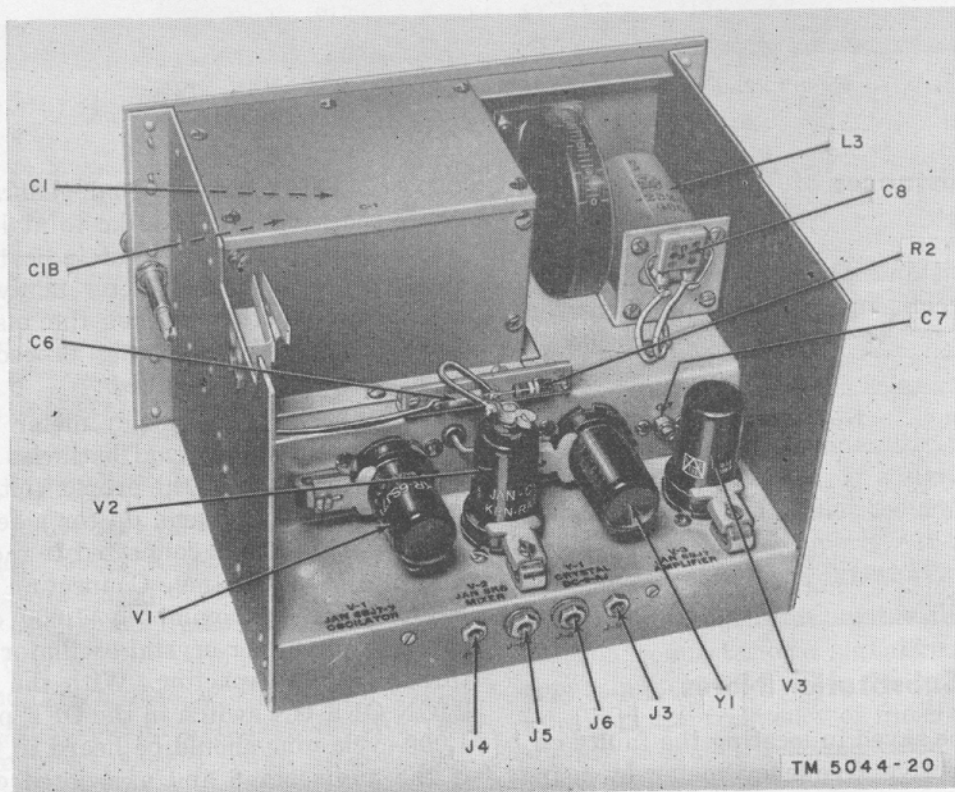


Figure 21. Frequency Meter TS-174B/U, rear view of chassis.

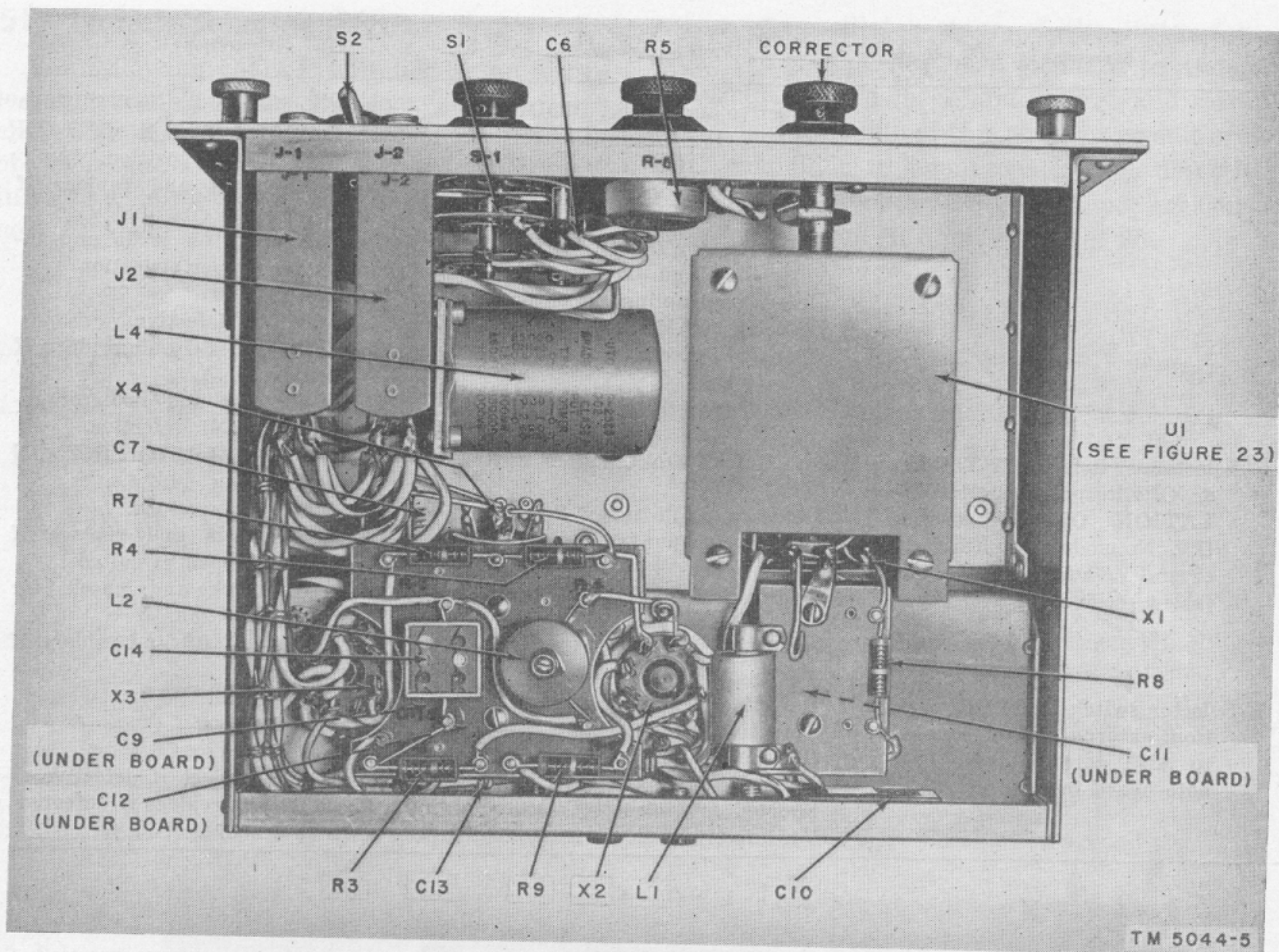


Figure 22. Frequency Meter TS-174B/U, bottom view of chassis.

52. D-c Resistances of Transformers and Coils

The d-c resistances of the transformer windings and the coils in the frequency meter are listed below.

