TM 11-2528

WAR DEPARTMENT TECHNICAL MANUAL

RANGE CALIBRATOR

I-223-A

RESTRICTED *DISSEMINATION OF RESTRICTED MATTER.* The information contained in restricted documents and the essential characteristics of restricted materiel may be given to any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work, but will not be communicated to the public or to the press except by authorized military public relations agencies. (See also par. 28, AR 380-5, 15 Mar 1944.)

WAR DEPARTMENT *7 NOVEMBER 1944*

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WAR DEPARTMENT,
WASHINGTON 25, D. C., 7 November 1944.

TM 11-2528, Range Calibrator I-223-A, is published for the information and guidance of all concerned.

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(For explanation of symbols see FM 21-6.)

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DESTRUCTION NOTICE

WHY —To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW —1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut—Use axes, handaxes, machetes.

3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives—Use firearms, grenades, TNT.

5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT —1. Smash—Tubes, meters, knobs, panels, switches, crystal case.

2. Cut—Cables, wires.

3. Burn—Technical manuals, circuit diagrams.

4. Bend—Case, nameplates.

5. Bury or scatter—Any or all of the above pieces after breaking.

DESTROY EVERYTHING

WARNING

HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if personnel fail to observe safety precautions

Operation of this equipment may involve the use of high voltages which are dangerous to human life. Operating personnel must at all times observe all safety regulations.

Do not change tubes or make adjustments inside the equipment with the on-off switch ON.

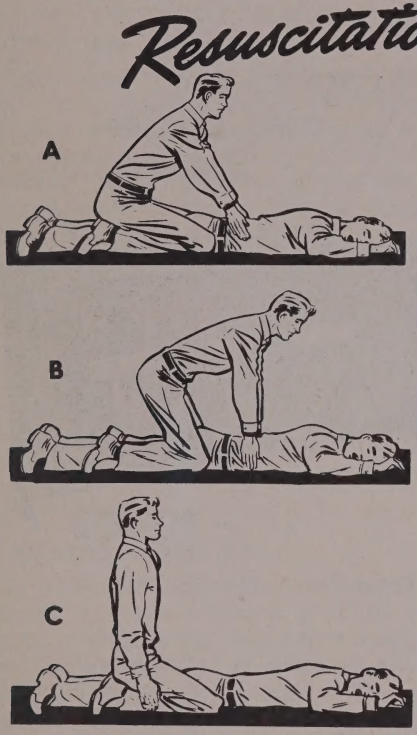
FIRST AID TREATMENT FOR ELECTRIC SHOCK

I. FREE THE VICTIM FROM THE CIRCUIT IMMEDIATELY.

Shut off the current. If this is not immediately possible, use a dry nonconductor (rubber gloves, rope, board) to move either the victim or the wire. Avoid contact with the victim. If necessary to cut a live wire, use an axe with a dry wooden handle. Beware of the resulting flash.

II. ATTEND INSTANTLY TO THE VICTIM'S BREATHING.

Begin resuscitation at once on the spot. Do not stop to loosen the victim's clothing. Every moment counts. Keep the patient warm. Wrap him in any covering available. Send for a doctor. Remove false teeth or other obstructions from the victim's mouth.



POSITION

1. Lay the victim on his belly, one arm extended directly overhead, the other arm bent at the elbow, the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing (fig. A).

2. Straddle the patient's thighs, or one leg, with your knees placed far enough from his hip bones to allow you to assume the position shown in figure A.

3. Place your hands, with thumbs and fingers in a natural position, so that your palms are on the small of his back, and your little fingers just touch his lowest ribs (fig. A).

FIRST MOVEMENT

4. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the victim. Your shoulders should be directly over the heels of your hands at the end of the forward swing (fig. B). Do not bend your elbows. The first movement should take about 2 seconds.

SECOND MOVEMENT

5. Now immediately swing backward, to remove the pressure completely (fig. C).

6. After 2 seconds, swing forward again. Repeat this pressure-and-release cycle 12 to 15 times a minute. A complete cycle should require 4 or 5 seconds.

CONTINUED TREATMENT

7. Continue treatment until breathing is restored or until there is no hope of the victim's recovery. Do not give up easily. Remember that at times the process must be kept up for hours.

8. During artificial respiration, have someone loosen the victim's clothing. Wrap the victim warmly; apply hot bricks, stones, etc. Do not give the victim liquids until he is fully conscious. If the victim must be moved, keep up treatment while he is being moved.

9. At the first sign of breathing, withhold artificial respiration. If natural breathing does not continue, immediately resume artificial respiration.

10. If operators must be changed, the relief operator kneels behind the person giving artificial respiration. The relief takes the operator's place as the original operator releases the pressure.

11. Do not allow the revived patient to sit or stand. Keep him quiet. Give hot coffee or tea, or other internal stimulants.

HOLD RESUSCITATION DRILLS REGULARLY

TL37451

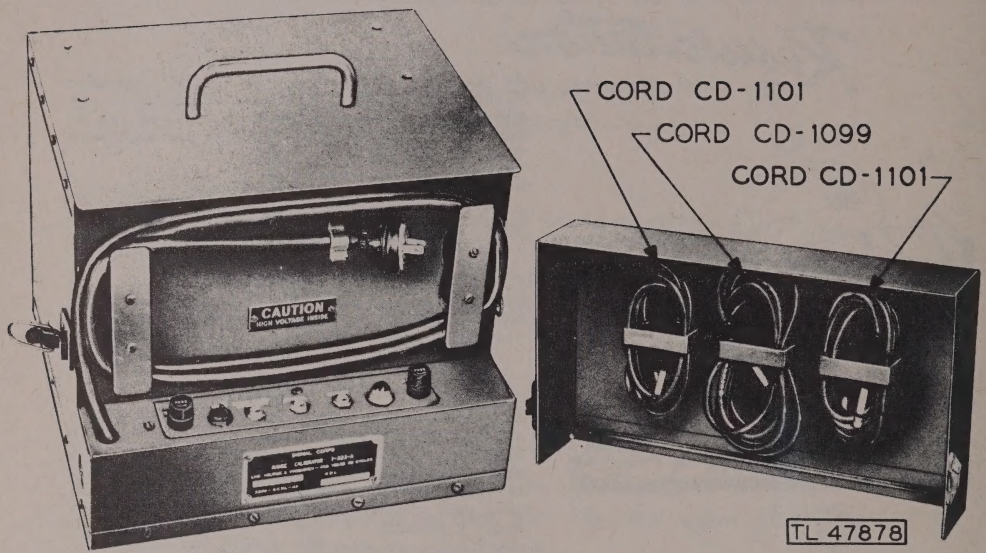


Figure 1. Range Calibrator I-223-A.

SECTION I

DESCRIPTION

1. PURPOSE.

The purpose of Range Calibrator I-223-A (fig. 1) is to provide means for checking and adjusting the range measuring circuits of a pulse-operated radar apparatus. The range calibrator is used to calibrate, at a number of selected points, the range indications of radar apparatus.

CAUTION: The operator should observe all safety regulations to avoid shock which might be dangerous to life. Although extremely high voltages are not prevalent in Range Calibrator I-223-A, it should be remembered that other apparatus in conjunction with which the range calibrator is used often does contain high voltages. Every precaution should therefore always be observed.

2. GENERAL DESIGN.

a. Range Calibrator I-223-A produces three outputs: a sine-wave output at 163.94 kilocycles, a synchronizing pulse with a repetition rate of approximately 240 pulses per second, and positive pulses having pulse width of not more than one microsecond and a repetition rate of 163,940 times per second. This latter pulse corresponds to a range separation of 1,000 yards between pulses.

b. Range Calibrator I-223-A is of single unit construction and is housed in a metal case. All controls and jacks required for operation are located on the operating panel and are clearly marked (fig. 2). The panel cover contains three cables, each 6 feet long, which are used to connect the calibrator to the unit under observation and also to an oscilloscope.

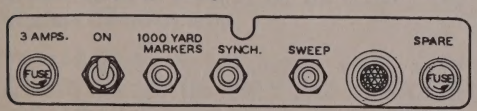


Figure 2. Range Calibrator I-223-A, operating panel.

c. Range Calibrator I-223-A has been designed to operate from a 117.5-volt, 60-cycle line. Its power consumption is 40 watts.

3. DIMENSIONS AND WEIGHT.

Consult the following table:

TABLE I. DIMENSIONS AND WEIGHT

Component	Dimensions	Weight
Range Calibrator I-223-A (in metal case)	Height 9¾″ Width 11 11/16″ Depth 12¼″	31 lb.
Test cable (Cord CD-1099)	Length 6′	
Test cable (Cord CD-1101)	Length 6′	
Power cord attached)	Length 6′	

4. VACUUM TUBES.

Range Calibrator I-223-A uses a total of eight tubes. A list of these tubes with Signal Corps type numbers and commercial numbers follows:

TABLE II. TUBE COMPLEMENT.

Quantity	Signal Corps type number	Commercial number
2	VT-107-A	6V6GT
2	VT-115-A	6L6G
1	VT-116	6SJ7
1	VT-197-A	5Y3G
2	VT-231	6SN7GT

SECTION II

OPERATION

5. RANGE CALIBRATION.

The range accuracy of a pulse-operated radar apparatus can be checked with Range Calibrator I-223-A by the following procedure:

a. Remove the cover of the calibrator.

b. Unwind the power cord and plug into a 117.5-volt, 60-cycle outlet. The calibrator is shown in figure 1; see figure 2 for the location of the operating controls.

NOTE: If the crystal oscillator of the calibrator fails to start at extremely low temperatures, the calibrator case or, if necessary, the crystal holder should be jarred to start oscillation.

c. In the cover of Range Calibrator I-223-A will be found two output cables, Cords CD-1101. With one of these connect the SYNCH jack of the calibrator to the synchronizing input of the apparatus under test.

d. Turn the power switch of the calibrator to the ON position.

e. Turn off the radar modulator to prevent the radar apparatus from being triggered.

f. Turn up the repetition rate control of the radar set until a stationary pattern appears on the oscillograph screen.

g. Turn the range control of the radar set to the position which makes the markers easily discernible.

h. Reduce the gain of the radar set receiver so that no noise is visible on the screen. The baseline should be level.

i. Using the second output cable, Cord CD-1101, connect the 1000 YARD MARKERS jack of the calibrator to the vertical input connection of the radar oscilloscope. The pattern which appears should have a number of markers equal to the range divided by 1,000.

j. The accuracy of the range measurements made with the radar equipment under test can now be checked very precisely. To do this it is necessary to line up the range reference point with a number of markers appearing on the screen. Figure 3 shows a range reference point properly lined up with one of the markers. The same thing may be done for any reference point. Rotate the ranging mechanism until the indicator reads zero. Then rotate it a little to the right to line up the first marker with the range reference point. Write the number "O" at the top of the first column of a table of which table III is an example. Record the range reading in the corresponding space of column 2. Rotate the ranging mechanism to the right to line up the next marker with the range reference point. Write the number 1 in the second space in column 1 and the new range in the second space of column 2. This process can be repeated throughout the range of the radar equipment.

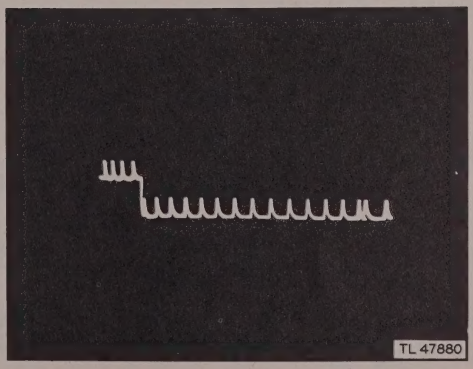


Figure 3. Step aligned with range marker reference point.

If it is desired, as indicated in the example, to omit readings of most of the markers, column 1 must show a jump of one for every marker omitted. In table III, for example, between 10 and 20 of column 1 there were nine markers for which no readings were taken. When columns 1 and 2 have been filled with the desired number of readings covering the range of the radar equipment, column 3 may be filled in. The figures in this column are arrived at by subtracting the first entry in column 2 from each succeeding entry in column 2. For example, 1,100 is derived by subtracting 400 from 1,500; 2,050 is derived by subtracting 400 from 2,450, etc. Column 4 is column 1 multiplied by 1,000. Column 5 is arrived at by subtracting the entries in column 4 from the corresponding entries in column 3. This column gives the error in yards of the range readings of the radar equipment.

k. After correcting any error in range calibration, disconnect the calibrator and return it to its case.

TABLE III.
EXAMPLE OF RANGE CALIBRATION

Marker passed	Range (yards)	Range between initial and following markers		Error (yards)
		Measured	Exact	
1	2	3	4	5
0	400	0	0	0
1	1,500	1,100	1,000	100
2	2,450	2,050	2,000	50
3	3,300	2,900	3,000	−100
4	4,200	3,800	4,000	−200
5	5,400	5,000	5,000	0
10	10,350	9,950	10,000	− 50
20	20,300	19,900	20,000	−100
30	30,300	29,900	30,000	−100
40	40,200	39,800	40,000	−200
50	50,250	49,850	50,000	−150
60	60,300	59,900	60,000	−100
70	70,100	69,700	70,000	−300
80	80,200	79,800	80,000	−200
90	90,100	89,700	90,000	−300
99	99,000	98,600	99,000	−400

SECTION III

FUNCTIONING OF PARTS

6. GENERAL.

a. The purpose of the range calibrator is to provide means for adjusting and checking the range measuring circuits of a pulse-operated radar apparatus. In order to meet this requirement the calibrator provides two separate and distinct methods. One of them is especially adapted to quick adjustment of the timing coil, and the other provides an overall check of the entire range circuit. In all, these methods require three output voltages, as follows:

(1) A crystal controlled sine wave of appropriate frequency. The frequency used is one in which the period (time required for one cycle) is the time required for electromagnetic waves to travel 1,000 yards and return. This frequency is 163.94 kilocycles.

(2) A marker-pulse wave exactly synchronous with the sine wave. This pulse wave is obtained directly from the sine wave by a wave-shaping process. The pulses are of positive polarity and no more than one microsecond in width.

(3) A synchronizing-pulse wave similar to the marker-pulse wave but with a repetition frequency of 240 cycles per second. Though these pulses occur relatively infrequently, they must remain in exact synchronism with the sine wave

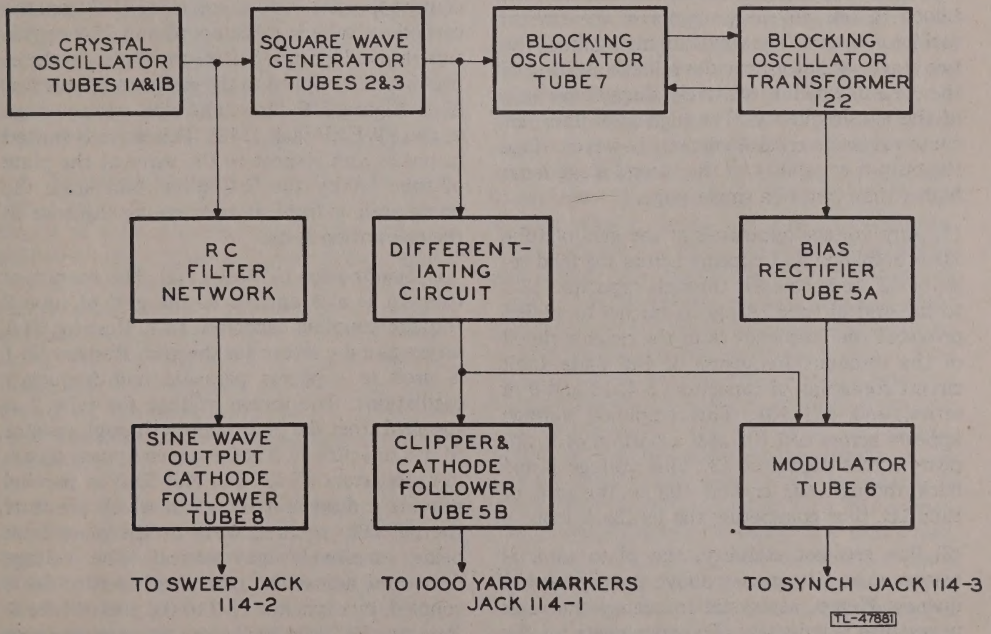


Figure 4. Range Calibrator I-223-A, block diagram.

and also with the marker wave. The synchronizing-pulse wave is obtained from the marker wave by a selection process whereby out of approximately 685 marker waves, one wave is allowed to pass.

b. Figure 5**A** to **J** inclusive, shows the time relationships and waveforms of the various voltages involved in the operation of the calibrator. With the exception of figure 5 **J**, which is on a different time scale, these figures are drawn so that a particular time interval is represented by the same abscissa on each curve, the time scale being so defined that one cycle of the crystal oscillator occupies six divisions. Therefore, since the period of one cycle is $\frac{1,000,000}{163,940}$ or 6.1 microseconds, one division represents 1.017 microseconds.

