TYPE TMV-75-B
Serial 538
RCA

INDEX

Illustrations

Drawings

FIGURE 1 - CARRYING POSITION

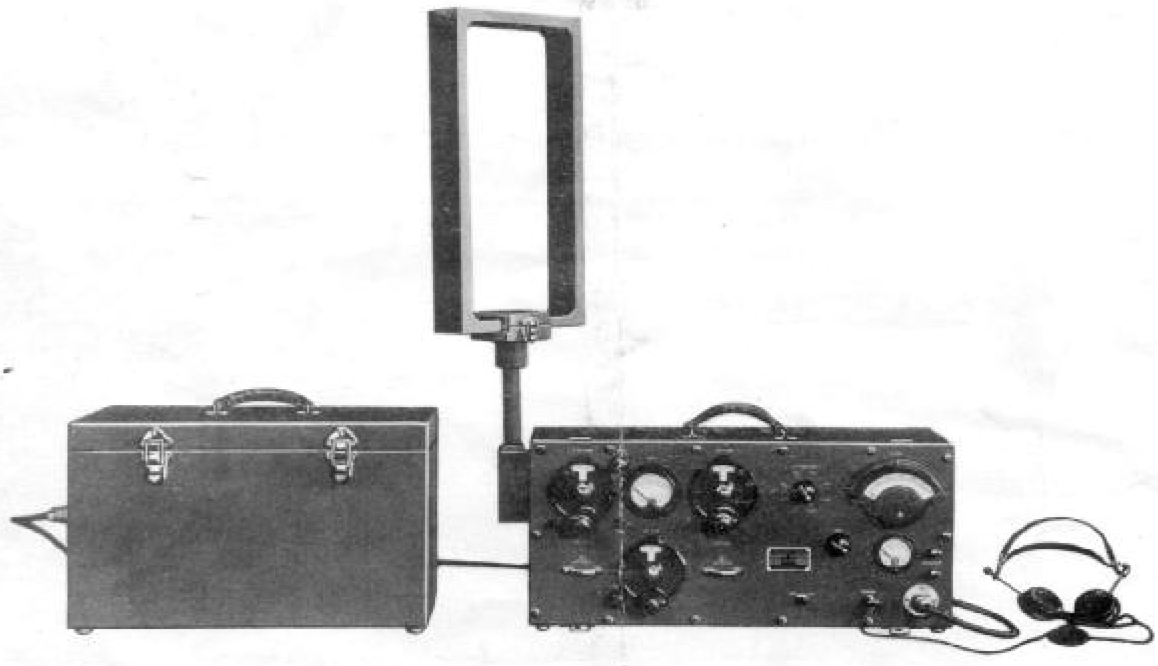


FIGURE 2 - OPERATING POSITION

I
INTRODUCTION

The Field-Intensity Meter, Type TMV-75-B, is capable of measuring field strengths throughout an intensity range of from 20 to 5,000,000 microvolts per meter at any frequency within the limits of 500 and 20,000 kilocycles. An independent calibration standard forms an integral part of this instrument, insuring results of the greatest possible accuracy. Field intensity measurements properly performed will be accurate to within five percent over the entire frequency range. The frequency calibration of the instrument is not permitted to deviate more than five percent in the factory alignment process.

The entire equipment, being contained in two compact and well-balanced carrying cases, may be transported conveniently by one person. One case is arranged to enclose the main instrument and the other to accommodate the associated loop antennas, plug-in coils and batteries. The former measures 9-1/2" x 24-1/2" x 11-3/4" high, and weighs approximately 30 pounds. The battery and accessory box has an aggregate weight of approximately 30 pounds when filled (exclusive of batteries) and overall dimensions of 19" x 20-1/2" x 13" high.

II
EQUIPMENT

The following parts constitute one complete equipment as furnished by the manufacturer:

- 1 - Type TMV-75-B Field-Intensity Meter (in carrying case)
- 4 - Loop Antennas
- 1 - Loop Holder
- 4 - Pairs Plug-in Coils
- 1 - Battery Cable (with plugs)
- 1 - Battery and Accessory Box for loop antennas, loop holder plug-in coils, battery cable and batteries
- 1 - Instruction Book (with set of calibration charts)

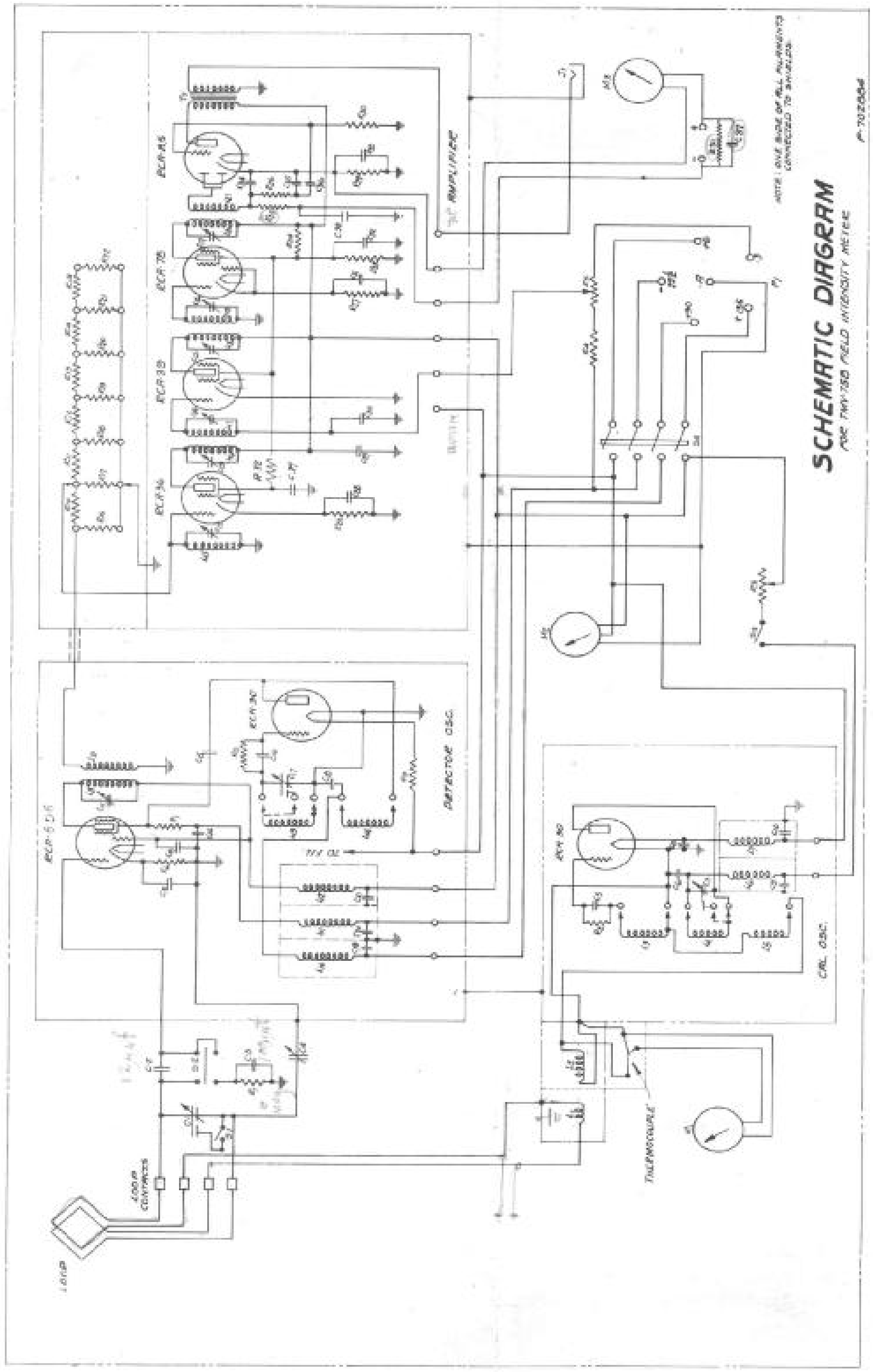
The following accessories are necessary for operation but are not supplied unless specified on the order:

- 1 - Set of Radiotrons, including: RCA-78 (1), RCA-39 (1), RCA-36 (1), RCA-30 (2), RCA-85 (1), RCA-6D6 (1)
- 1 - Set of Headphones
- 1 - Set of Batteries to provide: "A" voltage - 6 V.; "B" voltage - 135 V.; "C" voltage - 22½ V. tapped at 3 V., (1-Burgess #5156 or 3-Burgess #5540 or equivalent)

NOTE - The choice of batteries will be dependent upon considerations of cost, economy and weight as tabulated below:

"A" Supply

Quan.	Type	Weight (lbs.)	Approx. life (hours)
4	#6 cells (series)	9.25	4
8	#6 cells (series-parallel)	18.5	15
1	6 V. Storage Battery (Motorcycle Type)		15 (per charge)



151 X Atten. X Meter
KC.

"B" Supply

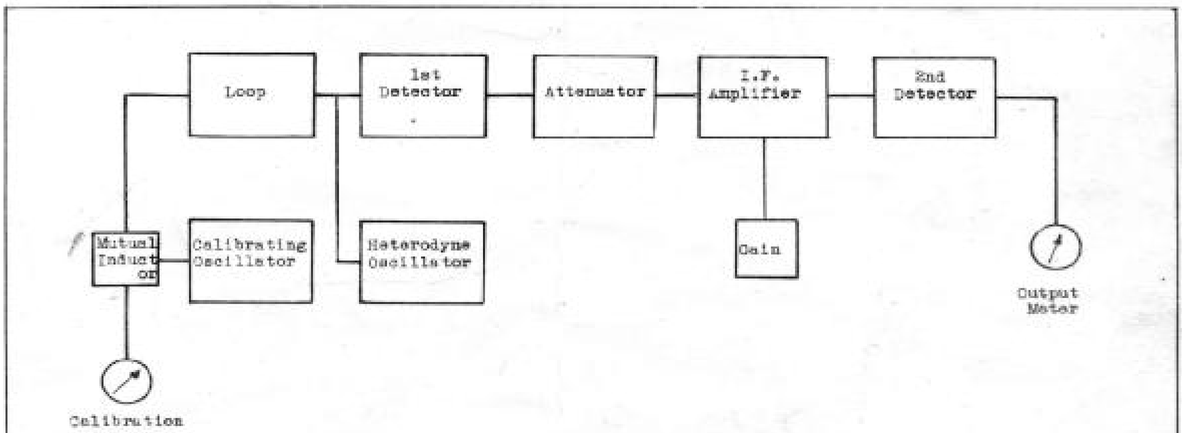
Quan.	Type (Burgess)	Wt. (lbs.)	Type (Eveready)	Approx. life-hours
6	#4156	6		7
3	#5308	9.75	#762(Spec.Battery)	15
3	#2305	27		60

The life of the "C" batteries will be equivalent to the "shelf" life.