Transformer or coil	Terminals	Ohms
L1	--	40
L2	--	10
L3	--	3,700
L4	1-2	20
	3-4	700

53. Signal Substitution Notes

Time may be saved in locating the faulty circuit in a defective frequency meter by using an audio oscillator and an r-f signal generator,

if available. The r-f signal generator should cover the range of 1,000 kc to at least 20 mc. Signal substitution will not indicate the accuracy of the frequency meter but will tell the repairman whether or not the instrument is functioning. The following procedure should be used in making this test:

a. Connect the frequency meter to a source of power, either external batteries or another supply, that will give the proper voltages. Allow the instrument to warm up for a few minutes. Be sure a headset is connected to the PHONES jack on the front panel. Connect an audio oscillator, set to approximately 1,000 cps, to pin No. 3 of the mixer-crystal oscillator tube (V2) through a .05 capacitor. With the MODULATION OFF-ON switch in the OFF position, the 1,000-cycle tone should be heard in the headset if the audio stage and associated circuits are functioning properly. For this test, the selector

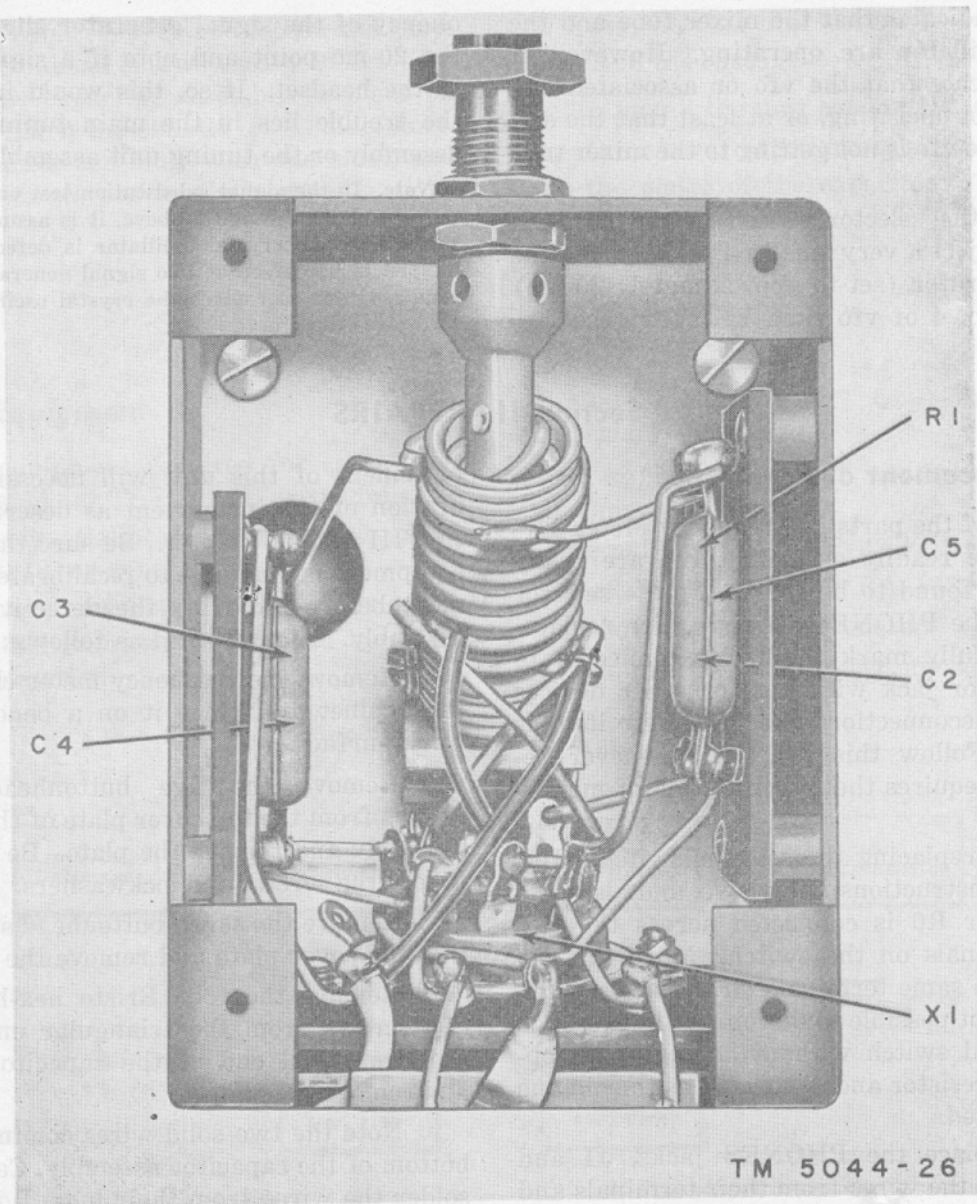


Figure 23. Tuning unit, location of parts.

switch on the front panel should be in the **CRYSTAL, OPER.,** or **CHECK** position.

b. If the above test indicates that the audio system is functioning, an r-f oscillator or signal generator may be used to check the mixer and the crystal oscillator stages.

c. Turn the selector switch to the **CHECK** position, and if no beat note is heard at a crystal check point, connect an r-f signal generator (set to approximately 1,000 kc) to pin No. 5 of tube V2, through a small capacitor. Adjust the fre-

quency of the signal generator until a signal is heard in the headset. If a signal is obtained it is a good indication that the crystal oscillator is not functioning properly. It also indicates that the mixer tube is functioning.

d. With the selector switch in the **CHECK** position, connect the r-f signal generator (set to approximately 20 mc) to the grid cap of tube V2. Vary the frequency of the signal generator slightly around the 20-mc value and note if a signal is heard in the headset. If a signal is

heard, it indicates that the mixer tube and the crystal oscillator are operating. However, it would indicate that the vfo or associated circuits are not operating, or at least that the signal from the vfo is not getting to the mixer tube grid.

e. With the selector switch in the CHECK position, inject a very small r-f signal from the signal generator (set to approximately 20 mc) into pin No. 4 of vfo tube V1. Vary the fre-

quency of the signal generator slightly around the 20-mc point and note if a signal is heard in the headset. If so, this would indicate that the trouble lies in the main tuning capacitor assembly or the tuning unit assembly.

Note. In the signal substitution test outlined in subparagraphs *a* through *e* above, it is assumed that only the vfo or the crystal oscillator is defective. If both happen to be defective, two signal generators would be required; one to replace the crystal oscillator and one to replace the vfo.

Section II. REPAIRS

54. Replacement of Parts

a. Most of the parts in Frequency Meter TS-174B/U are readily accessible and are easily replaced if found to be faulty. If the selector switch or the PHONES jacks require replacement, carefully mark the wires connected to the switch or jack with tags or other devices to avoid misconnection when the new item is installed. Follow this practice whenever replacement requires the disconnection of numerous wires.

b. When replacing the selector switch (S1), follow the instructions in *a* above, and also note that resistor R6 is connected across the two spare terminals on the switch. Move this resistor to the same terminals on the new switch or, if it is not possible to disconnect the resistor from the old switch without damaging it, obtain a new resistor and connect it as the old one was connected.

c. To replace the PHONES jacks, J1 and J2, unsolder the wires from their terminals and tag them as explained in *a* above. Remove the hex nut that holds the jack to the panel and slip out the jack. S1 must be loosened to remove J2.

d. To replace switch S2, it is necessary to remove the two PHONES jacks and lay them back across the chassis without removing their wiring. This will expose the switch and allow for easier replacement. Do not forget to tag the wires which lead to the switch to avoid misconnections.