7. DETAILED DESCRIPTION OF OPERATION.

Refer to the normal operating waveforms (fig. 5), to the block diagram (fig. 4) and to the schematic diagram of Range Calibrator I-223-A (fig. 32) for the discussion that follows.

a. Crystal Oscillator. Tubes 1A and 1B, contained in one envelope, comprise the crystal oscillator circuit. The resulting high gain of the two stage oscillator provides reliable starting of the crystal, which is relatively sluggish because of the low frequency. The high gain does not cause excessive crystal current, however, since the output capability of the second stage is no higher than that of a single stage.

(1) Any voltage appearing at the grid of tube 1B is amplified and appears across the load resistor 52. It is coupled through capacitor 12-3 to the grid of tube 1A and is further amplified provided the frequency is in the neighborhood of the resonant frequency of the plate tank circuit consisting of capacitors 5-4, 13 and 9 in series, and coil 101. This amplified voltage appears across coil 101 and a portion of it appears across capacitor 13. This voltage is fed back through the crystal 100 to the grid of tube 1B, thus completing the feedback loop.

(2) For greatest stability, the plate tank is resonated at a frequency above the crystal frequency. Hence, at crystal frequency the tank impedance is inductive. To compensate for the resulting "lead," the crystal operates at a frequency where it is inductive. This causes the crystal current to lag. The frequency, therefore, lies slightly above the resonant frequency of the crystal but below the adjacent antiresonant frequency. A moderately pure sine wave of about 125 volts rms is produced at the plate of tube 1A. Resistors 65-3 and 65-4 provide a d-c return path for tubes 1A and 1B, respectively. The cathode bias is developed across resistors 61-1 and 61-2 for tubes 1A and 1B, respectively. Resistor 68 and capacitor 11-1 constitute a filter to keep the oscillator current out of the power supply. Figure 5 **A** illustrates the crystal oscillator output voltage at the plate of tube 1A. Condenser 5-3 provides neutralization which prevents oscillation except under control of the crystal.

b. Sine-wave Output Cathode Follower. Resistors 54-3 and 62-1 and capacitors 6 and 5-2 constitute a filter which produces a nearly pure sine wave which is coupled by capacitor 7-3 to the grid of tube 8. This tube is used as a cathode follower to deliver a sine wave at low impedance to open-circuit jack 114-2. Capacitor 11-7 provides d-c insulation. Resistor 60-3 provides a comparatively low resistance path to ground to prevent hum pickup. Capacitor 7-2 couples the sine wave to capacitor 11-7 from the cathode of tube 8. Resistors 63 and 51-2 constitute the load for tube 8. Resistor 63 also produces bias which is applied to the grid through resistor 62-2. Figure 5 **B** shows the sine wave voltage at the SWEEP jack 114-2. This wave is shifted in phase with respect to the wave at the plate of tube 1A by the R-C filter, but, since the phase shift is fixed, it is of no consequence in the calibration tests.

c. Square-wave Generator. (1) The output of tube 1A is also applied to the grid of tube 2 through coupling capacitor 12-1. Resistor 54-1 serves as a d-c return for the grid. Resistor 53-1 is used to suppress parasitic high-frequency oscillations. The screen voltage for tube 2 is supplied from the plate supply through resistor 51-1. Capacitor 11-3 is the screen bypass capacitor. Resistors 55-1, 55-2, and 55-3 in parallel provide a degenerative action which prevents the partially squared wave at the plate from being excessively assymetrical. The voltage developed across the plate load resistor 56 is coupled, by capacitor 12-2 to the grid of tube 3. Resistors 53-2 and 54-2 serve the same purpose as resistors 53-1 and 54-1.

(2) Tube 3 and tube 2 are used to produce a square wave from the sine wave generated in tubes 1A and 1B. In order to obtain maximum output at low impedance, tube 3 is operated without bias except for the grid leak bias. The screen voltage is supplied from the plate supply through resistors 58-1 and 58-2 in parallel and is bypassed by capacitor 11-4. The square wave (fig. 5 **C**) appearing across the plate load resistor 57, is differentiated by capacitor 4 and resistor 59-1. The resulting wave, consisting of positive and negative pulses, is simultaneously applied to the grids of tubes 5B and 6. This wave is shown in figure 5 **D**.

d. Clipper and Cathode Follower. Tube 5b is used as a cathode follower. Although cathode followers do not usually draw grid current, the low impedance path from cathode to ground provided by capacitor 11-5 and resistor 69 results in the development of an appreciable grid leak bias which causes the negative pulses of the differentiated wave to be clipped in tube 5B. The positive pulses of this wave appearing at the cathode of tube 5B are coupled to jack 114-1 through capacitors 11-5 and 11-6. Jack 114-1 is an open-circuit jack which provides an outlet for the 1,000-yard marker wave used for calibrating purposes. Capacitor 11-6 provides d-c insulation for jack 114-1. Resistor 60-1 is the d-c return path for the cathode. Resistor 69, in addition to the function described above, provides a low output impedance. The 1,000-yard marker wave that is present at jack 114-1 is shown in figure 5**E**.

e. Blocking Oscillator. Capacitor 5-1 supplies a series of synchronizing pulses from the output of tube 3 to the grid of the blocking oscillator tube 7. This oscillator employs direct feedback from plate to grid through transformer 122. As a tank circuit, this transformer is characterized by a very high L-C ratio and a very low Q. The low Q results in a quickly damped oscillations as compared to the usual tank circuit. On the other hand the L-C ratio provides sufficient impedance to load the tube effectively.

(1) In the course of one cycle of operation as an oscillator, the amount of grid leak bias developed in the tube is considerably greater than is necessary to produce cut-off. In this respect the action is similar to that of an ordinary oscillator except that several cycles are usually necessary to build up sufficient bias to produce cut-off. In the ordinary oscillator, the oscillations produced by the tank circuit would carry over to the next cycle, thus bridging the gap until the tube could become active again. In this case, the oscillations are quickly damped and, as a result, the oscillation dies out before the next cycle occurs. The grid leak bias produced during the cycle remains, however, and appears as a charge on capacitor 8. This charge leaks off through resistor 65-1 and REPETITION FREQUENCY control 70 at a rate depending on the time constant of this resistance-capacitance (R-C) network. In the course of time, the grid voltage rises above the cut-off value, the tube conducts, and a new cycle starts. However, the synchronizing pulses, recurring at crystal frequency, are superimposed on this bias. Since the grid circuit is effectively shunted by the secondary winding of transformer 122, these pulses are highly distorted as shown in figure 5 **F**. Even while the bias voltage is still considerably greater than cut-off value, these pulses are able to make the tube conducting. As a result, the tube can start a new oscillation cycle before the grid voltage has had time to rise to the cut-off value.

(2) The exact manner in which a new blocking-oscillator cycle is started is highly complicated, but the following considerations apply. In the first place, successive synchronizing pulses are approximately 6 microseconds apart while the interval between successive blocking-oscillator cycles is more than 4,000 microseconds (for a repetition frequency of 240 cycles per second). Hence the bias potential, leaking off as described above, drops by only 25 millivolts, approximately, between successive synchronizing pulses. This change is so small compared to the total change that it can properly be considered a matter of chance whether the pulse which eventually starts a new cycle is just barely able to do so or the preceding one just barely fails. These are the extreme cases and any intermediate case can occur. It follows, therefore, that the operating condition of the circuit, at the time a new cycle is started, is indefinite to a certain extent. It is also known that several pulses preceding the one which starts the new cycle cause momentary plate current to flow, but these do not start a new cycle because the tube transconductance remains too low to meet the unity loop gain condition necessary for oscillation. These mo-

mentary pulses of plate current undoubtedly contribute, in an accumulative manner, to the indefiniteness of the operating conditions at the time a new cycle is started. It is also known that the main rise of the blocking-oscillator cycle (q-r, fig. 5 **F**) occurs about 2 microseconds after the pulse which starts the cycle. The oscillator is active during the 2-microsecond period, as shown by the fact that the voltage follows the path p-q instead of the path p-s-t which it would follow if a new cycle were not starting. In some ways this 2-microsecond delay in the main rise of the blocking oscillator cycle is extremely sensitive to difference in operating conditions which prevail at the time the new cycle is started. Instead of a delay which is the same every time a new cycle is started, there occurs a delay which is variable by as much as plus or minus ½ microsecond. Since the shape of the cycle following the main rise remains essentially fixed, the entire cycle, with the exception of the delay portion, "jitters" in a random manner with respect to the synchronizing pulse. This is illustrated in figure 5 **G** where the full line curve shows a delay of about 2 microseconds while the dotted and dashed curves show delays of 1½ and 2½ microseconds, respectively.

(3) Figure 5 **J** gives a general view of two blocking-oscillator cycles with the intervening synchronizing pulses superimposed on the slowly dropping bias potential, i.e., slowly rising voltage. The dashed line indicates cut-off bias. Since the pulses are $\frac{1,000,000}{163,940}$ or 6.1 microseconds apart and the two blocking-oscillator cycles are $\frac{1,000,000}{240}$ or 4,160 microseconds apart, approximately 682 pulses occur for every blocking-oscillator cycle. This figure is only approximate since the repetition frequency is not held exactly at 240 cycles per second. Even though the blocking oscillator supplies pulses at a repetition rate of approximately 240 cycles per second which are almost synchronous with the synchronizing pulses, and consequently, with the sine-wave sweep line and marker-wave pulses, this is not sufficient; there must be no jitter in the synchronizing pulse wave output. Although the blocking oscillator does not meet this condition, it does provide a means for obtaining a jitter-free synchronizing pulse wave. The main part of the blocking-oscillator cycle occupies approximately 8 microseconds, as shown in figure 5 **G**. This time is determined by the design of transformer 122 and the value of capacitor 8. At point **a** in figure 5 **F** and **G** is shown the start of the synchronizing pulse which started the oscillation. A portion of this pulse is blotted out by the oscillation. The pulse which appears simultaneously at the grids of tubes 5B and 6 is shown at **b** of figure 5 **D** while **c** of the same figure indicates the next positive pulse. It is clear that in spite of the jitter, the peak of pulse **c** occurs during the flat portion of the oscillation. The voltage shown in figure 5 **G** is coupled by capacitor 11-9 to the suppressor grid of tube 6 and plate of tube 5A.

f. Bias Rectifier. Tube 5A is used as a diode with the grid and plate connected together, and produces rectified negative bias voltage at its plate. The cathode of tube 5A, bypassed by capacitor 10-1, is held at a potential of 28 volts by resistors 66-1 and 60-2. The rectified negative-bias voltage at the anode is superimposed on the input wave. The a-c axis of this wave appears at the zero level in figure 5 **G**. At the anode of tube 5A, the bias produced depresses the a-c axis so that instead of extending from a slight negative value to approximately 130 volts positive as shown in figure 5 **G** the wave extends from approximately 100 volts negative to approximately 30 volts positive as shown in figure 5 **H**. (The fact that a portion of the trailing edge of the wave extends below approximately 100 volts is of no importance.)

g. Modulator. The output from the anode of tube 5A is applied to the suppressor grid of tube 6 at the same time that the wave shown in figure 5 **D** is applied to the control grid. The voltage, shown in figure 5 **H** applied to the suppressor grid (pin 3) of tube 6 makes it function as an electronic switch. During the flat portion of the oscillation cycle, approximately 5 microseconds, tube 6 can pass signals applied to its control grid (pin 4). At almost all other times, no signal can pass because of the high negative voltage on the suppressor. There are narrow borderline regions near the beginning and end of the oscillation cycle during which partial transmission could occur. However, since the input to the control grid of tube 6 is as shown in figure 5 **D** no positive input pulses occur during these borderline intervals. Since tube 6 is biased beyond cut-off by resistors 66-2 and 59-2, it cannot pass any negative

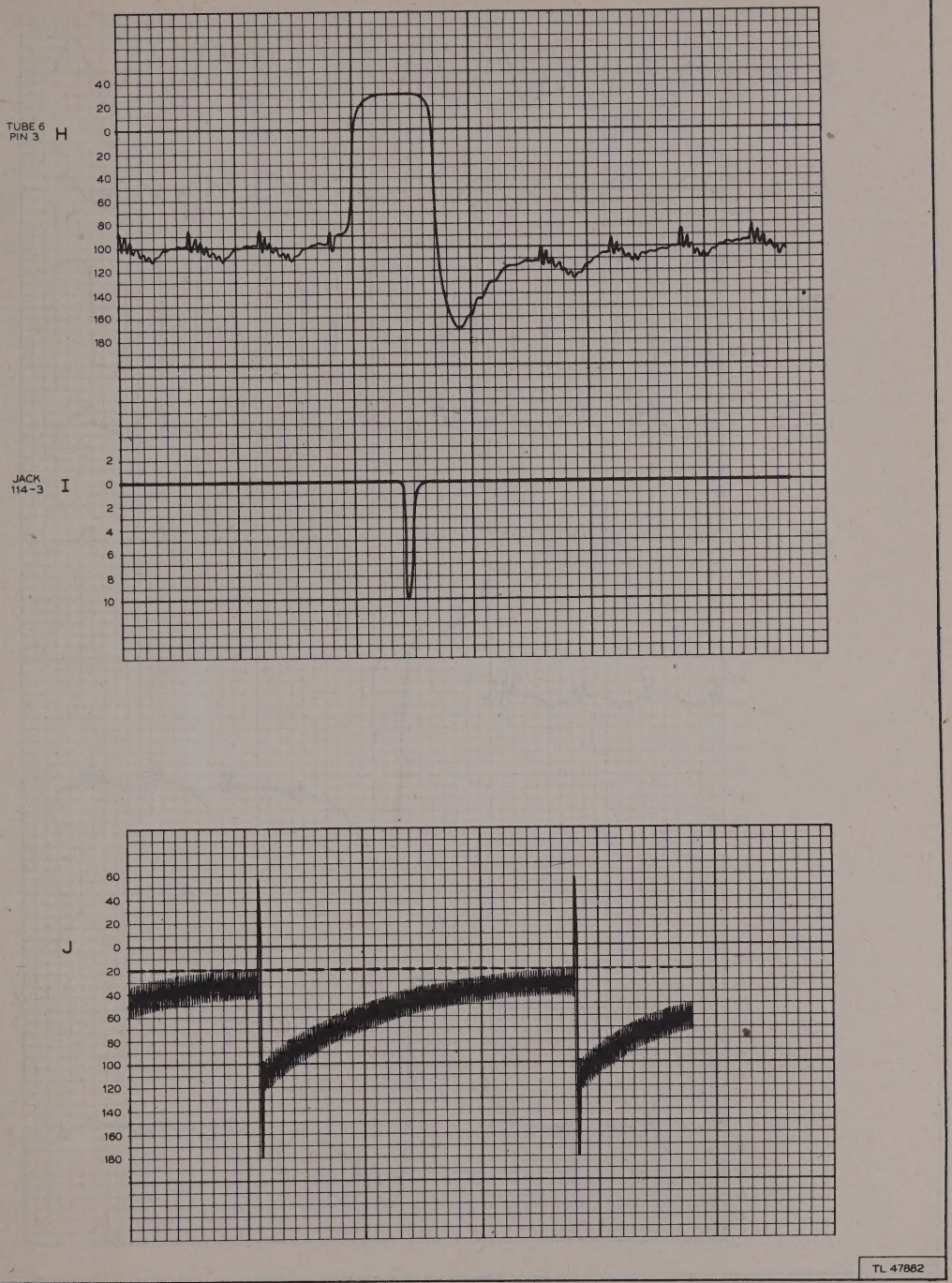


Figure 5. Range Calibrator I-223-A, normal operating waveforms.