An automatic recorder may be connected to the meter in order to record fading and other characteristics. For this purpose two binding posts have been provided; a d-c voltage of a value up to 1.8 volts depending on the field intensity appears across these posts, permitting the use of an external amplifier to furnish recorder current.

III
ELECTRICAL DESIGN

The equipment consists essentially of a receiver, a calibrating oscillator and a loop antenna. Embodied in the receiver are a step attenuator, a gain control and an output meter. The arrangement of the various units is shown by schematic diagram P-702884 and by the simplified block diagram.



BLOCK DIAGRAM

I.F. shifted to 315 KC. on June 1, 1943 (to eliminate interference to WENR and WPAA.)

The receiver is of the superheterodyne type, having three intermediate-frequency amplification stages tuned to a frequency of 300 (315) kilocycles. The second detector is designed to serve as a linear output voltmeter. The output of the receiver is controlled by means of a continuously-variable gain control in the i-f amplifier and a calibrated stepped-resistance attenuator located in the input circuit of the i-f amplifier. To facilitate identification of the incoming signal, a set of headphones may be inserted in the output circuit.

The calibrating oscillator is capable of fulfilling all necessary requirements for proper calibration of the instrument. Calibration is required only when there is reason to assume that the resistance of the loop or gain of the i-f amplifier may have changed between readings, or when making measurements at different signal frequencies. Coupling to the loop is obtained with a calibrating mutual-inductance attenuator which is shielded to eliminate electrostatic and external electromagnetic coupling. The input voltage is measured across the primary of the inductor by means of a three-legged thermocouple and a meter whose calibration is independent of frequency. The calibrating attenuator is so designed that the voltage it induces in series with the loop is constant over the entire frequency range for any given setting of the thermovoltmeter.

The total frequency range of the instrument is divided into four bands as follows:

Band A :	500 - 1,500 kc.	(Covered by coil set "A")
Band B :	1,500 - 4,600 kc.	(" " " " "B")
Band C :	4,600 - 10,000 kc.	(" " " " "C")
Band D :	10,000 - 20,000 kc.	(" " " " "D")

Each band is covered by a separate loop antenna, heterodyne oscillator coil and calibrating oscillator coil, these components having been designed so as to provide uniform sensitivity on all bands. This condition, however, has not been fully realized because of the extremely small size necessary for the highest frequency loop.

The complete equipment employs five tubes of the six-volt heater type and two of the two-volt heater type. A meter is provided which indicates both the plate and filament supply voltages.

IV
THEORY OF OPERATION

The theory of the superheterodyne receiver is well known and so will not be discussed here except as involved in deriving the formula for computation of field intensities from readings of the instrument.

When a loop antenna is placed in a magnetic field, a voltage is induced in its circuit. The magnitude of this voltage is dependent upon the strength of the field, the effective height of the loop and the angle between the field and the loop. When the loop is directed so as to give maximum induced voltage, this induced voltage may be expressed by the formula:

$$e = F.h \quad (1)$$

where e = induced voltage in microvolts
F = field intensity in microvolts per meter
h = effective height of the loop antenna in meters

If a variable capacitor is placed across the loop antenna and the circuit tuned to resonance with the frequency of the field, a voltage will appear across the loop antenna and condenser greater than the induced voltage by an amount termed here the "step up" of the loop, and expressed by the symbol Q. The voltage (E) across the loop antenna in the magnetic field thus may be expressed by the formula:

$$E = Q.e = Q.F.h \quad (2)$$

Since the loop must be balanced to ground in order to prevent antenna effects, only one-half of the actual voltage (or $\frac{E}{2}$) is impressed on the grid of the first detector and thence combined with the heterodyne oscillator. There will now appear across the plate load of the first detector a voltage of intermediate frequency (300 kc) whose amplitude is dependent both on the voltage $\frac{E}{2}$ and a constant (the conversion conductance of the first detector tube) designed as M_d. The circuits associated with the first detector are so designed as to make this quantity (M_d) constant for any input voltage ($\frac{E}{2}$) over the range of the instrument at any given frequency, and as nearly constant as possible for all frequencies without overloading any of the associated tubes.

The voltage (E_d) fed to the intermediate-frequency amplifier is, therefore:

$$E_d = \frac{E}{2} \cdot M_d = \frac{Q.F.h.M_d}{2} \quad (3)$$

The voltage (E_d) is impressed across a resistance attenuator network where it may be attenuated by any amount up to 50,000 (in steps of 4 and 5) such that the attenuation factors are 1, 5, 20, 100, 500, 2000, 10000 and 50000. The attenuated voltage is impressed on the grid circuit of the first tube of the three-stage intermediate-frequency amplifier. The gain of this amplifier may be varied by means of a potentiometer type control between rather wide limits. The gain at any constant setting will be designated by M_a and the setting of the attenuator will be designated by A_1, A_2, etc. The output voltage of the i-f amplifier is measured by means of a d-c microammeter and a diode rectifier. Because of the fact that the diode rectifier is not a true linear device, the meter scale is calibrated so that its readings are directly proportional to the output voltage. The output of the i-f amplifier will be designated as R_1, R_2, etc.

Thus, $R = \frac{E_d \cdot M_a}{A}$

$$\text{and from (3), } R = \frac{F.h.Q.M_d.M_a}{2.A} \quad (4)$$

$$\text{or } F = \frac{2.R.A}{h.Q.M_d.M_a} \quad (4a)$$

In order to calculate the field intensity giving the reading R, it is necessary to know the values of "h", "Q", "M_d", and "M_a". To find these values, it is necessary to calibrate the instrument. If a known voltage "V" is induced in the loop circuit, it will be possible to calculate a value which will include all of these constants with the exception of "h" which is known from the physical dimensions of the loop. This voltage is introduced in the loop circuit by means of a mutual-inductance attenuator.

The mutual-inductance attenuator consists of two self-inductances, inductively coupled to each other and shielded to prevent any capacitive coupling. The primary or larger inductance is fed with current from the calibrating oscillator and the voltage across the coil is measured by means of a thermocouple voltmeter. The secondary or smaller coil is connected in series with the loop antenna, the loops being opened at their electrical center so that one side of the secondary (as well as one side of the primary) of the mutual inductance will be at ground

The secondary voltage (V) is proportional to the primary current and the mutual inductance between the two coils, being expressed by the equation:

$$V = 2.\pi.\ f.I_p.L_m \quad (5)$$

and since the primary voltage $(E_p) = 2.\pi.f.I_p.L_p$ or $I_p = \frac{E_p}{2.\pi.f.L_p}$ (6)

$$\text{then } V = \frac{E_p}{L_p} \cdot L_m \quad (7)$$

Since L_m and L_p are constants, it follows that if E_p is held constant, the secondary voltage (V) also will be constant irrespective of frequency. We thus have a known constant voltage source as long as the primary voltage is held constant by means of the thermocouple voltmeter across the primary coil.

With the voltage "V" introduced in the loop circuit as outlined above, there will be impressed on the grid of the first detector a voltage equal to $\frac{VQ}{2}$ which will produce an output reading (R) proportional to "M_d", "M_a", and "A". Thus,

$$R = \frac{V.Q.M_d.M_a}{2.A} \quad (8)$$

To calibrate the instrument, we will choose certain calibrating values as follows:

$$R = R_1$$

$$V = V_1$$

$$A = A_1$$

and will adjust "Ma" so that these conditions may be met at this frequency. Then, from (8):

$$R_1 = \frac{V_1.Q.M_d.M_{a1}}{2.A_1}$$

$$\text{or} \quad \frac{2.A_1.R_1}{V_1} = Q.M_d.M_{a1} \quad (9)$$

If now we place the loop of the instrument in an unknown field of field strength "F" and allow the gain of the i-f amplifier to remain "M_{a1}", but vary the attenuator setting to A_2, the output reading will be some value R_2; from (4a), therefore:

$$F = \frac{2.R_2.A_2}{h.Q.M_d.M_{a1}} \quad (10)$$

and substituting (9) in (10):

$$F = \frac{2.R_2.A_2.V_1}{2.h.A_1.R_1} \quad (11)$$

from which the field strength may be calculated since all quantities except "F" are known.

By collecting the terms of the calibrating conditions, this formula may be simplified to the form:

$$F = \frac{R_2 \cdot A_2 \cdot K}{h} \quad (12) \qquad \text{where } K = \frac{V_1}{A_1 \cdot R_1}$$

This formula can be simplified still further by substituting therein the formula for the effective height of a loop antenna:

$$h = 2 \cdot \pi \cdot f \cdot S \cdot N \cdot A$$

where S = a constant
N = number of turns
A = area enclosed by the loop

For any given loop, this becomes $h = S'f$ (13)

and substituting (13) in (12):

$$F = \frac{R_2 \cdot A_2 \cdot C}{f} \quad (14) \qquad \text{where } C = \frac{K}{S'}$$

The value "C" is calculated for each loop so that calculation of field intensities from "R_2" and "A_2" are very simple, "f" being a known and constant quantity for any measurements such as when making a station survey or recording fading. It must be remembered that the quantities "Q" and "M_d" are not constants with respect to frequency so that the instrument must be recalibrated for each different frequency if the frequency difference is greater than a few percent. Frequency changes up to five percent do not affect these quantities appreciably.

In order that the higher field intensities may be measured, it is necessary first to attenuate the voltage across the loop to prevent overloading of the first detector. This is accomplished by placing a capacitance attenuator in the grid circuit of the first detector. This attenuator may be placed in or out of the circuit as desired. No attempt has been made to keep the attenuation ratio of this unit constant with respect to frequency so that when making measurements with this unit in the circuit, it will also be necessary to calibrate under like conditions.

