

WAR DEPARTMENT TECHNICAL MANUAL

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TS-34A/AP

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OSCILLOSCOPE TS-34A/AP

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WAR DEPARTMENT

WASHINGTON 25, D. C., 17 February 1945

TM 11-1067A, Oscilloscope TS-34A/AP, is published for the information and guidance of all concerned.

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IC 44: T/O-E 44-138, AAA Searchlight Btry

(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, case, panels, switches, dials, chassis, sockets.

2. Cut — Wiring, cord, cables, transformer windings.

3. Burn — Manuals, charts, schematics.

4. Bend — Framework, chassis, panels.

5. Bury or scatter — All of the above materials after destroying their usefulness.

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 INVOLVES THE USE OF HIGH VOLT-
AGES WHICH ARE DANGEROUS TO LIFE. ANY MAINTENANCE TEST
REQUIRING OPERATION OF THE OSCILLOSCOPE WITH EITHER OF ITS
COVERS REMOVED SHOULD BE UNDERTAKEN ONLY BY EXPERIENCED
REPAIR PERSONNEL UNDER CONDITIONS OF ADEQUATE PRECAUTION
AGAINST ELECTRIC SHOCK. ADJUSTMENT, REPLACEMENT OR REPAIR
OF PARTS INSIDE THE CASE SHOULD BE DONE WITH THE POWER CORD
DISCONNECTED FROM THE SOURCE OF SUPPLY.

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.

Resuscitation



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.

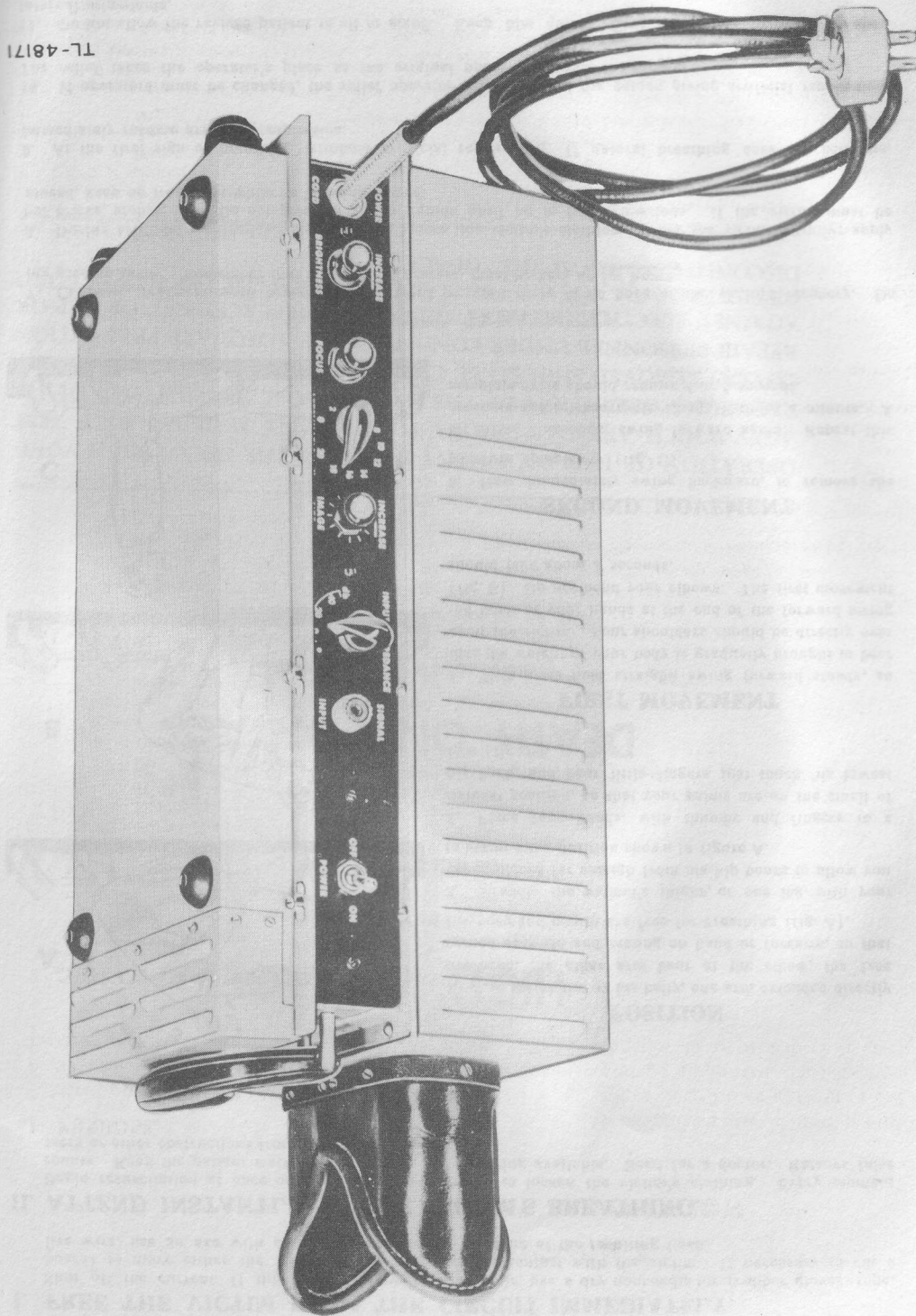


CONTINUED TREATMENT

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

Fig. 1-1. Oscilloscope TS-34A/AP



TL-48171

SECTION I GENERAL DESCRIPTION

intended for use in testing and maintaining radar and other electrical equipment in the field, in the laboratory, and on shipboard. This handbook describes its characteristics, basic principles, operation, and maintenance.

Oscilloscope TS-34A/AP, is a small, easily portable instrument for observing electrical wave-forms and for measuring their voltage, power, and duration. It is

2. OPERATING CHARACTERISTICS AND LIMITS.

Pulses and square waves observable.	1/4 to 30,000 microseconds.
Duration.	Positive or negative.
Polarity.	Sine waves observable.
Input impedance.	30 to 1,000,000 cycles per second.
Oscilloscope alone.	Low.
High.	62 ohms.
Oscilloscope with probe.	430,000 ohms paralleled by 30 mmf.
Input voltage and sensitivity.	4 megohms paralleled by 12 mmf.
Oscilloscope alone.	Oscilloscope and sensitivity.
Low impedance input 0.1 to 1 volt.	High impedance inputs.
0 db.	0.1 to 1 volt.
20 db.	1 to 10 volts.
40 db.	10 to 100 volts.
Oscilloscope with probe.	1 to 450 volts.
Oscilloscope with probe and Voltage Divider TS-89/AP. (Not furnished)	200 to 20,000 volts.
Calibrating voltage.	Any known value between input voltage limits.
Required only when measuring voltage.	May be of any frequency or wave shape but preferably similar to unknown.
Internal.	By signal under observation.
External, without probe.	2 to 100 volts.
External, with probe.	20 to 450 volts.
Synchronizing input impedance.	400,000 ohms paralleled by 30 mmf.
Sweep circuits available.	Start-stop.
Each impulse independent of preceding; used for observing nonperiodic as well as periodic pulses.	Sawtooth.
Synchronizes with periodic pulses; not satisfactory for nonperiodic pulses unless departure from periodicity is small.	Sweep speeds available. (Approximate Values)
Start-stop duration—microseconds	4 1/2 to 8
Sawtooth duration—microseconds	20 to 200
Sawtooth frequency—cycles per second	50,000 to 5,000
Measurement of signal duration.	Under 8 microseconds. By internally developed microsecond pulses.
Over 8 microseconds. By external pulses or sine waves of known frequency.	Power supply.
Volts.	115 ± 10.
Frequency.	50 to 1200 cycles per second.
Watts.	90 at 60 cycles per second, less at higher frequencies.
Direct connection to one vertical and both horizontal plates.	Available through external connectors and Cords CX-152/U.
Ambient temperature limits.	- 40° to + 120° F.
Maximum relative humidity.	95 percent.
Drip proof.	Yes, in upright position.
Effect of microwave fields.	Small.

Section I

Paragraphs 3-5

3. EQUIPMENT SUPPLIED.

Oscilloscope TS-34A/AP is shown in figure 1-1. All components with their over-all dimensions and weights are listed below:

Quantity	Name of Unit	Dimensions (in feet and inches)	Weight (in pounds)
1	Oscilloscope TS-34A/AP, including the following accessories: ing accessories:	20 3/4" x 9" x 8", inclusive of eyeshade which extends 3" above case.	29
2	Probe Assembly MX-50/AP	50" long; 1" max. dia.	1 1/2
2	Coaxial Cord CG-72/U	10' long	2 1/2
2	Cord CX-152/U	1' long (approx.)	1/4
1	Cord CX-150/U	15' long	3/4
1	Case CY-213/AP	23" x 11" x 12"	6
	Total		40

4. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

No equipment beyond that supplied is required for all ordinary uses of this oscilloscope. However, Voltage Divider TS-89/AP or a similar device may be used to extend its range above 450 volts.

5. DESCRIPTION OF EQUIPMENT.

a. OSCILLOSCOPE TS-34A/AP. (See fig. 1-1.)

(1) The dimensions and weight of the oscilloscope are given above. It has a central steel framework on which all the apparatus is mounted. Removable sheet steel covers attached to the top and bottom of this frame give access to all component parts. Both covers are provided with louvers to facilitate ventilation and render the oscilloscope drip-proof. Under these louvers are perforated inner linings as shields against micro-wave fields. A five and one-half foot cord for connecting the oscilloscope to the power supply is permanently attached. A handle for carrying purposes is located on the front.

(2) The two-inch cathode-ray tube on which the images are viewed is housed in an Armco-iron tube which serves as a shield against extraneous light and against electric and magnetic fields. Directly in front of the cathode-ray tube is a disc of clear plexiglas on which are engraved three horizontal lines 1/4 inch apart. This disc is edge-illuminated by a pilot light to make the engraved lines easily visible and to serve as an indicator of whether power is on or off. When making measurements, these horizontal lines across the face of the screen guide the operator in adjusting the amplitude of images to a standard reference value. A lens within the

viewing tube magnifies the images about two times and enables the operator to observe the screen comfortably from a closer position than would otherwise be possible. A soft eyeshade or hood on the front end of the frame completes the light-shield and viewing arrangements. (3) All controls are located in protecting channels along the sides of the oscilloscope, convenient for manipulation by either the right or the left hand while the operator views the screen. The means for making external connections are also on these control panels.

b. ACCESSORIES.

(1) PROBE ASSEMBLY MX-50/AP.—On one end of the probe assembly, figure 1-2, is a coaxial plug for attaching to the "SIGNAL INPUT" or "EXT SYNC" jack. On the other end are two alligator clips for making connections to equipment under test and a fiber tube housing necessary circuit elements. One of the clips is rigidly attached to the fiber tube while the other, the ground clip, is attached by a flexible rubber-covered wire. Between the fiber tube and the plug is a 43-inch length of coaxial cable. Two of these probes are supplied with each oscilloscope. One is marked "SIGNAL INPUT" indicating that the signal input has been adjusted to the exact characteristics of this probe. The other probe, unmarked, is for the sync input only, but the marked probe may also be used for the sync input.

(2) COAXIAL CORD CG-72/U.—Two identical coaxial patching cords are provided as shown in figure 1-2. Each consists of ten feet of coaxial cable terminated at each end in a coaxial plug. These cords are intended for connecting the "SIGNAL INPUT" and "EXT SYNC" jacks of the oscilloscope to other apparatus, where such apparatus is provided with suitable jacks.

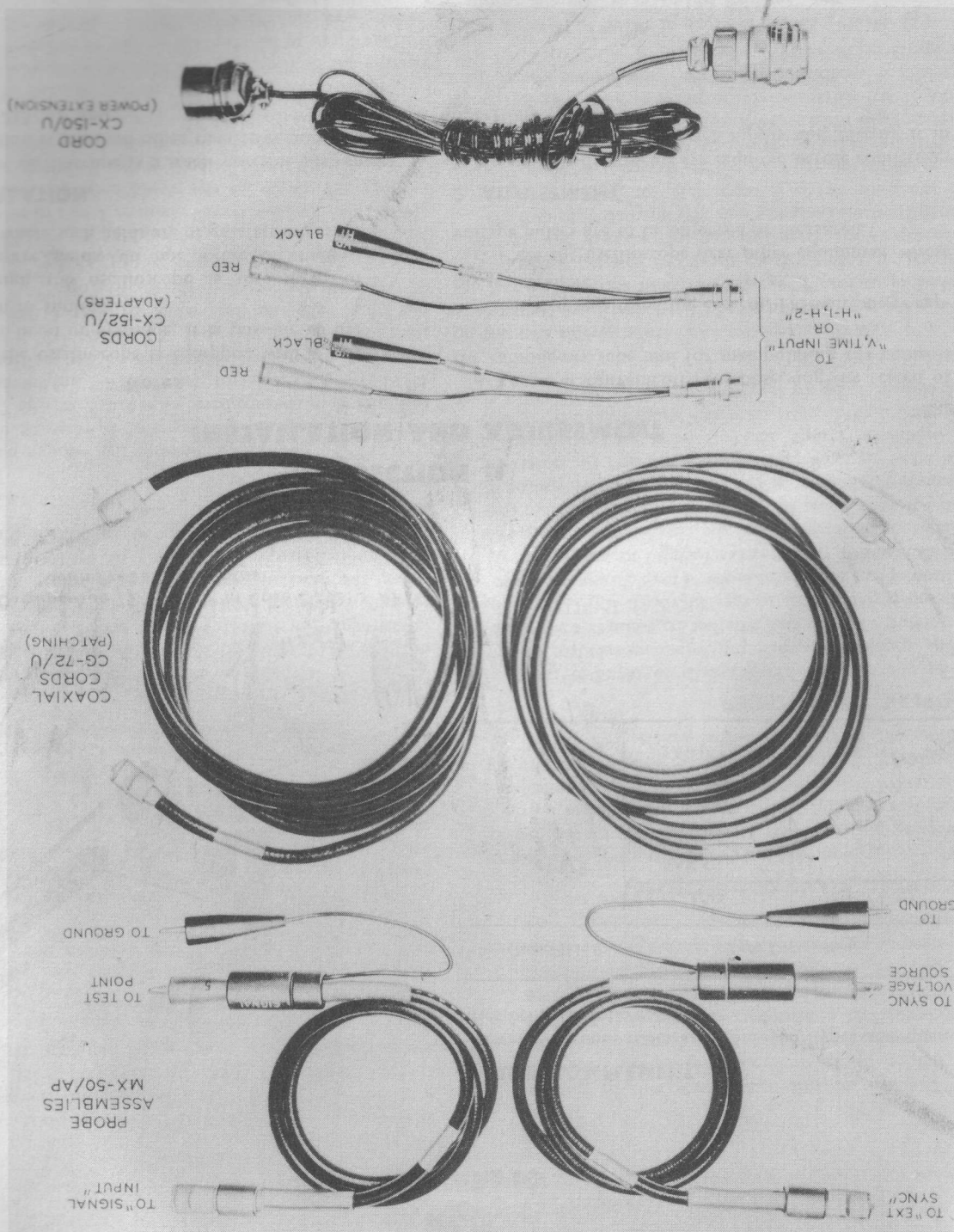
(3) CORD CX-152/U. (ADAPTERS).—These adapters, figure 1-2, consist of six- and eight-inch lengths of stranded wire covered with a 50-mil black Vinylite jacket terminating at one end in an MC2M connector and at the other end in clips. The clip on the longer length of wire is covered with a red rubber insulator and that on the shorter length of wire with a black rubber insulator. The MC2M connectors fit the PC2F connectors at the rear of the right-hand control panel of the oscilloscope. These adapters facilitate making outside connections to the H1, H2, and V plates and to the "TIME INPUT."

(4) CORD CX-150/U.—This 15-foot cord, shown in figure 1-2, is terminated at one end in a connector into which the "POWER CORD" of the oscilloscope may be plugged. The other end terminates in a connector which may be attached to the power supply outlets commonly employed in airplanes.

(5) CASE CY-213/AP.—This case, shown in figure 1-3, is of aluminum. It has a compartment for the above described probes, cords, and adapters, as well as for the oscilloscope proper and a copy of this handbook.

Fig. 1-2. Probes and Cords Supplied with Oscilloscope TS-34A/AP

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SECTION III OPERATION

as fully as possible, details of the voltage pulse or waveform to be observed. The image should, therefore, be spread horizontally over a substantial part of the screen. Increasing the sweep speed increases the spread.

(2) If the duration of the voltage pulse to be observed is known, the "SWEEP SPEED COARSE" selecting switch on the right side of the oscilloscope may be preset according to this duration, for "FAST," "MED," or "SLOW" speed.

(3) If the sawtooth sweep is employed, the exact frequency required for synchronization can be set only by manipulating the "FINE" control knob while observing the oscilloscope screen.

(4) If the duration of the pulse to be observed is entirely unknown, the "SWEEP SPEED" should be initially set at "MED" and subsequent adjustments of the sweep speed made while observing the image on the screen.

(5) It is to be remembered that, while the speed of both types of sweep is capable of coarse and fine adjustment, the start-stop sweep speed cannot be continuously adjusted over its whole range. On the other hand, the sawtooth sweep is continuously adjustable over its full range from about 20 to 100,000 microseconds, or frequencies from 10 to 50,000 cycles per second.

c. INPUT IMPEDANCE.

(1) To observe or measure the voltage output of a low-impedance line or piece of equipment, normally terminated in characteristic impedance, set the "INPUT IMPEDANCE" selector for "LOW" impedance. The otherwise high input impedance of the oscilloscope is then shunted by a resistance of 62 ohms, which produces but small reflection loss when circuits of either 50 or 72 ohms are connected to the oscilloscope.

(2) With the "INPUT IMPEDANCE" selector in its "LOW" position, the voltage across the "SIGNAL INPUT" should not exceed about ± 1 volt to avoid overloading the output of the signal amplifier with consequent distortion of the signal image. To secure adequate amplitude of image, the input voltage should not be less than 0.1 volt.