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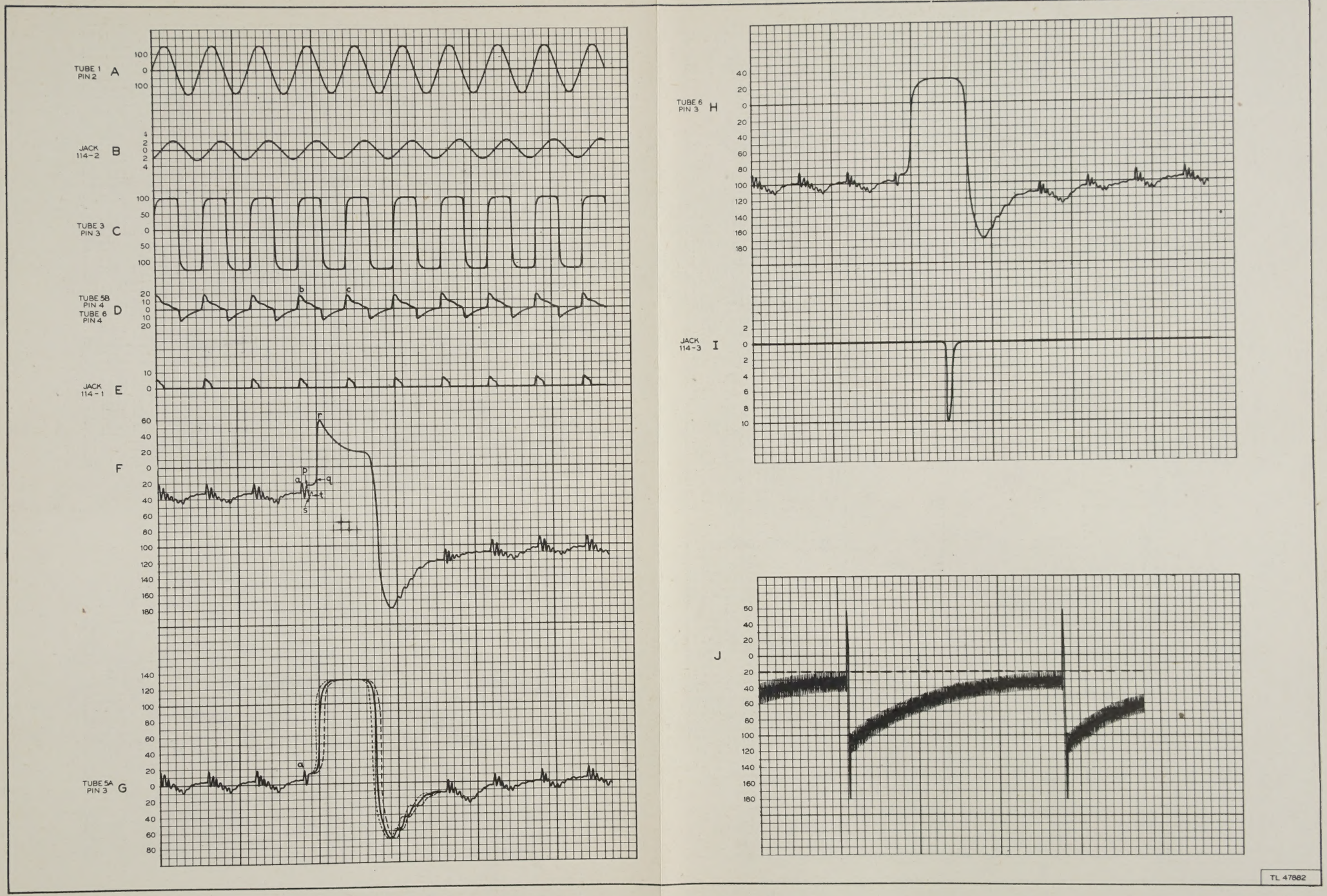


Figure 5. Range Calibrator I-223-A, normal operating waveforms.

input pulses regardless of the suppressor voltage and, therefore, pass as only the peak of a positive pulse because of the clipping action. Since, as previously mentioned, the peak of pulse **c**, figure 5 **D** occurs during the flat portion of the blocking-oscillator cycle, the instantaneous operating voltages of tube 6 (including the suppressor voltage) are exactly the same every time this peak occurs at the grid, regardless of the jitter. It follows that the positive peak of pulse **c**, and only pulse **c**, is passed by tube 6 and that the phase and amplitude of the resultant output pulse developed across load resistor 67 are jitter-free. The voltage across resistor 67 is coupled by capacitors 7-1 and 11-2 to the SYNCH jack 114-3. This voltage is the synchronizing pulse provided by the calibrator; it is shown in figure 5 **I**. Resistor 60-4 prevents hum pick-up and capacitor 11-2 provides d-c insulation.

h. Power Supply. The power supply circuit used in the calibrator is entirely conventional. Tube 4 is a high-vacuum, full-wave rectifier. The filtering is provided by capacitors 1-A,1-B, and 1-C and chokes 121-A and 121-B. Since the d-c voltage is used as the plate and screen supply, good voltate is necessary and, therefore, chokes are used instead of resistors. Transformer 120 is the power transformer supplying filament voltage for the rectifier tube from one secondary winding and the filament voltage for the remaining tubes from a separate secondary winding. The high-voltage secondary winding supplies the plates of rectifier tube 4. Pilot light 112 indicates when filament voltage is supplied to the tubes. The a-c power is applied to the double-pole, single-throw switch 111 from the a-c power input cable 113. Fuse 110 is a cartridge-type fuse rated at 3 amperes and 250 volts.

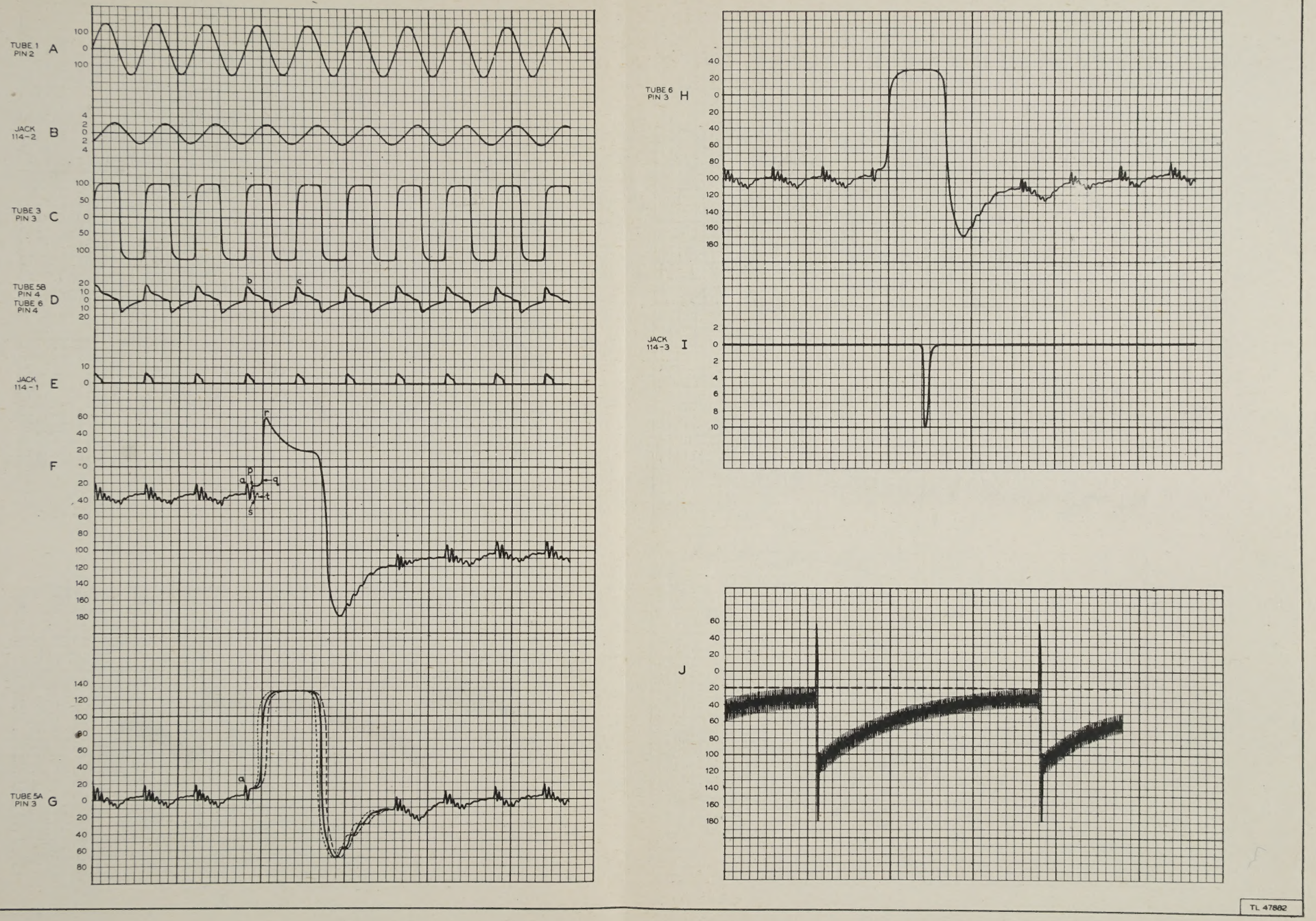


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SECTION IV

MAINTENANCE

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report). If Form No. 468 is not available, see TM 38-250. Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form No. 54 (unsatisfactory report).

8. MECHANICAL DISASSEMBLY AND REPLACEMENT OF PARTS.

The top and bottom covers of the calibrator are removed easily by removing the sheet metal screws which hold them in place. The schematic diagram and legend are mounted on the inside of the top cover. Tubes are removeable in the usual manner except for the 6L6-GA tubes (or 6L6-G, Tube VT-115-A). These are held by spring clamps. To remove one of these tubes, press down on the two bowed-up portions of the clamp and remove the tube in the usual way. In replacing the power transformer 120, the filter choke 121-A, B, or the blocking-oscillator transformer 122, use the following procedure for handling the wire connections.

a. Holding the lugs with pliers to keep them from turning, loosen the nuts which hold the lugs to the old transformer or choke, and lift the lugs off the transformer terminals without disconnecting them from the wires. One exception is the ground lug connection of the power transformer 120, which must be unsoldered.

b. Similarly, remove the lugs from the new unit. Make absolutely sure that the lugs and the nuts underneath do not turn. Otherwise, entire terminal assemblies may be loosened and the seals broken.

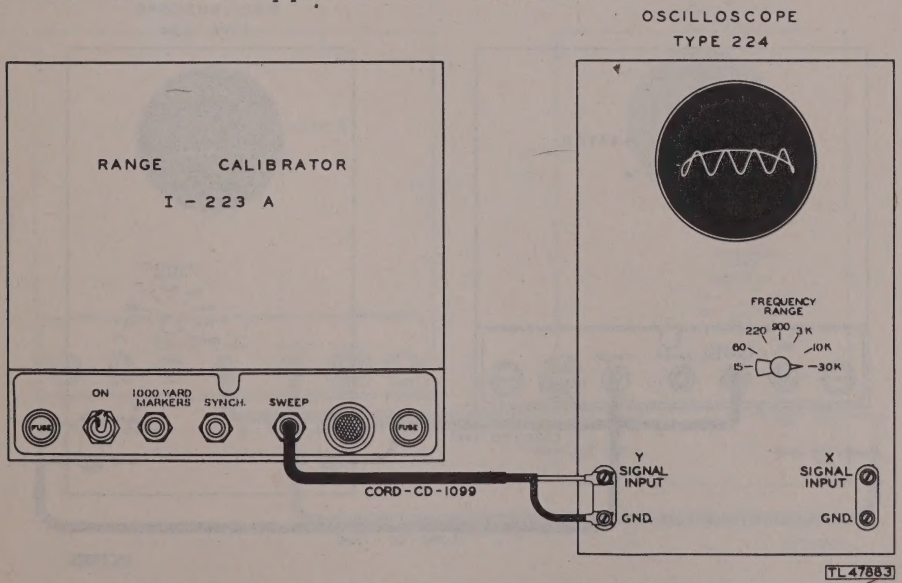


Figure 6. Connection diagram for observing SWEEP waveform.

c. After mounting the new unit, replace the old lugs, with wires attached, and replace and tighten the nuts. In the case of the power transformer 120, connect the ground lead to the ground lug on the transformer case and solder it.

9. CHECKING CALIBRATOR OPERATION; ADJUSTING REPETITION RATE.

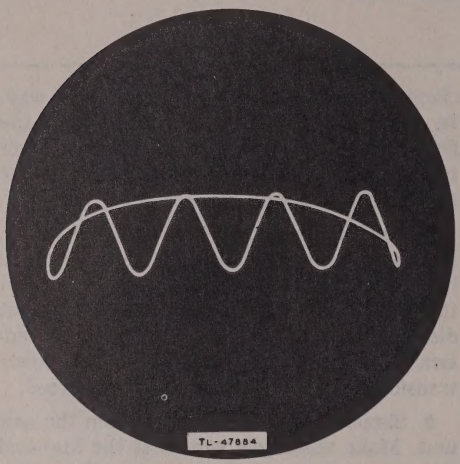


Figure 7. Waveform at SWEEP jack.

The frequency of the crystal oscillator in the calibrator cannot be checked unless reliable standard frequency equipment is available. No general method can be given. However, a sine wave of crystal frequency is available at the SWEEP jack and a pulse wave of the same fundamental frequency is available at the MARKER jack. Either of these may be used for frequency comparison. A test oscilloscope similar to Oscilloscope BC-1060-A (TM 11-2526) is required for servicing the calibrator. The oscilloscope controls referred to in this section are the controls on Oscilloscope BC-1060-A. Additional test cables and a 1,000-ohm-per-volt voltmeter, capable of reading voltages up to 500 volts, are required also.

a. Observing SWEEP Output Waveform and Amplitude. (1) Calibrate the Y-axis deflection od the test oscilloscope for approximately 5 volts per inch by using the small a-c line voltage at the TEST SIGNAL terminal. For Oscilloscope BC-1060-A this voltage is approximately 2.2 volts peak-to-peak. The amplitube of the signal voltages to be observed will range from 5 to 10 volts as shown in figure 5, waveforms **B**, **E** and **I**. Both DEFLECTION PLATE CONNECTIONS switches must be on the AMPLIFIER positions.

(2) Use Cord CD-1099, which comes packed

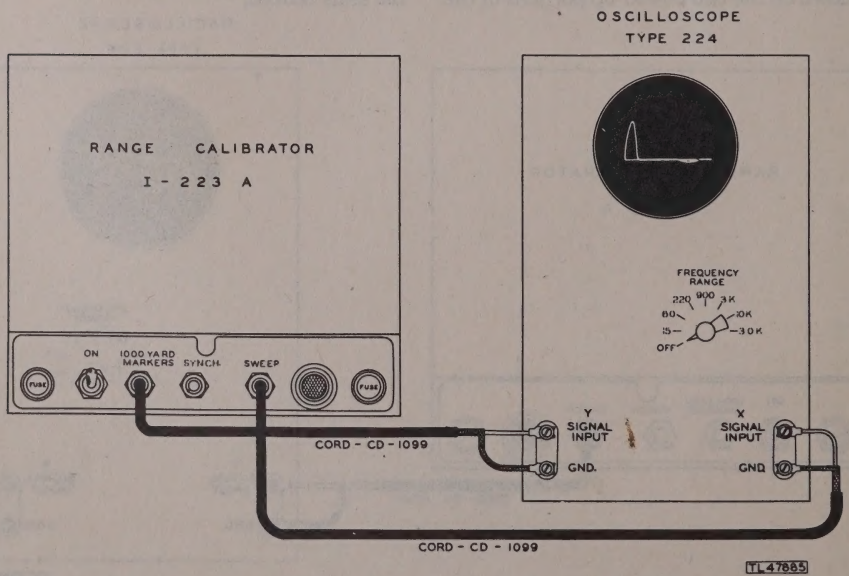


Figure 8. Connector diagram for observing 1000 YARD MARKERS waveform.

inside the calibrator cover, to connect the SWEEP jack of the calibrator to the Y SIGNAL INPUT and GND terminals of the oscilloscope (fig. 6). Since the frequency of the sine wave to be observed is 163.94 kilocycles, turn the FREQUENCY RANGE control to the 30K position (use higher frequency setting if available on oscilloscope used); turn the SYNC SELECTOR to the INT position. Adjust the SYNC SIGNAL control and the FREQUENCY VERNIER control to obtain a stationary pattern consisting of several cycles of a sinusoidal wave. The waveform should be almost a pure sine wave (fig. 7).

b. Observing 1000 YARD MARKERS Output Waveform and Amplitude. (1) Do not change the calibration of the oscilloscope (subpar. *a* above). Remove Cord CD-1099 from the Y SIGNAL INPUT and connect it to the X SIGNAL INPUT and GND terminals. The connections will be as shown in figure 8.

Turn the FREQUENCY RANGE control off and advance the X GAIN control to produce a sweep trace about 3 inches long, or as long as possible if this length cannot be obtained.

(2) Connect another Cord CD-1099 from the 1000 YARD MARKERS jack of the calibrator to the Y INPUT SIGNAL. The markers are

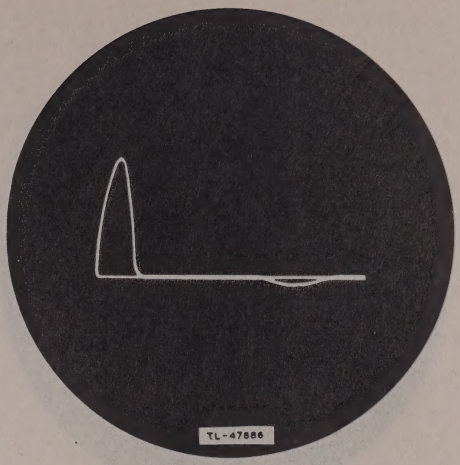


Figure 9. Waveform at 1000 YARD MARKERS jack.

displayed in the sinusoidal sweep of crystal frequency and should appear as shown in figure 9. This pattern may appear as a negative pulse depending upon the oscilloscope used.

c. Observing SYNCH Output Waveform and Amplitude. With the oscilloscope set up as in subparagraph *b* above, shift Cord CD-1099 from the 1000 YARD MARKERS jack of the

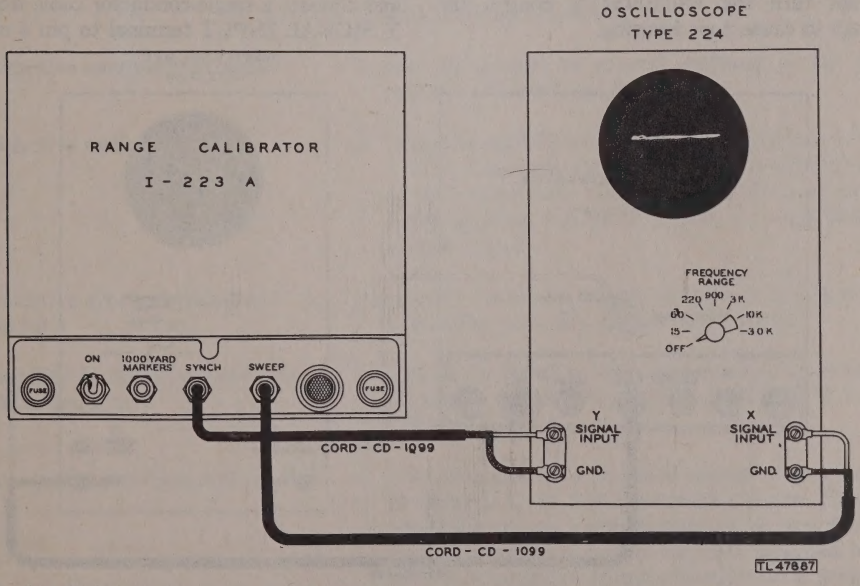


Figure 10. Connection diagram for observing SYNCH waveform.