When calibrating with the input attenuator in the circuit (position L), the i-f attenuator must be set on a different position than when the input attenuator is disconnected (position H). The field strength calculated by (14) therefore must be multiplied by the ratio of the previous i-f attenuator setting for calibration to the new i-f attenuator calibration setting.

V
OPERATION

Set-up:

The field-intensity meter should be set up for operation in the following manner:

1 - Connect the instrument to the batteries in the carrying case by means of the battery cable.

NOTE - To conserve the batteries, it is recommended that this cable be shortened by the customer to a length consistent with practical requirements, thereby minimizing the inherent voltage drop.

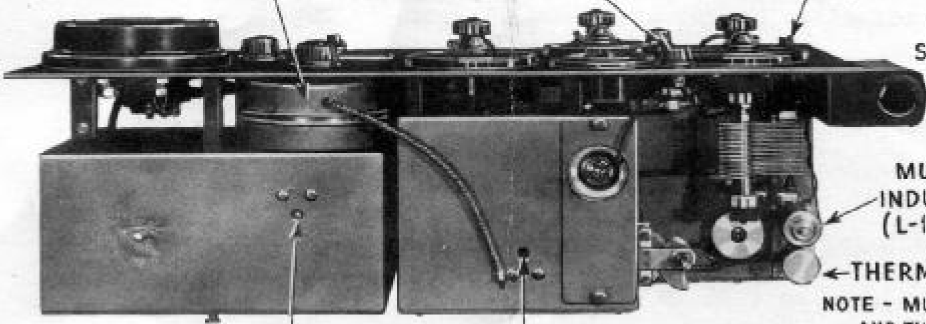


FIG. 3 - TOP VIEW OF METER PANEL ASSEMBLY

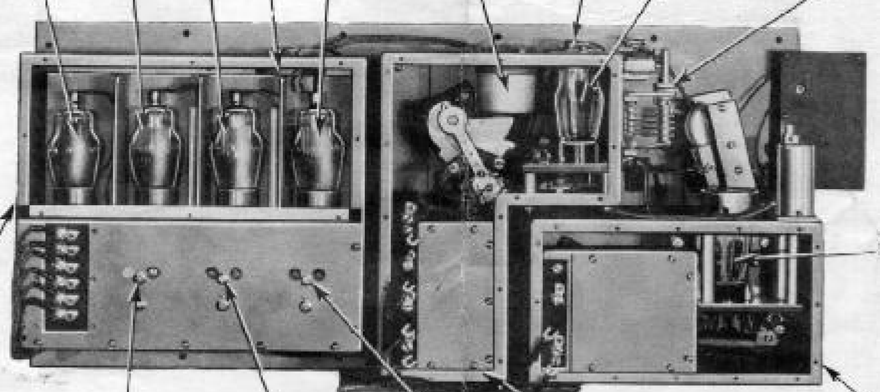


FIG. 4 - REAR VIEW OF METER PANEL ASSEMBLY (COVERS REMOVED)

2 - Insert the plug-in coils and loop antenna which are designed for the frequency of the signal to be measured.

In special cases where it is necessary to mount the loop antenna at a distance from the field-intensity meter (as for measurements in an automobile), the installation should be referred to the Engineering Department, RCA Victor Co.,Inc., Camden, N.J.

Procedure:

The complete procedure for measurement consists of three steps as follows:

(1) Adjustment of Receiver to Frequency

Turn the power "on" and tune the receiver to the signal to be measured by means of the loop (LOOP TUNE) and heterodyne-oscillator (HET.TUNE) tuning controls. Headphones may be employed to expedite this procedure, using the phone jack (PHONES) on the panel. After the desired signal is located and the receiver accurately tuned, rotate the loop until the signal is at a minimum, then turn the calibrating oscillator (CAL. TUNE) "on" and adjust that oscillator to the frequency for which the receiver is tuned.

NOTE - The loop tuning range switch (see Figure 3) should be set "inward" when using loop A or loop B and "outward" when using loop C or loop D.

(2) Calibration of the Receiver

Adjust the (CAL.) knob to a setting where the calibration meter (INPUT) reads "200". With the i-f attenuator set at "50,000" and the input attenuator switch (SENS) turned clockwise (H), adjust the gain of the i-f amplifier with the (GAIN) control until the OUTPUT meter reads "150".

NOTE - Since the battery voltages decrease slowly with age, it may be necessary at some time to take measurements with the calibration meter (INPUT) at a lower than prescribed setting. Under such conditions, the OUTPUT meter setting naturally will be lower also but not by the same amount. It will be advisable therefore, at the time new batteries are installed, to obtain several INPUT versus OUTPUT meter readings. Corresponding values may be determined by first performing the normal calibration procedure, then setting the INPUT meter by means of the (CAL) knob at various points and noting the OUTPUT meter readings, making no adjustment of the (GAIN) control.

(3) Measurement of Field Intensity

Turn the calibrating oscillator "off" and rotate the loop until the signal is again received, then adjust the i-f attenuator until the output meter reads a convenient value. The field strength is equal to the product of the output meter reading, the attenuator multiplier ratio, and a constant derived from the loop constants, all divided by the frequency in kilocycles at which the measurement is made, as shown by the following formula:

$$\text{Field Strength (microvolts per meter)} = \frac{\text{Meter Reading} \cdot \text{Attenuator Setting} \cdot C}{\text{Frequency (kc)}}$$

with "C" = ~~144.3~~ 157 for loop A
= 532.0 " " B
= 1687.0 " " C
= 7617.0 " " D

Note: When using the instrument with (SENS) control on "L", calibrate with the i-f attenuator set at 2000; to calculate the field intensity under such conditions, multiply the measured results by 25.

In actual practice, it will not be necessary to repeat steps (1) and (2) for measurements at a single frequency when the elapsed time between measurements is short. Where extremely accurate results are not required, field intensities greater than five volts per meter may be measured.

Errors:

Errors in the instrument may occur from several different sources and will be discussed in conjunction with measurements made on the component parts of one of these instruments. Perhaps the most serious error possible is that incurred through variation of the calibrating voltage. If any appreciable amount of capacitive coupling exists between the primary and secondary coils or if the secondary coil should resonate within the frequency range of the instrument, the calibrating voltage will not remain constant.

With the coupling adjusted to the proper value, the secondary voltage at various frequencies was compared with a voltage at corresponding frequencies emitted by a standard (Type TMV-18) signal generator. This test indicated that the calibrating voltage is constant (within the limits of normal errors in measurement) over the frequency range of 500 to 20,000 kc. Subsequent measurements of a more exacting nature on similar types of mutual-inductance attenuators enable interpretation of these results to assure an accuracy of at least ± 1 percent, including visual errors in reading the voltmeter.

Next in the order of importance is the error caused by non-linearity of the first detector over a wide range of input voltages. A curve of input voltage versus output voltage starting with an input of a few microvolts and continuing up to 5 volts input shows non-linearity of less than 2 percent; in other words, M_d varies less than ± 1 percent from calibrating to measuring conditions.

Another source of error is found in the attenuation factor of the i-f attenuator. Measurements of the attenuation ratios show a maximum error of ± 1.5 percent.

An error also may occur in marking or reading the output meter; this, however, will not be greater than one part in 50, 50 being the lowest point on the output meter scale which the operator will be required to read. Thus an error of ± 2 percent may occur at this point in the equipment, and since the errors in marking and reading the scale may be in the same direction, it will be possible to obtain a total error of ± 4 percent. At the point of calibration, however, the error in reading the output meter will be less than ± 1.5 percent including the calibration error.

Thus through percentage errors of ± 1.5 percent in the output meter, ± 1 percent in the calibrating voltage, and ± 1 percent because of non-linearity in the detector, the gain of the i-f amplifier may be incorrect by 3.5 percent. After calibrating the instrument and while making a measurement, an error of ±4 percent may occur in the output meter and one of ±1.5 percent in the I.F. attenuator. Thus the maximum error excluding that produced by improper tuning, is ±9%. The probability, however, that all of these errors will occur in the same direction is extremely small and the average error should be well within ± 5 percent. This fact is borne out by measurements of overall gain made between 15 microvolts and 2 volts input by means of the previously mentioned (Type TMV-18) signal generator. These measurements which include any errors which may occur in the first detector and i-f attenuator (as well as errors in reading the output meter) showed total errors of less than ± 1 percent where in the above calculations we have allowed errors of ±3.5%. Using these measurements as a basis for computing the overall error, the maximum probable error of the instrument will be within ± 2 percent.

Any errors resulting from improper tuning may be eliminated during calibration by adjusting the calibrating oscillator to "zero-beat" with the signal being measured.

VI
SERVICE NOTES

The following information is given to aid in making the adjustments which are most liable to be necessary for continued satisfactory operation of the Type TMV-75-B Field-Intensity Meter.

Incorrect Calibrating Voltage

When the accuracy of the calibrating-oscillator voltage is in doubt, or when the thermocouple across the primary of the calibrating attenuator has been replaced, the calibrating voltage should be checked in the following manner:

1 - Procure a signal generator, or similar piece of apparatus, which is capable of supplying 40,000 microvolts with known accuracy at a frequency within or above the standard-broadcast band (540-1500 kc). A Type TMV-18 signal generator is recommended for this application.

2 - Remove the field-intensity meter from its case and connect the batteries. Open the loop socket and connect the top and next to the top brushes of that socket to the high-potential and the ground binding posts of the signal generator, respectively. Turn both the field-intensity meter and the signal generator "on".

3 - After the instruments have been in operation a sufficient length of time to become well stabilized, set the attenuator of the signal generator to supply 40,000 microvolts. With coil set "A" installed (if broadcast frequencies are being used), tune the field-intensity meter to this signal and adjust the i-f attenuator to provide approximately full-scale deflection on the output meter.

4 - Turn the calibrating oscillator "on", insert a set of headphones and tune the oscillator to the frequency of the signal generator by the "zero-beat" method. Then disconnect the leads to the signal generator.

5 - Connect the top loop-socket brush to the third brush (from the top), using a short lead with test clips, and adjust the input meter to that reading specified under "Operation-Procedure", Section V. The output meter reading now should be the same as when the signal generator was connected.