(3) Should the "LOW" setting be used when connecting the oscilloscope to a high-impedance circuit, the voltage pulse to be observed would be reduced in magnitude and its shape probably distorted. Conditions would be so abnormal that the results would not be representative.

(4) To observe or measure a voltage pulse with the minimum disturbance of conditions in the circuit

The user of this oscilloscope will be greatly helped by an understanding of its theory of operation and by the ability to make necessary checks and adjustments and diagnose troubles when encountered. To this end he should read Sections III and IV of this instruction book even though he is not responsible for the maintenance of the equipment.

Note

1. CONTROLS AND CONNECTORS.

All external controls and connectors are located in two protecting channels, one along each side of the oscilloscope. The function of each control or connector is briefly indicated by the adjacent markings. Further explanation is, however, given in figure 3-1 by notes adjacent to the photographs of the two control panels.

2. OPERATING CHOICES.

The operating choices generally involved are: type of sweep, speed of sweep, input impedance source of synchronizing voltage, and whether to connect the voltage to be observed directly to the "SIGNAL INPUT" of the oscilloscope or to use the probe. These choices are generally determined by the character and magnitude of the voltage to be observed and the circuit conditions where such voltage occurs. If some or all of these external conditions are unknown, it will be necessary to determine by trial what oscilloscope conditions are best for observing the unknown voltage. The following paragraphs outline the general considerations which should govern the several choices to be made by the operator.

a. SWEEP TYPE.

(1) The characteristics and limitations of the two types of sweep, start-stop, and sawtooth, have been described in section I, paragraph 2 and section IV, paragraph 1. It follows from these characteristics that the start-stop sweep cannot be used for pulses or waveforms whose duration exceeds about 280 microseconds and that the sawtooth sweep is unsuitable for pulses or waveforms whose rate of recurrence is irregular by more than a small amount. If duration permits, it is almost always preferable to utilize the start-stop sweep. On the other hand, if the duration of the pulse exceeds 280 microseconds, it is necessary to utilize the sawtooth sweep if the entire pulse is to be observed.

(2) Having chosen the type of sweep to be used, at least initially, the "SWEEP SELECTOR" on the right side of the oscilloscope should be set correspondingly.

b. SWEEP SPEED.

(1) The sweep speed should be chosen to display,

Figure 3-1. Controls and Connections on Left and Right Sides of Oscilloscope TS-34A/AP

TL-48174

5 1/2-foot cord for connecting oscilloscope to 115-volt power supply of any frequency between 50 and 1200 cycles per second.

Potential divider controlling steady potential of control grid of cathode-ray tube and thus brightness of image.

Potential divider controlling steady potential of focusing anode of cathode-ray tube and thus sharpness of image.

Rotary switch and potential divider controlling attenuation in signal channel, giving losses from C to 20 db in 2-db steps. (Used in voltage measurements.)

Adjustable resistor controlling gain of coupling amplifier and thus size of signal image. Extreme counterclockwise rotation causes internal timing oscillations.

Rotary switch controlling input impedance of oscilloscope. LOW = 62 ohms. HIGH = 430,000 ohms paralleled by about 30 micromicrofarads. When input impedance is used, this input selector affords a choice of three input losses, 0, 20, and 40 db corresponding to input voltage multipliers of 1, 10, and 100, respectively.

Coaxial jack for connecting signal source directly to oscilloscope or through probe.

Double-pole switch to turn power on or off.

SWEEP TYPE	FAST	MED	SLOW
START-STOP	4-1/2-8	20-50	120-280
SAWTOOTH	20	200	4000-100,000

V-connection to vertical deflecting plate, by-passing amplifier and delay network. TIME INPUT—For connecting external timing or other pulses to cathode.

NORMAL position connects sweep amplifier directly to horizontal deflecting plates. H PLATES position decouples amplifier by inserting 2.2-megohm resistors but permits horizontal position control to remain effective.

H-1, H-2—Connections to horizontal deflecting plates.

CAUTION: For normal operation caps for both jacks should be screwed down tight and not interchanged.

Potential dividers controlling steady potentials on VERTICAL and HORIZONTAL-TAL deflecting plates of cathode-ray tube, thus vertical and horizontal position of image. Clockwise rotations move image downward to right.

Adjustable resistor, allowing continuous adjustment of SWEEP SPEED over each of the ranges, FAST, MEDIUM, and SLOW.

Rotary switch controlling sweep speed ranges by changing capacitance. Approximate microseconds

Switch connecting sweep, internally, to signal channel or to EXT SYNC jack.

Coaxial jack for connecting external source of synchronizing pulses.

Adjustable resistor controlling magnitude of synchronizing pulses.

Double-pole switch for reversing polarity of synchronizing pulses when using start-stop sweep.

Double-pole switch allowing selection of either sweep circuit.

Instructions for the calibration and use of the probe in voltage measurements are given in paragraph 5c, this section.

d. SOURCE OF SYNCHRONIZING VOLTAGE.

(1) In most cases, it is preferable to synchronize the operation of the sweep by the signal pulses to be observed. For this condition, the "EXT SYNC-INT SYNC" switch should be thrown to its "INT SYNC" position, which connects the input of the sweep channel to the output of the coupling amplifier in the signal channel.

(2) When the signal to be observed furnishes no reliable synchronizing pulse or when it is desired to control the sweep by a pulse which occurs in advance of the signal, introduce the desired external synchronizing pulses through the "EXT SYNC" jack on the right side of the oscilloscope and throw the "EXT SYNC-INT SYNC" switch to its "EXT SYNC" position.

(3) A series of observations such as would be involved in tracing a signal through different parts of a complex circuit presents another situation where it would be advantageous to use external synchronization. The synchronizing and sweep adjustments can in such cases be made once to serve for the whole series of observations.

(4) A probe should be used in connection with external synchronization if an input of very high impedance is required or if it is desired to use synchronizing voltages in the range 100 to 450. A probe may also be used with synchronizing voltages as low as 20 volts.

3. OPERATING PROCEDURE.

To observe or measure a voltage pulse of unknown characteristics, choose the oscilloscope conditions outlined in the previous paragraph. Steps necessary to operate the oscilloscope in the several ways which may be selected are described below under appropriate headings and in each case in about the order which should be followed.

a. START-STOP SWEEP SYNCHRONIZED

BY SIGNAL.

(1) Set the "SWEEP SELECTOR" on the right side of the oscilloscope in its "START-STOP" position. (2) See that the "EXT SYNC-INT SYNC" switch is in the "INT SYNC" position. In this position synchronizing pulses will be derived from the signal pulses. (3) See that the "NORMAL-H PLATES" switch is in "NORMAL" position.

(4) If the duration of the signal pulse is known approximately, the "SWEEP SPEED COARSE" switch may be preset in the required position. It is probably best not to attempt to adjust the "FINE" speed control until after the signal pulse is under observation. If the duration is not known even roughly, it is better to start out with the "COARSE" switch set for "MED" speed.

where the pulse occurs, set the "INPUT IMPEDANCE" switch on one of its "HIGH" positions. The input impedance is then about 430,000 ohms paralleled by parasitic capacitance of about 30 picofarads.

(5) With the "INPUT IMPEDANCE" selector set for "HIGH" impedance, three choices of sensitivity are available, depending upon whether the selector is set for 0, 20, or 40 db attenuation, the input impedance being substantially unaffected by the choice of db settings.

(a) On "0 db," the sensitivity is a maximum and the voltage impressed on the "SIGNAL INPUT" should be within the range of 0.1 to 1 volt, positive or negative instantaneous value.

(b) On the 20 db setting, the sensitivity is a medium and the input voltage should be between 1 and 10 volts, positive or negative instantaneous value.

(c) On the 40 db setting, the sensitivity is a minimum and the input voltage should lie between 10 and 100 volts, positive or negative instantaneous value.

Note

Since the above limits apply to the positive and negative fluctuations from a mean value, it follows that a symmetrical alternating voltage wave may have a peak-to-peak value double the above limits.

CAUTION

The voltages impressed on the "SIGNAL INPUT" of the oscilloscope should not greatly exceed the maximum values specified above. In preparing the oscilloscope to observe an unknown voltage, set the "INPUT IMPEDANCE" selector initially on its "HIGH 40 db" position, then subsequently reset it if necessary after observing the resulting deflection. When observing high voltages without the use of the probe, particular care should be taken not to turn the "INPUT IMPEDANCE" selector to its "LOW" position which might burn out the low impedance input circuit.

(6) To secure a higher input impedance than 430,000 ohms, connect Probe Assembly MX-50/AP "SIGNAL IN-PUT" of the oscilloscope. The input impedance of the probe is about 4 megohms paralleled by 12 picofarads. Introduction of the probe between the source of voltage to be observed and the oscilloscope causes a reduction of about 10 to 1 in the voltage applied to the oscilloscope proper. The lowest measurable voltage with the probe is, therefore, about one volt. The maximum voltage which should be impressed on the probe should not exceed 450 peak volts to avoid possible insulation failure.

WARNING

Such voltages are dangerous. Circuits producing dangerous voltages should be de-energized while test connections are made.

(5) Set "ATTENUATION" switch in its "0"

position.

(6) Turn "IMAGE SIZE" control to its extreme

clockwise position corresponding to minimum image

amplitude.

(7) Set the "INPUT IMPEDANCE" selector to

either its "LOW" or one of its "HIGH" positions, de-

pending on the impedance and the voltage of the circuit

in which wave forms are to be observed. The considera-

tions governing this choice are stated in paragraph 2c.

If the probe is to be used, the "INPUT IMPEDANCE"

selector should always be on one of its "HIGH" im-

pedance positions. Use of the probe is covered in more

detail in paragraphs 5c and d.

(8) Plug the "POWER CORD" into an a-c source

of supply of 115 volts and throw the "POWER" switch

to its "ON" position.

(9) After a 60-second warming-up interval adjust

the "BRIGHTNESS" control until a luminous spot just

appears on the screen. This spot should not be exces-

sively bright but just easily visible.

CAUTION

Do not allow the luminous spot to remain in

any one position on the screen.

(10) Adjust the "FOCUS" control until the spot

is as small and round as possible.

(11) Adjust the "POSITION CONTROLS,"

"VERTICAL" and "HORIZONTAL" until the spot is

in the left center of the screen.

(12) Connect the unknown signal to the "SIGNAL

INPUT" jack on the left side of the oscilloscope. At

this time, the spot may be swept across the screen show-

ing a luminous horizontal line and possibly the image

of a pulse.

(13) Ordinarily, set the "SYNC VOLTAGE" con-

trol to give maximum synchronizing voltage. However,

if the signal occurs more than about 2500 times per

second, the voltage may need to be reduced with this

control to obtain proper synchronization.

(14) If no pulse appears after step 13, the "SYNC

POLARITY" switch should be thrown to its other

position.*

(15) As soon as a pulse appears turn the

"BRIGHTNESS" control clockwise until the bright

spot at the left of the pulse disappears. Readjust the

"FOCUS" control, if necessary, to make the image as

sharp and clear as possible. (See fig. 3-2.)

* If a sweep but no pulse appears after trying both polarities and

carrying out all the above steps, either the signal is too weak to

be observed or the signal amplifier is out of order. If not even a

sweep appears after step 13 and a trial of both sync polarities,

either the signal is too weak to trip the sweep (which operates

on a smaller voltage than can be observed) or the oscilloscope

is out of order. Try increasing the brightness of the spot and if

a vertical line appears, but no sweep, it is an indication of the

presence of a signal pulse and probable trouble in the sweep

channel. Refer to Section V.

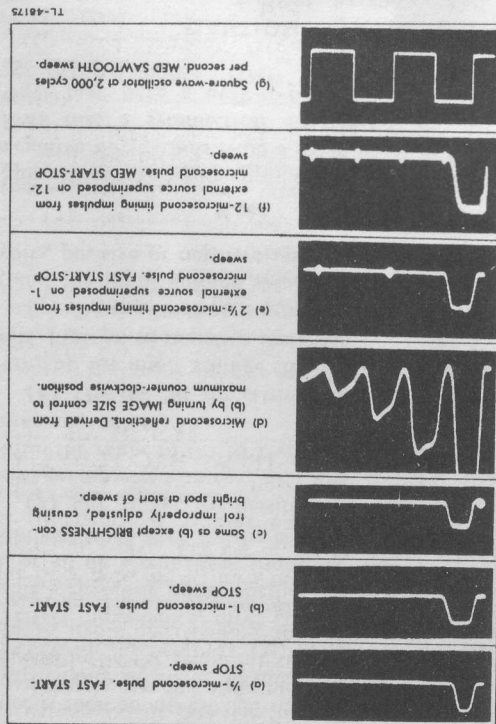


Figure 3-2. Images of Signal Pulses and Timing Waves

(16) The pulse image may be widened or contracted as needed by adjusting the sweep speed controls. If the entire pulse is not visible, the sweep speed should be decreased.

(17) With the "POSITION CONTROLS," place the beginning of the pulse about the middle of the left side of the screen and adjust the vertical position of the luminous horizontal base or zero line until it coincides with the middle engraved reference line across the screen. The engraved reference line should appear in the middle of the luminous base line.

(18) Adjust the "IMAGE SIZE" control until the top of the pulse coincides with the upper engraved reference line (lower engraved line if the pulse is inverted). The image of the pulse then has an amplitude of 1/4 inch which should be used as the standard reference deflection for voltage or power measurements. (See fig. 3-2.)

CAUTION

If the "IMAGE SIZE" control is in its extreme counterclockwise position the pulse will be badly distorted. This position should only be used for timing purposes as described in paragraph 4.

the "EXT SYNC" jack on the right side of the oscilloscope and throw the "EXT SYNC—INT SYNC" switch to its "EXT SYNC" position. Set and adjust the other controls as already described. Either the start-stop sweep or the sawtooth sweep may be used with external tripping pulses, but such pulses must occur simultaneously with the signal, or before it by not more than about half the sweep duration.

(2) If the external synchronizing source delivers more voltage than is necessary, the sweep may be shortened or behave erratically. Turn the "SYNC VOLTAGE" control counterclockwise to reduce the synchronizing voltage. If this control cannot effect a sufficient reduction, reduce the synchronizing voltage by use of Probe MX-50/AP, and if this is insufficient, by other external means such as a potential divider or attenuating network. The impedance looking into the "EXT SYNC" jack is approximately 400,000 ohms. If this impedance is insufficient, use of the probe will give an input impedance equivalent to about 4 megohms paralleled by 12 micromicrofarads.

(3) When employing the start-stop sweep synchronizing the start-stop sweep source, it may be desirable to utilize the "SYNC POLARITY" switch to choose between synchronizing the sweep with the start or end of the synchronizing pulse. Fine adjustment of synchronizing voltage can be used at times to advantage to control the point of time in the synchronizing pulse when the start-stop sweep will be tripped. Thus, for example, a slowly rising synchronizing voltage will take longer to reach the tripping value, if attenuation is introduced in the circuit. By combining adjustment of synchronizing voltage and change of polarity, it is sometimes possible to trip the start-stop sweep at any one of a number of different points along a synchronizing pulse derived from an external source.

4. TIMING—MEASUREMENT OF SIGNAL DURATION.

The duration of the sweep or a signal pulse can be determined in several ways.

a. DURATION LESS THAN 8 MICRORSECONDS. (1) Turn the "IMAGE SIZE" control to its extreme counterclockwise (largest image) position which mismatches the impedance at the output of the delay network.

(2) Apply a steep wave front pulse to the "SIGNATURE INPUT." Reflections of this pulse, which occur at the ends of the delay network, cause a series of damped voltage oscillations with 1-microrsecond intervals between peaks or discontinuities. An image, such as (d) of figure 3-2, for a 1-microrsecond pulse input appears on the oscilloscope screen. The exact form of image depends upon the sweep speed and character of pulse. For convenience, it may be desirable to adjust the "FINE SWEEP SPEED" control until an integral number of oscillations appear on the screen.

(1) To synchronize the sweep by other means than the signal, connect the other synchronizing source to

SOURCE.

c. SWEEP SYNCHRONIZED BY EXTERNAL

be objectionable. cross the signal image which may or may not produced by the sweep and the zero line will signal image will be dimmer than the zero line only once for every two or more sweeps, the frequency. In this case, since signals occur more than synchronization at a sub-multiple signal frequency. This is a more critical adjustment frequency to a higher multiple of the tooth frequency may be spread out by adjusting the sawtooth frequency of the signal pulse is a small fraction of the duration of the signal pulse is a small images.

When the sawtooth generator is employed, its natural frequency of oscillation must be closely adjusted to the frequency of recurrence of the signal pulse or some sub-multiple or multiple thereof; otherwise stable synchronous operation will not be preserved and successive signal pulses will not coincide on the screen to build up a steady clear image.

Note

sweep speed (sawtooth frequency) desired.

(5) Adjust the "FINE" control to obtain the exact

desired.

(4) Set the "COARSE" sweep speed control on "FAST," "MED," or "SLOW" depending on the range

in sawtooth circuit.

(3) Disregard "SYNC POLARITY" switch, not the sweep by excessive voltage.

(2) Adjust "SYNC VOLTAGE" control as necessary to obtain synchronization and to avoid shortening

"TOOTH" position.

(1) Set the "SWEEP SELECTOR" in its SAW-TOOTH position.

Proceed as outlined for start-stop sweep, except:

BY SIGNAL.

b. SAWTOOTH SWEEP SYNCHRONIZED

paragraphs 5 and 6. measurements of voltage and power is explained in alternating wave. The use of the oscilloscope in making case of a pulse or $\frac{3}{4}$ inch in the case of a symmetrical will occur if the image amplitude exceeds $\frac{3}{8}$ inch in the and to avoid overloading the signal amplifier, which only to make the image of convenient size for viewing to adjust the image amplitude to this standard size, but the voltage or the power represented, it is not necessary of a voltage pulse and not to determine the magnitude of (19) If it is merely desired to observe the shape of

Section III Paragraph 4

tions corresponds to an integral number of scale divisions.