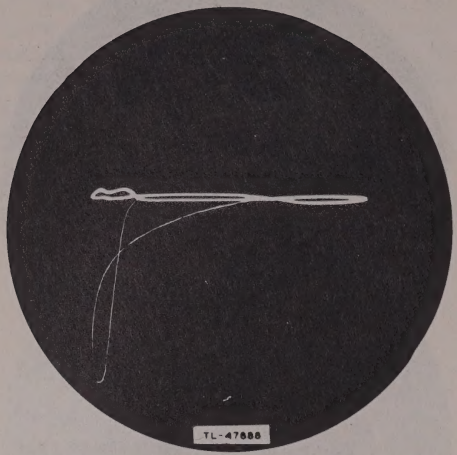


Figure 11. Waveform at SYNCH jack.

calibrator to the SYNCH jack of the calibrator. The connections will be as shown in figure 10. The SYNCH signal displayed on the sinusoidal sweep of the crystal frequency will appear as shown in figure 11 or as a positive pulse, depending upon the oscilloscope used. Since the pulse is extremely faint, turn up the INTENSITY control until the baseline is brilliant, but do not turn the INTENSITY control far enough to cause poor focusing.

d. Checking and Adjusting Repetition Rate. The synchronizing pulse delivered by the calibrator is so difficult to see that it cannot be used directly in observing repetition frequency. For such observation use the following procedure.

(1) With the oscilloscope and calibrator set up as in subparagraph **c** above, remove Cord CD-1099 which is connected between the SYNCH jack of the calibrator and the Y SIGNAL INPUT. Connect a lead from the Y SIGNAL INPUT to the TEST SIGNAL terminal. Adjust the oscilloscope to show 1 cycle of the 60-cycle line voltage by turning the FREQUENCY RANGE control to the 60 position. Then adjust the FREQUENCY VERNIER, SYNC SIGNAL, and X GAIN controls to obtain a stationary one-cycle pattern with a sweep trace about 4 inches long. Remove the connector to the TEST SIGNAL terminal.

(2) Shift Cord CD-1099 from the SWEEP jack of the calibrator to the SYNCH jack. Remove the connection to the X SIGNAL INPUT but leave the connection to the GND terminal to provide a ground connection between the calibrator and the oscilloscope.

(3) Remove the bottom cover of the calibrator and connect a single-conductor cable from the Y SIGNAL INPUT terminal to pin 4 of tube

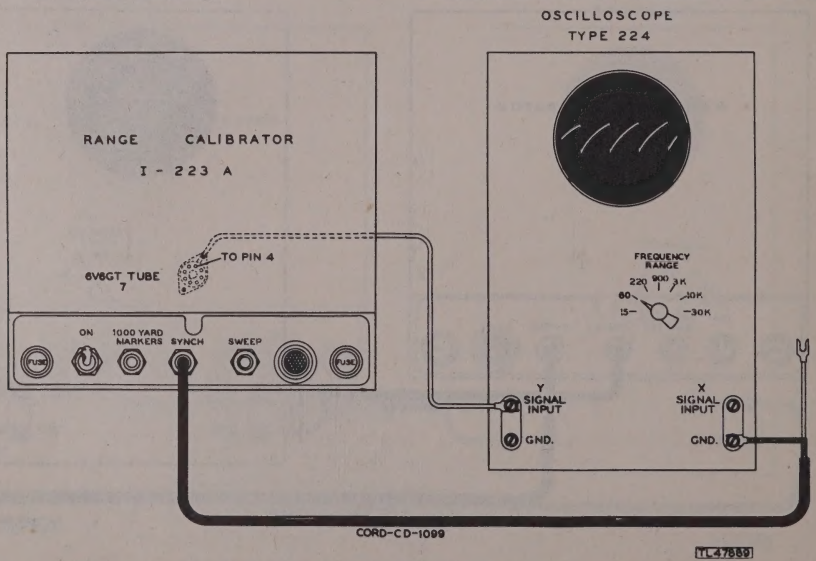


Figure 12. Connection diagram for adjusting repetition rate.

socket 7 of the calibrator. This connects the screen of the blocking oscillator to the input of the oscilloscope and supplies a saw-tooth voltage which has the same frequency as the SYNCH pulse and is easy to see on the oscilloscope screen. Figure 12 shows a diagram of the connections.

(4) If a pulse repetition frequency of 240 is required, a stationary pattern (fig. 13) should be obtained. Four cycles of 240 cps saw-tooth voltage will be obtained for every cycle of the 60-cycle sweep. A small error in frequency will cause the pattern to move to the right or to the left. Even moderate errors make the pattern unreadable. To adjust the calibrator for the proper frequency, remove the top cover of the calibrator and adjust REPETITION FREQUENCY control 70 to produce the desired oscilloscope pattern.



Figure 13. Waveform at pin 4, tube 7.

10. CALIBRATOR TROUBLE-SHOOTING CHART.

Trouble	Cause
1. No output on any of the three output jacks.	1. If the power is on, this condition is usually due to crystal oscillator failure which in turn may be due to a considerable variety of causes. A frequent cause is failure of the oscillator to start under extreme low temperatures. If this is the cause of trouble, jarring the calibrator case or, if necessary, the crystal holder should restore operation.
2. Defective sweep output wave.	2. May be caused by crystal oscillator or by sweep cathode follower (tube 8).
3. Defective marker output.	3. Usually caused by a defective marker cathode follower (tube 5-B). If this trouble is accompanied by defective synchronizing pulse output, the trouble may be anywhere in tubes 1-A, B, 2, 3, 5-B, 6, 7, and their associated circuits.
4. Defective synchronizing-pulse output.	4. Usually caused by trouble in tubes 6, 7, 5-A and associated circuits. See trouble No. 3 above.
5. Inability to obtain correct repetition frequency.	5. Caused by defect in tube 7 or associated circuits; in particular the REPETITION FREQUENCY control 70.
6. Incorrect crystal frequency.	6. May be caused by a defective crystal or other trouble in tubes 1-A, B, and associated circuits. However, oscillation at the wrong frequency is very unlikely, since the oscillator circuit has been designed on the basis that complete failure of oscillation is preferable to false frequency operation.

11. ANALYSIS OF DEFECTIVE CALIBRATOR.

It is often possible to guess from the symptoms shown by the calibrator the approximate location of the trouble. The chance of making a good guess depends upon a knowledge of the calibrator operation, which can be gained only by careful study of the section on theory of operation. The method of analysis given below, however, does not depend on such intuitive methods. It constitutes a functional analysis, in which a search is made for the circuit which fails to operate properly. In this way, the search for the actual defect narrowed down to a small portion of the unit and is therefore speeded up.

a. Plug the a-c cord of the calibrator into the a-c line and turn on the power switch. If the pilot lamp does not light, check the fuse and replace it if necessary. If the lamp is still dark, check the lamp and install a new one if necessary. If the lamp still remains dark, check to see whether the new fuse has burned out. Remove the cord from the a-c line. Leaving the power switch on, check the resistance across the prongs. The normal value is 2 ohms. If an open or short circuit is found, locate the fault by continuity checks in the primary circuit consisting of the primary of the power transformer 120, switch 111, fuse 110, and cord 113. If no defect has yet been found, but a new fuse still burns out, the cause is probably a short circuit in one of the power transformer output circuits (including B+). This probably will be located in the course of the tests described below.

b. Turn off the power switch and remove the top and bottom covers of the calibrator. Make sure that crystal 100 and all tubes are firmly seated in their sockets. Check the resistance from terminals 3 and 5 of the power transformer to terminal 4. The normal value for each is 100 ohms. Check continuity from terminal 4 to ground.

c. Check the resistance from the terminal of capacitor 1-C (B+) to ground. The normal value is 86,000 ohms. If the value obtained differs appreciably from the normal value then check for location of trouble as follows.

(1) If the resistance from B+ to ground is distinctly higher than normal, some of the circuits may not be receiving B+ power. Follow out the B+ wiring by continuity checks. Refer to the wiring diagram (fig. 31) for the way in which B+ is distributed.

(2) If the resistance from B+ to ground is low, refer to table IV for possible location of the short circuit. Normal value is taken as 86,000 ohms. The accuracy of this table is limited by several factors.

a. The normal resistance from B+ to ground is not known exactly.

b. A short circuit may be only a partial short circuit, having a resistance greater than zero.

c. A short circuit may cause a resistor to burn so badly as to change its resistance or even to burn out completely. Table IV is based on the assumption that the component which becomes shunted across B+ as a result of the short circuit maintains its normal value.

TABLE IV

Resistance in ohms from B+ to ground (K = 1,000)	Possible location of short circuit
920	Rectifier tube, filament to one plate.
820	Capacitor 1-A to ground.
410	Capacitor 1-B to ground.
0	Socket 8 (pin 3) or 4 to ground. Socket 5 (pin 5) to ground. Any B+ wiring to ground. Capacitor 1-C to ground.
4	Socket 7 (pin 3) to ground.
4470	Socket 6 (pin 8) to ground.
77K	Socket 6 (pin 6) to ground.
30.4K	Socket 7 (pin 4) to ground.
24.4K	Socket 3 (pin 4) to ground.
2430	Socket 3 (pin 3) to ground.
12.8K	Socket 2 (pin 4) to ground.
4700	Socket 2 (pin 3) to ground.
990	Socket 1 (pin 2) to ground. Coil 101 to ground.

d. If the resistance from B+ to ground is less than about 15,000 ohms, the trouble should be found by resistance measurements, to avoid damage to major components which might

result if the power were left on very long. Such a low resistance path to ground can be easily located by successively dividing the B+ wiring and noting which of the two sections still shows the low resistance path. Note that when a component, such as a resistor or coil winding, burns out as a result of a short circuit, this is not usually the fault of the burned component. When replacing such a component, make sure that the short circuit which originally caused the trouble does not remain to damage the new part too.

e. If the resistance from B+ to ground is more than about 15,000 ohms, the power can be turned on without damaging major components. With the power on, the fault can be located as described below. Also refer to paragraph 12. Plug the a-c cord into the a-c line and turn on the power switch. Observe which tubes, if any, fail to light. (In the case of tube 6, a tube VT-116, observe whether the shell temperature rises appreciably.) If a new fuse still burns out, proceed with the checks described below:

(1) If none of the tubes light (on account of immediate fuse burnout) remove all the tubes and also the pilot lamp.

(2) Disconnect the lug, with wire attached, from terminal 10 of power transformer 120 (par. 8**a**). Check continuity between terminals 10 and 11 of the transformer. Check continuity from terminal 11 to socket 4 pin 2 and from the lug removed from terminal 10 to socket 4 (pin 8). Check for a short circuit between pins 2 and 8 of socket 4.

(3) Disconnect the lug (with wire attached) from terminal 6 of power transformer 120 (par. 8**a**). Check continuity between terminals 6 and 7 of the power transformer. Check continuity from terminal 7 to ground, and from the lug removed from terminal 6 to pin 7 of each tube socket (except the rectifier tube, socket 4). Check for a short circuit between pin 7 of any tube socket (except socket 4) and ground.

(4) If no defect has been located as yet, but a new fuse still burns out immediately, the power transformer is probably defective and should be replaced (par. 8**a**).

(5) If all of the other tubes light but the rectifier, tube 4, does not, replace the tube. If this does not help, make the checks described in sub-paragraph (2) above.

(6) If the rectifier tube 4 lights, but the others do not, make the checks described in sub-paragraph (3) above.

(7) If only a few of the tubes (excluding the rectifier) light there is probably an open circuit in the heater wiring. The fault can be located by continuity checks in connection with the wiring diagram (fig. 31).

(8) If a single tube remains dark, it is probably defective. However, the heater wiring may be at fault. In particular, the heater ground return (pin 8 of a Tube VT-231, pin 2 of other tubes) may be broken.

f. With the a-c cord plugged in an a-c line, turn on the power switch. Measure the d-c voltage from the terminal of capacitor 1-C (B+) to ground. The normal value is about 265 volts.

(1) If no voltage is present, the defect is located in the rectifier and filter system consisting of tube 4, choke 121-A, B, and capacitor 1-A, B, C, provided the resistance from B+ to ground is not zero (subpar. **c** above).

(2) If the voltage is higher than normal, some portion of the unit is not taking its normal current. This may or may not show up in a higher than normal resistance reading from B+ to ground (see subpar. **c** above). For example, a defective tube which refuses to take its normal current may not affect the resistance reading from B+ to ground because the cold tube is an open circuit anyway. In such cases, the trouble will be found by means of the functional test described in paragraph 12 below.

(3) If the resistance from B+ to ground is lower than normal (subpar. **c** above), the voltage may also be low on account of a higher current than normal. One very important case of low voltage, however, is caused in a way which does not show directly in the resistance measurements. This is the result of excessive current drawn by tube 3 (Tube VT-115-A) when the crystal oscillator fails, thus removing excitation from tube 3. This lowers the B+ voltage to about 240 volts. Of course, the defect which causes failure of the crystal oscillator may itself cause additional excessive current and further reduce the voltage.

12. FUNCTIONAL ANALYSIS OF RANGE CALIBRATOR I-223-A.

When the approximate location of a defect is found by following the procedure outlined in paragraph 11, find and repair it before proceeding with the tests (subpar. **f** below).

a. Follow the procedure described in paragraph 9*a* above to observe the SWEEP output. If the SWEEP output is normal (fig. 7), this indicates that the crystal oscillator, the SWEEP cathode follower, and the associated circuits are operating. If no SWEEP output is obtained, shift Cord CD-1099 from the Y SIGNAL INPUT to the X SIGNAL INPUT and GROUND terminals. Using a single conductor cable to make connection to the SIGNAL INPUT terminals, observe the signal at the grid of the SWEEP cathode follower, tube 8, pin 5. If the signal appears there, the SWEEP cathode follower circuit is defective. If not, the crystal oscillator is probably not oscillating.

b. With normal output at the SWEEP jack, follow the instructions in paragraph 9**c**(1) to obtain a sweep line adapted to testing of the other parts of the circuit.

c. Observe the waveforms at the following points:

(1) Plate of tube 2, socket 2, pin 3 (fig. 14).

(2) Plate of tube 3, socket 3, pin 3 (fig. 15).

(3) Grid of tube 5B, socket 5, pin 4 (fig. 16).

(4) Marker output, contact spring of jack 114-1 (fig. 9).

(5) Grid of tube 7, socket 7, pin 5 (fig. 17). The single line portion is very faint and jittery.

(6) Suppressor of tube 6 (grid and plate of tube 5A), socket 6, pin 3 (fig. 18). See subparagraph (5) above.

(7) Synch output, contact spring of jack 114-3 (fig. 11). The pulse is very faint, but should be absolutely stable.

NOTE: In order to observe some of the waveforms at the above points it will be necessary to apply the signal directly to the vertical or Y-deflecting plates of the oscilloscope. On Oscilloscope BC-1060-A the two direct connections to the Y-deflecting plates are terminals D3 and D4 on the upper left corner of the front panel. On some oscilloscopes these connections are located at the rear. Connect a 400-volt fixed capacitor of a value between 0.1 and 0.25 between terminal D4 and the source of the input signal.

d. Observation of the waveforms at various points in the circuit as described above should serve to localize the trouble. It should be noted however, that if the waveforms are correct up to a certain point and then the next point shows a faulty waveform, this does not indicate necessarily that the trouble is located between the two points of observation. The abnormal waveform may be caused by effects, such as abnormal loading, in the stage following the

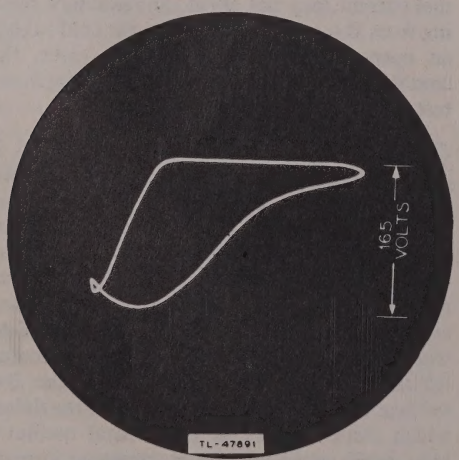


Figure 14. Waveform at pin 3, tube 2.