6 - If this is not the case, the reading of the input meter should be varied to produce the required output-meter deflection and the final indication of the input meter should be used for future calibrations in place of that value specified under "Operation-Procedure" - Section V.

Low Sensitivity

Low sensitivity may be produced by any of the following:

1 - Low battery voltage.

2 - Poor connection to loop. If necessary, the loop-socket brushes and loop slip rings may be cleaned with fine sandpaper.

3 - Weak or defective tubes. The tubes should be removed and tested at regular intervals, new tubes being substituted when necessary.

4 - I-F transformers not properly aligned. To re-align the i-f transformers,an external voltage at a frequency of 300 kilocycles must be applied.

NOTE-The Type TMV-18 Signal Generator also may be employed in this adjustment. The signal generator should be connected to the field-intensity meter (see "Incorrect Calibrating Voltage") and both instruments turned "on". When the instruments have been in operation long enough to become properly stabilized, set the i-f attenuator of the field-intensity meter at 10,000, the gain control at a normal value, and vary the output of the signal generator until the output meter of the field-intensity meter reads approximately two-thirds of its full scale deflection. The i-f transformers (see Figure 4) now may be aligned by means of an insulated screw-driver, reducing the output of the signal generator as necessary to prevent overloading of the output meter of the field-intensity meter. These adjustments should be made, starting with the 1st i-f transformer, then proceeding to the coupling trimmer (C-22) and the 2nd, 3rd and 4th i-f transformers in sequence.

A small error will occur when the loop-balancing capacitor (C4) is not properly adjusted. This may be corrected by rotating the loop through 180 degrees while receiving a signal, and adjusting the balancing capacitor until the output meter reads the same in both positions of the loop.

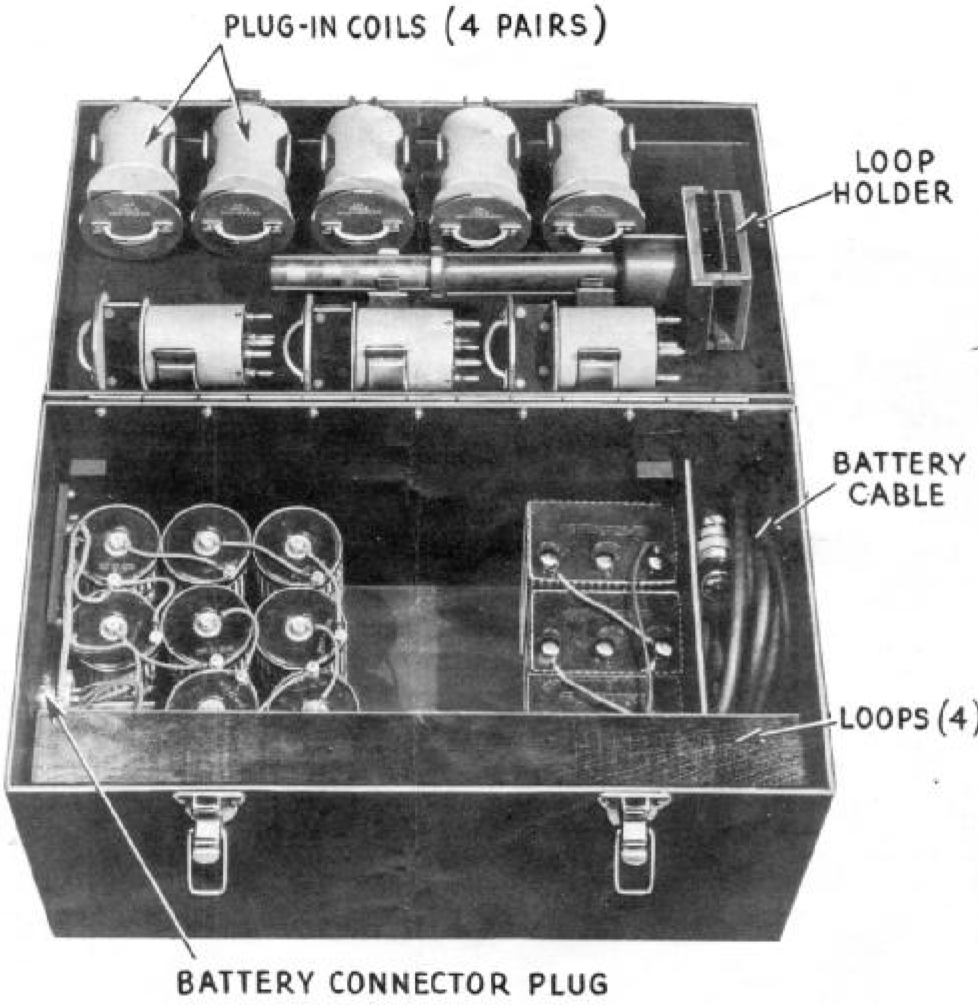
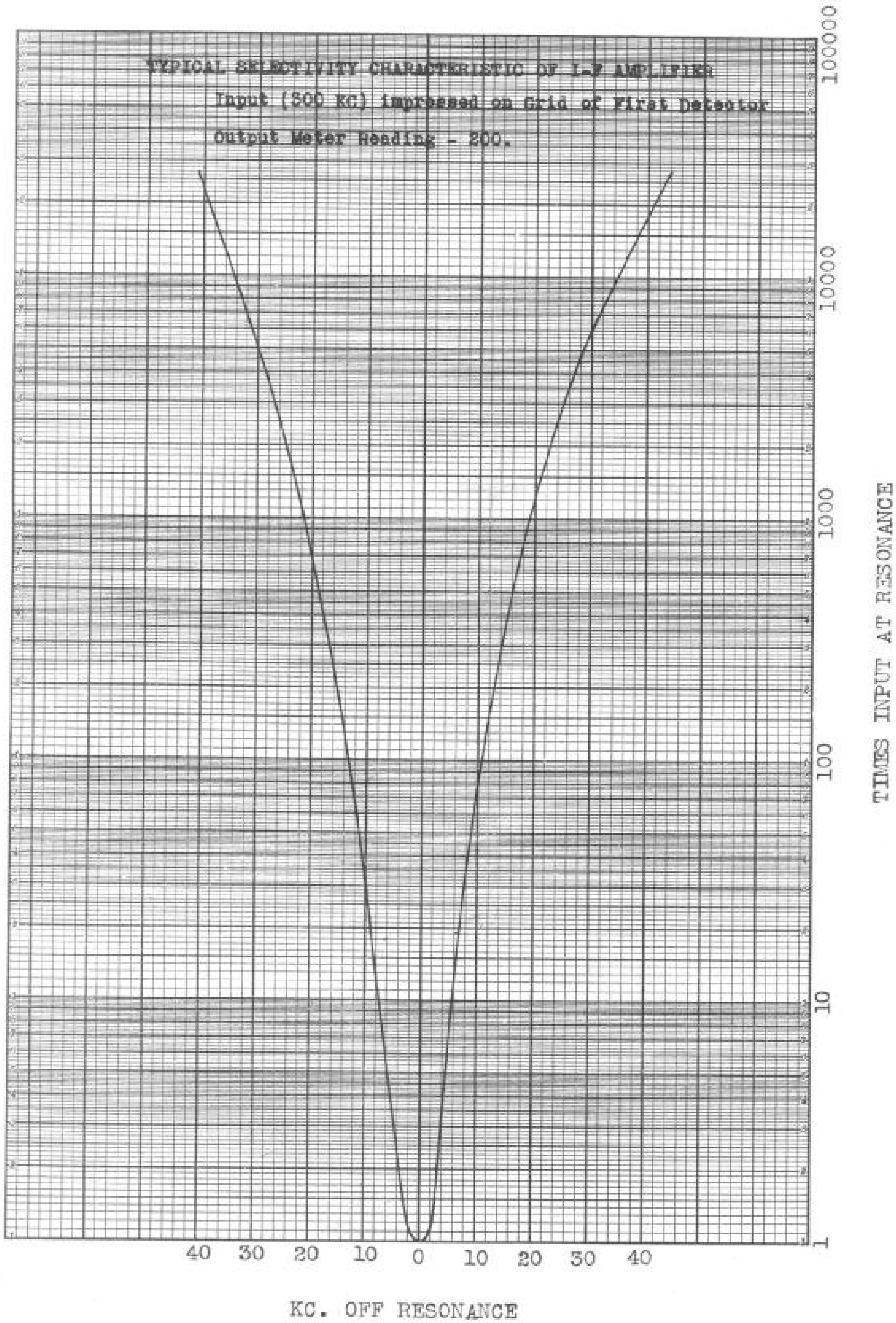
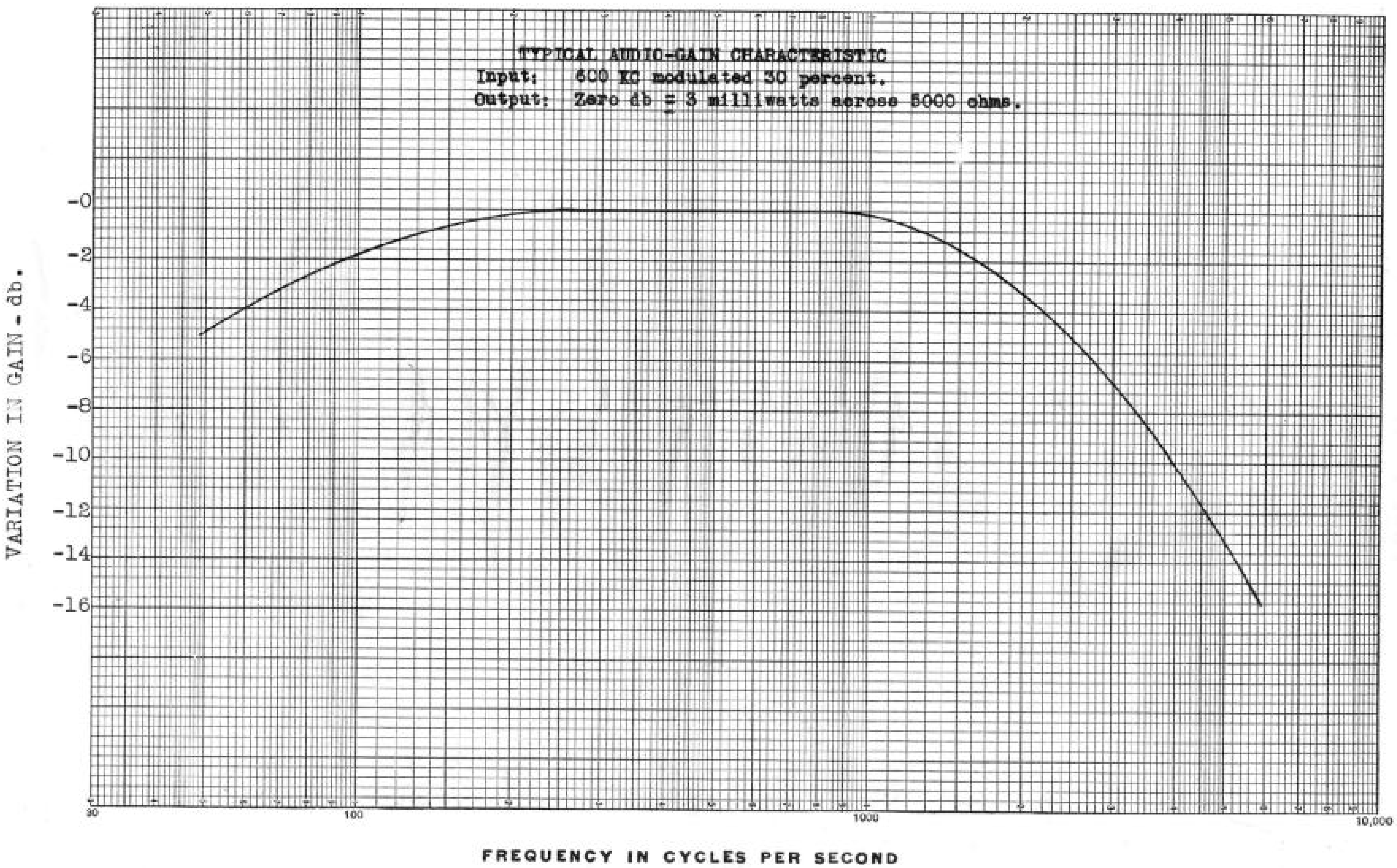