(3) Compare visually, with the aid of the horizontal scale, the distance between these peaks and the length of the signal pulse or the length of the entire sweep and thus estimate the duration of the pulse or the sweep. No change should be made in the "SWEEP SPEED" or "HORIZONTAL POSITION" controls in shifting from signal to timing oscillations in order to make such a comparison.

Note

It is not possible to observe simultaneously a signal pulse and the timing oscillations. If a steep wave front pulse is to be timed, the shift from signal pulse to timing oscillations may be made simply by turning the "IMAGE SIZE" knob. When turned extreme counterclockwise, the timing oscillations will be set up by the signal pulse. When turned clockwise to a position giving proper image size, the timing oscillations are suppressed and the signal pulse is transmitted normally through the signal amplifier.

(1) If the speed of the sweep is such that these internal timing oscillations at 1-microsecond intervals occur too close together on the screen for a satisfactory timing determination, use impulses at longer intervals from an external source.

(2) One method of calibrating slower sweeps is to apply a sine wave of known frequency to the "SIGNAL INPUT" of the oscilloscope. The number of cycles which appear across the screen is a measure of the sweep duration. To determine the duration of a signal pulse, estimate the number of timing cycles in the space formerly occupied by the signal image with the aid of the scale divisions on the middle horizontal reference line. In shifting from signal to timing wave the "SWEEP SPEED" and "HORIZONTAL POSITION" controls must not be moved.

(3) Timing impulses or markers from range or range calibrating units may also be connected to the "SIGNAL INPUT" and used in place of a sine wave for timing as above described. The synchronizing pulse provided with such units should be used to synchronize the oscilloscope through the "EXT SYNC" connection.

(4) Timing impulses may also be employed simultaneously with the observation of a signal pulse provided

6. DURATION OVER 8 MICROSECONDS.

Figure 3-3. Attenuation vs. Voltage and Power Ratios

Difference in Attenuation db	Ratio of Voltages	Ratio of Powers	Difference in Attenuation db	Ratio of Voltages	Ratio of Powers
0	1	1	40	100	10^8
2	1.26	1.6	42	126	1.6×10^8
4	1.6	2.5	44	160	2.5×10^8
6	2	4	46	200	4×10^8
8	2.5	6.3	48	250	6.3×10^8
10	3.2	10	50	320	10^9
12	4	16	52	400	1.6×10^9
14	5	25	54	500	2.5×10^9
16	6.3	40	56	630	4×10^9
18	8	63	58	800	6.3×10^9
20	10	100	60	1,000	10^{10}
22	12.6	160	62	1,260	1.6×10^{10}
24	16	250	64	1,600	2.5×10^{10}
26	20	400	66	2,000	4×10^{10}
28	25	630	68	2,500	6.3×10^{10}
30	32	1,000	70	3,200	10^{11}
32	40	1,600	72	4,000	1.6×10^{11}
34	50	2,500	74	5,000	2.5×10^{11}
36	63	4,000	76	6,300	4×10^{11}
38	80	6,300	78	8,000	6.3×10^{11}
40	100	10,000	80	10,000	10^{12}

PEDANCE," until the amplitude of the image of the unknown voltage is made as nearly equal as possible to the standard image amplitude of the calibrating voltage.

CAUTION

Do not change the setting or touch the uncalibrated "IMAGE SIZE" control between comparisons of known and unknown voltages.

(5) If the order of magnitude of the unknown voltage is not sufficiently known to set the "INPUT IMPEDANCE" selector on its proper db position, try the 40 db position first and then reduce the attenuation as necessary.

(6) The total db difference in the settings of the attenuators in the two cases shows how much the unknown voltage is greater or less than the calibrating voltage. The ratio of voltages corresponding to db differences may be obtained from the logarithmic table, figure 3-3.

(7) If a greater db attenuation is required with the unknown voltage, it is greater than the calibrating voltage. Therefore, multiply the calibrating voltage by the voltage ratio obtained from figure 3-3 to evaluate the unknown voltage.

(8) If a lesser db attenuation is required with the unknown voltage, it is less than the calibrating voltage. Therefore, in this case, divide the calibrating voltage by the voltage ratio obtained from figure 3-3 to evaluate the unknown voltage.

(9) In comparing the image amplitudes of a low-frequency sine wave and a short square-wave pulse, say of 1-microsecond duration, entirely different sweep speeds will be required. This is permissible since changes in sweep speed have no effect on signal amplification. It is even possible to stop the sweep with the sine wave and use only the resulting vertical line as a guide in adjusting the amplitude of the image. However, before doing so, it is important that the sine wave be observed very carefully to insure that it is sufficiently free from harmonics to warrant its use as a calibrating wave.

(10) Since the smallest step of attenuation provided is 2 db, it may not be possible to find a setting which will make the amplitude of the unknown voltage image equal the standard amplitude within the precision to which this can be judged. In this event the amplitude of the unknown should be estimated as a decimal fraction of the standard amplitude, and this fraction considered as a correction factor in calculating the unknown voltage. The amplitude of the image is closely proportional to the input voltage, if the signal amplifier is not overloaded. (Amplitude on screen should not exceed $\frac{3}{8}$ inch, if a pulse, or $\frac{1}{4}$ inch, if an alternating wave.)

5. MEASUREMENT OF VOLTAGE.

a. GENERAL.

(1) The peak-to-peak voltage of recurrent short pulses and nonsinusoidal wave forms may be determined by a substitution method with the aid of this oscilloscope and a calibrated source of voltage.

(2) The calibrating voltage need not be of the same waveform as the unknown voltage since the frequency characteristic of the signal channel is flat over a wide range.

(3) A continuous sine wave is convenient for calibrating since its effective value may be read directly on a suitable indicating meter.

CAUTION

Sine waves of less than 60 cycles per second should not be used. It is important also that any sine wave used be free enough from harmonics so that reliance may be placed on the normal 2.8 ratio of peak-to-peak and effective values.

(4) Always use a "HIGH INPUT IMPEDANCE" setting for voltage measurements.

b. VOLTAGE APPLIED DIRECTLY TO SIGNAL INPUT.

(1) The voltage in this case should lie between 0.1 and 100 volts, positive or negative. The equivalent limits for sine waves are 0.07 to 70 volts, effective values.

(2) Set the "INPUT IMPEDANCE" selector on its proper "HIGH" position for the calibrating voltage to be used. (See par. 2c (5).)

(3) Connect the calibrating voltage to the "SIGNAL INPUT" of the oscilloscope and following the general operating procedure of paragraph 3 adjust the "IMAGE SIZE" control and the "ATTENUATION" control as necessary to standardize the sensitivity of the oscilloscope by making the image amplitude equal to the standard reference deflection of $\frac{1}{4}$ inch, the distance between the middle reference line and either the upper or the lower reference lines.

(4) Immediately substitute the unknown voltage for the calibrating voltage and reset the calibrated attenuation controls, "ATTENUATION" and "INPUT IMPEDANCE".

(11) Examples.

On calibration	
Voltage pulse	+0.5 volt
Image amplitude	standard = $\frac{1}{4}$ inch
"INPUT IMPEDANCE"	0 db
"ATTENUATION"	16 db
Total calibrating attenuation	16 db

Unknown voltage pulse	E
Image amplitude	1.1 standard
"INPUT IMPEDANCE"	40 db
"ATTENUATION"	14 db
Total attenuation	54 db
Calibrating attenuation	16 db
Increased attenuation required by unknown	38 db
Voltage ratio (see fig. 3-3)	$E = 0.5 \times 80 \times 1.1 = 44$ volts.

On calibration	
Voltage—sine wave—effective value	30 volts
Image amplitude	standard = $\frac{1}{4}$ inch
"INPUT IMPEDANCE"	40 db
"ATTENUATION"	18 db
Total calibrating attenuation	58 db

Unknown voltage pulse or square wave	E
Image amplitude	0.9 standard
"INPUT IMPEDANCE"	20 db
"ATTENUATION"	2 db
Total attenuation	22 db
Calibrating attenuation	58 db
Decreased attenuation required by unknown	36 db
Voltage ratio (see fig. 3-3)	$E = 30 \times 2.8 \times 1/63 \times 0.9 = 1.2$ peak-to-peak volts.

On calibration	
Voltage—sine wave—effective value	30 volts
Image amplitude	twice standard = $\frac{1}{2}$ inch
"INPUT IMPEDANCE"	40 db
"ATTENUATION"	12 db
Total calibrating attenuation	52 db

Unknown voltage pulse or square wave	E
Image amplitude	0.9 standard
"INPUT IMPEDANCE"	20 db
"ATTENUATION"	2 db
Total attenuation	22 db
Calibrating attenuation	52 db
Decreased attenuation required by unknown	30 db
Voltage ratio (see fig. 3-3)	$E = 30 \times 2.8 \times 0.5 \times 1/32 \times 0.9 = 1.2$ peak-to-peak volts.

* Permissible with symmetrical alternating wave.

c. VOLTAGE APPLIED THROUGH PROBE.

(1) With the "SIGNAL INPUT" probe connected to the "SIGNAL INPUT" of the oscilloscope, voltages ranging from 1 to 450 may be observed and measured.

CAUTION

Do not interchange probes of different oscilloscopes. If any probe other than the particular "SIGNAL INPUT" probe originally supplied with the oscilloscope is used, the signal input capacitors must be readjusted as described in Section V, paragraph 7c.

(2) The general procedure in making a voltage measurement with the probe is the same as explained above for the case of voltage applied directly to the "SIGNAL INPUT," but it must be remembered that introduction of the probe between a source of voltage and the oscilloscope reduces the voltage impressed on the oscilloscope by a factor of 10 to 1, equivalent to 20 db attenuation.

(3) Two methods of calibration may be used when employing the probe: (a) the calibrating voltage may be applied to the probe or (b) the calibrating voltage may be applied directly to the "SIGNAL INPUT," in which case an allowance of 20 db attenuation must be made for the probe when calculating the unknown voltage.

Note

If the second method of calibration is used, any departure of the probe from its normal 20 db attenuation loss is reflected as an error in the voltage determination. It is, therefore, somewhat more accurate to calibrate by applying a voltage to the probe, so the probe attenuation may be neglected in the calculation which then remains exactly the same as in the case of measurements made with the voltage applied to the "SIGNAL INPUT" of the oscilloscope. Calibrating voltages applied to the probe need to be ten times greater than those required at the "SIGNAL INPUT" of the oscilloscope for the same deflections and settings of the controls.

(4) When using the probe, connect the alligator clip on the flexible lead to the grounded side of the circuit, then connect the rigid clip to the non-grounded side on which the voltage appears.

WARNING

Avoid contact with dangerous voltages by making connections with the circuit de-energized.

d. VOLTAGE APPLIED THROUGH HIGH-VOLTAGE DIVIDER AND PROBE.

(1) If the unknown voltage to be measured exceeds 450 volts, it is unsafe to apply such voltage directly to the probe which should, in this case, be supplemented by a voltage divider designed for higher voltages, such as

(4) After these connections are complete, energize the high-voltage apparatus and adjust the oscilloscope exactly as described for making a measurement with the voltage connected directly to the "SIGNAL INPUT."

(5) As an example, assume the oscilloscope and probe calibrated on 2 volts, "ATTENUATION" and "INPUT IMPEDANCE" both being set in their "0 db" positions. If the final settings on the unknown voltage were:

“ATTENTION”
“INPUT IMPEDANCE”
14 dB
20 dB
Total increase required by unknown
Voltage ratio (see fig. 3-3) 34 dB
Image divider ratio 50
Image amplitude 100
the unknown voltage is then $2 \times 50 \times 100 \times .9 = 9000$

6. MEASUREMENT OF POWER IN SIGNAL

PULSE.

2. The determination of the power represented by a signal pulse is similar to voltage measurements, a matter of comparing pulses of known and unknown powers and adjusting attenuation in the path of the unknown until its image on the oscilloscope screen has the same amplitude as the image produced by the pulse of known power.

6. Three differences are important.

(1) The oscilloscope, in the case of a power determination, takes the place of the device which normally receives the power and, therefore, should have the same impedance as such receiving device. This is usually a low impedance, 50 to 72 ohms. Therefore, the "LOW" setting of "INPUT IMPEDANCE" has been made 62 ohms which is sufficiently near to either 50 or 72 ohms to satisfy, in most cases, the requirement for low reflection loss in terminating lines of either 50 or 72 ohms.

(2) If the power pulses to be compared, with the aid of the oscilloscope, are of ultra-high-frequency, detecting device will be required to rectify the pulses and supply unidirectional or "video" pulses corresponding to the frequency range of the oscilloscope. Since rectifying or detecting devices, such as a crystal detector, have an output voltage which does not vary exactly in proportion to the input, in other words are not linear, any attenuation which is introduced in the path of the signal pulse or the known calibrating pulse, in order that their corresponding images on the screen of the oscilloscope may be equal, must be introduced by

big-b-frequency attenuator on the input side of the receiving device. No change or adjustment whatsoever in any of the "INPUT IMPEDANCE," "IMAGE SIZE," or "ATTENUATION" controls of the oscilloscope or anything between the oscilloscope and the detector must be made during a comparison of known and unknown high-frequency pulses.

(3) The power ratios, rather than the voltage ratios, from figure 3-3, must be used in computations unless the db difference in power suffices.

(3) The clip marked "TO GROUND" in figure 3-4 should be grounded. The clip marked "TO HIGH VOLTAGE" should be connected to the point whose voltage is to be measured, the other end of this high-voltage lead being connected to the terminal on the voltage divider giving the desired ratio. Bring the coaxial output lead of the voltage divider outside the grounded cage. After the oscilloscope and probe have been calibrated, connect the probe's input clips to the coaxial cable, the clip on the flexible lead being connected to the outer or ground conductor and the rigid clip to the inner conductor.

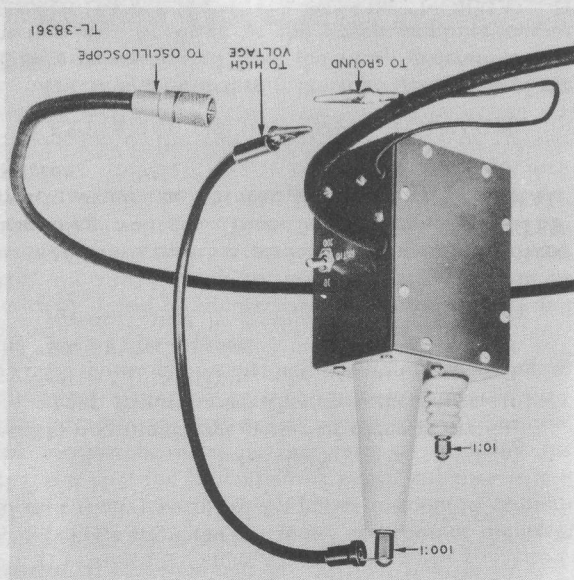
Special precautions need to be taken in view of the high voltages involved. Preferably locate the high-voltage apparatus within a grounded cage and make connections to this apparatus only with power turned off. Locate the voltage divider inside the grounded cage.

WARNING

(2) Apply the calibrating voltage in this case directly to the probe or to the oscilloscope as previously described. Otherwise, an unnecessarily high calibrating voltage would need to be employed. If the voltage-divider ratio cannot be relied upon, the divider should be calibrated as a separate undertaking.

figure 3-4. This divider has two inputs giving ratios of 10 and 100 to 1. The 10:1 input is suitable for voltages between 200 and 2000 and the 100:1 input for voltages between 2000 and 20,000 peak volts. When this voltage divider is used with the probe and the oscilloscope, the probe should be plugged into the "SIGNAL INPUT" of the oscilloscope in the normal manner.

Fig. 3-4. Voltage Divider TS-89/AP (D-150669)



7. DIRECT APPLICATION OF VOLTAGE PULSES TO VERTICAL DEFLECTING PLATE.

a. Voltages above about 20 volts are sufficient to produce observable deflection of the cathode-ray beam without amplification, and those above about 140 volts will deflect the beam off the screen. Consequently, voltage pulses between these limits may be observed by applying them directly to one of the vertical deflecting plates through V and an internal coupling capacitor of 50,000 micromicrofarads. The impedance to ground looking into V is approximately 3.9 megohms paralleled by a capacitance of about 25 micromicrofarads.

Note

Connection to V may be made by use of Cord CX-152/U having a 2-prong connector on one end and 2 independent clips on the other end. Connect to clip marked "VP."

b. Pulses applied to the oscilloscope through this connection by-pass the signal amplifiers and internal synchronizing circuit. Therefore, synchronization of the "EXT. SYNC" input from some point in the circuit under test which can supply a voltage pulse of appropriate magnitude and timing.

c. Since no amplifier is involved, no overloading is to be guarded against and the deflection is limited only by the usable portion of the cathode ray screen. Voltages deflecting the beam off the screen should not be connected.

d. Since the calibrated "ATTENUATION" control is not available with this connection and since the screen of the cathode-ray tube is not accessible for measuring deflections, this method of operating the oscilloscope is not recommended for voltage measurements. It does, however, provide a means for comparing the wave shape of pulses with and without the signal amplifiers and thus for checking the latter for distortion.

8. USE OF CONNECTIONS MARKED H-1 AND H-2. APPLICATION OF EXTERNAL VOLTAGE DIRECT TO HORIZONTAL DEFLECTING PLATES.

(1) If for any purpose it is desired to apply an external wave-form or a series of voltage pulses directly to the horizontal deflecting plates, connection may be made through H-1 and H-2, by using Cord CX-152/U. These terminals are connected to the horizontal deflecting plates through 50,000-micromicrofarad capacitors. The switch marked "NORMAL—H PLATES" should be thrown to its "H PLATES" position which inserts 2.2-megohm decoupling resistors between the sweep amplifier and the horizontal deflecting plates. A high impedance is thus presented to pulses connected to H-1 and H-2 since the deflecting plates are not then shunted by the relatively low impedance to ground through the sweep amplifier tube and its plate resistors. However, the steady potentials controlling the horizontal position

of the beam continue to be effective through these resistors.