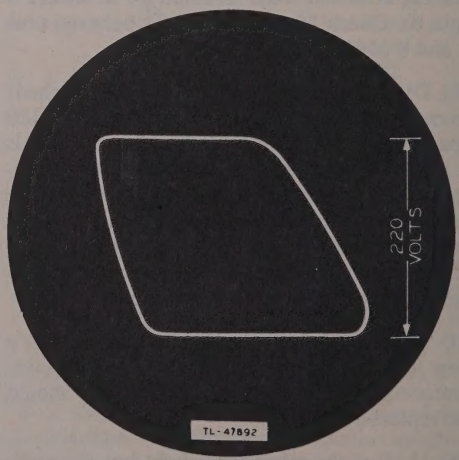


Figure 15. Waveform at pin 3, tube 3.

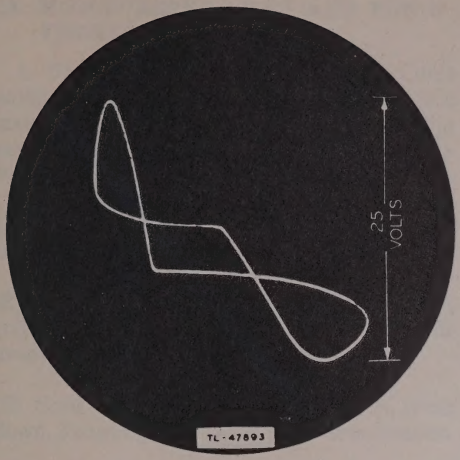


Figure 16. Waveform at pin 4, tube 5B.

point at which the incorrect waveform is observed. For example, if it is found that the crystal oscillator is inoperative (subpar. **a** above), this might be caused by a short circuit at the grid of tube 2, which would effectively shunt capacitor 12-1 across the crystal tank circuit.

e. As an example of the method of interpreting the results obtained in subparagraph **c** above, suppose that the waveform at the plate of tube 3 (subpar. **c**(2) above) is correct but a defective waveform is seen at the grid of tube 7 (subpar. **c**(5) above). Since these points are separated only by capacitor 5-1, this capacitor might be the cause of trouble, or on the other hand the blocking oscillator circuit may be defective. Reference to the theory of operation of the calibrator indicates that in the normal waveform (fig. 17) the band of light with curved top and bottom edges is actually a family of closely spaced curves, all alike and similar to the top and bottom edges. These curves are wave trains resulting from the action of the blocking-oscillator transformer 122 on the waves coupled by capacitor 5-1 from the plate of tube 3. The faint single-line part of the figure is the blocking-oscillator cycle and the vertical spreading of the family of curves into a band of light is the result of the comparatively slow leak-off of the bias produced during the blocking oscillator cycle. It is now possible to attempt an interpretation of the defective waveform observed at the grid of tube 7.

(1) If no signal appears, the grid circuit of tube 7 is probably short circuited.

(2) If the top and bottom edges of the band of light are straight as shown in figure 19, this suggests that capacitor 5-1 is open so that no waves are coupled from the plate of tube 3. The single-line portion of the waveform in figure 19 is shown in a definite position (different from that in figure 17, however). In the absence of synchronizing waves, this portion



Figure 17. Waveform at pin 5, tube 7.

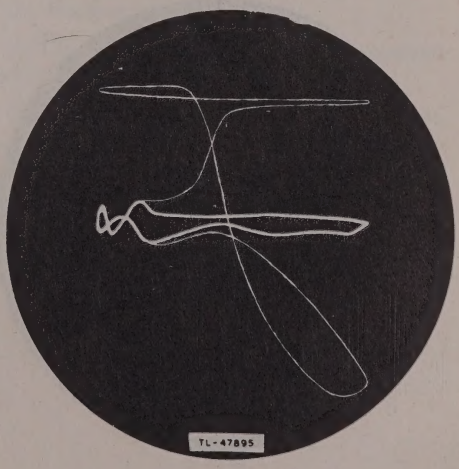


Figure 18. Waveform at pin 3, tube 6.

of the wave may not stay in any definite position but may appear in random positions. If this occurs, it may be almost impossible to see it.

(3) If the family of curves is not spread out vertically into a band and if the single-line curve is absent, leaving the waveform shown in figure 20, the blocking oscillator is inoperative. However, the normal appearance of the synchronizing waves indicates that the secondary of the blocking-oscillator transformer 122 is still effectively shunted across the grid circuit of tube 7 as it should be (capacitor 8 acting as a coupling capacitor).

(4) If the waveform appears as shown in figure 21 with the synchronizing waves unaffected by transformer 122, this suggests that something is wrong with capacitor 8 or the secondary of the blocking oscillator transformer (or associated wiring) so that the transformer winding is no longer connected across the grid circuit of tube 7.

f. When the approximate location of a defect has been found as described above, the specific trouble can be found by the following procedure.

(1) Visual inspection of parts and wiring of the circuits in question.

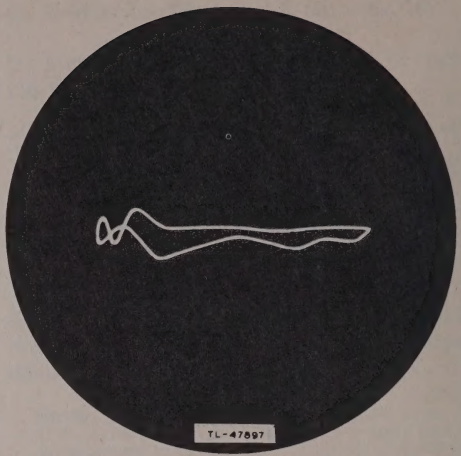


Figure 20. Waveform at pin 5, tube 7, blocking oscillator inoperative.

(2) Replacement of the tube or tubes involved and, in the case of the crystal oscillator, crystal 100.

(3) Voltage measurements.

(4) Resistance measurements.

(5) In following out the parts and wiring in a given circuit, refer to the wiring and schematic diagrams (figs. 31 and 32).

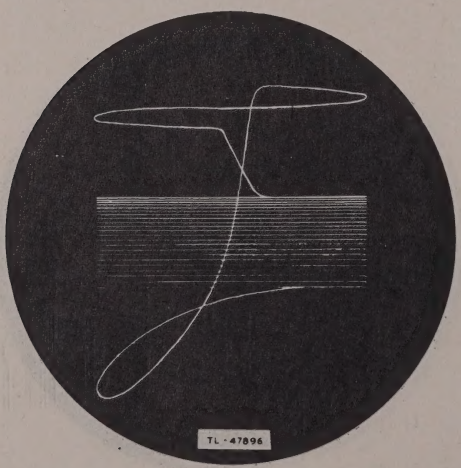


Figure 19. Waveform at pin 5, tube 7, open capacitor 5-1.

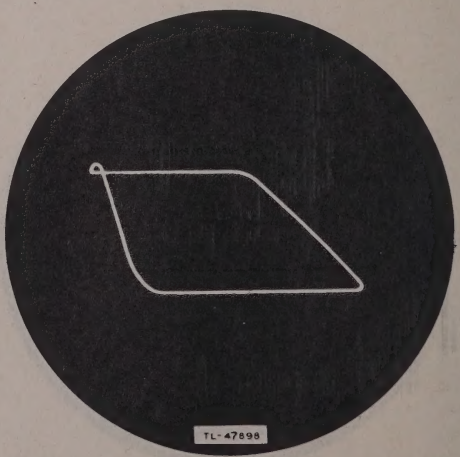


Figure 21. Waveform at pin 5, tube 7, transformer 122 ineffectual.

13. MOISTUREPROOFING AND FUNGIPROOFING.

a. General. The operation of Signal Corps equipment requires special attention in tropical areas where temperature and relative humidity are extremely high. Following are typical problems which may be encountered in operation:

(1) Resistors, capacitors, coils, chokes, and transformer windings fail.

(2) Electrolytic action takes place in resistors, coils, chokes, and transformer windings, causing eventual break-down.

(3) Hook-up wire and cable insulation break down. Fungus growth accelerates deterioration.

(4) Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs.

b. Treatment. A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun or brush. Refer to TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing.

CAUTION: Varnish spray may have toxic effects if inhaled. To avoid inhaling spray, use respirator if available; otherwise, fasten cheesecloth or other cloth material over nose and mouth.

c. Step-by-step Instructions for Treating Calibrator I-223-A.

(1) PREPARATION. Make all repairs and adjustments necessary for proper operation of the equipment.

(2) DISASSEMBLY.

(*a*) Remove the 24 screws from around the edges of the top and bottom cover.

(*b*) Remove the crystal holder. Replace after drying.

(*c*) Clean all dirt, dust, rust, fungus, and grease from the equipment.

(3) MASKING (fig. 22).

(*a*) Mask jacks 114-1, 114-2, and 114-3 ①.

(*b*) Mask resistor 57 ②.

(4) DRYING.

(*a*) Place the equipment in oven or under heat lamps and dry for 2 to 3 hours at 160° F.

(*b*) Do not heat the crystal.

(5) VARNISHING.

(*a*) Apply three coats of Lacquer: fungus resistant; Spec. No. 71-2202 (Stock No. 6G-1005.3), or equal.

(*b*) Spray all unmasked surfaces and objects on the under side of the chassis.

(*c*) Spray the transformer and choke labels (fig. 231).

(6) REASSEMBLY.

(*a*) Remove all masking tape.

(*b*) Clean all contacts with varnish remover, and burnish the contacts.

(*c*) Reassemble the set and test its operation.

(7) MARKING. Mark the set with "MFP" and the date of treatment.

Example: MFP—1 October 1944.

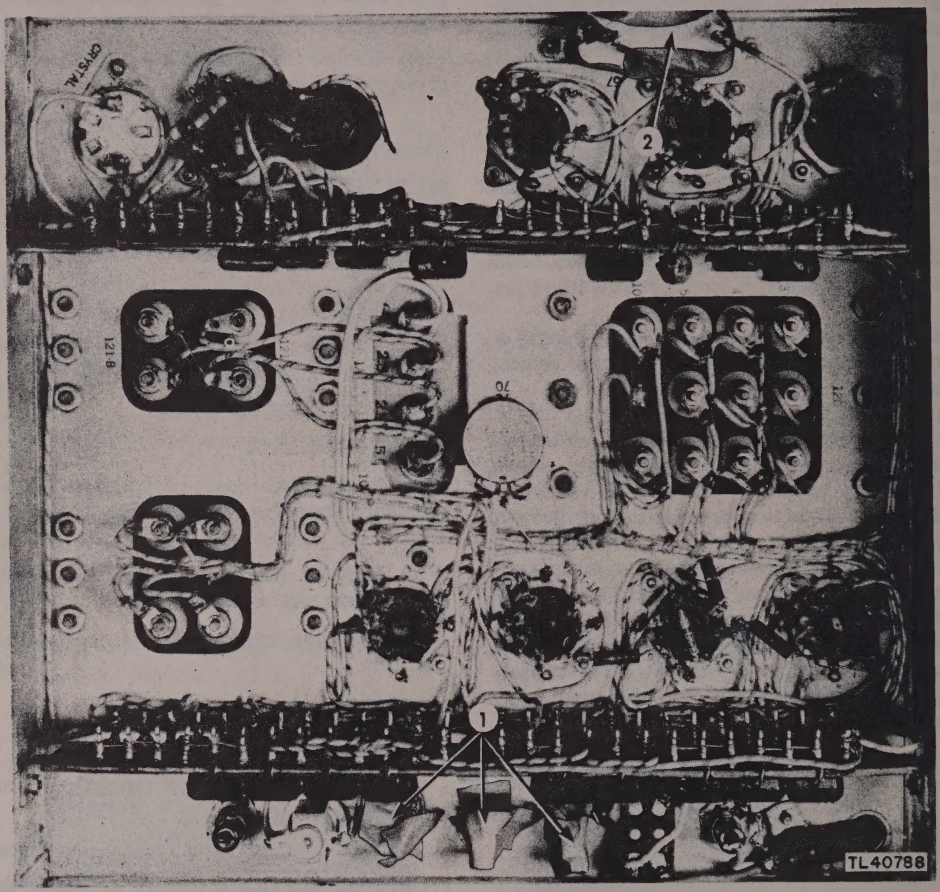


Figure 22. Range Calibrator I-223-A, bottom view showing masked parts.

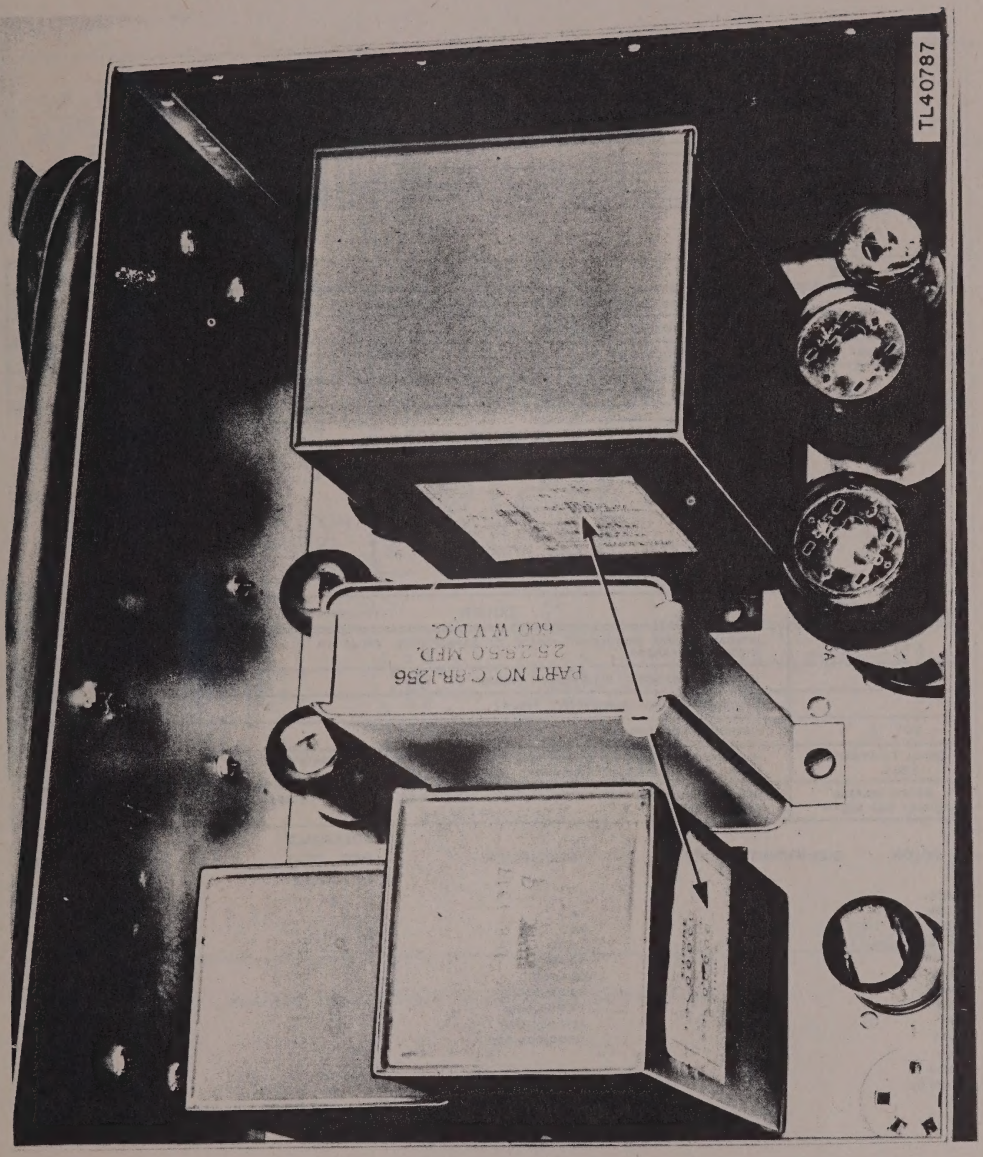
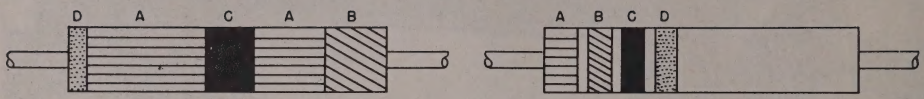


Figure 23. Range Calibrator I-223-A, top view, ready for brushcoat.