FIG. 5 - BATTERY AND ACCESSORY BOX

INTERMEDIATE FREQUENCY SELECTIVITY
T.M.V. 75B




TYPICAL AUDIO-GAIN CHARACTERISTIC
Input: 600 KC modulated 30 percent.
Output: Zero db = 3 milliwatts across 5000 ohms.
VARIATION IN GAIN - db.
-0
-2
-4
-6
-8
-10
-12
-14
-16
30
100
1000
10,000
FREQUENCY IN CYCLES PER SECOND

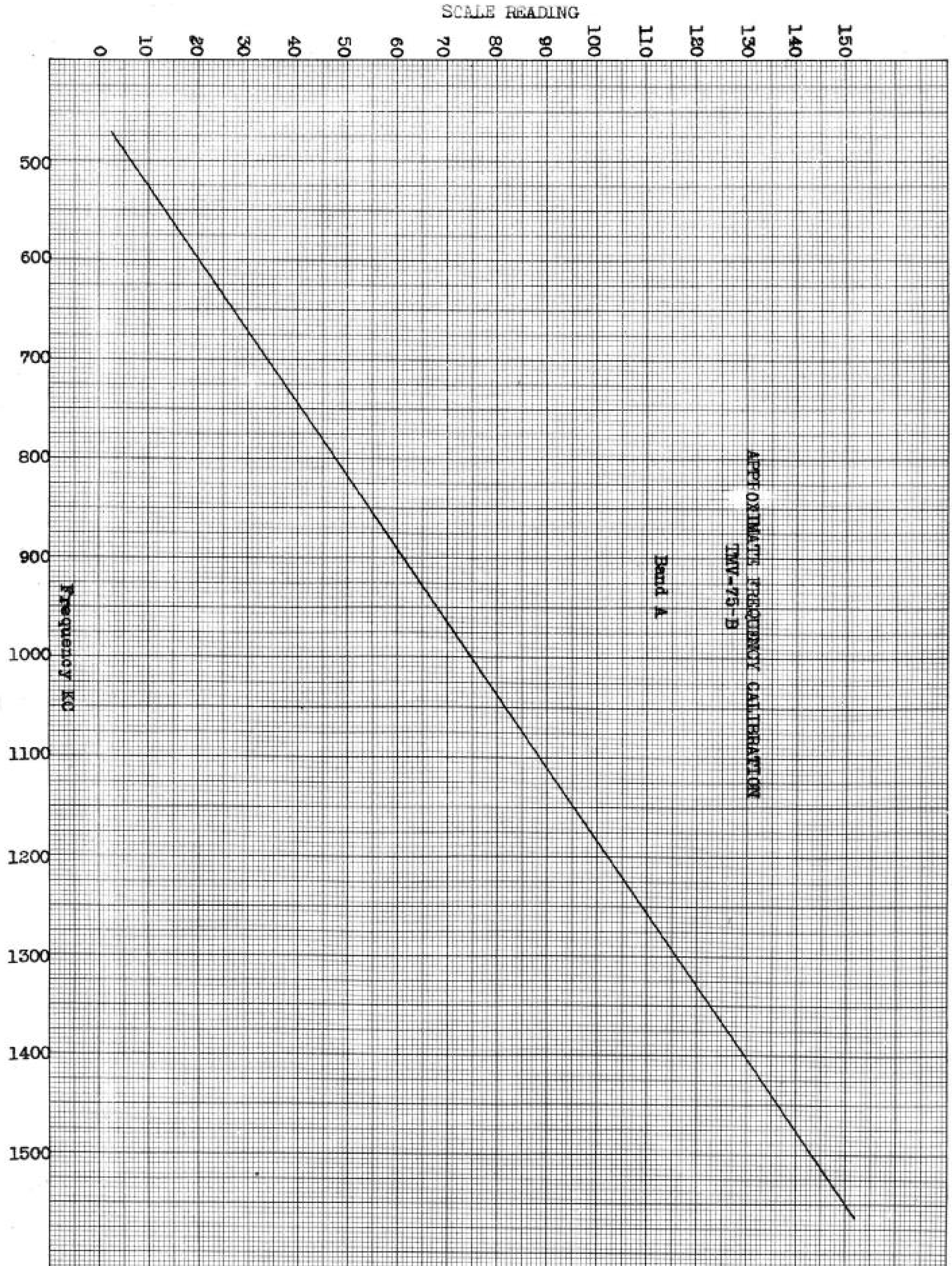
VII
PARTS LIST

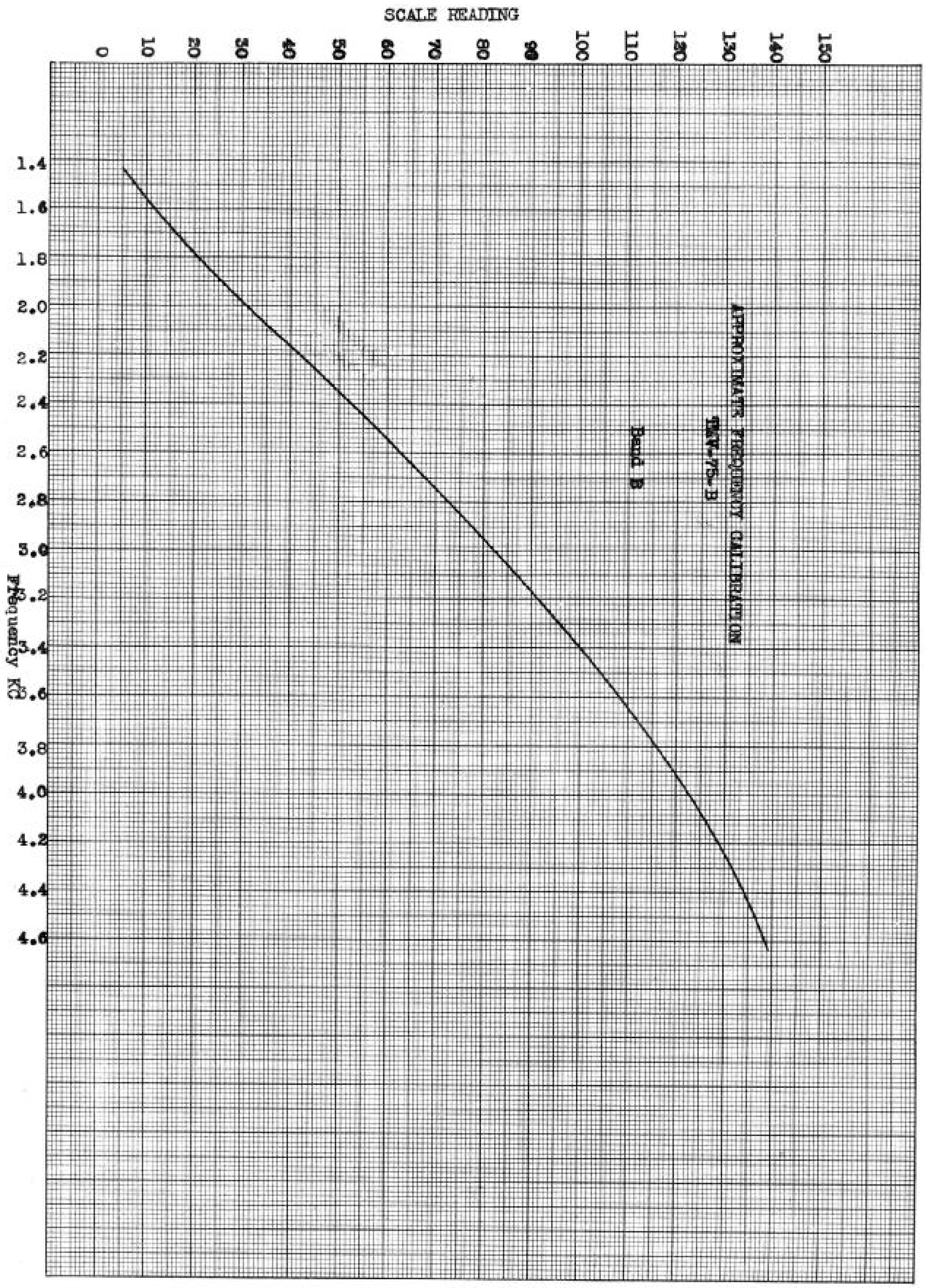
The following parts list is included to facilitate the identification of parts and order of replacements. When ordering such parts, the manufacturer's drawing number and a suitable description of each unit should be specified. All symbol numbers may be cross-referenced readily to the schematic diagram and the locations of the major components are shown on Figures 3 and 4.