(2) To allow the horizontal deflection of the beam to be entirely controlled by pulses introduced through H-1 and H-2, the generation of sweep impulses within the "SWEEP SELECTOR" to its "START-STOP" position, the "EXT. SYNC—INT. SYNC" switch to its "EXT. SYNC" position and by not connecting anything to the "EXT. SYNC" input.

(3) When no connection is made through H-1 and H-2, the shielded cap for their connectors should be screwed down tight to prevent pick-up of microwave disturbing voltages. The "NORMAL—H PLATES" switch should be thrown back to its "NORMAL" position.

9. EXTERNAL USE OF SWEEP VOLTAGES.

(1) If it is desired to make any external use of the voltage pulses derived from the sweep generators, connection may be made to the sweep amplifier output through H-1 and H-2. In this event the "NORMAL—H PLATES" switch should remain in its "NORMAL" position. Thus, the oscilloscope can be operated normally while supplying sweep voltages to some external circuit.

(2) The sawtooth wave is more apt to be desired for external testing purposes. From H-1 or H-2 to ground, a sawtooth voltage of about 150 volts can be supplied to a load impedance of not less than 500,000 ohms. To obtain this value of voltage, it may be necessary to turn the "HORIZONTAL POSITION" control counterclockwise, particularly if the H-2 terminal is used where the voltage is somewhat less than on H-1. The load impedance should not be less than the value stated if the operation of the oscilloscope is not to be affected.

(3) After completing any tests of this kind, the connector cap should be screwed down tight to prevent interference from extraneous microwave fields.

9. PRECAUTIONS.

a. OVERLOADING.—The amplitude of the vertical deflection due to a signal pulse should not be allowed to exceed $\frac{3}{8}$ inch since a greater deflection cannot be obtained without overloading the output tube of the signal amplifier thus giving a nonlinear relationship of deflection to input voltage. This is especially true if the pulse is negative. The oscilloscope was designed to give usable linear deflections up to $\frac{3}{8}$ inch from the zero position. If, therefore, the wave form being observed is alternating in character with approximately equal positive and negative areas, the over-all deflection, peak-to-peak, may be allowed to reach $\frac{3}{4}$ inch without danger of overloading.

Note

Distance between middle and outer reference lines across screen is $\frac{1}{4}$ inch.

(2) The use of the oscilloscope for observing high-voltage pulses in radar or other types of equipment should be carried out only by personnel familiar with the circuits being tested. Test connections to the oscilloscope from high-voltage equipment should be made while such high-voltage equipment is de-energized.

f. VIBRATION.—The tubes of this oscilloscope are not provided with shock-absorbing mountings. Consequently, the oscilloscope should not be placed directly on a vibrating support. If this precaution is not observed, vibration of tube elements may produce false images.

SECTION IV

ELECTRICAL AND MECHANICAL CHARACTERISTICS

1. BASIC PRINCIPLES.

and consists essentially of a high-vacuum glass envelope containing an electron gun which fires a stream or beam of electrons at a fluorescent screen covering the large

a. The cathode-ray tube shown schematically in the block diagram, figure 4-1, is the heart of the oscilloscope

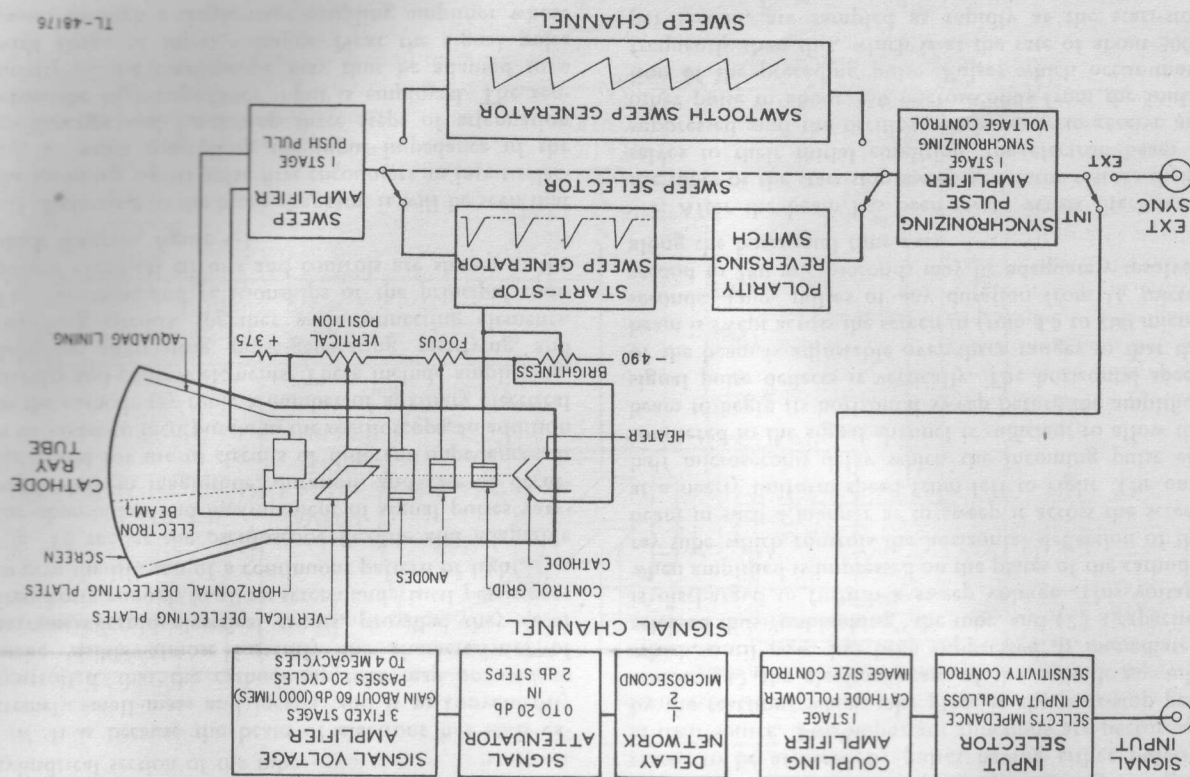


Figure 4-1. Block Diagram Showing Function and Relation of Oscilloscope Components—TS-34A/AP

end of the tube and two pairs of plates for deflecting these electrons, vertically under control of the voltage pulses to be observed and horizontally under control of a sweep or timing circuit. The combination of these two motions results in a luminous picture of the variation of signal voltage with time, or in other words, an image of the signal.

b. The electron gun comprises a cathode which emits electrons on being indirectly heated by alternating current, a grid whose potential with respect to the cathode is adjustable for controlling the electron density of the beam, hence, the brightness of the luminous spot produced by the impact of the electrons on the fluorescent screen, and two cylindrical anodes at positive potentials with respect to the cathode for accelerating the electrons and focusing them on a small spot on the screen. Of these two anodes, the one nearer the cathode is adjustable in potential for controlling the concentration or focus of the beam.

c. Between the electron gun and the screen are the two pairs of deflecting plates. Between the plates of the first pair, the incoming voltage pulse (amplified) sets up an electric field which deflects the electrons vertically as they pass between the plates on their way to the screen. Between the other pair of plates, at right angles to the first pair and nearer the screen, another electric field set up by a properly-timed sweep circuit deflects the electrons horizontally. The electron gun and both pairs of deflecting plates are all contained in the small cylindrical section of the tube.

d. It is because the beam of electrons has such extremely small mass and inertia, and is so conveniently controlled, that the cathode-ray tube may be used to make visible almost instantly the characteristics of extremely rapid electrical events, provided they recur frequently enough to allow screen and visual persistence to give the illusion of a continuous pattern of light.

e. To render the oscilloscope flexible and adaptable for observation and measurement of signal pulses varying widely in magnitude, duration, and rate of occurrence and for use in circuits of different impedances, it is necessary to incorporate in the oscilloscope, in addition to the cathode-ray tube, a number of auxiliary electrical circuits and control elements. These include amplifying, delaying, attenuating, pulse-generating, rectifying, and switching circuits, together with connecting elements. The functions and relationships of the principal component electrical circuits and controls are shown in the block diagram, figure 4-1.

f. Referring to the block diagram, it will be seen that the incoming signal pulse first encounters an input selector, a switch controlling the input impedance of the oscilloscope and furnishing three steps of attenuation when the high-impedance input is employed. The sensitivity of the oscilloscope may thus be adapted to a wide range of input voltages. Next the signal pulse passes through a single-stage coupling amplifier whose gain may be adjusted to regulate the image size for convenient viewing, or, in case of measurements, to a standard.

and amplitude represented by the distance between lines engraved on the plexiglas in front of the cathode-ray tube. From the coupling amplifier, the signal passes through a network which delays it one-half microsecond to allow time to start the horizontal sweep of the cathode-ray beam. Thence the signal pulse enters another calibrated attenuator in the form of an eleven-step voltage divider by which known proportions of the signal voltage may be impressed on the input of the fixed three-stage, wide-band signal-voltage amplifier. The voltage pulse from the output of this amplifier, a faithful reproduction of the incoming signal magnified about 1000 times, is impressed on one of the plates which control the vertical deflection of the electron beam in the cathode-ray tube.

g. Synchronizing pulses obtained internally from the coupling amplifier of the signal channel or externally from a source synchronized with the signals, enter the sweep channel of the oscilloscope through the selector switch and voltage control. Voltage control is by means of an adjustable resistor controlling the amplifier and voltage control. The result is control of the magnitude of the synchronizing voltage directed to either of the two sweep generators, start-stop or sawtooth, by the sweep selector switch which follows the amplifier.

b. Before reaching the start-stop sweep generator, the synchronizing pulse passes through another switch which may be used to reverse its polarity, enabling this generator to be actuated by pulses having either polarity at their source. Two important functions are performed by the reactions which take place in the start-stop generator: (1) the electron beam of the cathode-ray tube which, until now, has been suppressed, is immediately released thus "unblanking" the tube, and (2) a capacitor is discharged to furnish a sweep voltage. This voltage when amplified is impressed on the plates of the cathode-ray tube which controls the horizontal deflection of the beam in such a manner as to sweep it across the screen at a nearly uniform speed from left to right. The one-half microsecond delay which the incoming pulse encountered in the signal channel is sufficient to allow the beam to begin its horizontal sweep before the amplified signal pulse deflects it vertically. The horizontal speed of the beam is adjustable over three ranges so that the beam is swept across the screen in from 4.5 to 280 micro-seconds. Thus, pulses of any duration from 1/4 micro-second to 280 microseconds may be adequately resolved along the horizontal time axis.

i. After the beam has been swept across the screen, the tubes of the start-stop sweep generator restore themselves to their initial condition, the electron beam is suppressed, and the oscilloscope is ready to receive another pulse in about 330 microseconds from the initiation of the preceding pulse. Pulses which occur more frequently than this, which is at the rate of about 3000 per second, are sampled as rapidly as the start-stop sweep resets itself.

j. The synchronizing pulse may also be directed to

described in more detail in the following paragraphs.

2. CATHODE-RAY TUBE CONTROLS AND SPECIAL CONNECTIONS

a. The cathode-ray tube of this oscilloscope is a 2AP1 tube having a screen diameter of about 2 inches. The fluorescent color of the screen is green and its "persistance" is medium. The tube is shown in figure 7-3.

b. Figure 4-2 is a diagrammatic representation of this tube, its direct voltage controls, and special connections. The total voltage needed to operate the tube is approximately 800 volts. This voltage is obtained from a multi-element potential divider connected between the positive and negative filtered outputs of two rectifiers in the power supply circuits described in paragraph 5. The power supply also provides an isolated a-c supply for the cathode heater as the latter must be kept at the potential of the cathode.

c. Brilliance of image, focusing, and control of the vertical position of the beam at rest and of the image during operation are accomplished by adjustment of the potential divider settings which control the continuous voltages applied to the control grid, anodes, and deflecting plates according to conventional practice. The potentiometer which control the horizontal position of the beam are supplied directly from the sweep amplifier by a

the sawtooth generator which produces a recurring sawtooth voltage capable of being synchronized with periodic pulses. The frequency of the sawtooth voltage is continuously adjustable over a range from about 10 cycles per second to 50,000 cycles per second. When the sawtooth generator is used, the cathode-ray beam is not suppressed at any time and there is no standby time between successive sweep pulses.

k. The output voltages of the sweep generators are not large enough to be applied directly to the horizontal deflecting plates of the cathode-ray tube. Therefore, a sweep amplifier is employed to increase the generated voltages by the requisite amount and at the same time to transform a voltage which is wholly unbalanced with respect to ground into roughly balanced voltages to ground which may be applied to the horizontal plates to produce push-pull forces on the electron beam.

l. By accurate synchronization of the horizontal sweep of the cathode-ray beam with recurrent voltage pulses, traces of similar pulses coincide on the screen of the tube and, if they follow one another with sufficient rapidity, the retentive properties of the fluorescent screen and the eye make it possible to see clearly images formed by pulses of as short duration as one-quarter microsecond. The manner in which the component circuits of the oscilloscope function to accomplish this result is

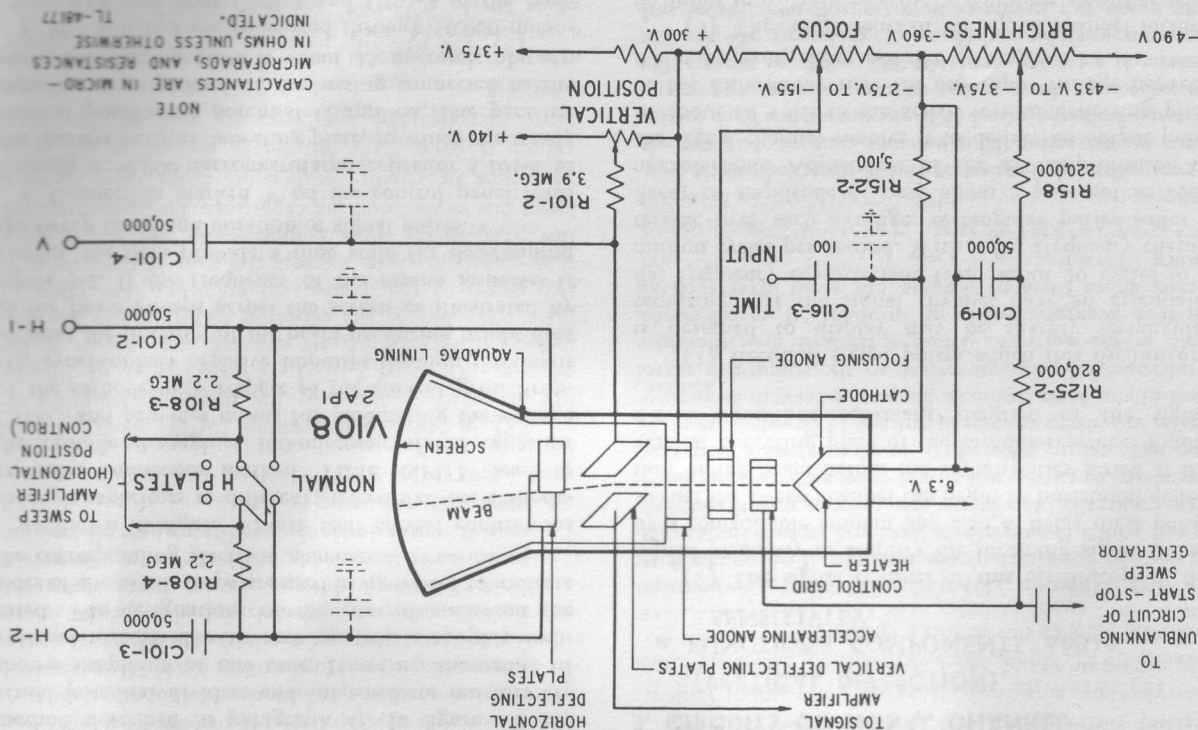


Figure 4-2. Cathode-Ray Tube, Beam Controls, and Special Connections—Simplified Schematic

Section IV
Paragraphs 2-3

e. SIGNAL ATTENUATOR.—The normal termination of the delay network is furnished by a 550-ohm potential divider with 11 taps selected by a rotary switch. This potential divider controls the input potential supplied to the fixed signal amplifier and its 11 steps provide for a total of 20 db attenuation in 2-db units. Figure 7-6 shows two views of the signal attenuator assembly.

f. FIXED SIGNAL-VOLTAGE AMPLIFIER.

(1) This amplifier together with the coupling amplifier is included in one sub-assembly shown in figure 7-7. The combination is designed to have a practically flat frequency characteristic over a range from 20 cycles to 3 megacycles. The three stages of the fixed amplifier are capacitance coupled, the last two stages being compensated for parasitic capacitance in the tube and associated wiring which shunts the plate resistance. At very high frequencies, this parasitic capacitance results in a reduction of the load impedance and the gain, directly proportional to such impedance, would decrease with frequency. In the absence of compensation. The small inductance coils, in series with the load resistance of the last two tubes, make the impedance of this path rise with frequency, thereby compensating for the decreasing impedance of the parasitic capacitance path.

Note

Adjustable brass collars are provided on these coils to vary their inductance and thereby compensate for deviations in other circuit elements. The effect of these deviations is small but noticeable when an extremely fast-rising pulse is observed. These collars are set in optimum positions at the factory, and they are not to be moved except under the conditions provided in section V, paragraph 5c.

(2) In order to compensate for the relative loss at low frequencies caused by the interstage coupling capacitors, capacitors C107-1, -2 and C127-1 of 500,000 micromicrofarads each are shunted around part of the plate resistance of the coupling amplifier and the first two stages of the fixed-signal amplifier. The effect of these capacitors is to increase the gain of these tubes at low frequencies, thus compensating for the relative losses due to the coupling capacitors. To compensate for variations of circuit components from their nominal values, R126 is made adjustable. Increasing this resistance increases the low-frequency gain of the signal amplifier.