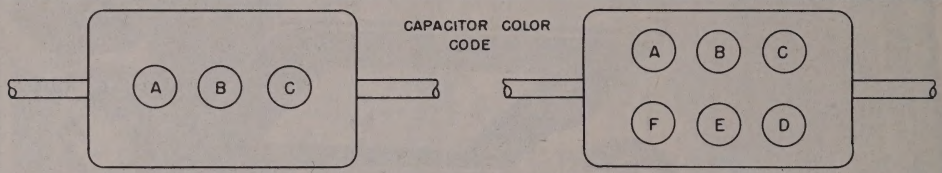
RESISTOR COLOR CODE



OLD STYLE NEW STYLE

OLD STYLE	COLOR	NEW STYLE
BODY A	INDICATES FIRST SIGNIFICANT FIGURE OF RESISTANCE IN OHMS	BAND A
END B	INDICATES SECOND SIGNIFICANT FIGURE	BAND B
BAND OR DOT C	INDICATES MULTIPLIER	BAND C
END D	IF ANY, INDICATES TOLERANCE IN PER CENT OF THE NOMINAL RESISTANCE VALUE. IF NO COLOR APPEARS TOLERANCE IS ±20%	BAND D

CAPACITOR COLOR CODE



ONE ROW DOTS	COLOR	TWO ROWS OF DOTS
DOT A	INDICATES FIRST SIGNIFICANT FIGURE OF CAPACITANCE VALUE IN MICROMICROFARADS	DOT A
DOT B	INDICATES SECOND SIGNIFICANT FIGURE	DOT B
	INDICATES THIRD SIGNIFICANT FIGURE	DOT C
DOT C	INDICATES MULTIPLIER	DOT D
USUAL TOLERANCE ±20%	INDICATES TOLERANCE IN PER CENT OF THE NOMINAL CAPACITANCE VALUE. IF NO COLOR APPEARS TOLERANCE IS 20%	DOT E
RATED VOLTAGE USUALLY 500 VOLTS	USUALLY INDICATES THE RATED VOLTAGE. SOMETIMES INDICATES DESIGN CHARACTERISTICS	DOT F

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE PER CENT (IF GIVEN)	RATED VOLTAGE (IF GIVEN)
BLACK	0	1	20	
BROWN	1	10		100
RED	2	100	2	200
ORANGE	3	1,000		300
YELLOW	4	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		800
WHITE	9	1,000,000,000		900
GOLD		0.1	5	1,000
SILVER		0.01	10	2,000
NO COLOR			20	500

TL 39617

Figure 24. Color code for resistors and capacitors.

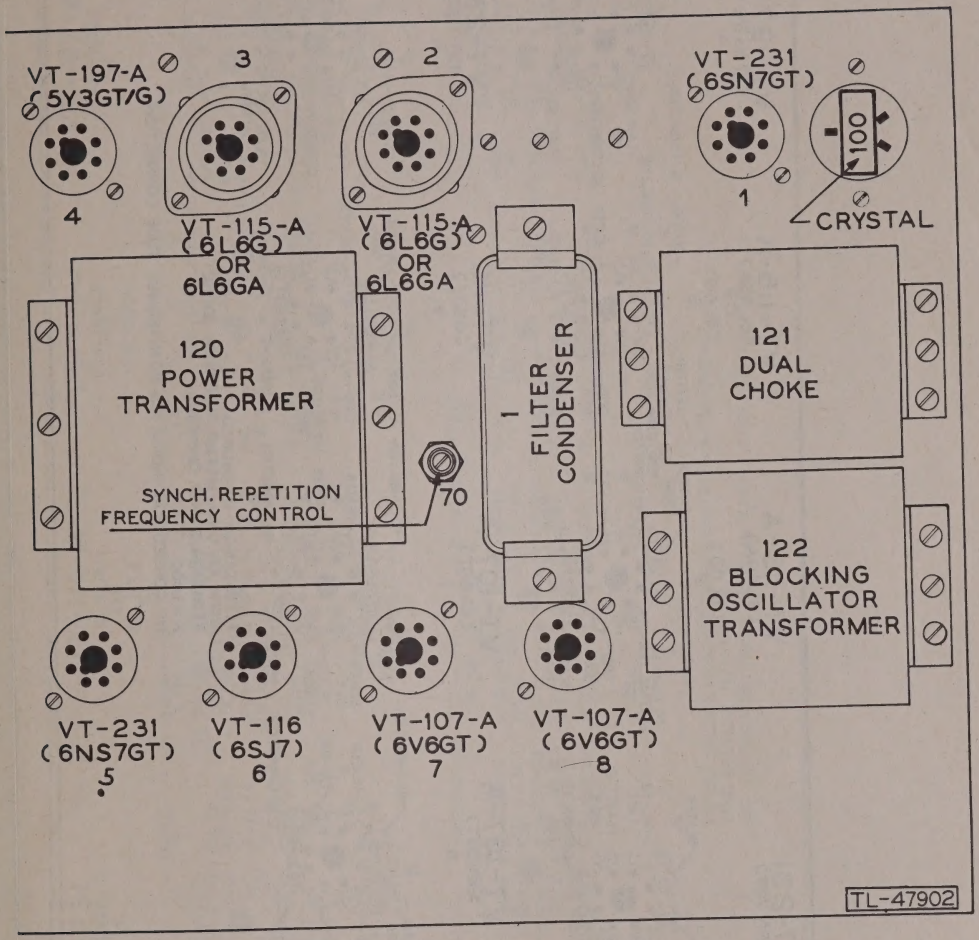


Figure 25. Range Calibrator I-223-A, top view showing tube arrangement.

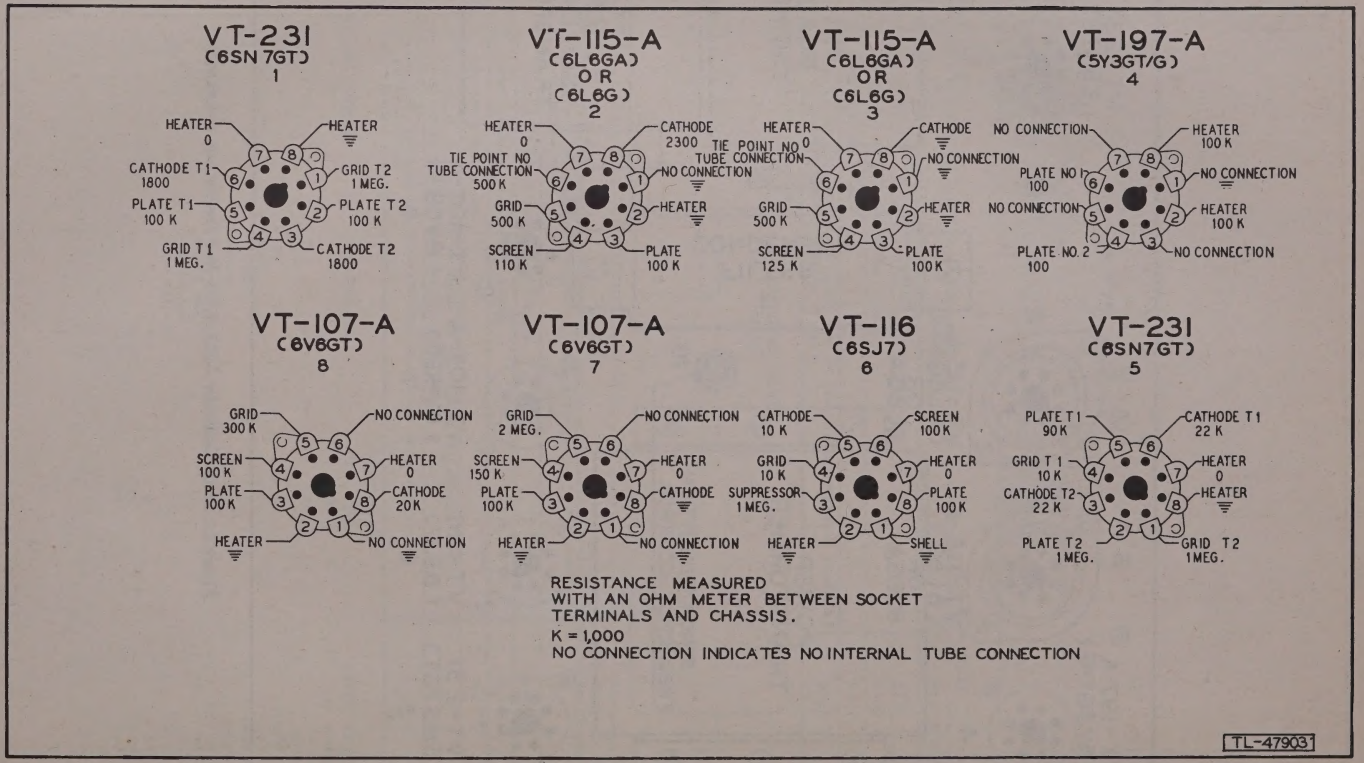


Figure 26. Range Calibrator I-223-A, tube-socket resistance chart.

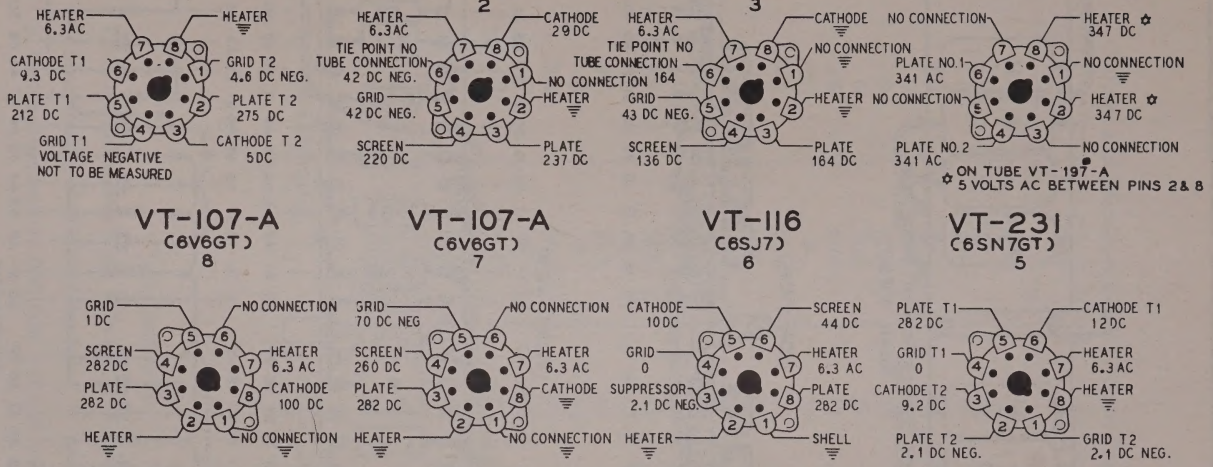


Figure 27. Range Calibrator I-223-A, tube-socket voltage chart.

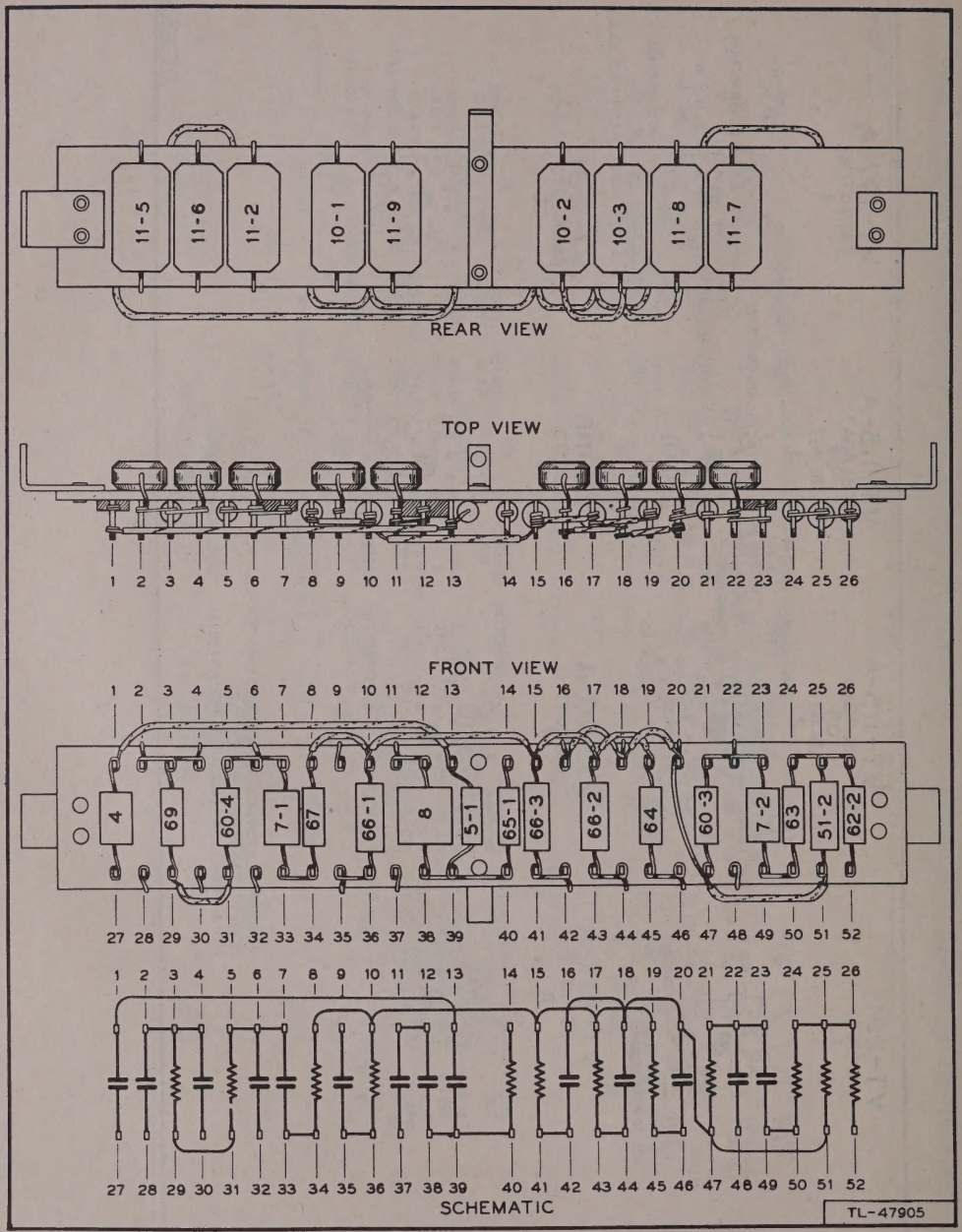


Figure 28. Range Calibrator I-223-A, front terminal board.

Voltage and Resistance Chart of Front Terminal Board

Terminal	*Volts*	*Ohms*	*Terminal*	*Volts*	*Ohms*
1	150	100K	27	0	10K
2	0	220	28	20	22K
3	0	220	29	0	0
4	0	220	30	0	Infinite
5	0	20K	31	0	0
6	0	20K	32	0	Infinite
7	0	20K	33	255	100K
8	265	90K	34	255	100K
9	0	0	35	22	20K
10	265	90K	36	22	20K
11	0	2	37	–3.2	1 meg
12	0	2	38	–60	2 meg
13	150	90K	39	–60	2 meg
14	–0.3	650K	40	–60	2 meg
15	265	90K	41	50	100K
16	0	0	42	50	100K
17	265	90K	43	8.6	10K
18	0	0	44	8.6	10K
19	265	90K	45	230	150K
20	0	0	46	230	150K
21	0	23K	47	0	0
22	0	23K	48	0	Infinite
23	0	23K	49	90	20K
24	75	15K	50	90	20K
25	75	15K	51	0	0
26	75	15K	52	10	250K

K = 1,000 ohms meg = 1,000,000 ohms

Test Conditions

1. All measurements made between points indicated and chassis.
2. Line voltage of 117.5 volts a-c.
3. Voltages measured 1,000 ohms per volt voltmeter.