55. Replacement of Tuning Capacitor

To replace the capacitor assembly (C1) follow the instructions below. Remember that re-

placement of this unit will necessitate recalibration of the instrument as described in section III of this chapter. Be sure the necessary equipment is available to recalibrate the instrument before removing the defective capacitor assembly. Then proceed as follows:

a. Remove the frequency meter chassis from the cabinet and place it on a bench or other work surface.

b. Remove the five buttonhead machine screws from the top cover plate of the capacitor assembly and remove the plate. Be careful not to lose the screws and lockwashers.

c. Remove the seven buttonhead screws from the side cover plate and remove the plate.

d. Remove the four Bristo hex-head socket cap screws from the triangular end plate on the drum dial end of the capacitor assembly and remove the plate.

e. Note the two solid wires coming from the bottom of the capacitor assembly. Carefully unsolder the wires from their lugs. Do not loosen screws holding lugs.

f. Remove the three screws from the dial handle assembly on the front panel and remove the handle.

g. Loosen the two screws on the dial lock striker plate far enough to allow the dial to be removed. Be careful not to loosen the screws too much, or the plate on the rear will drop off. Just loosen them a few turns until the dial is ready to be removed. Then remove only one of the screws.

h. Loosen the two setscrews on the aluminum hub of the fast-running dial with a Bristo wrench and remove the fast-running dial.

i. Turn the chassis over and loosen the three No. 8-32 buttonhead screws that hold the base casting of the capacitor assembly in place on the chassis. Turn the chassis on its side, holding the capacitor assembly with one hand, and remove the screws previously loosened.

j. Ease the capacitor assembly out of position and off the chassis.

k. To install the new capacitor assembly, reverse the above directions. Take care not to touch the plates of the capacitor.

Section III. CALIBRATION PROCEDURES

56. Test Equipment

The test equipment required for calibration of Frequency Meter TS-174B/U are as follows:

Frequency Calibrator-Meter Set AN/URM-18, or equal.

Radio Receiving Set AN/TRR-6, or equal.

100-kc multivibrator,* controlled by primary standard.

50-kc multivibrator,* controlled by primary standard.

10-kc multivibrator,* controlled by primary standard.

Signal Generator TS-497/URR, or equal.

Rectifier Power Unit RA-133, or equal.

Frequency deviation meter.*

Amplifier AM-34/TIQ-3, or equal.

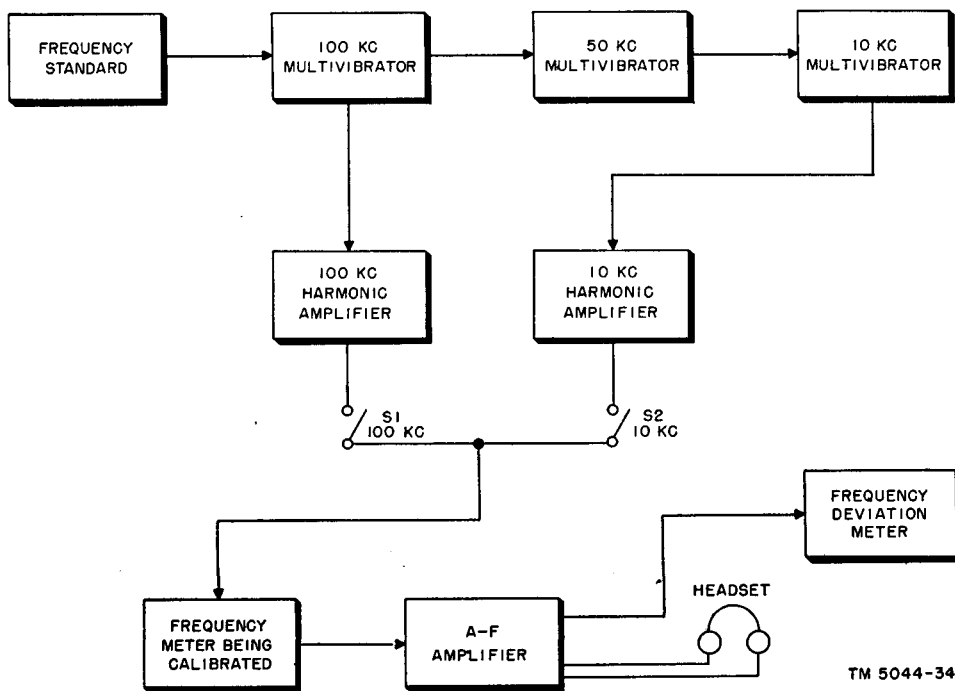


Figure 24. Block diagram showing calibration set-up.

* These components are a part of Frequency Calibrator-Meter Set AN/URM-18.

57. Calibration of Frequency Meter TS-174B/U

a. GENERAL. When calibrating the frequency meter, remember that the accuracy of the instrument is dependent to a large extent on the accuracy of the calibration equipment. Extreme care must be taken throughout the operation to insure satisfactory results. A carelessly done calibration will render the instrument useless in many cases.

b. PRELIMINARY SET-UP. In preparing for the calibration procedures, connect the equipments to be used (fig. 24) and turn them on for a sufficiently long period of time so that they will be well warmed up and stabilized. This is particularly true of the frequency standard to be used. Be sure that the frequency meter to be calibrated is in good operating condition. Connect the instrument to a well regulated and stabilized source of plate voltage (135 volts d-c) and filament voltage (6 volts d-c). A power supply should be used to furnish the plate voltage. This will overcome the drop in voltage associated with batteries. Heavy storage batteries may be used for the filament voltage. Be sure that the batteries are fully charged. After the frequency meter has been connected to a source of power, turn on the instrument and allow it to warm up for at least 4 or 5 hours. This will allow the instrument to stabilize properly. The calibration takes considerable time and any drift during calibration will add to the inaccuracy of the instrument. Protect the instrument from drafts or vibration during the calibration.

c. ADJUSTING CRYSTAL OSCILLATOR TO 1,000 KC. The accuracy of the frequency meter depends to a large extent on the accuracy of the crystal oscillator. To adjust the frequency of this oscillator, set the selector switch in the CRYSTAL position. Loosely couple the antenna of the receiver to the antenna of the frequency meter and the output of the 100-kc multivibrator. Tune the receiver to 1 mc and listen for the beat note in the receiver speaker. It is unlikely that the crystal oscillator will be off frequency enough so that the beat will not be heard. Adjust tuning capacitor C7 (fig. 21) with a small screw driver until exact zero beat is obtained. Holding the screw driver on the screw, tighten the

locknut with a small wrench. If tightening the locknut moves the frequency slightly, make the necessary adjustments to the screw so that zero beat is maintained when the locknut is tightened. Make this adjustment very carefully.

d. CALIBRATION OF VARIABLE FREQUENCY OSCILLATOR.

- (1) Follow the procedures outlined in *a*, *b*, and *c* above.
- (2) Set selector switch (S1) to the CHECK position. Check battery voltages to be sure that they are 135 volts and 6.0 volts.
- (3) Loosely couple the output of the 100-kc harmonic amplifier (fig. 24) to the antenna of the frequency meter. Connect the output of the PHONES jacks to the input of an audio amplifier. The output of the amplifier should be connected to a loudspeaker or preferably a headset for an audible check on the zero beat. A frequency deviation meter also may be connected as a visual means of checking the zero beat.
- (4) The first step in the actual calibration is to determine whether or not the tuning dial on the frequency meter will cover the range of 20 to 40 mc in the 5,000 dial divisions available on the tuning dial. With the harmonic amplifier mentioned in (3) above decoupled, set the selector switch to CHECK, the CORRECTOR control to 5 on the dial, and set the main tuning dial to 0000.0. Slowly rotate the main tuning dial until a zero beat is heard. If no radical changes have been made to the instrument, the first zero beat should be located somewhere between 0000.0 and 0500.0 on the main tuning dial. To check this, set the selector switch to OPER., loosely couple a receiver to the antenna of the instrument, and tune the receiver through 20 mc while set up for cw. A distinct beat should be obtained at 20 mc. If the beat is obtained at 20 mc, set the receiver to 40 mc and turn the main tuning dial of the frequency meter up scale until a beat note is heard again in the

phones or loudspeaker. The tuning dial should read above 4000.0 in this case. The object of this check is to be sure that the main tuning dial will cover the range of 20 to 40 mc, and that the range is spread out over as much of the dial as possible. If the complete range is covered, proceed with (6) below. If the range is not completely covered, follow the instructions in (5) below.