(3) The first two stages of the fixed-signal amplifier employ 6AK5 pentodes while the last stage employs a 6AG7 power amplifier pentode. For simplification the cathode heaters and the screen grid connections of the tubes are omitted in the functional diagram

6. INPUT IMPEDANCE SELECTOR.—The "INPUT IMPEDANCE" selector shown in figure 7-5 consists of a four-position, two-circuit rotary switch with associated resistors and capacitors so arranged that in one position the input impedance of the oscilloscope has the "LOW" value of 62 ohms, while in three positions it has the "HIGH" value of 430,000 ohms. The "LOW" value is generally suitable for terminating 50- and 72-ohm circuits, while the "HIGH" value is suitable for connection to moderately high impedance circuits without disturbing conditions. In the three "HIGH" positions, the input selector serves as an attenuator, giving three different losses while maintaining constant impedances. The input circuits resulting from the different settings of the selector are shown by figure 4-4 which includes also a schematic of Probe Assembly MX-50/AP. The probe is designed to act with the "HIGH" settings of the input selector as a voltage divider, giving a 10:1 reduction in voltage between the tip of the probe and the "SIGNAL INPUT" of the oscilloscope. The switch connections are shown in the full schematic, figure 7-10.

g. COUPLING AMPLIFIER—IMAGE SIZE CONTROL.

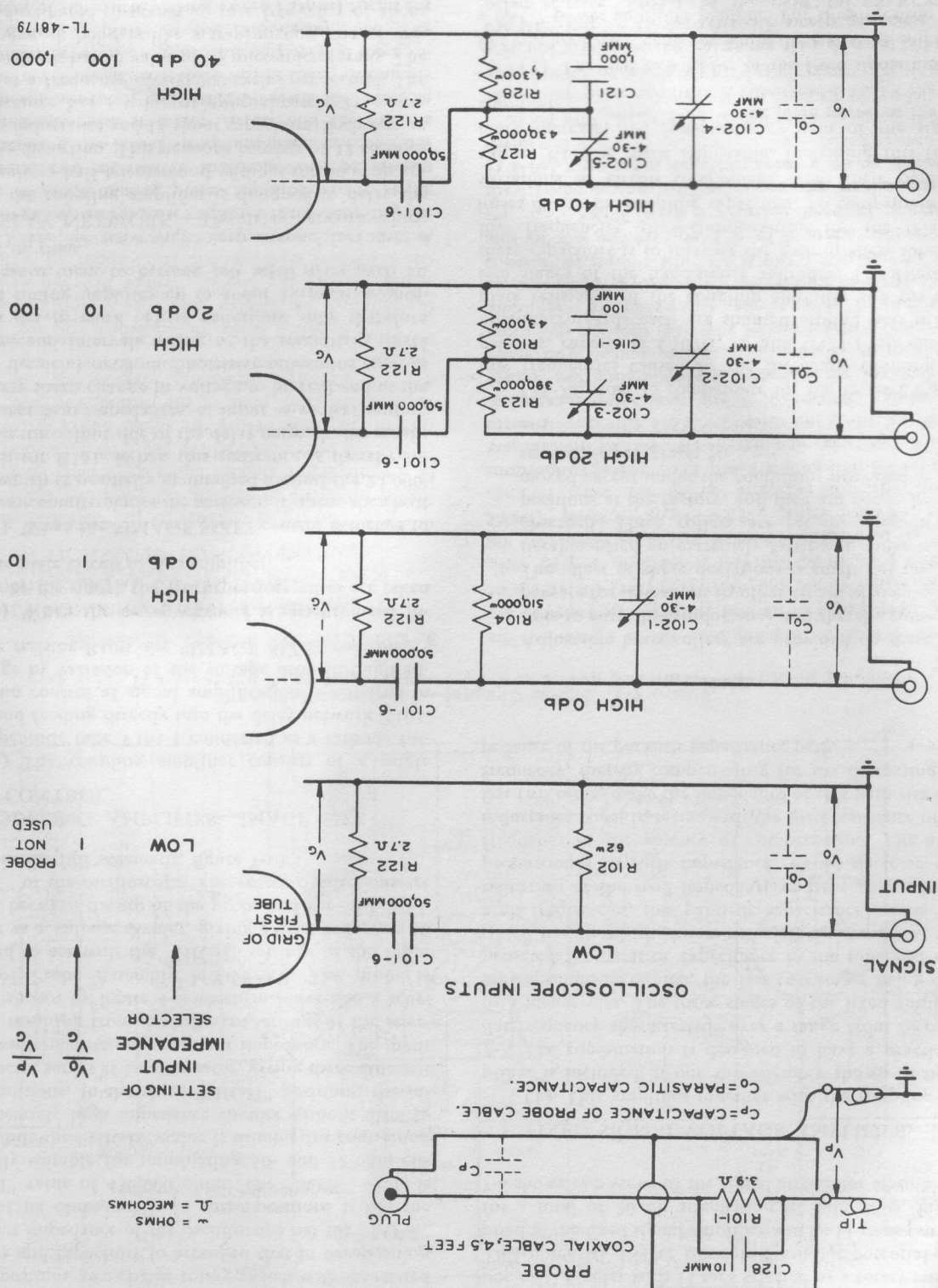
(1) The coupling amplifier consists of a single 6AK5 pentode tube V101-1 connected as a cathode follower and feeding directly into the delay network Z101. The gain control of signal amplification is achieved in this stage by variation of the voltage drop through adjustable resistor R109, the "IMAGE SIZE" control.

(2) When the sweep channel is synchronized internally by the signal, the synchronizing pulses are taken from the plate circuit of this amplifier.

(3) When the "IMAGE SIZE" control is turned to its extreme counterclockwise position, it opens the short circuit which is normally maintained around the 22,000-ohm resistor R121. When this resistance is thereby inserted on the output side of the delay network, the resulting mismatch in impedances, at input as well as output, causes any sharp change in voltage to be reflected at the ends of the delay network. Successive reflections recur at 1-microsecond intervals owing to the round-trip travel time in the network. These reflections may therefore serve as timing impulses up to about 10 microsecond. Losses cause them to become too small after such an interval of time.

4. DELAY NETWORK.—The delay network which follows the coupling amplifier is designed to delay the signal pulse a half-microsecond without introducing appreciable distortion. This network consists of 12 sections of series inductance and 11 shunt capacitors. Each section of inductance has a value of approximately 21 microhenries at a frequency of 100,000 cycles per second. The capacitors each have a value of 75 micromicrofarads. The whole network behaves like a transmission line of unit-formly distributed constants up to a frequency of about 5 megacycles per second. Its impedance is approximately 550 ohms.

Figure 4-4. Probe and Oscilloscope Inputs—Functional Schematic



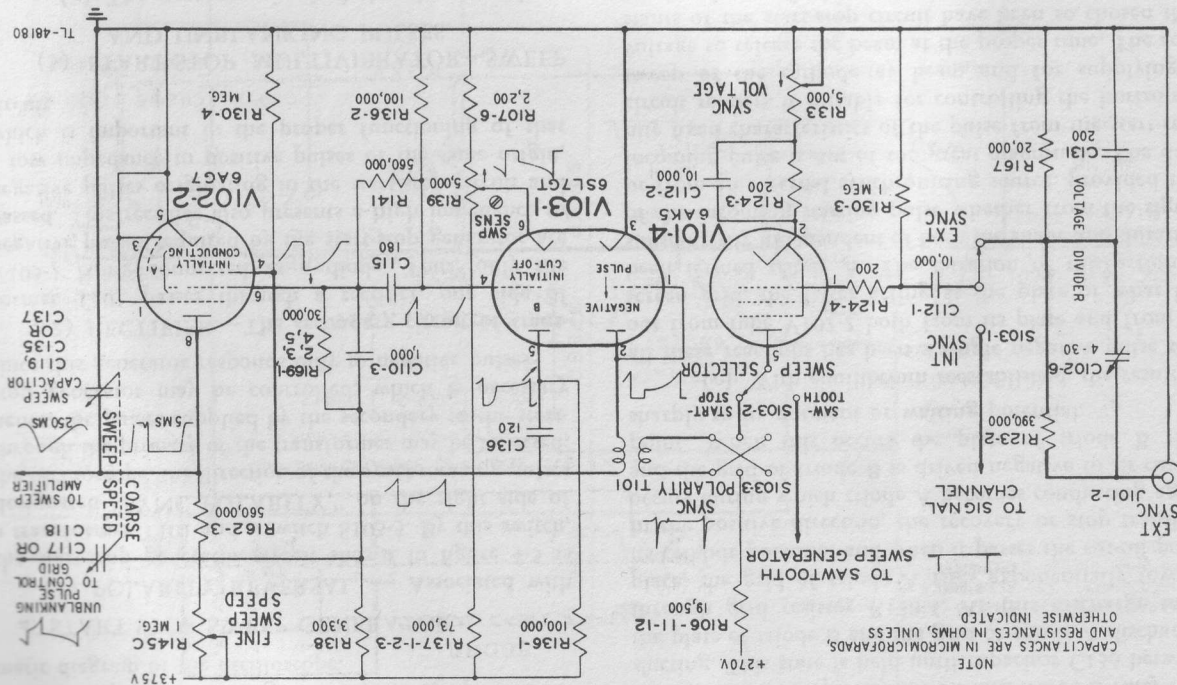


Figure 4-5. Synchronizing Pulse Amplifier and Start-Stop Sweep Generator—Functional Schematic

4. SYNCHRONIZING SWEEP CHANNEL (HORIZONTAL DEFLECTION).

a. FUNCTIONS AND COMPONENTS.

(1) This channel is designed to sweep the electron beam horizontally across the screen in synchronism with recurring signal pulses. At the input of this channel is a switch which connects it internally to the signal channel or to the "EXT SYNC" jack through which actualing pulses from an external source may be received. When the sweep is synchronized by internal connection to the signal channel, the half-microsecond delay network therein allows the beam to be moving horizontally at appropriate speed before the signal pulse delays it vertically. The same holds true for external triggering pulses which occur simultaneously with the signal.

(2) The synchronizing sweep channel includes: A

[illegible]

being a single-pulse start-stop circuit and the other a free-running sawtooth oscillator; a switch for selecting which of these two generators will be used; and finally an amplifying device between the generator output and the horizontal deflecting plates of the cathode-ray tube. The equipment for the synchronizing sweep channel forms the deep amplifiers and sweep speed selector assemblies shown in figures 7-8 and 7-9.

6. SYNCHRONIZING-PULSE AMPLIFIER AND VOLTAGE CONTROL.—A functioning schematic diagram of this amplifier is included in figure 4-5. When the sync-selecting switch S103-1 is thrown to its "INT SYNC" position, synchronizing pulses from the signal channel enter the sweep amplifier directly through coupling capacitor C112-1 and the oscillation suppressing resistor R124-5. When the sync-selecting switch is thrown to its "EXT SYNC" position, a voltage divider is interposed between the "EXT SYNC" input jack J101-2 and switch S103-1, reducing the external synchronizing voltage in the ratio of about 20 to 1. Control of the voltage delivered by the synchronizing pulse amplifier to the sweep generators is by adjustable resistor R133 in series with the cathode of V101-4. This control, marked "SYNC VOLTAGE," is on the right side of the oscilloscope. Use of a probe connected to the "EXT SYNC" jack is a further means of controlling the synchronizing voltage, since the probe and the external sync input together form a 10 to 1 voltage divider.

c. SWEEP SELECTOR.—The plate circuit of the synchronizing pulse amplifier is connected through the first par, S103-2, of the "SWEEP SELECTOR" switch, figure 4-5. The synchronizing pulses are thus directed either to the start-stop or to the sawtooth sweep generator. The other portion, S103-4, of the "SWEEP SELECTOR" switch connects the output of the selected generator to the sweep amplifier at the same time demagnetizing the

unused generator. Switch S103-4 is not shown in figure 4-5 but may be seen in figure 7-10, the complete schematic diagram of the oscilloscope.

4. START-STOP SWEEP GENERATOR.

(1) POLARITY REVERSAL. — Associated with the start-stop generator circuit shown in figure 4-5 is a transformer T101 and a switch S103-3. By this switch, designated "SYNC POLARITY," on the right side of the oscilloscope, the direction of the synchronizing pulses through the primary of the transformer may be reversed; hence, the pulses supplied by the secondary to the start-stop generator may be controlled, which is necessary since this generator responds only to negative pulses.

(2) RECTIFIER.—The secondary circuit of transformer T101 passes through a rectifier, one side of V103-1 being connected as a diode. Thus, only the negative pulses required by the start-stop generator are passed. This rectifier also presents a high impedance to negative pulses originating in the start-stop circuit and a low impedance to positive pulses of the same origin, which is important in the proper functioning of that circuit.

(3) START-STOP MULTIVIBRATOR—SWEEP AND UNBLANKING PULSES.

(a) The start-stop circuit derives its name from the fact that, once started by an incoming pulse, the circuit continues independently through its cycle, restores itself, and then awaits another starting pulse before going through another cycle. In other words, it must be restarted independently for every cycle of operation. A multivibrator-type circuit is used for this purpose employing the control grid, cathode and screen grid of tube V102-2 as one triode, and one half of tube V103-1 as the second triode necessary for the multivibrator circuit. These two triodes are identified in figure 4-5 by the letters A and B for convenient reference in this description.

(b) Initially and during its dormant period awaiting a negative pulse from the synchronizing source, triode A is fully conducting with its grid held at cathode potential by resistor R130-4 and its plate (the screen grid) potential reduced to a low value by the voltage drop caused by the current through resistors R138 and R169. The grid of triode B is held at sufficient negative potential with respect to its cathode so that it passes no current. The circuit remains dormant in this condition until a negative starting pulse is received. Such a pulse divides the grid of triode A toward cut-off causing its plate (the screen grid) potential to rise since there is less drop through the resistors R138 and R169. This rise in potential is applied to the grid of triode B through coupling capacitor C115. As the cut-off potential is passed, conduction begins in triode B. This drops the potential of its plate and sends a negative pulse through coupling capacitor C136 to reinforce the starting pulse. Thus the leading edge of the square wave characteristic

of multivibrators is initiated. The action progresses until triode A is completely cut off and triode B fully conducting. This state is held until capacitor C136 between the plate of triode B and the grid of triode A discharges through grid resistor R130-4. As this discharge takes place, the grid of triode A rises exponentially toward its cathode potential and when it passes the cut-off point in the positive direction, the recovery or stop transient occurs during which triode A becomes conducting again and the grid of triode B is driven negative to its cut-off point. When this occurs the plate of triode B rises sharply to its dormant or waiting potential.

(c) With equilibrium reestablished, the result of all these reactions has been a single negative pulse sent out from tube V102-2 both from its plate and from its screen grid, the latter acting as the plate of what has been termed triode A. The duration of this action is substantially independent of both the shape and duration of the incoming starting pulse whether from the signal or from an external synchronizing source, provided this incoming pulse is not of too great magnitude. The definite fixed characteristics of the pulse from the start-stop circuit renders it suitable for controlling the horizontal sweep of the cathode-ray beam and for supplying a voltage to release the beam at the proper time. The constants of the start-stop circuit have been so chosen that its complete operating cycle requires approximately 300 microseconds.

(d) Resistor R139 has been made adjustable with a screwdriver, to permit readjustment of the sensitivity and stability of the start-stop circuit, sometimes necessitated by replacement of tube V102-2. Directions for this are given in section V, paragraph 2.

(e) The positive output pulse from the plate of V102-2 charges the adjustable sweep capacitance through resistors R145C and R162-3, the former being adjustable to control the charging rate of the sweep capacitance, thus constituting the "FINE" control of the start-stop sweep speed. The "COARSE" control of the sweep speed is accomplished by switch S104B which selects one of three capacitors, C119, C135, or C137 for "FAST," "MED," or "SLOW" speed. The charging of the sweep capacitance produces the sweep voltage which is amplified and then applied to the horizontal deflecting plates as described in paragraph 4b. The charge of the sweep capacitor is allowed to continue for such a short interval that the total rise in voltage is only about 5 per cent of the total supply voltage, thus providing a relatively linear change.

(f) By means of a voltage divider consisting of resistors R138, R169, R141, and R136-2, a portion of the potential rise of the screen grid of tube V102-2 (acting as the plate of triode A) is transmitted through an adjustable blocking capacitor to the control grid of the cathode-ray tube, thus releasing the beam. This blocking capacitor is also adjustable and under control of the "SWEEP SPEED" selector so that the beam will be suppressed sooner for the fastest sweep.

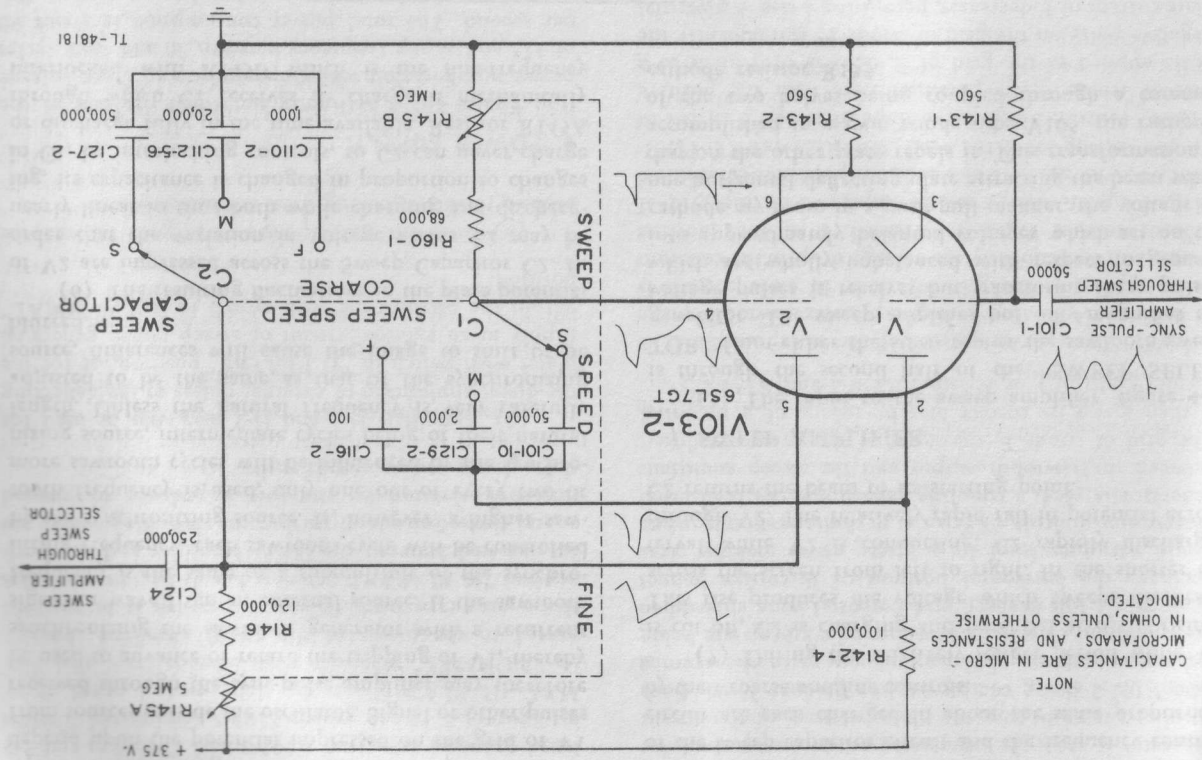


Figure 4-6. Sawtooth Sweep Generator—Functional Schematic

e. SAWTOOTH SWEEP GENERATOR.