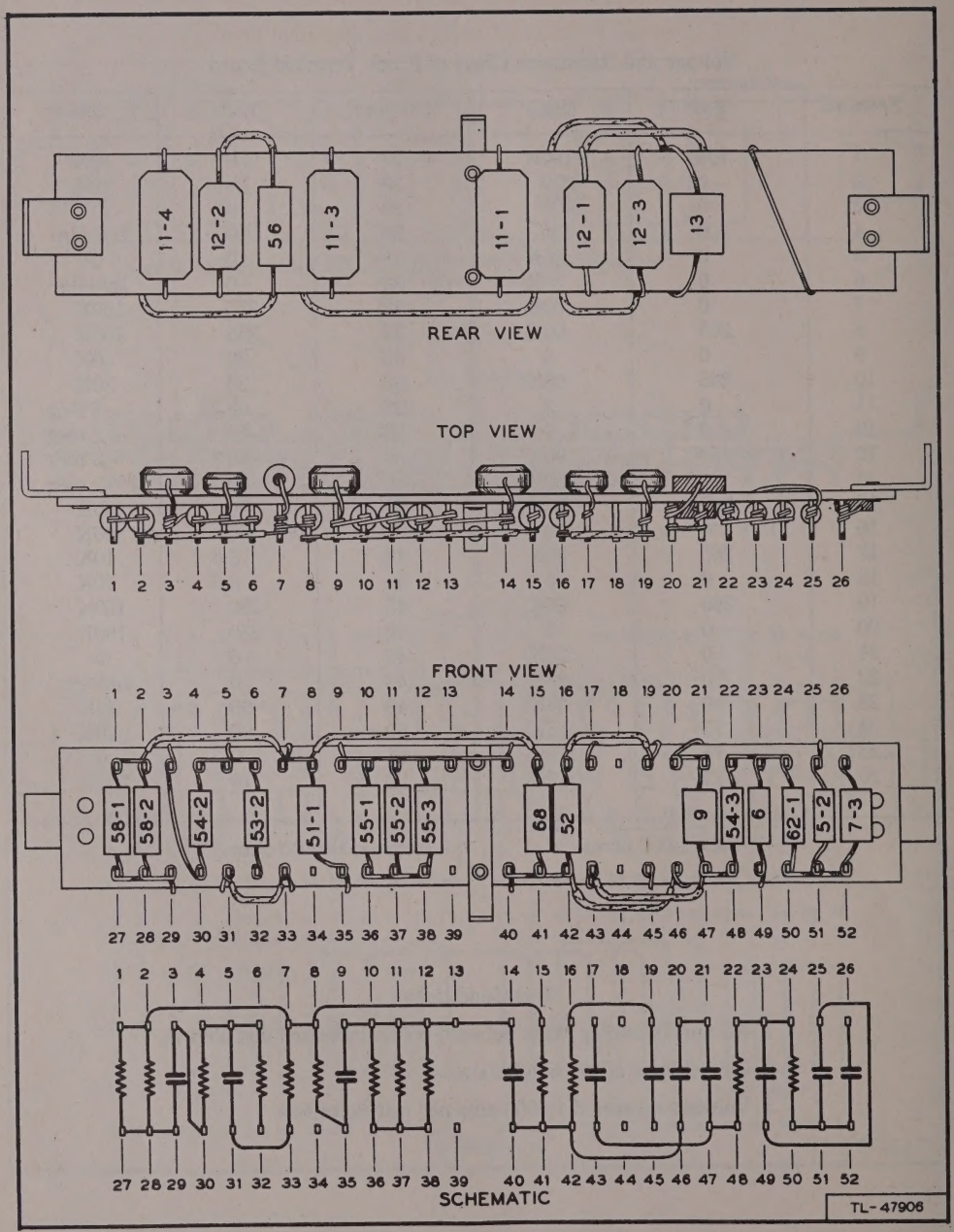


Figure 29. Range Calibrator I-223-A, rear terminal board.

Voltage and Resistance Chart of Rear Terminal Board

Terminal	*Volts*	*Ohms*	*Terminal*	*Volts*	*Ohms*
1	265	90K	27	140	120K
2	265	90K	28	140	120K
3	0	0	29	140	120K
4	–45	500K	30	0	0
5	–45	500K	31	220	100K
6	–45	500K	32	–45	450K
7	265	90K	33	220	100K
8	265	90K	34	N.C.	N.C.
9	0	0	35	200	100K
10	0	0	36	30	2300
11	0	0	37	30	2300
12	0	0	38	30	2300
13	0	0	39	N.C.	N.C.
14	0	0	40	260	90K
15	265	90K	41	260	90K
16	200	100K	42	260	90K
17	–45	500K	43	250	90K
18	N.C.	N.C.	44	N.C.	N.C.
19	200	100K	45	–3.8	1 meg
20	0	Infinite	46	260	100K
21	0	Infinite	47	250	90K
22	130	550K	48	250	90K
23	130	550K	49	0	0
24	130	550K	50	55	800K
25	0	0	51	55	800K
26	10	250K	52	55	800K

K = 1,000 ohms N.C. = no connection meg = 1,000,000 ohms

Test Conditions

1. All measurements made between points indicated and chassis.
2. Line voltage of 117.5 volts a-c.
3. Voltages measured 1,000-ohms-per-volt voltmeter.

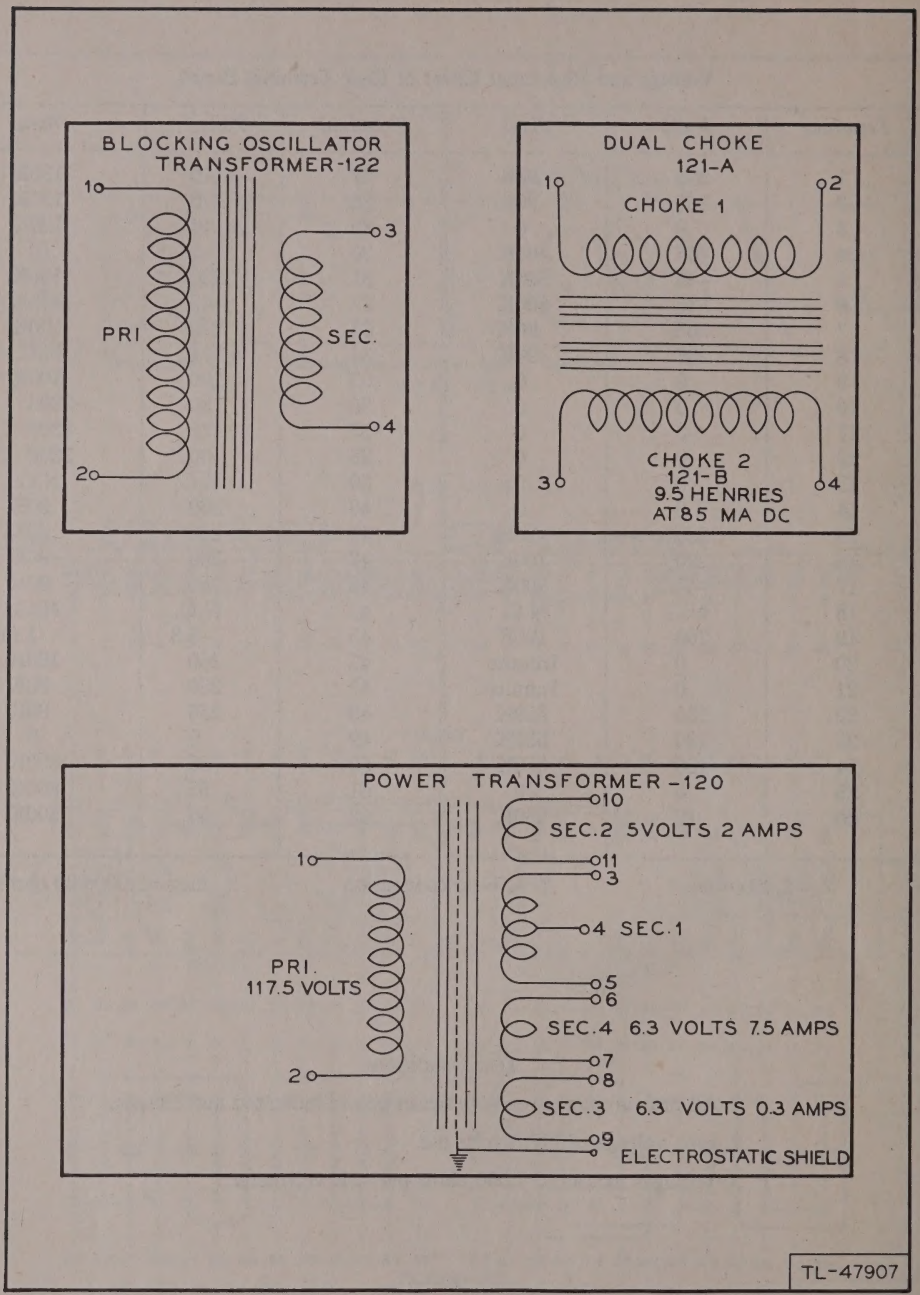


Figure 30. Range Calibrator I-223-A, schematic diagram of transformers and choke.

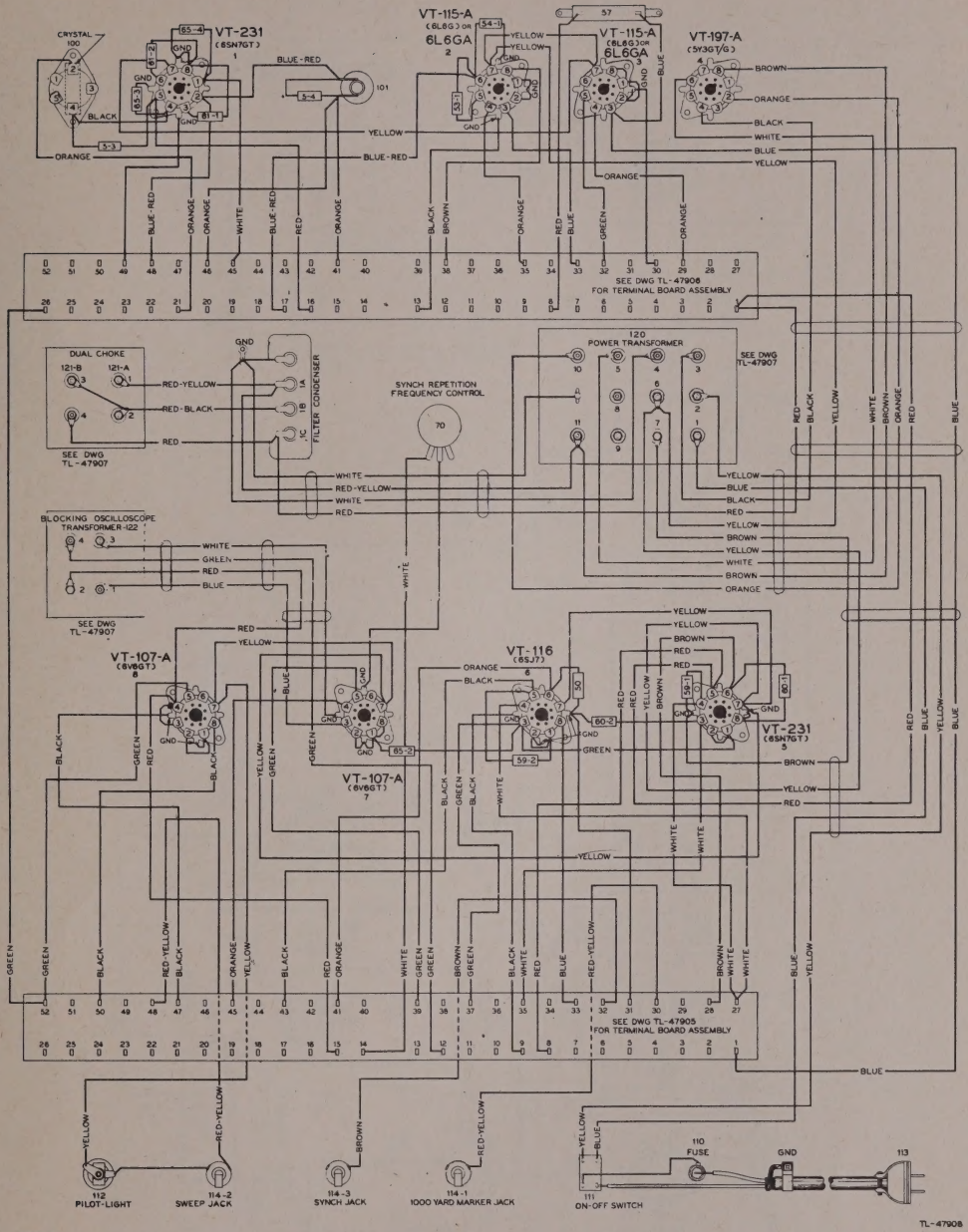


Figure 31. Range Calibrator I-223-A, wiring diagram.

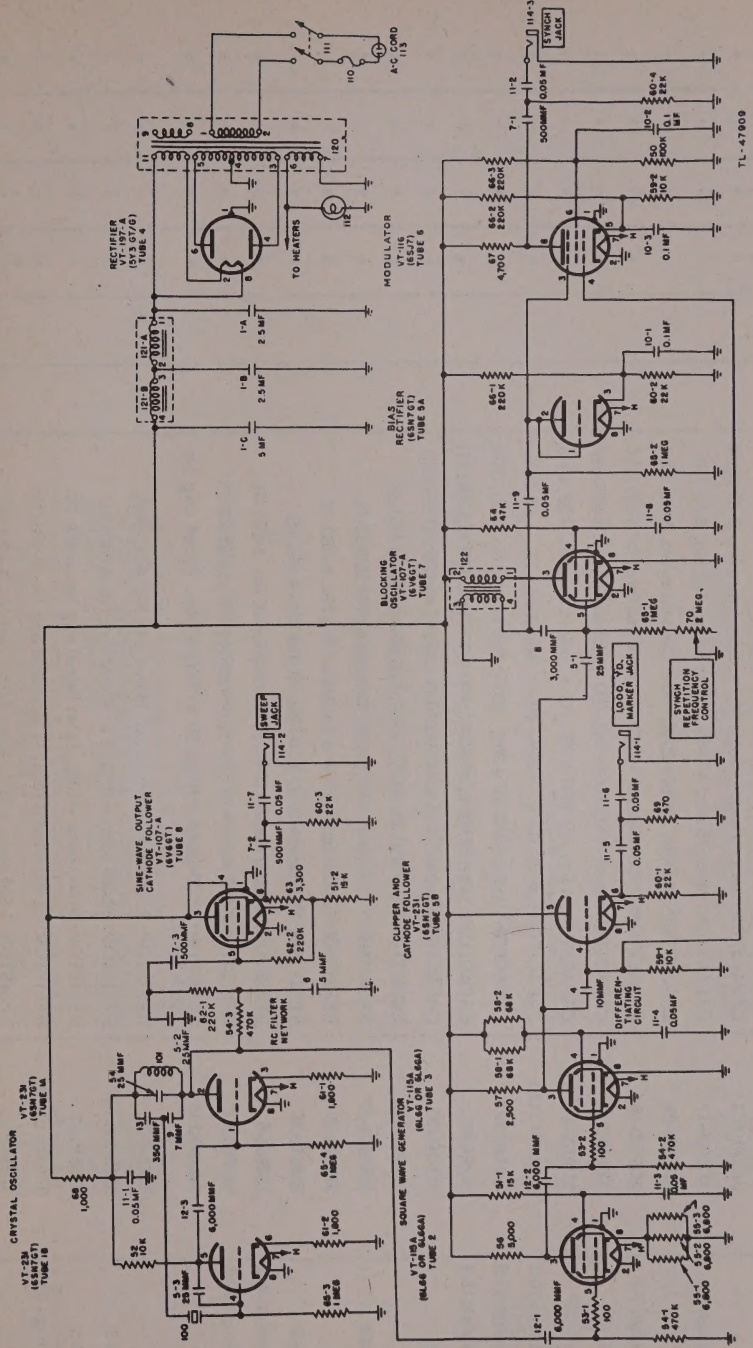


Figure 32. Range Calibrator I-223-A, schematic diagram.