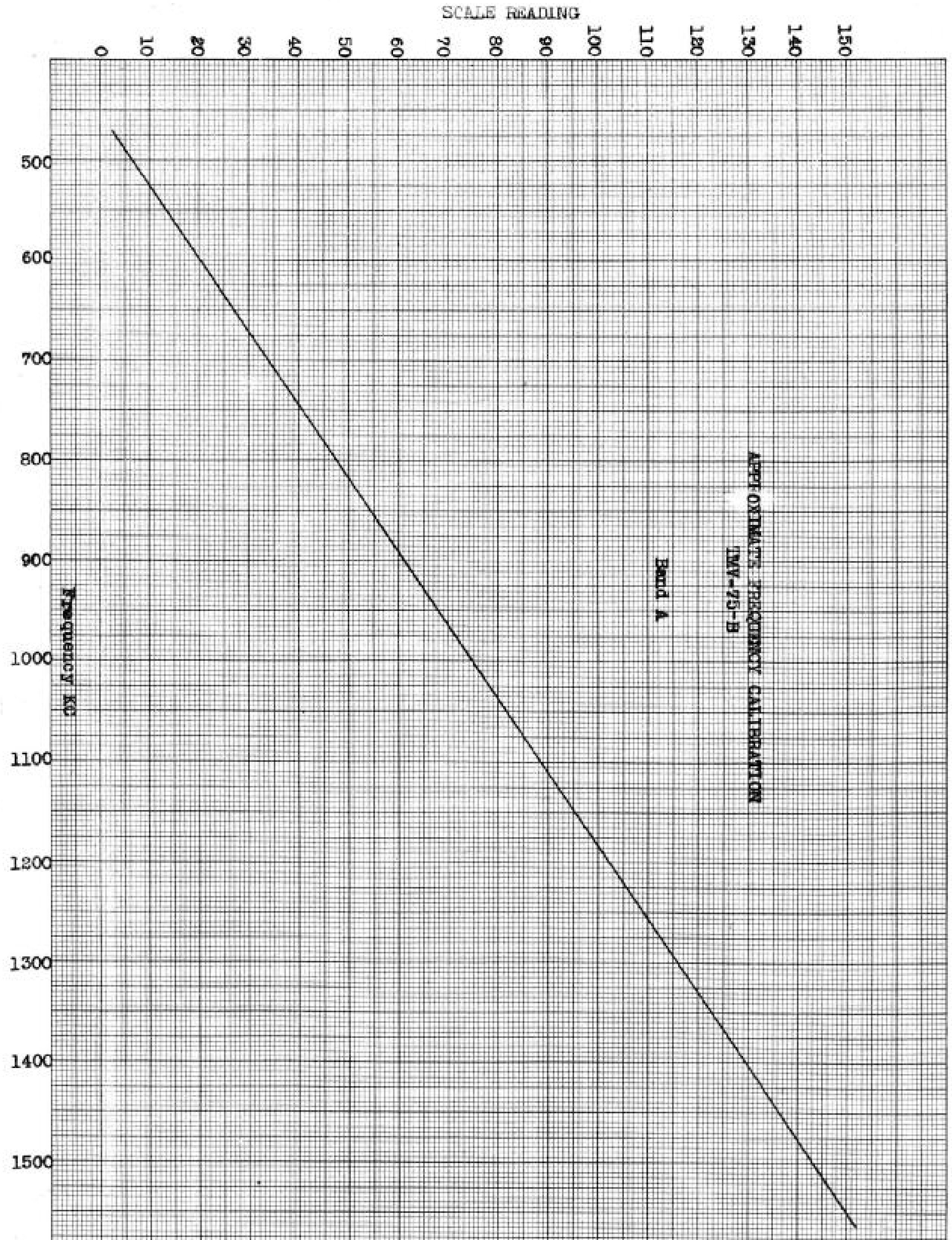
Reference	Description	Drawing No.
	Coils	
L-1 and L-2	Mutual inductor of calibrating attenuator	M-402769, G1
L-3, L-4, L-5	Calibrating oscillator coils	M-402766
L-6	Calibrating osc. "+B" filter (16 millihenries)	M-64086, G1
L-7	Calibrating osc. filament resistor (66 ohms)	M-402771
L-8 and L-9	1st i-f transformer	M-402774, G2
L-10 and L-12	Detector-oscillator filter (16 millihenries)	M-64086, G1
L-13 and L-14	Heterodyne-oscillator coils	M-402766
L-15	I-F amplifier input filter	M-402744, G3
L-16 and L-17	2nd i-f transformer	M-402745, G1
L-18 and L-19	3rd i-f transformer	M-402745, G2
L-20 and L-21	4th i-f transformer	
T-1	Output transformer	M-64322, G1
	Capacitors	
C-1	Loop-tuning capacitor (500 mmf.-variable)	P-702855, P25
C-2	Input attenuator cap. (12 mmf.)	K-59224, P3
C-3	Input attenuator cap. (100 mmf.)	K-59224, P9
C-4	Loop-balancing cap. (25 mmf.) National Type SEU	
C-5	Calibrating osc. grid cap. (300 mmf.)	K-59134, P41
C-6	Calibrating osc. filter cap. (0.1 mf.)	K-69033, G1
C-7	Calibrating osc. tuning cap. (500 mmf.-variable)	P-702855, P24
C-8, C-9, C-10	Calibrating osc. filter cap. (0.1 mf.)	K-69033, G1
C-11	1st i-f tuning capacitor	Supplied with L-8 and L-9
C-12, C-13, C-14	Detector filter capacitor (0.1 mf.)	K-69033, G1
C-15	Heterodyne osc. coupling cap. (1200 mmf.)	K-59044, P15
C-16	Heterodyne osc. grid cap. (300 mmf.)	K-59134, P41
C-17	Heterodyne osc. tuning cap.(500 mmf.-variable)	P-702855, P24
C-18, C-19, C-20, and C-21	Heterodyne osc. filter cap.(0.1 mf.)	K-69033, G1
C-22	Amplifier input tuning capacitor	Supplied with L-15
C-23 and C-24	2nd i-f tuning capacitor	Supplied with L-16, L-17
C-25 and C-26	3rd i-f tuning capacitor	Supplied with L-18, L-19
C-27	4th i-f tuning capacitor	Supplied with L-20, L-21
C-28	Amplifier filter capacitor (0.5 mf.)	M-68501, G1
C-29 and C-30	Amplifier filter capacitor (1.0 mf.)	M-68501, G1
C-31	Amplifier filter capacitor (0.1 mf.)	K-69033, G1
C-32	Amplifier filter capacitor (1.0 mf.)	K-68501, G1
C-33	Amplifier filter capacitor (0.1 mf.)	K-69033, G1

Reference	Description	Drawing No.
C-34	Amplifier filter capacitor (300 mmf.)	K-59134, P41
C-35	Amplifier filter capacitor (400 mmf.)	K-59044, P6
C-36	A-f coupling capacitor (0.025 mf.)	K-69078, G1
REMOVED ~~C-37~~	Recorder filter capacitor (0.1 mf.)	K-69033, G2
C-38	Detector filter capacitor (745 mmf.)	M-59044, P20
C-39	Amplifier filter capacitor	K-69032, G1
	Resistors	
R-1	1st det. grid leak (10 meg., 1/4 watt carbon)	K-63876, P16
R-2	Cal. osc. grid leak (15000 ohms, 1/2 watt carbon)	K-59136, P9
R-3	Cal. output control (0-15000 ohms Stackpole potentiometer)	K-802820
R-4	Fixed bias control (13000 ohms, 1/2 watt carbon)	K-63875, P19
R-5	Variable bias control (6000 ohms) - Yaxley H6MP	
R-6	1st detector bias (3500 ohms, 1 watt carbon)	K-67514, P1
R-7	Heterodyne coupling resistor (13000 ohms, 1/2 watt carbon)	K-63875, P19
R-8	Heterodyne osc. grid leak (15000 ohms, 1/2 watt carbon)	K-59136, P9
R-9	Heterodyne osc. filament resistor (International Resistor Co., Type PA, 67 ohms)	
R-10 to R-22	I-f attenuator resistors	M-402767, G1
R-23	1st i-f amp. bias resistor (500 ohms - 1/2 watt carbon)	K-67514, P17
R-24	I-f screen grid bleeder resistor (15000 ohms - 1/2 watt carbon)	K-59136, P9
REMOVED ~~R-25~~	Diode load resistor (50000 ohms - 1/2 watt carbon)	K-63875, P26
R-26	A-f filter resistor (60000 ohms - 1/4 watt carbon	K-63876, P12
R-27	3rd i-f bias resistor (850 ohms - 1/4 watt carbon)	K-63876, P29
R-28	I-f screen grid voltage divider (20000 ohms - 1/2 watt carbon)	K-63875, P23
R-29	Output tube bias resistor (2800 ohms - 1/2 watt carbon)	K-59136, P22
R-30	A-f coupling resistor (500,000 ohms - 1/4 watt carbon)	K-63875, P11
REMOVED ~~R-31~~	Recorder voltage divider (6000 ohms - 1/4 watt carbon)	K-63876-P21
R-32	Amplifier filter resistor (1000 ohms - 1/2 watt carbon)	K-63875,P2
	Miscellaneous	
J-1	Phone jack	K-7862073, P1
M-1	Input meter - Weston Model 600 (250 ma., - 20 ohms)	
M-2	Voltmeter (Pl. and Fil.) - Weston Model 506 (7.5/150 volts)	
M-3	Output meter - Weston Model 269 (300 ma. - 900 ohms)	
S-1	Loop tuning-range switch	M-402751, G1
S-2	Input attenuator (SENS) switch	K-802821
S-3	Cal. osc. ON-OFF toggle switch	K-30066, P3
S-4	Main ON-OFF switch - Yaxley 744	
-	Thermocouple	M-402132, P1