(1) Figure 4-6 is a functional schematic of the sawtooth sweep generator. In this circuit the two triodes V1 and V2 of tube V103-2 form a free-running non-symmetrical multivibrator or relaxation oscillator whose feedback path is through adjustable capacitor C1, actually C101-10, C129-2, or C116-2, and the common cathode resistor R143-2. The periodicity of this oscillator is governed by the capacitance of C1 and the resistance of R160-1 and R145B in series.

(2) To analyze this circuit physically, assume first a negative change in the grid potential of V1. The current through V1 immediately decreases causing an increase in plate potential. A positive impulse is transmitted through coupling capacitor C1 to the grid of V2, immediately increasing its current and dropping its plate potential. The potential of the common cathode rises, reinforcing the effect of the assumed negative change in the grid potential of V1. This action progresses rapidly until the current through V1 is a minimum and through V2 a maximum.

(3) As C1 becomes charged, its current and the grid potential of V2 decrease exponentially. As soon as C1 attains maximum charge, it begins to discharge, reversing the current in R160-1 and driving the grid of V2 negative and below cut-off. The common cathode potential falls, equivalent to a positive impulse on the

grid of V1, which therefore increases its current. This action rapidly progresses until current through V1 is a maximum and V2 is completely cut off. V2 remains cut off until the discharge of C1 is nearly complete enough so that its grid potential rises above the cut-off point. As conduction through V2 resumes, the common cathode potential rises, equivalent to a negative impulse to the grid of V1, and so begins another cycle of the self-sustaining operation.

(4) V2 thus cuts off as the charge on C1 attains a maximum and resumes conduction as that charge reaches a minimum. The times required to charge and discharge C1 are, however, different. During most of the charging period the grid of V2 is positive so that it draws current through C1, in fact most of the charging impedance is so much lower than the resistance through R160-1 and R145B. During the discharge period of C1 the grid of V2 is negative, therefore, the discharge time is much longer, resulting in an unsymmetrical cycle of operation.

(5) The natural length of the sawtooth cycle is governed by the capacitance of C1 adjustable in three steps by the "SWEEP SPEED" selector, and by the resistance in series with C1 continuously adjustable by R145B, "SAWTOOTH FREQUENCY," between wide enough limits to make the three frequency ranges over-

control of the sawtooth oscillator, thus the time constants of the sweep capacitor circuit and the frequency control circuit are each changed in about the same proportion by their coarse and fine controls.

(7) During the relatively longer period while V2 is cut off, C2 is charging and potential across it rising. This rise produces the voltage which sweeps the beam across the screen from left to right. In the shorter interval while V2 is conducting, C2 rapidly discharges through V2. The relatively rapid fall in potential across C2 returns the beam to its starting point.

f. SWEEP AMPLIFIER.

(1) The input to the sweep amplifier, figure 4-7, is through the second half of the "SWEEP SELECTOR" from either the start-stop or the sawtooth sweep generator. The sweep amplifier not only magnifies the voltage pulses it receives but transforms these pulses, which are wholly unbalanced with respect to ground, into approximately balanced voltages which act on the cathode-ray beam in a push-pull manner, the voltage on one horizontal deflecting plate attracting the beam while that on the other plate repels it. This transformation is accomplished in a twin triode tube V105, the cathodes of the two halves being coupled through a common cathode resistor R153.

The actual length of the sawtooth cycle will also depend upon the potential impressed on the grid of V1 received through the sync-pulse amplifier may therefore be used to advance or retard the tripping of V1, thereby synchronizing the sawtooth generator with a recurrent signal or wave from an external source. If the sawtooth frequency is the same or a submultiple of the synchronizing frequency, each sawtooth cycle will be controlled by the synchronizing source. If, however, a higher sawtooth frequency is used, only one out of every two or more sawtooth cycles will be influenced by the synchronizing source, intermediate cycles being of their natural length. Unless the natural frequency is very carefully adjusted to be the same as that of the synchronizing source, differences will cause the image to shift or be blurred.

(6) The resulting fluctuations in the plate potential of V2 are impressed across the Sweep Capacitor C2. In order that the variation in voltage across C2 may be nearly linear in time both while charging and discharging, its capacitance is changed in proportion to changes in C1, by interlocking controls, so C2 can never charge or discharge fully in the time available. Resistor R145A through which C2 receives its charge is mechanically interlocked with R145B which is the fine-frequency

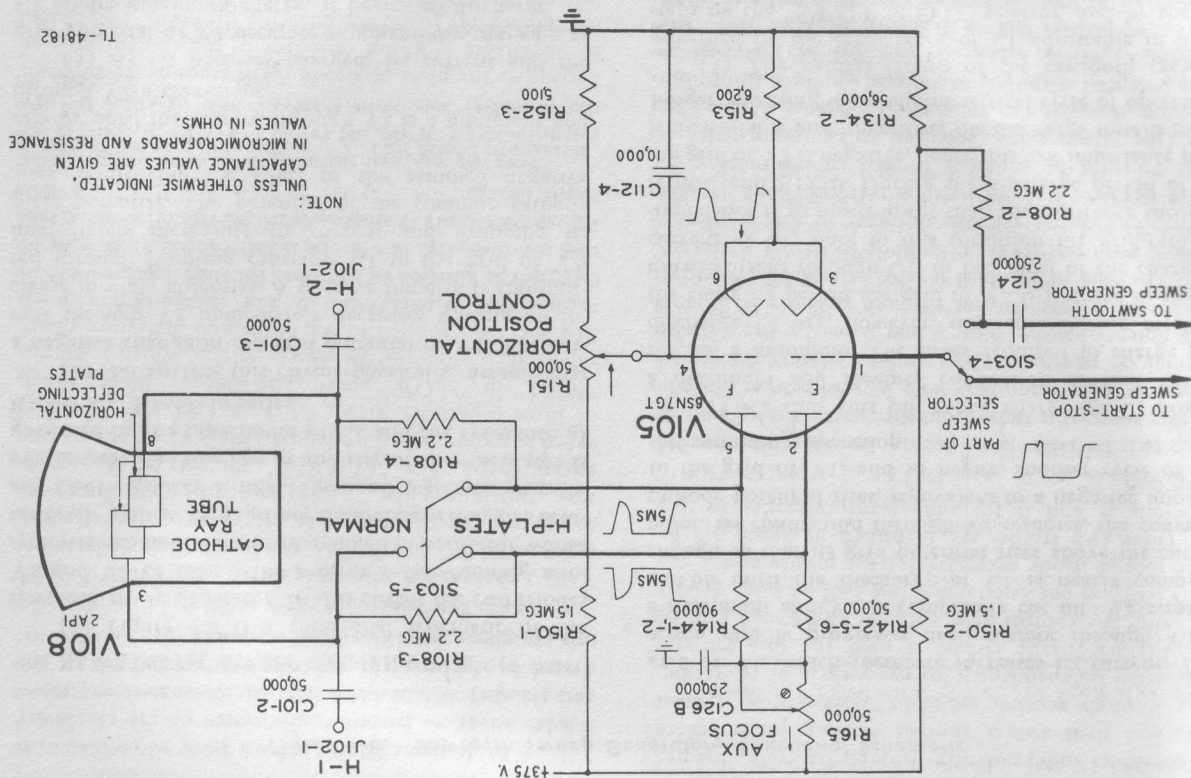


Figure 4-7. Sweep Amplifier—Functional Schematic

NOTE: UNLESS OTHERWISE INDICATED, CAPACITANCE VALUES ARE GIVEN IN MICROMICROFARADS AND RESISTANCE VALUES IN OHMS.

horizontal deflecting plates through 50,000-microfarad coupling capacitors C101-2 and C101-3, as shown by figure 4-7. When switch S103-5, designated "NORMAL-H PLATES" on the right control panel, is in its "NORMAL" position, these terminals are also connected to the plates of the sweep amplifier through these same capacitors. When this switch is in position marked "H PLATES," 2.2-megohm decoupling resistors are inserted between the sweep amplifier and the horizontal deflecting plates so that the deflecting plates are not then shunted by the low impedance to ground through the sweep amplifier.

(2) Terminals H-1 and H-2 may thus be used for the direct application of external pulses to the deflecting plates with switch in "H PLATES" position, or for the supply to an external circuit of sweep pulses generated within the oscilloscope with switch in its "NORMAL" position.

(3) Cord CX-152/U, shown in figure 1-2, may be used to facilitate making these connections.

5. POWER SUPPLY.

a. Figure 4-8 is a slightly simplified diagram of the power supply circuit which operates on an input voltage of 115 and at any frequency between 50 and 1200 cycles per second. The total power consumption is about 90 watts at 60 cycles and somewhat less at higher frequencies.

b. From the input cord the circuit leads directly to two-ampere fuses in each side of the line. These fuses are replaceable by removing the top cover of the oscilloscope. Next in the circuit is a double-pole toggle switch S103-6 on the left side of the oscilloscope, to turn the power "ON" or "OFF," the primary of transformer T102. This transformer supplies power to two rectifier circuits and to the different cathode heaters. The upper rectifier circuit employs a 5Y3GT/G tube, V106, connected for full-wave rectification. It supplies positive voltage to the plates of the vacuum tubes. A simple filter consisting of a series inductance and shunt capacitances smooths out the ripples in this rectified voltage. No regulating means are provided. The lower rectifier circuit, deriving its power from only one 350-volt winding of the transformer, employs a 6X5GT/G tube, V107, with the plates connected in parallel to give half-wave rectification. Smoothing action is entirely by resistors and capacitors. The voltage supplied by this rectifier is approximately 490 volts negative to ground.

c. Fixed and adjustable potential dividers composed of resistors connected between the +375-volt and -490-volt outputs of the combined rectifiers supply proper voltages for the different electrodes of the cathode-ray tube. The voltages supplied to the control grid, first anode, and vertical deflecting plates are adjustable for controlling the brightness, focus, and vertical position of the electron beam.

(2) It may be noted that when the start-stop sweep generator is used, the connection of the sweep amplifier is a direct metallic one, the plate potential of the output tube V102-2 being correct for the grid of V105. Such a direct connection obviates fluctuations in the average grid potential of V105 when aperiodic signals are being observed. If this average grid potential were allowed to fluctuate, the horizontal position of successive images would vary, resulting in a jittery effect making clear observation difficult. When the periodic sawtooth sweep generator is used, a coupling capacitor C124 is inserted between the sawtooth output and the sweep amplifier. The grid of triode E, the input of the sweep amplifier, is then given its correct bias by means of a potential divider consisting of resistors R150-2 and R134-2.

(3) The operating cycle of the sweep amplifier is as follows: Assuming a single positive sawtooth pulse to be applied to the grid of triode E, more current is drawn and consequently the voltage drop in the common cathode resistor R153 is increased. It will be noticed that no signal voltage can be impressed on the grid of triode F, which is held at a constant potential determined by the setting of R151, the "HORIZONTAL POSITION" control. Since the cathode of triode F is tied to that of triode E, its potential rises with the positive pulse applied to the grid of E. This is equivalent to a negative pulse on the grid of triode F; consequently the plate current of F decreases, permitting a rise in potential of plate 5 while plate 2 falls, thus the outputs of triodes E and F are approximately balanced voltages. These plates are connected directly without coupling capacitors to the horizontal deflecting plates of the cathode-ray tube which makes it impossible to obtain beam positioning in the usual manner by potential dividers in the power supply.

(4) Positioning in this case is accomplished by potential divider R151 which controls the steady potential of the grid of triode F. A change in this grid potential causes a decrease in the potential of one of the plates and an increase in the potential of the other. Thus the steady forces exerted on the electron beam change with a resulting change in the horizontal position of the spot where the beam strikes the screen.

(5) Adjustable resistor R165 permits adjustment of the average potential of the horizontal deflecting plates with respect to the anode of the cathode-ray tube. This potential reacts on the sharpness of focus obtainable with the "FOCUS" control (R161) and, as different tubes require somewhat different average potentials of the horizontal deflecting plates for sharpest beam focusing, R165 permits the necessary adjustment when tubes are changed.

g. H-1, H-2 CONNECTOR AND "NORMAL-H PLATES" SWITCH.

(1) The connector marked H-1, H-2 on the right control panel has its two terminals connected to the

6. MECHANICAL CHARACTERISTICS.

a. INFLUENCE OF WEIGHT.—The design of this oscilloscope departs from conventional practice because of the great importance of saving weight and volume without undue sacrifice of convenience of manufacture and maintenance.

b. FRAME AND SUB-ASSEMBLIES.—The chassis is of sheet steel in the form of a rectangular frame, 7 by 15 by 12 inches. Apparatus is mounted within and above and below this central frame, as shown by figures 7-1, 7-2, 7-3, and 7-4, which are top, bottom, and side views of the oscilloscope with the covers removed. Groups of related circuit elements are assembled on phenol fabric panels which are completely wired before these sub-assemblies are mounted on the chassis. Six of these sub-assemblies are shown in figures 7-5, 7-6, 7-7, 7-8, and 7-9. Two of these, the sweep amplifier assembly and the signal amplifier assembly, are mounted on the top side of the frame, one on each side of the cathode-ray tube housing, as shown by figures 7-1 and 7-3. On the under side of the frame, as shown by figure 7-2, vertical fabric brackets, which are removable for maintenance, hold miscellaneous circuit elements. The power transformer is mounted on the lower side of the frame, and the choke coil of the filter on the upper.

c. CATHODE-RAY TUBE HOUSING AND VIEW-ING ARRANGEMENTS.—The cathode-ray tube is

housed in a shield of armco iron and permalloy which runs lengthwise along the center line on the top of the chassis. This shield is shown clearly by figure 7-1, while figure 7-3 shows the shield and cathode-ray tube removed.

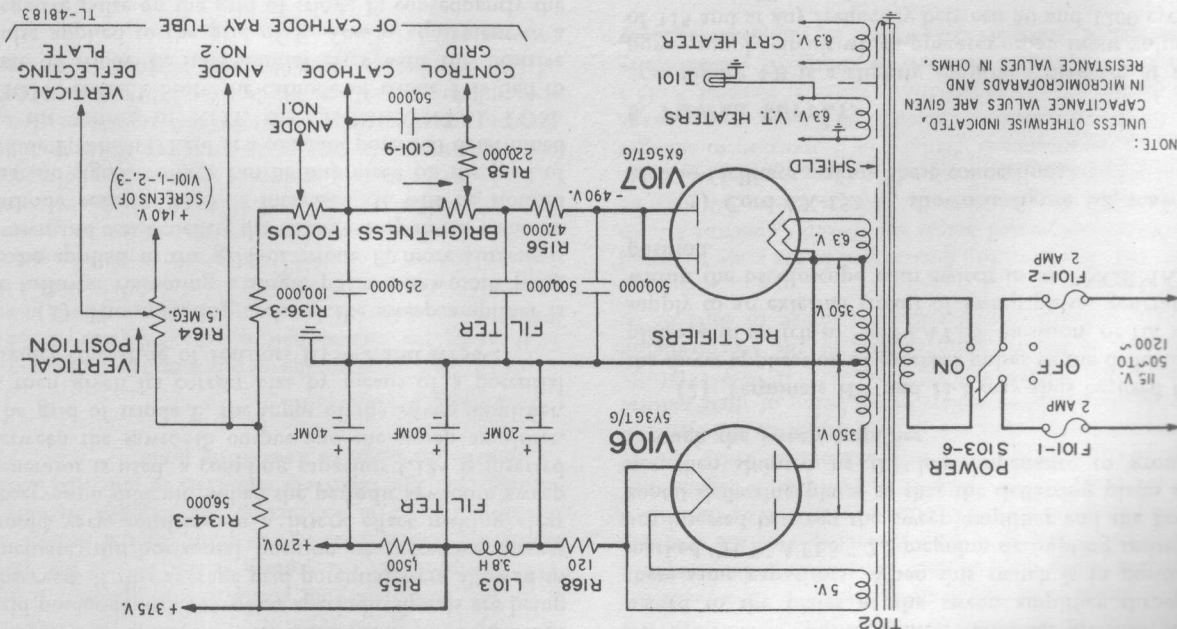
d. CIRCUIT CONTROLS.—The circuit controls appear on both sides of the chassis along the 15-inch dimension. This construction permits each control to be located near its best circuit position.

e. COVERS AND ELECTRICAL SHIELDING.

(1) The covers are of sheet steel provided with louvers in their upper portions and so formed as to shed rain and condensing moisture when the oscilloscope is in its upright position. For the same purpose the viewing tube is closed by a transparent Vinylite window.