- (5) Follow the procedure below if the frequency range is not covered in the dial range.

- (a) Occasionally, the replacement of a main tuning capacitor assembly may result in the 20-mc and 40-mc point being located below 0000.0 or above 5000.0 on the dial. The usual cause of this is an incorrect placement of the dial on the capacitor shaft. To check this, set the main tuning dial to 0000.0. Remove the five button-head screws which hold the top plate of the capacitor assembly cover in place. Note the setting of the capacitor plates. At 0000.0 on the dial, the capacitor should be set for maximum capacity or the plates should be meshed completely. By carefully placing a finger on the exposed edges of the plates and rocking the main tuning dial back and forth, the exact setting can be obtained. If this position does not correspond to 0000.0 on the dial, the dial will have to be removed and relocated to read 0000.0. To do this, remove the three flathead machine screws in the knob and remove the knob from the dial. Using the Bristo wrench which is provided, loosen the two setscrews on the hub of the tuning dial and rotate the dial to read 0000.0. Tighten the setscrews and replace the tuning knob. Replace the top cover plate over the capacitor assembly. Recheck the 20-mc and 40-mc points as outlined in (4) above, and be sure that they are now in the proper range on the main tuning dial.

- (b) If the procedure outlined in (5) (a) above does not correct the condition, it will be necessary to adjust trimmer capacitor C1B. A small hole located just above the Dzus fastener on the upper right-hand side of the chassis (fig. 21) gives access to the slotted shaft of the trimmer capacitor. Locate the check point at the end of the dial which does not fall within the dial divisions. Adjust the trimmer capacitor to move the frequency up or down, as the case may be, so that it will be located within the dial divisions. The exact point of setting depends on circuit conditions and cannot be predicted accurately. Be careful not to close the plates together during the adjustment; this will short out the tuning capacitor.

- (6) Return the main tuning dial to the 20-mc check point as determined above. Recouple the 100-kc harmonic amplifier and set the selector switch to CHECK. Note the beat notes produced by the mixing of these frequencies. The beat notes are produced by the harmonic amplifier signal, the internal crystal oscillator, and the vfo. If switching the 100-kc harmonic amplifier in and out causes a considerable change in beat note, recheck the crystal oscillator frequency as described in *c* above. When the best possible zero beat is obtained, note carefully the dial setting. This will be the dial setting for 20 mc as well as the 20-mc crystal check point.
 - (7) The frequency determined in (6) above was 20.00 mc. The next point to be determined will be 20.01 mc, a point 10 kc above 20.00 mc. With the 10-kc harmonic amplifier coupled, and the 100-kc harmonic amplifier *decoupled*, the beat produced by the 10-kc and the internal vfo output can be tracked audibly from 20.00 mc to 20.01 mc. The beat note will increase from zero beat to 10 kc and back down to zero beat again. The total excursion of the dial should be between 2.0 and 2.4 dial

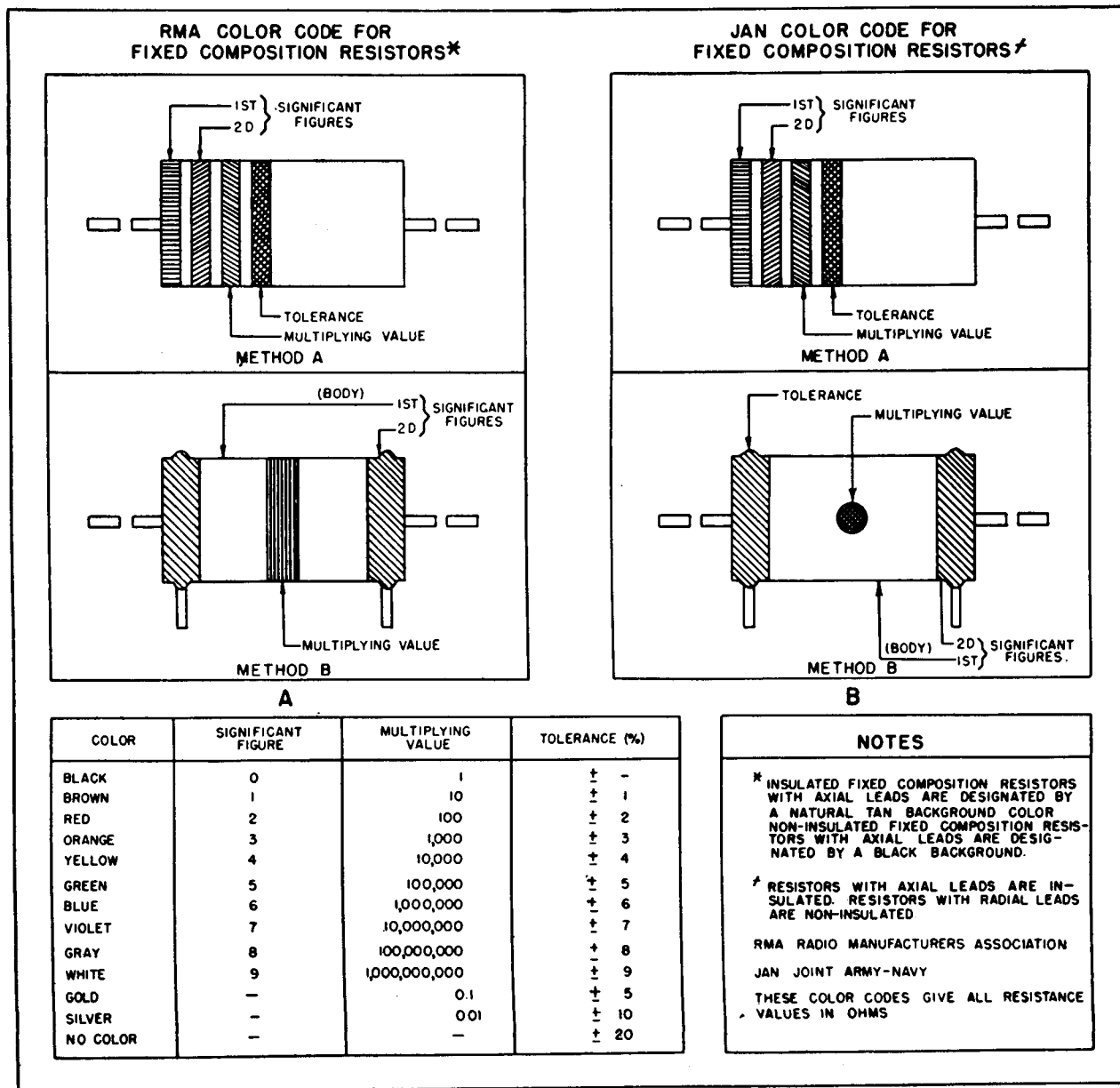
divisions from one 10-kc point to the next one. Half-way between these points, a weak zero beat will be heard and should be disregarded. As the zero beat for 20.01 mc is approached, slowly turn the dial to the exact beat without reversing the direction of the tuning dial. If the zero beat is passed accidentally, back the dial up well past the point of the zero beat and again approach the zero-beat point. Remember to always approach the zero-beat point by turning the dial clockwise. This will avoid any errors due to backlash in the gearing of the capacitor assembly. When the reading or dial setting for 20.01 mc has been noted, proceed to 20.02 mc. When passing from one zero-beat region to the next, note that the tone can be heard all the way up to 10 kc and back down again. By concentrating on this signal, zero-beat points will not be missed.