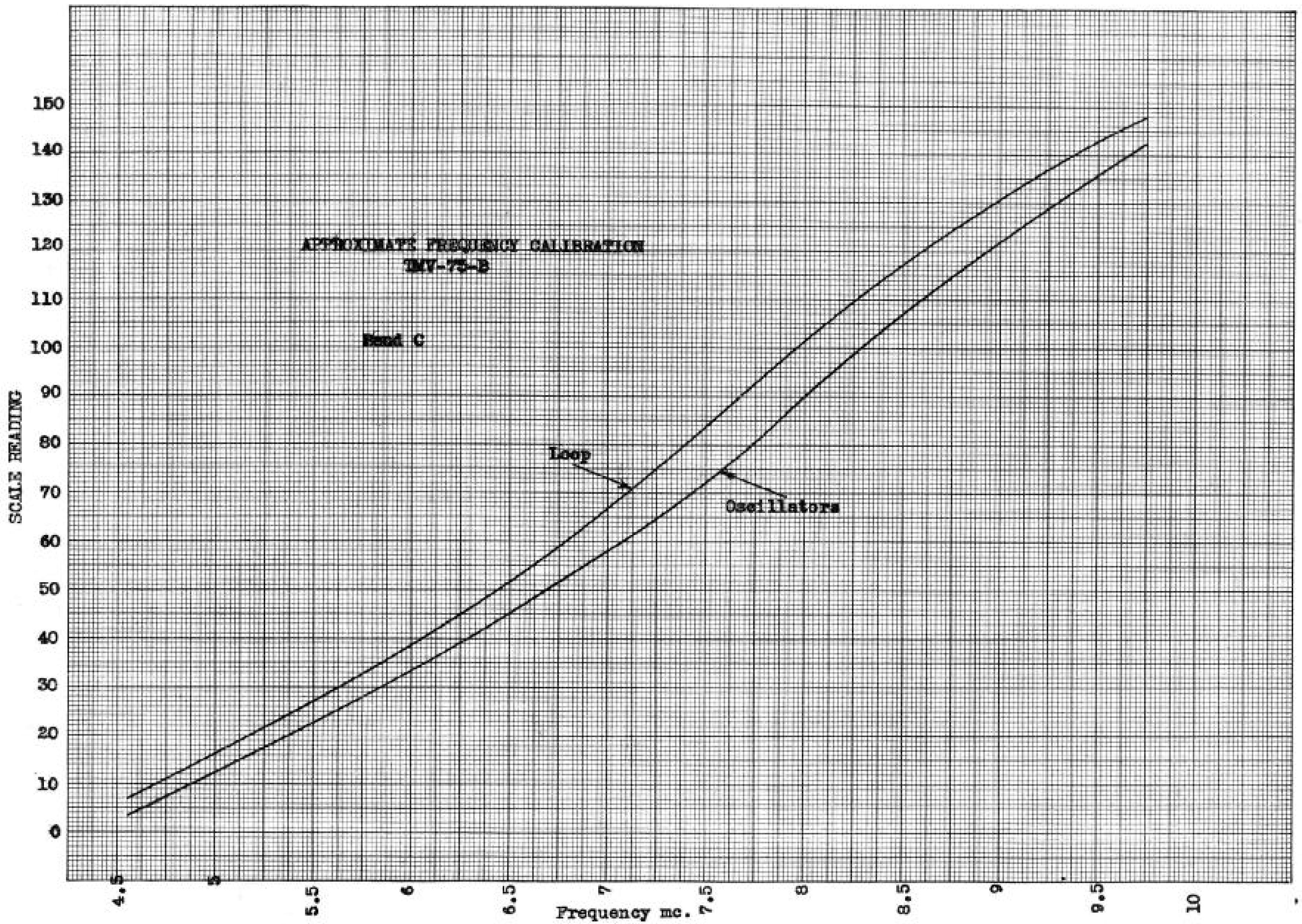
R33 0.25 MEG, 1/4 WATT CARBON
R34 0.25 " , " " "


SCALE READING
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
APPROXIMATE FREQUENCY CALIBRATION
TMV-75-B
Band A
Frequency KC
500
600
700
800
900
1000
1100
1200
1300
1400
1500

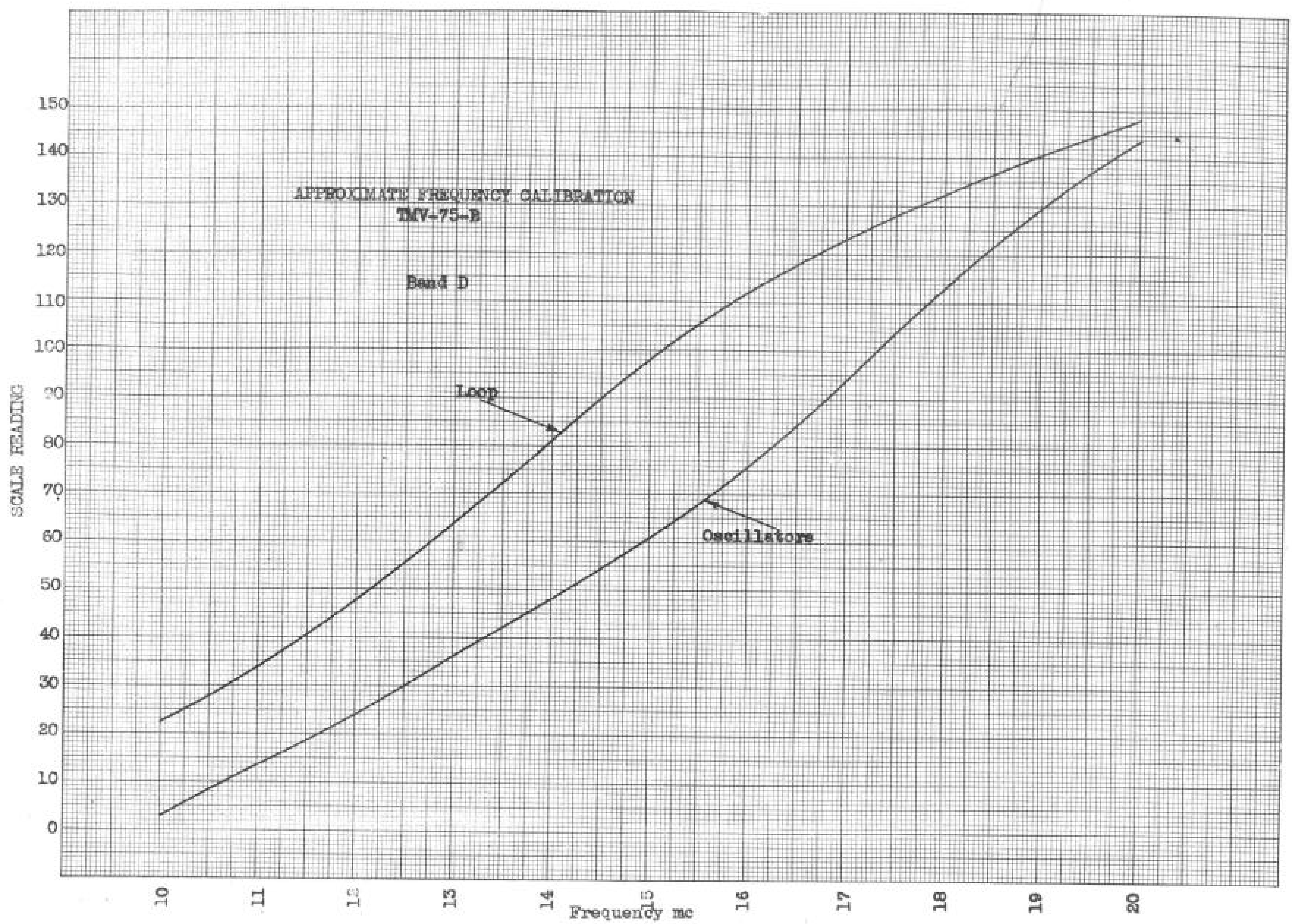

SCALE READING
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
APPROXIMATE FREQUENCY CALIBRATION
TMV-75-B
Band B
Frequency KC
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6



SCALE READING
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Frequency KC
APPROXIMATE FREQUENCY CALIBRATION
LMV-75-B
Band A



APPROXIMATE FREQUENCY CALIBRATION
Band C
Loop
Oscillators
SCALE READING
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
Frequency mc.


APPROXIMATE FREQUENCY CALIBRATION
TMV-75-B
Band D
Loop
Oscillators
SCALE READING
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Frequency mc
10
11
12
13
14
15
16
17
18
19
20

Form 1
G P O 11—1784

UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON

Jim

National Bureau of Standards

Certificate

FOR

Radio Field Intensity Meter
R.C.A. Type TMV-75-B, Serial No. 538.
Submitted by:
Queen City Broadcasting Co., Inc.,
Cobb Building,
Seattle, Wash.

- - - -

The instrument included a shielded case containing the measuring apparatus, tuning condensers, and calibrating voltage source. A rotatable loop antenna fitted into a suitable rotatable mounting on the shielded case.

The method of measurement consists of inserting in series with the loop antenna at its center a fixed calibrating voltage, and comparing the latter with the induced field voltage by means of a sensitive vacuum-tube voltmeter; the latter comprises a superheterodyne radio receiver with a linear first detector and a resistance-type voltage attenuator connected between the detector and the intermediate-frequency amplifier. The output indicating system includes an ammeter connected through a suitable compensating circuit to a linear second detector. The calibrating voltage, measured with a thermocouple-type meter, is adjusted to a fixed value. The amplification of the i-f amplifier is varied to obtain a fixed reading of the output indicator. In this way the overall sensitivity of the instrument is maintained constant and may be included in the antenna coefficient.

The set was submitted for calibration on March 21, 1941.

The following measurements were made:

I. Circuit measurements, to determine the degree of linearity of the first detector in the frequency range from 550 to 1500 kilocycles per second, the degree of

Test No. Te-91709

linearity of the output indicating system, the actual voltage-attenuator ratios corresponding to the several steps of the voltage-attenuator of the instrument, and the variation of calibrating voltage with frequency in the interval from 550 to 1500 kilocycles per second.