14. MAINTENANCE PARTS LIST FOR RANGE CALIBRATOR I-223-A.

Ref symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Orgn stock 1st ech	Orgn stock 2d ech	3d ech	4th ech	Depot stock
1A, 1B, 1C	3DB5-26	CAPACITOR: oil; 2.5-2.5-5.0 mf +20% −10%; 600 v; Belrad dwg No. C-8B-1256.			*	*	*	*
4	3K2010011	CAPACITOR: mica; 10 mmf ±10%; 500 v; Belrad dwg No. B-8F-3233.			*	*	*	*
5-1 through 5-4	3D9025-17	CAPACITOR: mica; 25 mmf ±10%; 500 v; Belrad dwg No. B-8F-755.			*	*	*	*
6	3D9005-24	CAPACITOR: ceramic; 5 mmf ±20%; 500 v; Belrad dwg No. A-8G-3082.			*	*	*	*
7-1 through 7-3	3D9500-55	CAPACITOR: mica; 500 mmf ±20%; 500 v; Belrad dwg No. B-8F-4214.			*	*	*	*
8	3K3030212	CAPACITOR: mica; 3,000 mmf ±3%; 500 v; Belrad dwg No. B-8F-3310.			*	*	*	*
9	3D9130-5	CAPACITOR: mica; 130 mmf ±5%; 500 v; Belrad dwg No. B-8F-4026.			*	*	*	*
10-1 through 10-3	3DA100-112.1	CAPACITOR: paper; 0.1 mf ±20%; 400 v; Belrad dwg No. A-8J-1626.			*	*	*	*
11-1 through 11-9	3DA50-57.1	CAPACITOR: paper; 0.05 mf ±20%; 600 v; Belrad dwg No. A-8J-1995.			*	*	*	*
12-1 through 12-3	3DA6-45	CAPACITOR: paper; 6,000 mmf ±20%; 600 v; Belrad dwg No. A-8J-1851.			*	*	*	*
13	3D9500-25	CAPACITOR: mica; 500 mmf ±5%; 500 v; Belrad dwg No. B-8F-4021.			*	*	*	*
50	3Z6700-61	RESISTOR: 100,000 ohms ±10%; ½ w; Belrad dwg No. A-9B1-86.			*	*	*	*
51-1, 51-2	32K6615-67	RESISTOR: 15,000 ohms ±10%; 1 w; Belrad dwg No. A-9B2-76.			*	*	*	*
52	3Z6610-59	RESISTOR: 10,000 ohms ±10%; 1 w; Belrad dwg No. A-9B2-74.			*	*	*	*
53-1, 53-2	3Z6010-36	RESISTOR: 100 ohms ±10%; ½ w; Belrad dwg No. A-9B1-50.			*	*	*	*
54-1 through 54-3	3Z6747-6	RESISTOR: 470,000 ohms ±10%; ½ w; Belrad dwg No. A-9B1-94.			*	*	*	*
55-1 through 55-3	3Z6568-10	RESISTOR: 6,800 ohms ±10%; 1 w; Belrad dwg No. A-9B2-72.			*	*	*	*
56	3Z6500-138	RESISTOR: 5,000 ohms ±10%; 10 w; wire-wound; Belrad dwg No. A-9C-3187.			*	*	*	*
57	3Z6250-21	RESISTOR: 2,500 ohms ±10%; 25 w; Belrad dwg No. A-9C-3044.			*	*	*	*
58-1, 58-2	3ZK6668-14	RESISTOR: 68,000 ohms ±10%; 1 w; Belrad dwg No. A-9B2-84.			*	*	*	*
59-1, 59-2	3Z6610-57	RESISTOR: 10,000 ohms ±10%; ½ w; Belrad dwg No. A-9B1-74.			*	*	*	*
60-1 through 60-4	3Z6622-10	RESISTOR: 22,000 ohms ±10%; ½ w; Belrad dwg No. A-9B1-78.			*	*	*	*
61-1, 61-2	3Z6180-3	RESISTOR: 1,800 ohms ±10%; ½ w; Belrad dwg No. A-9B1-65.			*	*	*	*
62-1, 62-2	3Z6722-5	RESISTOR: 220,000 ohms ±10%; ½ w; Belrad dwg No. A-9B1-90.			*	*	*	*

63	3Z6330-23	RESISTOR: 3,300 ohms ±10%; ½ w; Belrad dwg No. A-9B1-68.			*	*	*	*
64	3Z6647-5	RESISTOR: 47,000 ohms ±10%; ½ w; Belrad dwg No. A-9B1-82.			*	*	*	*
65-1 through 65-4	3ZK6801-61	RESISTOR: 1 meg ±10%; ½ w; Belrad dwg No. A-9B1-98.			*	*	*	*
66-1 through 66-3	3Z6722-15	RESISTOR: 220,000 ohms ±10%; 1 w; Belrad dwg No. A-9B2-90.			*	*	*	*
67	3Z6470-8	RESISTOR: 4,700 ohms ±10%; ½ w; Belrad dwg No. A-9B1-70.			*	*	*	*
68	3Z6100-80	RESISTOR: 1,000 ohms ±10%; 1 w; Belrad dwg No. A-9B2-62.			*	*	*	*
69	3Z6047-5	RESISTOR: 470 ohms ±10%; ½ w; Belrad dwg No. A-9B1-58.			*	*	*	*
100	2X24-163	CRYSTAL: 163.94 kc; Belrad dwg No. A-8K-2938.			*	*	*	*
101	3C1084N-1	INDUCTANCE: oscillator coil assembly; Belrad dwg No. B-204-587.			*		*	*
110	3Z1950	FUSE: 3 amp; 250 v; Belrad dwg No. A-46B-1109.		*	*	*	*	*
111	3Z9845-11.1	SWITCH: toggle; DPST; Belrad dwg No. A-200-3516.						
112	2Z5927	LAMP: 6-8 v; Belrad dwg No. A-46A-1621.		*	*	*	*	*
114-1 thru 114-3	2Z5534A	JACK: telephone; open circuit; Belrad dwg No. A-44A-300.			*	*	*	*
120	2Z9613.133	TRANSFORMER: power; Belrad dwg No. D-12A-1319.			*			*
121A, B	3C323-4K	CHOKE: dual; 9.5 hy each section; Belrad dwg No. C-16B-1317.			*			*
122	2Z9643.42	TRANSFORMER: blocking oscillator; Belrad dwg No. C-12A-1318.			*			*
VT-107-A (8) VT-107-A (7)	2J6V6GT	TUBE: beam power amplifier.		*	*			*
VT-115-A (2) VT-115-A (3)	2J6L6	TUBE: beam power amplifier.			*			*
VT-116 (6)	2J6SJ7	TUBE: triple grid detector amplifier.			*			*
VT-197	2J5Y3GT	TUBE: full-wave high-vacuum rectifier.			*			*
VT-231 (1A, 1B) VT-231 (5A, 5B)	2J6SN7GT	TUBE: ½ twin triode amplifier.			*	*		*
70	2Z7274-13	CONTROL: variable, 2 meg; Belrad dwg No. B-10B-3027.			*	*	*	*
111	3Z9849.66	SWITCH: toggle; DPST; Belrad dwg No. A-200-3516.			*	*	*	*
113	3E7144-1	CABLE AND PLUG ASSEMBLY: Belrad dwg No. B-201-614.			*			*

*Indicates stock available.

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TECHNICAL MANUAL

RANGE CALIBRATOR I-223-A

CHANGES No. 1

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *24 October 1949*

TM 11-2528, 7 November 1944, is changed as follows:

On figure 5, add an asterisk (*) near the caption for curve G and add the following footnote:

*On Range Calibrators I-223-A, serial numbers 501 to 565 inclusive, curve G applies to terminal 4 of transformer 122 instead of to pin 3 of tube 5A.

On figure 27, add an asterisk (*) near the voltage readings for pins 5 and 6 of tube 2 and add the following footnote:

*On Range Calibrators I-223-A, serial numbers 501 to 565 inclusive, the voltage at pins 5 and 6 of tube 2 is 0.

Facing figure 28, in the voltage and resistance chart of the front terminal board, add an asterisk (*) next to the resistance shown for terminals 2, 3, and 4 (220 ohms), and add the following footnote:

*On Range Calibrators I-223-A, serial numbers 501 to 565 inclusive, the resistance at terminals 2, 3, and 4 is 470 ohms.

Add the following note to figure 29:

Note.—On Range Calibrators I-223-A, serial numbers 501 to 565 inclusive, capacitor 5-2 is on the rear of the terminal board instead of on the front.

Facing figure 29, in the voltage and resistance chart of the rear terminal board, add an asterisk (*) next to the voltage reading for terminal 17 (—45 volts) and add the following footnote.

*On Range Calibrators I-223-A, serial numbers 501 to 565 inclusive, the voltage at terminal 17 is 0.

On figure 32, change the reference symbol of the capacitor above tube 1A from 54 to **5-4.** Add an asterisk (*) next to the values shown for each of the following capacitors: 5-1, 5-2, 5-3, 5-4, 7-1, 7-2, 7-3, 9, and 13. Add the following footnote to the figure:

*On Range Calibrators I-223-A, serial numbers 501 to 565 inclusive, the value of certain capacitors is different from that shown, as follows:

Capacitator	*Value (mmf)*
5-1, 5-2, 5-3, 5-4	24
7-1, 7-2, 7-3	470
9	130
13	510

14. Maintenance Parts List for Range Calibrator I-223-A (1876-MPD-44)

Note (added). The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as T/O & E, T/A, T/BA, SIG 6, SIG 7 & 8, SIG 7-8-10, SIG 10, list of allowances of expendable material, or another authorized supply basis. For an index of available catalog pamphlets in the Department of the Army Supply Catalog, see the latest issue of SIG 1.

* * * * * * *

862365—49

15. (Added.) Identification Table of Parts for Range Calibrator I–223–A, Serial Numbers 501 to 565 Inclusive

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
1A, 1B, 1C	CAPACITOR, fixed: paper; 3 sect; 2.5–2.5–5 mf +20% −10%; 600 vdcw; oil filled, metal can; $3\frac{13}{16}$'' wd x $1\frac{9}{16}$'' d x $5\frac{7}{8}$'' h; 4 ins term on top w/$\frac{1}{2}$'' h solder lug; $\frac{7}{32}$'' mtg holes $4\frac{1}{2}$'' c to c; Micamold #S–1481–P.	D-c power supply filter	3DB5–26
4	CAPACITOR, fixed: mica; 10 mmf ±10%; 500 vdcw; $5\frac{1}{64}$'' lg x $1\frac{5}{32}$'' wd x $\frac{7}{32}$'' thk; molded low-loss bakelite case; 2 axial wire leads; JAN type CM20B100K.	Tube 3 plate coupling	3K2010021
5–1, 5–2, 5–3, 5–4	CAPACITOR, fixed: mica; 24 mmf ±5%; 500 vdcw; $5\frac{1}{64}$'' lg x $1\frac{5}{32}$'' wd x $\frac{7}{32}$'' thk; molded bakelite case; 2 axial wire leads; JAN type CM20C240J.	5–1: Tube 3 plate coupling 5–2: Part of r-f filter. 5–3: Neutralizing. 5–4: Tuned circuit.	3K2024032
6	CAPACITOR, fixed: ceramic; 5 mmf ±1 mmf; 500 vdcw; 0.562'' lg x 0.250'' diam; 2 axial wire leads; JAN type CC21UK050F.	Part of r-f filter	3D9005–79
7–1, 7–2, 7–3, 13	CAPACITOR, fixed: mica; 510 mmf ±5%; 500 vdcw; $5\frac{1}{64}$'' lg x $1\frac{5}{32}$'' wd x $\frac{7}{32}$'' thk; molded low-loss bakelite; 2 axial wire leads; JAN type CM20B511J.	7–1: Tube 6 output coupling 7–2: Tube 8 output coupling. 7–3: Coupling to grid of tube 8. 13: Tuned circuit.	3K2051122
8	CAPACITOR, fixed: silver mica; 3,000 mmf ±5%; 500 vdcw; $5\frac{3}{64}$'' lg x $5\frac{3}{64}$'' wd x $\frac{5}{32}$'' thk; molded bakelite case; two $1\frac{1}{8}$'' lg pigtail leads; JAN type CM-30D302J.	Oscillator grid capacitor	3K3030242
9	CAPACITOR, fixed: mica; 130 mmf ±5%; 500 vdcw; $5\frac{1}{64}$'' lg x $1\frac{5}{32}$'' wd x $\frac{7}{32}$'' thk; molded low-loss bakelite case; #20 AWG axial wire leads, $1\frac{1}{8}$'' lg; JAN type CM20B131J.	Tuned circuit	3K2013122
10–1, 10–2, 10–3	CAPACITOR, fixed: paper; 100,000 mmf ±20%; 400 vdcw; molded phenolic case; $1\frac{15}{32}$'' lg x $\frac{49}{64}$'' wd x $\frac{13}{32}$'' thk; 2 axial wire leads #18 AWG $1\frac{1}{4}$'' lg; JAN type CN43E104M.	10–1: Tube 5A cathode bypass 10–2: Tube 6 screen bypass. 10–3: Tube 6 cathode bypass.	3DA100–711
11–1 through 11–9	CAPACITOR, fixed: paper; 50,000 mmf ±20%; 400 vdcw; molded phenolic case; $1\frac{15}{32}$'' lg x $\frac{49}{64}$'' wd x $\frac{13}{32}$'' thk; two axial wire leads #18 AWG $1\frac{1}{4}$'' lg; JAN type CN43E503M.	11–1: Tube 1 plate filter 11–2: Tube 6 output coupling. 11–3: Tube 2 screen bypass. 11–4: Tube 3 screen bypass. 11–5 and 11–6: Tube 5B output coupling. 11–7: Tube 8 output coupling 11–8: Tube 7 screen bypass. 11–9: Tube 7 output coupling.	3DA50–304
12–1, 12–2, 12–3	CAPACITOR, fixed: paper; 6,000 mmf ±20%; 600 vdcw; molded phenolic case; $1\frac{3}{8}$'' lg x $\frac{41}{64}$'' wd x $\frac{9}{32}$'' thk; two axial wire leads #18 AWG $1\frac{1}{4}$'' lg; JAN type CN41E602M.	12–1: Tube 1A output coupling 12–2: Tube 2 plate coupling. 12–3: Tube 1B plate coupling.	3DA6–112
50	RESISTOR, fixed: composition; 100,000 ohms ±10%; ½ w; max body dimen 0.488'' lg x 0.249'' diam overall; 2 axial wire leads; JAN type RC20BF104K.	Tube 6 screen voltage divider	3RC20BF104K

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
51–1, 51–2	RESISTOR, fixed: composition; 15,000 ohms ±10%; 1 w; max body dimen 0.750″ lg x 0.280″ diam overall; 2 axial wire leads; JAN type RC30BF153K.	51–1: Tube 2 screen dropping 51–2: Tube 8 cathode resistor.	3RC30BF153K
52	RESISTOR, fixed: composition; 10,000 ohms ±10%; 1 w; max body dimen 0.750″ lg x 0.280″ diam overall; 2 axial wire leads; JAN type RC30BF103K.	Tube 1B plate resistor	3RC30BF103K
53–1, 53–2	RESISTOR, fixed: composition; 100 ohms ±10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam overall; 2 axial wire leads; JAN type RC20BF101K.	Parasitic suppressors	3RC20BF101K
54–1, 54–2, 54–3	RESISTOR, fixed: composition; 470,000 ohms ±10%; ½ w; max body dimen 0.468″ lg x 0.249″ over-all; 2 axial wire leads; JAN type RC20BF474K.	54–1: Tube 2 grid resistor 54–2: Tube 3 grid resistor. 54–3: Part of r-f filter.	3RC20BF474K
55–1, 55–2, 55–3	RESISTOR, fixed: composition; 6,800 ohms ±10%; 1 w; max body dimen 0.750″ lg x 0.280″ diam over-all; 2 axial wire leads; JAN type RC30BF682K.	Tube 2 self-bias resistors	3RC30BF682K
56	RESISTOR, fixed: WW; 5,000 ohms ±5%; 9 w; max body dimen 2 1/16″ lg x ⅝″ diam over-all; 2 axial wire leads; JAN type RW56J502.	Tube 2 plate resistor	3RW28520
57	RESISTOR, fixed: WW; 2,500 ohms ±5%; 12 w; max body dimen 2″ lg x 1 3/32″ diam over-all; 2 radial solder lug term; JAN type RW32G252.	Tube 3 plate resistor	3RW26707
58–1, 58–2	RESISTOR, fixed: composition; 68,000 ohms ±10%; 1 w; max body dimen 0.750″ lg x 0.280″ diam over-all; 2 axial wire leads; JAN type RC30BF683K.	Tube 3 screen dropping	3RC30BF683K
59–1, 59–2	RESISTOR, fixed: composition; 10,000 ohms ±10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam over-all; 2 axial wire leads; JAN type RC20BF103K.	59–1: Tube 5B grid resistor 59–2: Tube 6 cathode voltage divider.	3RC20BF103K
60–1, 60–2, 60–3, 60–4	RESISTOR, fixed: composition; 22,000 ohms ±10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam over-all; 2 axial wire leads; JAN type RC20BF223K.	60–1: Tube 5B cathode resistor 60–2: Tube 5A cathode voltage divider. 60–3: Tube 8 load. 60–4: Tube 6 load.	3RC20BF223K
61–1, 61–2	RESISTOR, fixed: composition; 1,800 ohms ±10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam over-all; 2 axial wire leads; JAN type RC20BF182K.	61–1: Tube 1A self-bias resistor 61–2: Tube 1B self-bias resistor.	3RC20BF182K
62–1, 62–2	RESISTOR, fixed: composition; 220,000 ohms ±10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam overall; 2 axial wire leads; JAN type RC20BF224K.	62–1: Part of r-f filter 62–2: Tube 8 grid resistor.	3RC20BF224K
63	RESISTOR, fixed: composition; 3,300 ohms ±10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam overall; 2 axial wire leads; JAN type RC20BF332K.	Tube 8 cathode resistor	3RC20BF332K
64	RESISTOR, fixed: composition; 47,000 ohms ±10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam overall; 2 axial wire leads; JAN type RC20BF473K.	Tube 7 screen dropping	3RC20BF473K

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
I–1	LIGHT, indicator: with lens; ½″ diam red frosted lens; for minature bayonet base; 6–8 v AC; inclosed shell; satin chrome finish on brass shell; 1⅞″ lg x 15/16″ diam; 11/16″ diam mtg hole for ¼″ thk panel max; horizontally mtd; lamp replaceable from front; thd jewel; 2 solder lugs located on opposite side of base of socket; Drake mfg #50; Temco part #790–39–I1.	Pilot lamp socket	2Z5991
X–1	SOCKET, tube: 5 cont; metal plate under chassis mtg; two 9/64″ x 5/16″ slots on 1 11/16″ mtg/c; 1 3/16″ diam x 3/8″ thk ceramic; phosphor bronze, silver plated; Amphenol part #49–RSS5M; Temco part #790–39–X1.	Crystal socket	2Z8763.4
X–2 through X–9	SOCKET, tube; octal; metal saddle mtg; two 5/32″ diam mtg holes on 1½″ mtg/c; 1 3/16″ diam x ½″ thk low-loss yellow bakelite; beryllium copper, silver plated; Cinch part #51A13405;' Temco part #790–39–X2.	Tube sockets	2Z8678.313

[AG 300.7 (6 Oct 49)]

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