- (8) When 11 points have been recorded, decouple the 10-kc harmonic amplifier and couple the 100-kc harmonic amplifier. The eleventh zero beat from the 20.00 mc check point (counting 20 mc as check point one) should coincide with the zero beat caused by the 100-kc harmonic amplifier. This point will be the 20.10 mc calibration point. It is well to check between each 100-kc point in this manner to avoid mistakes.
- (9) Proceed in the calibration to the 21.00-mc check point. Here it will be possi-

ble to double check the calibration by means of the internal crystal oscillator, as was done at the 20.00-mc check point in (6) above.

- (10) In the manner outlined above, proceed in calibration until the 40.00-mc check point is reached. Be sure to note each crystal check point as it is reached. These points have to be recorded and entered in the calibration book separately from the regular calibration points. In all, 2,000 points must be calibrated. It must be realized that this will take a considerable period of time to do by hand and the entire procedure should be done without interruption and as rapidly as possible.
- (11) If a blank calibration book is not available, a new book will have to be made up to contain the information derived from the calibration procedure. In addition to the calibration points and crystal check points, each page of the calibration book should list the frequencies and dial divisions listed on that page and the average dial divisions per 10 kc for purposes of interpolation. The average dial divisions per 10 kc can be figured by taking the total dial divisions covered on each page and dividing it by the number of calibration points on the page. For the standard calibration book, this figure will run from approximately 1.8 to 2.3 dial divisions per 10 kc.

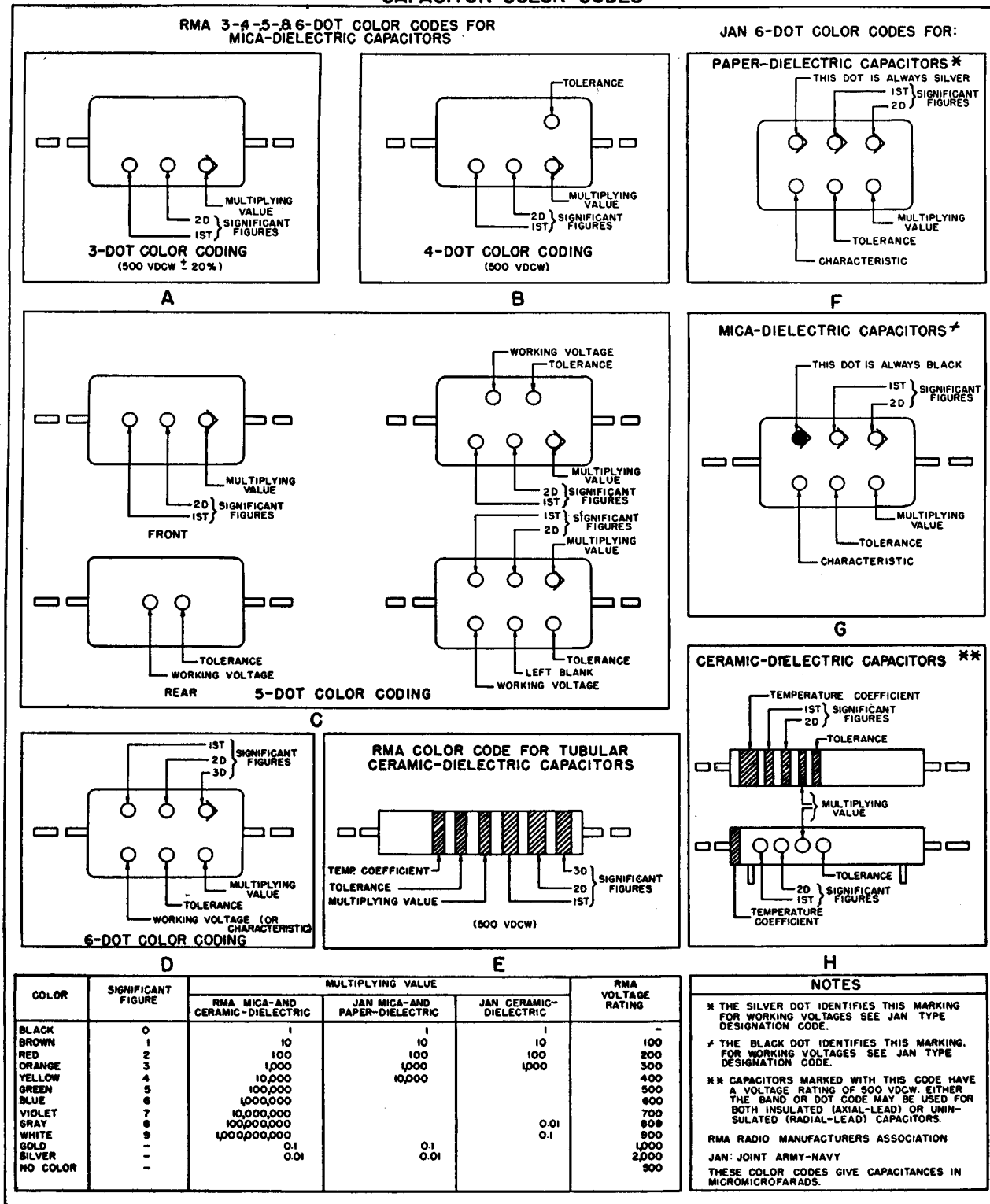
RESISTOR COLOR CODES



TL 324545

Figure 25. Resistor color codes.

CAPACITOR COLOR CODES



RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS

E

CERAMIC-DIELECTRIC CAPACITORS **

H

6-DOT COLOR CODING

D

COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE			RMA VOLTAGE RATING
		RMA MICA-AND CERAMIC-DIELECTRIC	JAN MICA-AND PAPER-DIELECTRIC	JAN CERAMIC-DIELECTRIC	
BLACK	0	1	1	1	-
BROWN	1	10	10	10	100
RED	2	100	100	100	200
ORANGE	3	1,000	1,000	1,000	300
YELLOW	4	10,000	10,000		400
GREEN	5	100,000			500
BLUE	6	1,000,000			600
VIOLET	7	10,000,000			700
GRAY	8	100,000,000		0.01	800
WHITE	9	1,000,000,000		0.1	900
GOLD	-	0.1	0.1		1,000
SILVER	-	0.01	0.01		2,000
NO COLOR	-				500

NOTES

* THE SILVER DOT IDENTIFIES THIS MARKING FOR WORKING VOLTAGES SEE JAN TYPE DESIGNATION CODE.