II. Overall field intensity measurements, to evaluate the antenna coefficient in the frequency range from 550 to 1500 kilocycles per second, and to determine whether this coefficient is dependent on the operating frequency.

The results of the measurements are shown in the following tabulations. In these tests the antenna coefficient (C) relates the value of the radio field intensity to the reading of the output indicator and to the voltage-attenuator ratio of the measuring set, and is defined by the relation

$$C = \frac{Ef}{MA}$$

where   is the radio field intensity in microvolts per meter,
f is the frequency in kilocycles per second,
M is the reading of the output indicator,
A is the measured voltage-attenuator ratio.

I. Circuit Measurements.

The first detector was found to be linear within plus or minus 2 percent for input voltages up to 2.0 volts. In use an input voltage of 2.0 volts corresponds approximately to a radio field intensity of 1.0 volt per meter.

The output indicating system was linear to plus or minus 1.5 percent from 15 to 100 percent of full scale.

The voltage-attenuator ratios were found to have the following relative values, referred to the calibrating step (50,000). The measured relative values were accurate within 2 percent.

Indicated voltage-attenuator ratio	Measured voltage-attenuator ratio
50,000	50,000
10,000	9,680
2,000	1,842
500	509
100	89.0
20	16.3
5	4.17
1	0.86

The values of the calibrating voltage was 43.6 millivolts at the setting of 200 specified by the manufacturer and was found to be independent of frequency in the interval from 550 to 1500 kilocycles per second. The accuracy of the voltage determination was ±1 percent.

The beat oscillator frequency was found to drift and to require retuning within a half minute after a previous tuning, particularly at the higher frequencies.

II. Overall Field Intensity Measurements.

The determination of the antenna coefficient for the loop antenna in the frequency range from 550 to 1500 kilocycles per second was made on March 28, 1941, at the Bureau's transmitting station at Beltsville, Md., in terms of radio field intensities as measured by a standard field intensity measuring set of the Bureau.

The results of the measurements are given in the following table, in which the letter symbols are as defined in the expression on page 2.

Frequency, kilocycles per second, f	Field intensity measured on standard, microvolts per meter, E	Instrument under test: Reading of output indicator, M	Instrument under test: Measured voltage-attenuator ratio, A	Instrument under test: Antenna coefficient, $C = \frac{Ef}{MA}$
550	2090	87.5	89	148
850	2550	156	89	156
1000	3365	239	89	158
1100	3495	52	509	145
1200	3545	57	509	147
1400	3900	73	509	147
1500	3720	76	509	144

It was found that successive measurements of the same field intensity varied by as much as 6 percent. This is believed due to faulty contact at the base of the loop antenna, since the sensitivity of the instrument varied considerably if the orientation of the loop antenna were varied during a measurement. It was found that less error was introduced by keeping the direction of the loop antenna fixed for maximum signal strength, for measurement of field intensities less than 5000 microvolts per meter.

III. Conclusion

The values of the antenna coefficient as a function of frequency are tabulated in the last column of the foregoing table, and are seen to be within ±5 percent of 151. When based on the use of this antenna coefficient, and on the measured values of voltage-attenuator ratio reported in Section I, the measurement of radio field intensity by this instrument was found to be accurate within ±7 percent at the frequencies and field intensities reported in Section II.

From this and the measurements of linearity, etc., reported in Section I, it is estimated that the accuracy of measurement with this instrument for radio field intensities ranging from 100 µv/m to 1.0 v/m in the frequency range from 550 to 1500 kilocycles per second, is within 10 percent when the corrected value of the antenna coefficients and the measured values of voltage-attenuator ratio reported in Section I, are employed.

Lyman J. Briggs, Director.

Your order No. 229
Test No. Te-91709,
April 4, 1941.
JJF:ANK

On September 27, 1945 This instrument was checked for calibration at the University of Washington with the output of a General Radio Type 605-B Standard Signal Generator, with the following conclusions.

Calibrating with a setting of 200 on the input meter results in readings that are 15% high.

Calibrating with a setting of 248 on the input meter results in readings that are correct.

Calibrating with a setting of 225 on the input meter results in readings that are 10% high.

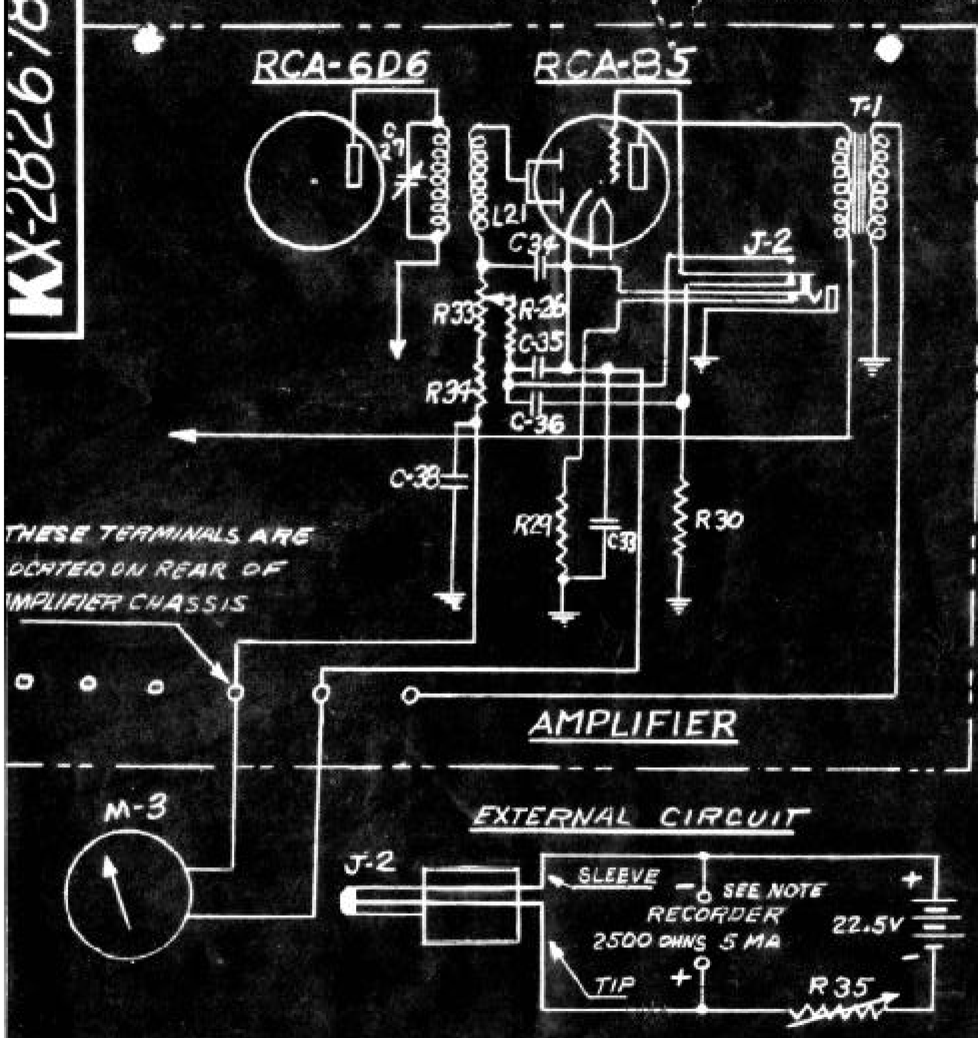
The calibration meter readings indicate the following voltages at the third brush from the top.

This run was made at a frequency of 1020kcs.

250	40,000	Microvolts
230	37,000	"
200	33,900	"
180	31,000	"
160	28,700	"
140	26,100	"
120	23,800	"
112	22,800	"

J. B. Hatfield
H. A. Ray Jr.

Dimensions in Inches



Variations on Finished Dimensions unless otherwise marked

Basic Dimensions	Fractional Dimensions	Decimal Dimensions
Up to ½	[illegible]	± .005
Above ½ to 6	± 1/64	± .005
Above 6 to 24	± 1/32	± .010
Above 24	± 1/16	± .015

REFER TO SCHEM. DIA. IN INST. BOOK.

DISCONNECT RECORDER BINDING POSTS

REMOVE R-31 AND C-37

REWIRE METER M-3 AS SHOWN -

REPLACE R-25 WITH R-34 -

ADD R-33 AND J-2 AS SHOWN -

MOUNT J-2 AND R-34 ON THE INSIDE OF THE AMPLIFIER SHIELD -

ADDITIONAL PARTS REQUIRED

R-34	27000 OHMS 1/2 WATT CARBON.
R-33	30000 OHMS LINEAR CARBON POT. WITH SLOTTED SHAFT FOR SCREW DRIVER ADJ.
J-2	JACK - YAXLEY NO. 705
R-35	10000 OHM WIRE WOUND RHEOSTAT

NOTE

FOR RECORDERS LESS THAN 2500 OHMS - ADD SERIES RESISTANCE

FOR RECORDERS LESS THAN 5MA. - SHUNT TO 5MA.

INSTRUCTIONS

WITH THE TMV-75B "ON" AND M-3 READING ZERO CONNECT THE RECORDER, LEAVING THE BATTERY CIRCUIT OPEN. THE RECORDER SHOULD GO OFF SCALE. WITH R-35 AT MAX RESISTANCE CONNECT THE BATTERY AND ADJUST R-35 UNTILL THE RECORDER READS FULL SCALE. TUNE IN SIGNAL AND SET OUTPUT METER M-3 TO FULL SCALE. ADJUST R-33 TO GIVE A ZERO READING ON THE RECORDER. FIELD STRENGTH READINGS WILL BE REVERSED ON THE RECORDER SCALE AND WILL BE LINEAR WITHIN 10 PERCENT.

MFG. BY R.H.B. Oct.

FIELD INTENSITY METER

ALTERATIONS FOR USE WITH EXTERNAL CURVE RECORDER

FIRST MADE FOR TMV-75 B

DRAWN BY

TRACED BY

CHECKED BY R.H.B. 4-3-36

MATERIAL

R C A Manufacturing Co. Inc.
R C A Victor Division

KX-282678