(2) Surrounding the frame of the chassis is a locking band which forms a special seal with the top and bottom covers to exclude microwave fields. The opening through which the cathode-ray tube is observed and the openings for the control shafts are especially arranged to minimize leakage of external high-frequency fields through the casing. Under the louvers is a perforated sheet steel inner lining for blocking high-frequency fields which enter through the louvers. The oscilloscope can thus be used for testing within reasonably close range of radar transmitters.

Figure 4-8. Power Supply—Simplified Schematic



SECTION V MAINTENANCE

be removed from their sockets without first turning off the power or disconnecting the power cord from the source of supply. Removing one of these tubes without turning off the power puts excessive voltage on the screen grids of the 6AK5 tubes remaining in their sockets. In any repair work involving replacing of small tube sockets (V101-1-2-3-4) or any wiring to these sockets, extreme care should be exercised not to bind the socket terminals. They should be placed under tension. If any wiring is done on these small sockets, a dummy tube or an old tube should be in the socket while the wiring is done. In soldering, as little heat as possible should be applied to prevent hardening of the terminals with consequent socket trouble. If there is any circuit trouble in the parts of the equipment where these sockets are used, they should be inspected very carefully for broken or misaligned terminals.

In the following chart are outlined the main manifestations of troubles, together with the procedure to be followed in each case for determining the cause, location, and remedy. For maintenance purposes, it will be necessary to consult the complete schematic and wiring diagrams of the oscilloscope which are included in section VII as figures 7-10 and 7-11, respectively.

REMEDY	CAUSE	TROUBLE AND DIAGNOSIS
Try replacing in turn all tubes of signal channel or check tubes V101-1, V101-3 and V102-1 by the general method described for checking V101-1 in paragraph 7c (2).	Defective tubes.	a. SIGNAL CHANNEL OSCILLATES. This condition is indicated by the continuance of vertical deflection after the oscilloscope is disconnected from the signal source.
Locate by continuity and ohmmeter measurements, paragraphs 15 and 16. Special care should be taken in the measurement of resistors R108-1, R107-2, R137-4, R107-3 and R125-1. Capacitors C101-7, C110-1 and C129-1 should be checked for leakage.	Defective resistor, capacitor or wiring.	

WARNING

This equipment has dangerous voltages and no safety switches are provided. When replacing parts, do not rely upon the oscilloscope switch for turning off the power; disconnect the power supply cord.

1. REMOVAL OF COVERS.

For changing tubes and fuses, and for making adjustments of cathode-ray tube and all adjustable resistors only the top cover need be removed. Both top and bottom covers may need to be removed for maintenance tests and for replacing parts. To remove the bottom cover, 12 screws around the flange must be loosened but should not be removed from the cover. To remove the top cover, loosen the 12 screws around the flange and the four screws inside the light shield.

CAUTION

These covers are specifically designed to prevent interference from microwave fields. When replacing covers, care should be taken that they are firmly in place and all screws tightened, not forgetting the four screws inside the light shield.

2. SYMPTOMS OF TROUBLE, DIAGNOSIS, AND REMEDY.

CAUTIONS

Tubes V101-1, V101-2, and V-103 should not

REMEDY	CAUSE	TROUBLE AND DIAGNOSIS
If no defective resistor or capacitor is found, or if found and replaced and the signal channel still oscillates, turn the control of resistor R126 in a clockwise direction until the oscillation stops. CAUTION Unless circuit elements have been changed, adjustable control R126 should not be touched, except as a last resort. It determines the low-frequency response of the signal channel. Unless special equipment is available, adjustment of this control for the correct response is very difficult. See paragraph 5b. Replace.	Incorrect adjustment of R126.	a. SIGNAL CHANNEL OSCILLATES (Continued)
Measure socket voltages of V102-1. Check resistors and capacitors, paying special attention to capacitor C129-1. If this capacitor has a high leakage, V102-1 will operate over the incorrect part of its characteristic. See d.	Defective tube V102-1.	b. SIGNAL CHANNEL OVERLOADS. Overloading of the signal amplifier is revealed by distortion of a pulse shape before an image amplitude 20 per cent in excess of the distance between adjacent reference lines is reached, or if a sine wave is being viewed, distortion should not occur before an amplitude 20 per cent in excess of the distance between the two outside reference lines is reached.
Reduce setting to "0 db."	Oscillation of start-stop generator.	c. SWEEP BUT NO SIGNAL APPEARS WITH START-STOP SETTING. Try effect of throwing sync selecting switch to "EXT SYNC" position, being sure there is nothing connected to "EXT SYNC" jack. At same time, turn brightness control to maximum. If sweep continues after sync selecting switch is thrown to "EXT SYNC" position, oscillation of the start-stop generator is indicated. If sweep disappears, and no vertical deflection appears, it is an indication of trouble in the signal channel beyond tube V101-1.
Try replacing tubes. Locate by (1) tracing signal with another oscilloscope, see paragraph 11; (2) measuring tube socket voltages, see paragraph 13; (3) continuity tests, see paragraph 15.	Signal attenuator set for too high attenuation. Defect in signal channel between coupling amplifier and cathode-ray tube Defective tube V101-2, V101-3, or V102-1 Defective wiring, resistor or capacitor.	

TROUBLE AND DIAGNOSIS	CAUSE	REMEDY
d. START-STOP SWEEP CIRCUIT OSCILLATES. This condition will be indicated by the continuance of the start-stop sweep after the signal and synchronizing sources are disconnected. Before concluding that this trouble really exists be sure that the "SWEEP SELECTOR" is thrown to the "START-STOP" position. If in the "SAWTOOTH" position, it is normal for the sweep circuit to oscillate and therefore is no indication of trouble.	Defective tube V103-1 or V102-2. Defective resistor, capacitor, or wiring.	Readjust R139 only after eliminating other possible causes. Turn R139 clockwise until a sweep appears and then return it gradually in a counterclockwise direction until oscillation stops. This adjustment should be made with no signal or synchronizing connection.
e. VERTICAL DEFLECTION BUT NO START-STOP SWEEP APPEARS. Check all controls for correct settings, adjust "SYNC VOLTAGE," and try different positions of "SWEEP SPEED" controls. See that grounding cap is not through error on "H-2, H-1" jack. Throw the "SWEEP SELECTOR" to "SAWTOOTH." If this fails to produce a sweep, the trouble probably lies in the sweep amplifier, though it is remotely possible that both sweep generators or the sawtooth generator and sync pulse amplifier are defective. If switching to "SAWTOOTH" produced a sweep, thus eliminating the sweep amplifier (V105 and associated elements) as the source of trouble, throw the "SWEEP SELECTOR" back to "START-STOP" and turn the control of R139 to its extreme counterclockwise position. The resulting effect will indicate the condition of the start-stop generator. The conclusion to be drawn from this test are: 1. If a sweep occurs (due to oscillation of start-stop generator), it is an indication that the start-stop generator is probably in good condition and that the trouble lies ahead of this generator in the sync-pulse amplifier or in the plate circuit of the coupling amplifier V101-1. 2. If a sweep does not appear (start-stop generator will not oscillate), the start-stop generator is defective. NOTE Readjust R139 after this test. Refer to g.	Defective sweep amplifier, tube V105 and associated elements. Defective sync-pulse amplifier, tube V101-4 and associated elements. Plate circuit of V101-1, including resistors R106-1, -2, R107-1, and capacitor C107-1. Defective start-stop generator, tubes V103-1 and V102-2 including switches S103-3 and S104A and B. Defect in switch S103-1, -2, -3, or -4. Caps for jacks "H-2, H-1," and "TIME INPUT, V" interchanged.	Having made a general diagnosis of the trouble and its location, the procedure in finally isolating the defective component is similar in all cases. First try replacing tubes in the affected portion of the circuit. If this fails to make the circuit operative, measure the tube socket voltages, check resistors, capacitors, and switches, and replace any defective parts. If tube V105 is replaced, some selection may be necessary to obtain suitable sweep speeds. See paragraph 8. If a part is replaced in the start-stop generator, R139 must be readjusted. See paragraph 8.

TROUBLE AND DIAGNOSIS	CAUSE	REMEDY
f. VERTICAL DEFLECTION BUT NO SAWTOOTH SWEEP APPEARS. Check all controls for correct settings. Adjust "SYNC VOLTAGE." Try different adjustments of "SWEEP SPEED" controls, "COARSE" and "FINE". See that grounding cap is not through error on "H-2, H-1" jack. Throw sweep selector to "START-STOP." Adjust "SYNC VOLTAGE" control and try both sync polarities. If a sweep appears, it is an indication that the sawtooth sweep generator is defective. If a sweep does not appear, it is an indication that the trouble probably lies in the sweep amplifier, or it is remotely possible that both sweep generators are defective, or that both the sawtooth sweep generator and the sync-pulse amplifier are defective. See e.	Defective sawtooth generator.	Try replacing V103-2. If this does not remedy trouble, measure tube socket voltages and check resistors, capacitors, and condition of switches S103-4 and S104-C and -D, replacing defective components.
g. INSENSITIVE START-STOP SWEEP. Whenever the start-stop sweep is synchronized by the signal (switch on "INT SYNC"), the sweep circuit should be sufficiently sensitive to start in time to show the beginning of a fast rising pulse, with a short portion of the zero line to the left. With an insensitive sweep circuit, the tripping pulse cannot reach the threshold stage required for tripping the start-stop generator as soon as it would with a sweep generator of normal sensitivity. A similar effect would be produced if the synchronizing pulse were made weaker.	Defective start-stop generator.	Replace V103-1 or V102-2 if defective. To adjust this resistor, disconnect all signal and synchronizing sources, turn R139 clockwise until a sweep appears due to oscillation of the start-stop circuit, and then turn R139 counterclockwise until the oscillation just stops as evidenced by the disappearance of the sweep. Adjustment of R139.
	"NORMAL H PLATES" position.	Throw switch to "NORMAL" position.
	Defective tubes V101-1 or V101-4.	A weakening of the synchronizing pulse delivered to the start-stop generator will occur if the coupling tube V101-1 or the sync-pulse amplifier tube V101-4 is defective. Therefore, these tubes should be checked or replaced if there is evidence of insensitivity, provided tubes V103-1 and V102-2 in the start-stop generator have already been checked or replaced and resistor R139 adjusted.
	Defective resistor, capacitor, or wiring.	If the sensitivity is still unsatisfactory, the tube socket voltages should be measured and resistors and capacitors checked and any defective components replaced.

TROUBLE AND DIAGNOSIS		CAUSE	REMEDY
6. SPOT BUT NO VERTICAL OR HORIZONTAL DEFLECTION WITH START-STOP SWEEP SETTING. Shift to sawtooth sweep. If a horizontal deflection now appears, a defect is indicated in coupling amplifier, probably tube V101-1, or input impedance selector circuits. If neither "SAWTOOTH" nor "START-STOP" positions of "SWEEP SELECTOR" produce a horizontal and no vertical deflection can be obtained, trouble is indicated in both the signal channel and the sweep amplifier or the signal channel of the sweep amplifier is suggested. A check of the signal channel, then the sweep generators.		Defective coupling amplifier.	Replace tube V101-1. Should this not remedy trouble, check other elements and input impedance selector circuits.
		Defect in input impedance selector circuits.	Check switch S101-1 and associated resistors and capacitors.
7. SAWTOOTH SWEEP WILL NOT SYNCHRONIZE. This condition is indicated by inability to adjust sawtooth frequency so that image will remain stationary. Shift to start-stop sweep. If synchronization is obtained, trouble is indicated in sawtooth generator. If synchronization is not obtained with start-stop sweep, trouble is indicated in sync-pulse amplifier, switch S103-2 or resistor R135.		Defective sawtooth generator.	Try replacement of V103-2. If this does not remedy trouble, measure tube socket voltages and check resistors and capacitors of sawtooth generator, replacing defective components.
		Defective sync-pulse amplifier.	Try replacing V101-4. If this does not remedy trouble, measure tube socket voltages and check resistors and capacitors associated with V101-4, including R135 which is connected through S103-2.
			Throw switch to "NORMAL"
7. SWEEP CIRCUIT NON-LINEAR.		"NORMAL H PLATES" position.	Replace with proper cap.
		Grounding cap "VP, TI" on "H-2, H-1" jack.	
		Failure of outside power supply.	
8. NO SCALE ILLUMINATION AND NO SPOT APPEARS.		Power supply cord disconnected.	Connect cord.
		Fuses blown.	Replace.

TROUBLE AND DIAGNOSIS		CAUSE	REMEDY
7. SCALE ILLUMINATION BUT NO SPOT APPEARS.		Failure of rectifier tube V106 or V107.	Replace defective tube.
m. INABILITY TO CENTER BEAM VERTICALLY.		Filter capacitor failure.	Check the power supply voltages and, if these voltages are not within the prescribed limits, check capacitors C133A, C133B, C109-1C, C109-1D, C125A, C125B and C126A. Replace any defective capacitors.
n. INABILITY TO CONTROL INTENSITY.		Defective resistor or wiring of internal power supply circuit.	Make continuity tests and ohmmeter measurements, paragraphs 15 and 16.
o. INABILITY TO FOCUS.		Defective cathode-ray tube.	Replace tube. (See par. 9.)
p. IMAGE UNDULY DISTURBED BY MECHANICAL VIBRATION AND POWER-FREQUENCY RIPPLE.		Defective resistors associated with vertical position control R164.	Check voltages and resistors. Replace defective resistors.
		Defective cathode-ray tube, resistors, or wiring.	Check voltage from terminal 10 of V108. Check resistors R125-2, R158, and R166. Replace defective part.
		Incorrect adjustment of R165.	Readjust R165. (See par. 10.)
		Defective cathode-ray tube.	Replace tube. (See par. 9.)
		JAN6AK5 Tubes are primarily designed and tested for use only in high-frequency circuits. When used in the circuits of this oscilloscope for transmission of frequencies from 30 cycles to several megacycles, an occasional tube, not more than about one in a hundred, is found to be unsatisfactory. Such tubes cause either a power-frequency ripple (exceeding $\frac{1}{4}$ small-scale division) to appear with a slow sweep or cause rapid and erratic vertical deflections when the oscilloscope is subjected to slight jars or vibrations. All tubes cause slight effects of this nature.	Select, by trial, a JAN6AK5 Tube which does not cause these effects to an objectionable degree.

(1) The normal gain-frequency characteristic of the complete signal channel should be about as shown by the curve of figure 5-1.

(2) This frequency characteristic may be checked by applying to the signal input of the oscilloscope known voltages of different frequencies, sufficiently covering the range from 20 cycles to 3,000,000 cycles, and determining the value of the voltage required at each frequency to give the standard image amplitude on

5. FREQUENCY RESPONSE OF SIGNAL CHANNEL.

a. GENERAL.

If one side of the power supply is grounded, be sure that the probe is connected to the live or non-grounded side.

WARNING

Under these conditions and assuming a power supply voltage of about 115, the amplitude of the image should approximate the distance between the two outside reference lines. Variation and aging of tubes may cause the amplitude to vary from half to double this amount, assuming in the latter case the signal amplifier did not overload. This 2:1 variation in amplitude from the standard is equivalent to a change in attenuation of ± 6 db. This method of checking the gain of the signal amplifiers is recommended only when there is doubt as to the condition of the signal channel and other more refined means are unavailable.

Control	Setting
INPUT IMPEDANCE	40 db
IMAGE SIZE	Maximum
ATTENUATION	4 db

amplitude of the image with the controls set as follows:

TROUBLE AND DIAGNOSIS	CAUSE	REMEDY
g. SWEEP NOT HORIZONTAL.	Cathode-ray tube improperly aligned.	Re-align tube. (See par. 9.)
	Grounding cap "VP, TI" left off "TIME INPUT, V" jack.	Put cap in place.
h. SHORT START-STOP SWEEP ON SLOW SPEED.	Defective tube V102-2.	Replace.
	Defective capacitor or resistor in start-stop generator, particularly low values of R130-4 and C136.	Check resistors and capacitors and replace defective parts.
Abnormally short "operate" period of start-stop multi-vibrator causes horizontal deflection to cease before beam is swept entirely across screen.		

probe, the a-c power supply voltage and observing the signal channel may be made by applying, through the available, a rough check of the sensitivity or gain of the known voltage of 0.1 volt is not

b. If an accurately known voltage of 0.1 volt is not two adjacent horizontal reference lines.

have an amplitude at least equal to the distance between INPUT," the image on the oscilloscope screen should to-peak sine wave or pulse applied to the "SIGNAL. SIZE" control turned to maximum, and 0.1 volt peak-0 db," "ATTENUATION" on "0 db," "IMAGE

4. SIGNAL CHANNEL SENSITIVITY.

The pulse of 0.07 volt is obtained by adjusting the external attenuator to reduce the output voltage of the pulse generator by the required amount.