† THE BLACK DOT IDENTIFIES THIS MARKING FOR WORKING VOLTAGES SEE JAN TYPE DESIGNATION CODE.

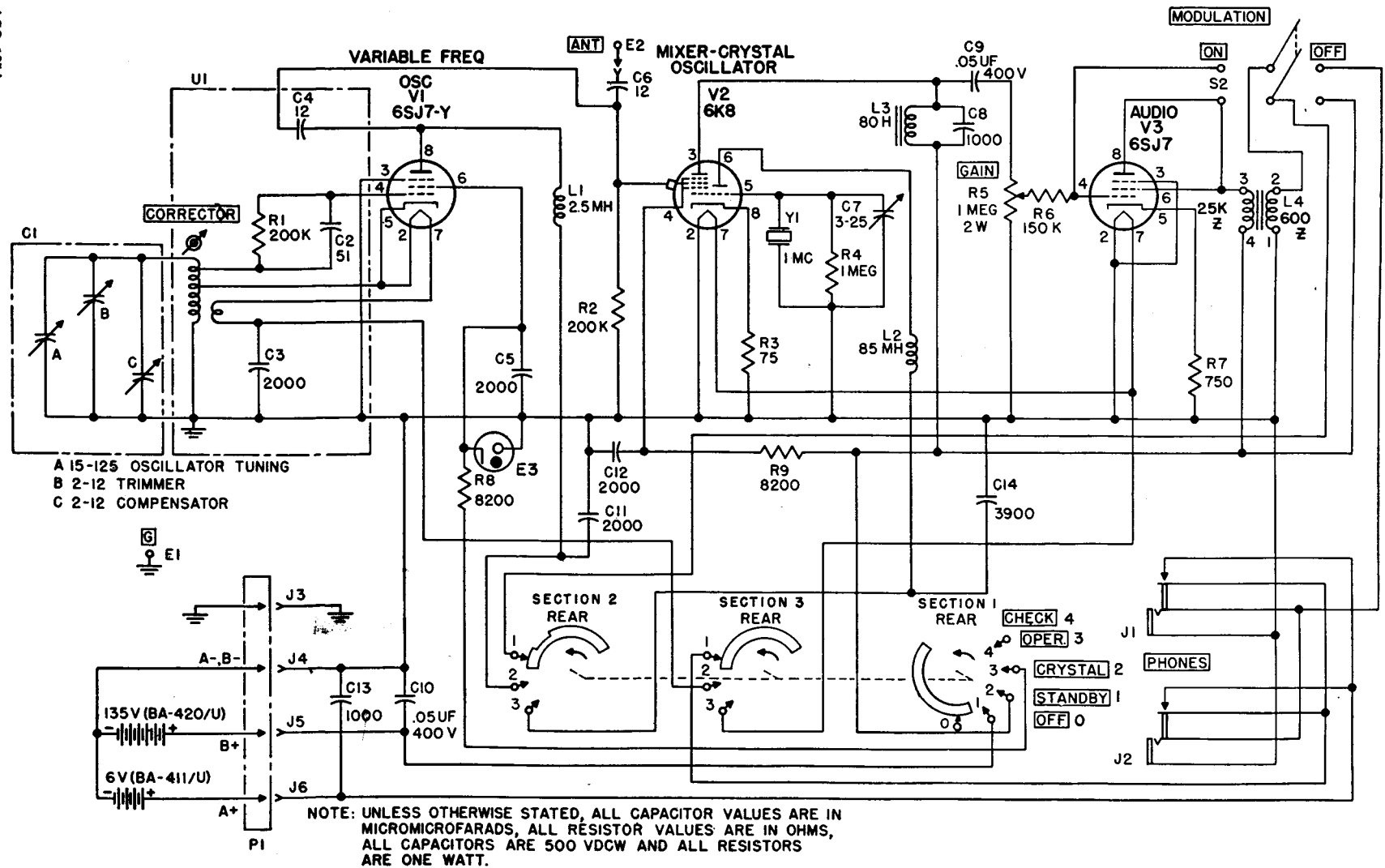
** CAPACITORS MARKED WITH THIS CODE HAVE A VOLTAGE RATING OF 500 VDCW. EITHER THE BAND OR DOT CODE MAY BE USED FOR BOTH INSULATED (AXIAL-LEAD) OR UNINSULATED (RADIAL-LEAD) CAPACITORS.

RMA RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

THESE COLOR CODES GIVE CAPACITANCES IN MICROMICROFARADS.

TL 324533

Figure 26. Capacitor color codes.



TM 5044-11

Figure 27. Frequency Meter TS-174B/U, complete schematic.

Section IV. FINAL TESTING

58. General

This section is intended as a guide to be used in determining the quality of a repaired Frequency Meter TS-174B/U. The minimum test requirements outlined in paragraphs 60 through 63 may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation.

59. Test Equipment Required for Final Testing

The equipment needed for testing the repaired instrument are listed in the following table:

Quantity	Equipment
1	Temperature-controlled cabinet capable of housing the frequency meter in its cabinet and with a temperature range of minus 40°C. to plus 55°C.
1	Regulated power supply: (Rectifier Power Unit RA-133, RA-133A, or Power Supply PP-351/U, or equal).
1	Heavy-duty storage battery or other source of 6.0 volts d-c with means of varying the output voltage from 5.4 to 6.0 volts (Power Supply PP-351/U, or equal).
1	Frequency Calibrator Meter Set AN/URM-18, or equal.
1	Signal Generator TS-497/URR, or equal.
1	Amplifier AM-34/TIQ-3, or equal.
1	Radio Receiving Set AN/TRR-6, or equal.

60. Audio Output

a. AUDIO POWER OUTPUT WITH INTERNAL CRYSTAL OSCILLATOR R-F INPUT.

- (1) Set the selector switch to the CHECK position and allow the meter time to warm up.
- (2) Connect a 600-ohm resistor across the terminals of a spare phone plug and then insert the plug into the spare PHONES jack.
- (3) Connect the vacuum-tube voltmeter to the plug in the other PHONES jack.
- (4) Set the main tuning dial to the 20-mc check point. Adjust the CORRECTOR to give a 500-cycle tone in output. Use the frequency deviation meter to de-

termine frequency of beat note. Note the reading on the voltmeter.

- (5) Proceed as in (4) above for all crystal check points.
- (6) Calculate the power output from formula $P = E^2/R$, where E = voltage reading and $R = 600$ ohms.
- (7) Reduce the plate voltage to 121.5 volts and the filament voltage to 5.4 volts and repeat the directions given in (4), (5), and (6) above.
- (8) Minimum audio power output obtained in the steps above will be not less than .1 mw.

b. AUDIO POWER OUTPUT WITH EXTERNAL R-F INPUT.

- (1) Set the selector switch to the OPER.

position and allow the meter time to warm up.

- (2) Repeat steps in (2) and (3) above.
- (3) Couple the signal generator (with a range of 20 to 250 mc and calibrated output dial) to the antenna of the frequency meter, and set the output of the signal generator to .1 volt.
- (4) Set the main tuning dial of the frequency meter to the 20-mc crystal check point.
- (5) Adjust the signal generator to 20 mc and note the beat note. Adjust the beat note to 500 cycles.
- (6) Note the voltage output reading.
- (7) Adjust the signal generator to 40 mc and adjust the beat note to 500 cycles.

- (8) Note the voltage output reading.
- (9) Proceed as in (4) through (8) above at the 30-mc check point, using 30 mc, 60 mc, and 120 mc on the signal generator. Note the voltage output readings.
- (10) Proceed as in (4) through (8) above at the 40-mc crystal check point, using 40-, 80-, 120-, 160-, 200-, 240-, and 280-mc settings on the signal generator.
- (11) Minimum audio power output over the fundamental range of 20 to 40 mc should be not less than 1.0 mw, with an r-f input of .1 volt. Minimum audio power output over the harmonic range of 40 to 250 mc should be not less than .002 mw, with an r-f input of .1 volt.

61. R-f Output

a. Connect the ANT terminal of the frequency meter to the receiver, and tune the frequency meter and the receiver to 20 mc. Note the reading on the S-meter of the receiver.

b. Disconnect the frequency meter and connect the signal generator to the receiver. Tune the signal generator to exactly the same frequency (20 mc). Adjust the output of the signal generator to produce the same S-meter reading as obtained in *a* above. The output voltage of the signal generator is now the same as the output of the frequency meter. Repeat the above procedure for several points throughout the range of the frequency meter.

c. The r-f voltage available between the antenna terminal and ground terminal should be not less than 15,000 μV at any fundamental frequency in the calibrated range, or less than 300 μV at any point from 40 to 250 mc.

62. Drift After Warm-up Period

This test should be made (at room temperature) at 20 mc, and at 40 mc. After 15 minutes operation, the vfo should be adjusted against the crystal check point to give a convenient audio beat note. All test conditions should be kept constant for an additional 5 minutes, after which the change in beat note shall be noted and recorded by means of an accurate deviation meter or an accurately calibrated audio oscillator. The emitted fundamental frequency should not deviate under these conditions by more than .005 percent (1,000 cycles at 20 mc, or 2,000 cycles at 40 mc).

63. Calibration Accuracy

The emitted fundamental frequency of the frequency meter shall not deviate from the published calibrated frequency by more than .04 percent when corrected at the nearest crystal check point and when subjected to any combination of the following conditions: temperature range of -40°C to $+55^{\circ}\text{C}$, plate voltage 121.5 to 135.0 volts, and filament voltage 5.4 to 6.0 volts.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

64. Removal of Batteries

When Frequency Meter TS-174B/U is to be shipped or prepared for limited storage, be sure that the batteries are removed from the battery compartment and the compartment is cleaned. If the batteries are not removed, they may deteriorate over a period of time and damage the cabinet.

65. Repacking for Shipment or Limited Storage

a. The exact procedure in repacking for ship-

ment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Refer to paragraphs 5 and 10 and reverse the instructions.

b. Whenever practicable, place the dehydrating agent, such as silica gel, inside the cabinet. Protect the box with a waterproof paper barrier. Seal the seams of the paper barrier with waterproof sealing compound or tape. Pack the protected cabinet in a padded wooden case, providing at least 3 inches of excelsior padding or some similar material between the paper barrier and the packing case.

Section II. DEMOLITION OF MATÉRIEL TO PREVENT ENEMY USE

66. General

The demolition procedures outlined in paragraph 67 will be followed to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander. DESTROY EVERYTHING.

67. Methods of Destruction

a. SMASH. Smash the tuning unit, crystal, controls, tubes, switches, capacitors, and headsets, using sledges, axes, handaxes, pickaxes, hammers, crowbars, or other heavy tools.

b. CUT. Cut cords, headsets, and wiring, using axes, handaxes, or machetes.

c. BURN. Burn resistors, capacitors, coil, wiring, technical manuals, and calibration books, using gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. BEND. Bend panels, cabinet, and chassis.

e. EXPLOSIVES. If explosives are necessary, use firearms, grenades, or TNT.

f. DISPOSAL. Bury or scatter the destroyed parts in slit trenches, fox holes or other holes, or throw them into streams.

APPENDIX I

REFERENCES

Note. For availability of items listed, check SR 310-20-3 and SR 310-20-4. Check Department of the

Army Supply Catalog SIG 1 for Signal Corps supply catalogs.

1. Army Regulations

- AR 380-5 Safeguarding Military Information.
AR 750-5 Maintenance Responsibilities and Shop Operation.

2. Supply Publications

- SIG 1 Introduction and Index.
SIG 3 List of Items for Troop Issue.
SB 11-6 Dry Battery Supply Data.
SB 11-47 Preparation and Submission of Requisitions for Signal Corps Supplies.
SB 11-76 Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.

3. Publications on Auxiliary Equipment and Test Equipment

- TM 11-307 Signal Generators I-72-G, H, J, K, and L.
TM 11-472 Repair and Calibration of Electrical Measuring Instruments.
TM 11-2524 Oscillator I-151-A and I-151-E.
TM 11-2526 Oscilloscope BC-1060-A.
TM 11-2531* Public Address Set AN/TIQ-3.
TM 11-2571 Battery Testers TS-183/U and TS-183A/U.
TM 11-2626 Test Unit I-176, I-176-A, and I-176-B.
TM 11-2627 Tube Testers I-177 and I-177-A.
TM 11-5527 Multimeter TS-352/U.

* Contains instructions on Amplifier AM-34/TIQ-3.

4. Painting, Preserving, and Lubrication

- TB SIG 13 Moistureproofing and Fungiproofing Signal Corps Equipment.
TB SIG 69 Lubrication of Ground Signal Equipment.
TM 9-2851 Painting Instructions for Field Use.

5. Camouflage

- FM 5-20 Camouflage, Basic Principles.

6. Decontamination

- TM 3-220 Decontamination.

7. Demolition

- FM 5-25 Explosives and Demolitions.

8. Other Publications

- FM 24-18 Field Radio Techniques.
FM 72-20 Jungle Warfare.
SR 310-20-3 Index of Training Publications (Field Manuals, Training Circulars, Firing Tables and Charts, Army Training Programs, Mobilization Training Programs, Graphic Training Aids, Joint Army - Navy - Air Force Publications, and Combined Communications Board Publications).

SR 310-20-4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment.	TM 11-415	Dry Batteries.
SR 700-45-5	Unsatisfactory Equipment Report (Reports Control Symbol CSGLD-247).	TM 11-430	Batteries for Signal Communication. Except those pertaining to Aircraft.
SR 745-45-5 AFR 71-4	} Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD-66 (Army), and AF-MC-U 2 (Air Force)).	TM 11-453	Shop Work.
		TM 11-455	Radio Fundamentals.
TB SIG 66	Winter Maintenance of Signal Equipment.	TM 11-483	Suppression of Radio Noises.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.	TM 11-486	Electrical Communication Systems Engineering.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.	TM 11-490	Electrical Fundamentals.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.	TM 11-660	Introduction to Electronics.
TB SIG 178	Preventive Maintenance Guide for Radio Communication Equipment.	TM 11-4000	Trouble Shooting and Repair of Radio Equipment.
TB SIG 223	Field Expedients for Wire and Radio.		
TM 9-2857	Storage Batteries Lead-Acid Type.		
TM 11-310	Schematic Diagrams for Maintenance of Ground Radio Communication Sets.		

9. Abbreviations

a-c	alternating-current
a-f	audio-frequency
a-m	amplitude-modulated
avc	automatic volume control
bfo	beat-frequency oscillator
cps	cycles per second
c-w	continuous-wave
d-c	direct-current
DPDT	double-pole, double-throw
f-m	frequency-modulated
h-f	high-frequency
h-v	high-voltage
i-f	intermediate-frequency
kc	kilocycle
l-f	low-frequency
ma	milliampere
mc	megacycle
μ f	microfarad
$\mu\mu$ f	micromicrofarad
μ v	microvolt
mw	milliwatt
r-f	radio-frequency
vfo	variable-frequency oscillator

APPENDIX II

IDENTIFICATION TABLE OF PARTS

1. Requisitioning Parts

The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite a specific T/O&E, T/A, SIG 7&8, list of allowances of expendable material, or other authorized supply basis. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1.

2. Identification Table of Parts for Frequency Meter TS-174B/U

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
C1	CAPACITOR ASSEMBLY: c/o main capacitor, variable; 15 to 125 μmf w/110; 1 gear reduction box; 2 ea var trimmer capacitors 2 to 12 μmf mtd on main capacitor.	Tunes the variable-frequency oscillator (V1) to a desired frequency.	3D9125V-9
C2	CAPACITOR, fixed: mica; 51 μmf $\pm 5\%$; 500 vdcw; JAN type CM20C510J.	Grid capacitor for V1-----	3K2051032
C3, C5, C11, C12	CAPACITOR, fixed: mica; 2000 μmf $\pm 5\%$; 500 vdcw; JAN type CM35B202J.	R-f bypass capacitors-----	3K3520222
C4, C6	CAPACITOR, fixed: ceramic; 12 μmf $\pm 10\%$; 500 vdcw; JAN type CC21CH120K.	Coupling capacitors-----	3D9013-2
C7	CAPACITOR, variable: air; plate meshing type; 4 to 23 μmf ; JAN type CT1C025.	Crystal trimmer-----	3D9023V-8
C8, C13	CAPACITOR, fixed: mica; 1000 μmf $\pm 10\%$; 500 vdcw; JAN type CM30B102K.	C8: A-f bypass; C13: Filament bypass.	3K3010221
C9, C10	CAPACITOR, fixed: paper; 50,000 μmf $\pm 20\%$; 400 vdcw; JAN type CN43A503M.	C9: A-f coupling; C10: B+ bypass.	3DA50-288
C14	CAPACITOR, fixed: mica; 3900 μmf $\pm 10\%$; 500 vdcw; JAN type CM35B392K.	R-f bypass-----	3K3539221
L1	COIL, R-F: choke; unshielded-----	Plate choke (r-f) for tube V1	3C323-50H
J3 thru J6	CONNECTOR, receptacle: 1 rd female cont; straight---	Ground and battery connections to chassis.	2Z5574.1
Y1	CRYSTAL UNIT, D-C-9-AJ: 1000 kc-----	Determines frequency of crystal oscillator.	2X185.1-1000
I1	DIAL: drum-----	Determines hundreds in calibration figures.	2Z3723-279
E3	LAMP IM-54: Striking V 65V A-C, 90 v D-C; 1/25 w; unbased.	Voltage limiter for screen of V1.	2Z5954
I2	DIAL: disk type-----	Determines units in calibration figures.	2Z3723-280
I3	SCALE: vernier scale for tuning dial-----	Determines tenths of units in calibration figures.	2Z8076-164
J1, J2	JACK, telephone: for 2 cond plug .253" dia; JAN type JJ-104.	Phones jacks and filament closing switch.	2Z5598A-104

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
P2	CONNECTOR, PLUG: 8 rd male cont similar to octal tube base; angle type, 90 deg; marked BA-420/U.	A battery connector-----	2Z3028-64
P1	CONNECTOR ASSEMBLY, receptacle: termination for 2 batt cables used for connection of batt power to the freq meter chassis.	Connects battery power to frequency meter chassis.	2Z3105-19
E1	POST, binding: push type-----	Ground connection-----	3Z635-9.1
E2	POST, binding: Binding Post TM-214; screw type-----	Antenna connection-----	3Z314
P3	CONNECTOR, plug: 8 rd male cont similar to octal tube base; angle type, 90 deg; marked BA-411/U.	B battery connector-----	2Z3028-65
L3	REACTOR: 80 hy, 5 ma; 3700 ohm D-C resistance; HS metal case.	Plate choke (a-f) for mixer section of tube V2.	3C573-44
R1, R2	RESISTOR, fixed: comp; 200,000 ohm $\pm 5\%$; 1 w; JAN type RC30BF204J.	R1: Grid resistor for V1, R2: Grid resistor for V2.	3RC30BF204J
R3	RESISTOR, fixed: comp; 75 ohms $\pm 5\%$; 1 w; JAN type RC30BF750J.	Cathode bias resistor for tube V2.	3RC30BF750J
R4	RESISTOR, fixed: comp; 1 meg $\pm 10\%$; 1 w; JAN type RC30BF105K.	Oscillator grid bias-----	3RC30BF105K
R5	RESISTOR, variable: comp; 1 meg $\pm 20\%$; 2 w; JAN type RV4APFK105D.	A-f gain control-----	3RV61032
R6	RESISTOR, fixed: comp; 150,000 ohm $\pm 10\%$; 1 w; JAN type RC30BF154K.	R6: grid bias resistor for tube V3.	3RC30BF154K
R7	RESISTOR, fixed: comp; 750 ohm $\pm 5\%$; 1 w; JAN type RC30BF751J.	R7: Cathode bias resistor for tube V3.	3RC30BF751J
R8, R9	RESISTOR, fixed: comp; 8200 ohm $\pm 10\%$; 1 w; JAN type RC30BF822K.	R8: Determines screen voltage for tube V1. R9: Determines screen voltage for mixer.	3RC30BF822K
S1	SWITCH, rotary: 3 pole, 5 position; 3 decks-----	Main selector switch-----	3Z9825-62.585
S2	SWITCH, toggle: DPDT; JAN type ST22N-----	Changes V3 operation from a-f amplification to modulation.	3Z9849.135
X1 thru X4	SOCKET, tube: octal; 1 piece under chassis mtg; JAN type TSB8T101.	Receptacle for tubes and crystal.	2Z8678.326
H1	GROMMET: rubber; fits $\frac{5}{16}$ " dia hole-----	Insulates battery wires from case.	6Z4858-3
L4	TRANSFORMER, A-F: plate coupling type; pri 25,000 ohm, secd 600 ohm impedance; aluminum case, iron core.	Couples V3 to phones and also serves as a modulation transformer.	2Z9632.639
V1	TUBE, electron: JAN type 6SJ7Y-----	Variable-frequency oscillator	2J6SJ7-Y
V2	TUBE, electron: JAN type 6K8-----	Mixer and crystal oscillator	2J6K8
V3	TUBE, electron: JAN type 6SJ7-----	Audio amplifier or modulator	2J6SJ7
U1	TUNING UNIT, R-F: osc tuning and correcting-----	Frequency determining unit for variable-frequency oscillator.	2Z11150-38
	WRENCH: Bristo set screw; .0760" max dia; "L" shape, 1 leg $1\frac{27}{32}$ " lg, other leg $2\frac{1}{32}$ " lg; alloy steel, cad or nickel pl; spcl for Bristo #6 multiple-spline set screw.	Used for removing screw in controls.	6R55230

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