Note

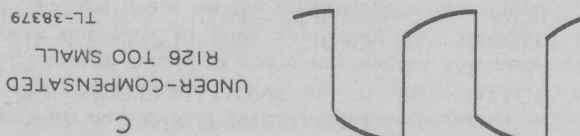
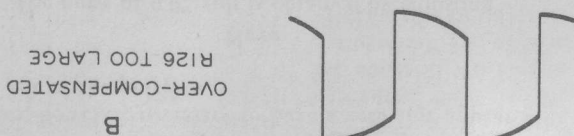
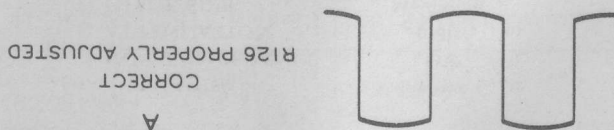
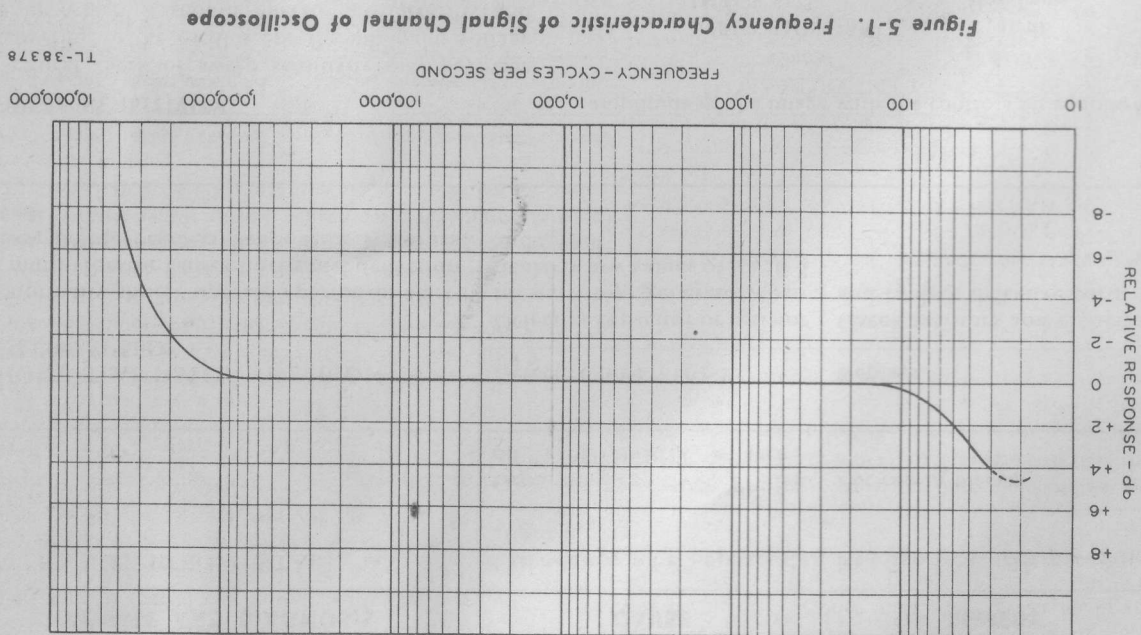
Under these conditions a pulse of 0.07 volt, peak-to-peak, applied to the "SIGNAL INPUT" should be sufficient to trip the start-stop sweep in time to make the entire pulse visible on the screen. At this low input voltage it is not, however, necessary to have a zero line appear at the left of the pulse.

Control	Setting
INPUT IMPEDANCE	LOW
ATTENUATION	0 db
IMAGE SIZE	Maximum

control settings:

adjustable attenuator is required. Make the following delivering a known voltage pulse and a 50- or 72-ohm pulse on which it should operate satisfactorily, and observing the result. To do this, a pulse generator by delivering to the oscilloscope the minimum voltage

3. SWEEP SENSITIVITY.



that the low-frequency response is too small—under compensation—and R126 should be increased by rotating its control counterclockwise.

the oscilloscope screen. When the relative values of the voltages are expressed in db, the results should not depart from the curve of figure 5-1 by more than ± 2 db.

(3) The above process is long and tedious and rarely justified, particularly if means are available for checking the low- and high-frequency response as described under the two following sub-headings.

6. LOW-FREQUENCY RESPONSE OF SIGNAL CHANNEL.

(1) CHECK.—To check the low-frequency response of the signal channel, a good flat-topped square wave of from 200 to 300 cycles per second should be applied to the "SIGNAL INPUT." Using the sawtooth sweep, the image of this wave should be observed on the screen. If the low-frequency response is correct, the top of the image will be substantially flat and parallel to the reference lines on the screen. Such a wave form is shown by A of figure 5-2.

(2) ADJUSTMENT.

(a) If the image of a low-frequency square wave is not itself substantially square, the low-frequency response of the signal channel is too great or too small as indicated by the character of the image.

(b) If as shown by B of figure 5-2 the deflection increases during each half cycle reaching its maximum at the end of the half cycle, it means that the low-frequency response is too large—over compensation—and R126 should be decreased by rotating its control clockwise.

(c) If on the other hand the deflection reaches its maximum at the beginning of each half cycle and then diminishes, as shown by C of figure 5-2, it means

of the wave is peaked at the start. If too small, the start changes in these capacitors. If too large, each half-cycle of figure 5-3 shows the effect on a square wave of adjustment is made with the probe. The upper portion later, C102-5. These should be adjusted before any one adjustable capacitor, the former, C102-3 and the voltage dividers for the 20 and 40 db steps each contain IN INPUT SELECTOR.—As shown by figure 4-4, the

b. ADJUSTMENT OF VOLTAGE DIVIDER WITH-

pulse as described below.

(3) A convenient way of testing and adjusting a voltage divider is to observe its effect on a square signal in the high and low voltage portions of the divider. resistance and capacitance impedances must be preserved through a voltage divider, the same proportion of both thereby the wave form of the signal preserved in passing components of any signal may be equally reduced and

(2) In order that both high- and low-frequency

10:1 ratio.

(1) The 20 and 40 db high impedance positions of the input impedance selector set up potential dividers which reduce the voltage between the signal input and coupling amplifier by factors of 10 and 100, as shown by figures 4-4. The probe, together with any high impedance input setting, constitutes another voltage divider with a

a. GENERAL.

7. ADJUSTMENT OF CAPACITORS OF SIGNAL AND SYNC INPUTS.

proper condition.

same amplitude of image if the attenuator is in position should be increased by 20 db to give the age is increased by a factor of 10:1, the attenua- tained from figure 3-3. For example, if the volt- The required ratio of voltages may be ascer-

removal may influence the applied voltage. the oscilloscope during adjustment since its meter should remain across the input circuit of quired to cover the range of voltage. The volt- One or more accurate voltmeters will be re-

pose. supply may be used conveniently for this pur- is recommended. The alternating current power wave voltage of 1000 or less cycles per second For convenience in testing, a continuous sine

Note

For convenience in testing, a continuous sine wave voltage of 1000 or less cycles per second is recommended. The alternating current power supply may be used conveniently for this purpose.

One or more accurate voltmeters will be required to cover the range of voltage. The voltage of the oscilloscope during adjustment since its removal may influence the applied voltage. The required ratio of voltages may be ascertained from figure 3-3. For example, if the attenuation should be increased by 20 db to give the same amplitude of image if the attenuator is in proper condition.

By increasing or decreasing both the voltage applied to the signal input and the attenuation so that the change in one should offset the change in the other and noting whether the amplitude of the image remains constant as it should under such circumstances.

a. By carefully measuring the resistances of all steps and comparing their values with those given by figure 7-10 and in the Table of Replaceable Parts, section VI, making due allowance for the tolerances specified in the table.

b. By increasing or decreasing both the voltage applied to the signal input and the attenuation so that the change in one should offset the change in the other and noting whether the amplitude of the image remains constant as it should under such circumstances.

c. By increasing or decreasing both the voltage applied to the signal input and the attenuation so that the change in one should offset the change in the other and noting whether the amplitude of the image remains constant as it should under such circumstances.

d. By increasing or decreasing both the voltage applied to the signal input and the attenuation so that the change in one should offset the change in the other and noting whether the amplitude of the image remains constant as it should under such circumstances.

e. By increasing or decreasing both the voltage applied to the signal input and the attenuation so that the change in one should offset the change in the other and noting whether the amplitude of the image remains constant as it should under such circumstances.

f. By increasing or decreasing both the voltage applied to the signal input and the attenuation so that the change in one should offset the change in the other and noting whether the amplitude of the image remains constant as it should under such circumstances.

g. By increasing or decreasing both the voltage applied to the signal input and the attenuation so that the change in one should offset the change in the other and noting whether the amplitude of the image remains constant as it should under such circumstances.

h. By increasing or decreasing both the voltage applied to the signal input and the attenuation so that the change in one should offset the change in the other and noting whether the amplitude of the image remains constant as it should under such circumstances.

checked in two ways:

The calibrated attenuation steps of the "INPUT IMPEDANCE" selector and signal attenuator may be

6. CHECK OF ATTENUATION

per second.

employing frequencies from 15,000 to 4,000,000 cycles

checked by making a frequency run as described above,

(3) The high-frequency response may also be

occupied on the old coil.

should be placed in the same relative position

not be moved unless coil L101-1 or L101-2 must

generator is not available, the collars should

ing. (Image b of figure 3-2.) If a suitable pulse

screen is flat-topped and free from over-shoot-

respective coils, until the pulse as viewed on the

ing them in the same relative positions on their

position of the collars should be adjusted, keep-

shooting, is available. With such a pulse the

a fast-rising well-shaped pulse, free from over-

this adjustment should not be attempted unless

end of fast-rising and -falling pulses. However,

obtain proper response at the beginning and

on L101-1 and L101-2 should be readjusted to

Z101, the position of the brass tuning collars

R137-4, coil L101-1, or L101-2, or network

R124-1, -2, R125-1, R170-1, -2, -3, -4, R131, or

the signal channel, resistor R107-2, -3, R108-1,

After replacing any of the following parts of

Note

high-frequency response is as it should be. See figure 3-2.

oscilloscope, the image should have a flat top if the

When such a pulse is applied to the signal input of the

microsecond) and having a flat top, must be available.

which is known to have a fast rise (better than 0.07

should be set on "0 db" and a half-microsecond pulse,

signal channel, the "INPUT IMPEDANCE" selector

(2) To check the high-frequency response of the

in its original position.

elements and that the wiring is undisturbed or put back

replacing resistors or capacitors that the replacing ele-

main unchanged, extreme care must be exercised when

L101-1 and L101-2. In order that this response may re-

than the adjustable brass collars on inductance coils

high-frequency response of the signal channel, other

(1) There is no adjustment available to alter the

CHANNEL.

c. HIGH-FREQUENCY RESPONSE OF SIGNAL

response characteristics.

wave generator is available for checking the

absolutely necessary to prevent the signal chan-

This control should not be touched unless it is

CAUTION

Section V Paragraphs 7-8

TEST ON OSCILLOSCOPE ALONE
20,000-CYCLE SQUARE-WAVE INPUT; FAST SAWTOOTH SWEEP.

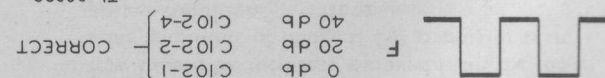
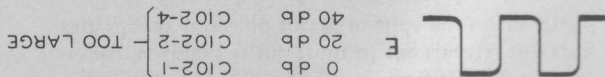
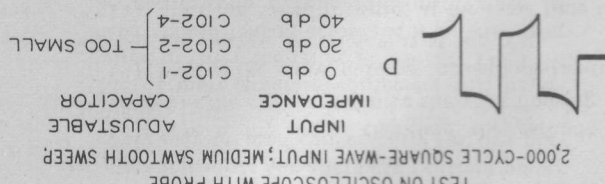
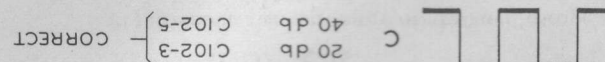
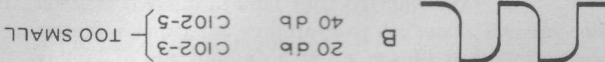
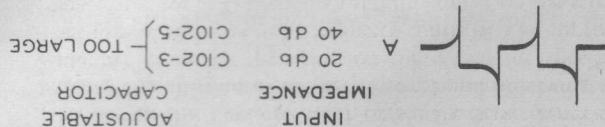


Figure 5-3. Adjustment of Capacitors of Input Impedance Selector

of each half-cycle is rounded. The correct values give flat-topped square waves. The frequency of the square wave used for this test should be about 20,000 cycles per second and the fast sawtooth sweep should be employed.

c. ADJUSTMENT OF SIGNAL VOLTAGE DIVIDER FORMED WITH PROBE.

(1) After the voltage divider contained entirely within the oscilloscope has been properly adjusted, the probe may be connected to the signal input and capacitors C102-1, C102-2, and C102-4 adjusted in a similar manner, so that any high impedance input of the oscilloscope together with the probe constitutes a distortionless voltage divider. For this test, a 2000-cycle square wave should be applied to the input of the probe and a medium sawtooth sweep employed. Typical wave shapes are shown in the lower portion of figure 5-3.

Note

The reversed relationship of wave shape and capacitance in the two cases of figure 5-3 is due to the changed position of the variable capacitor in the two cases, upper portion of the voltage divider in one and lower in the other.

(2) If it is not possible to secure a satisfactory adjustment of C102-1 (with the "INPUT IMPEDANCE"

selector in its "0 db" position), it is probable that tube V101-1 is defective.

Note

V101-1 may be checked in place by observing the change in plate voltage as its grid (terminal 1) is short-circuited to ground (frame of the oscilloscope). If the tube is defective, this will cause a 5- to 70-volt change in plate voltage. If the tube is good, there will be little or no change in plate voltage (0 to 2 volts).

If no voltmeter is available, this same test may be performed by observing the deflection on the screen of the oscilloscope with no signal input. If, as the grid is grounded, there is little or no movement of the spot on the screen, the tube is good. A large vertical movement, possibly accompanied by a sweep (sweep selector on start-stop), indicates a defective tube. In grounding the grid, care must be taken not to jar the chassis or the tube, which would cause generation of voltage due to microphonic movement of the tube elements. In grounding the grid, a wire should first be attached to the oscilloscope frame and then, and not until then, the other end of the wire should be touched to the grid, terminal (1) of socket of the tube under test. Either microphonic action or a faulty grounding procedure will cause a vertical deflection on the screen.

d. ADJUSTMENT OF EXTERNAL SYNC VOLTAGE DIVIDER.—The adjustment of capacitor C102-6 of the external sync input is similar to the adjustment of capacitors C102-3 and C102-5 of the signal input impedance selector, using a square-wave signal. The criterion of proper adjustment of this capacitor is the undistorted transmission through the external sync input of a square-wave pulse. Another oscilloscope is required to observe this pulse. The input of the second oscilloscope should be connected to the grid of V101-4 by use of a probe. By observing the form of the pulse after passing through the voltage divider and by reference to the upper portion of figure 5-3, it may be determined whether C102-6 is too large or too small, and the necessary adjustments made until a square-wave output is obtained.

8. SWEEP SPEED CHECK AND ADJUSTMENT.

a. START-STOP SWEEPS.

(1) To check the "FAST" start-stop sweep, apply signal pulses of about one microsecond to the signal input of the oscilloscope, using internal sweep synchronization and setting the "IMAGE SIZE" control in its maximum counterclockwise position to cause timing oscillations to appear on the screen. These oscillations are approximately one microsecond apart. With the "FINE" sweep speed control turned to its extreme clockwise position, five or a lesser number of oscillations should

b. SAWTOOTH SWEEPS.—The speed of the sawtooth sweeps may be checked by applying waves of known frequency from an oscillator or square wave generator to the signal input of the oscilloscope and observing the number of cycles appearing on the screen for specified settings of the sawtooth frequency controls. The approximate number of cycles which should appear on the screen for different conditions are tabulated at the bottom of the preceding column.

9. REPLACEMENT OF CATHODE-RAY TUBE.

a. REMOVAL OF TUBE.

- (1) Remove the top cover of the oscilloscope.
- (2) Loosen the two nuts (not the screws) holding the pilot light and remove light.
- (3) Loosen the screw clamping the cathode-ray tube socket in the cathode-ray tube shield or housing.
- (4) Loosen the screw holding the cathode-ray tube shield to the chassis. This screw is at the rear.
- (5) Slide the shield forward, at the same time lifting its front ends slightly to unhook the stud which holds the shield at the front of the chassis, allowing the cathode-ray tube and socket to slide out of the shield.
- (6) Grasp the socket in one hand and gently rock and pull the tube until it is removed from the socket.

Note

If the tube sticks in the socket, it may be pried loose by inserting a screwdriver in the slots in the side of the socket mounting.

b. INSERTION OF TUBE.—Reverse the procedure for removing the tube, pushing the new tube into the shield until it is against the stop, but do not clamp the socket firmly to the shield until its sweep is aligned with the horizontal reference line on the plexiglas disc in front of the tube screen.

c. ALIGNMENT OF TUBE.

- (1) Plug the "POWER CORD" into an appropriate socket.
- (2) Turn on the oscilloscope.
- (3) Set the "SWEEP SELECTOR" to "SAWTOOTH."
- (4) Turn up the "INTENSITY" and adjust "FOCUS."
- (5) The luminous sweep line should be exactly parallel to the horizontal reference line on the plexiglas. If not parallel, note the misalignment and disconnect the "POWER CORD."
- (6) Turn the tube socket with reference to the shield by the estimated amount required. Recheck the alignment and repeat until a satisfactory result is obtained.
- (7) Tighten the screw holding the socket in position and recheck alignment before replacing cover.

appear on the screen. With the "FINE" control turned extreme counterclockwise, seven or more oscillations should appear. If the "FAST" sweep speed is within these limits, it is probable that the "MED" and "SLOW" speeds will also be approximately correct, providing capacitors C135 and C137 are not defective and have correct values.

(2) To check the "FAST," "MED," or "SLOW" sweep speeds, a sine or square wave of appropriate frequency may be applied to the "SIGNAL INPUT." Then adjust "SYNC VOLTAGE" until a satisfactory stationary image is obtained. The approximate number of cycles which should appear on the screen for different conditions are tabulated below.

COARSE	FINE	EXTREME POSITION	SAWTOOTH SWEEP SPEED		Frequency of Square Wave Generator or Oscillator Cycles per Second	Cycles Normally Appearing on Screen
			FAST	MED.	SLOW	
Clockwise	Counter-clockwise	Clockwise	1,000,000	100,000	20,000	5 or less
			1,000,000	100,000	20,000	7 or more
Clockwise	Counter-clockwise	Clockwise	100,000	10,000	2,000	3 or less
			100,000	10,000	2,000	4 1/2 or more
Clockwise	Counter-clockwise	Clockwise	20,000	2,000	400	2 or less
			20,000	2,000	400	4 1/2 or more

(3) If all three start-stop sweep speeds fall outside these limits in the same direction, the cause is probably a common factor, as abnormal gain in the sweep amplifier. Replacing tube V105 will probably rectify the condition.

COARSE	FINE	EXTREME POSITION	SAWTOOTH SWEEP SPEED		Frequency of Square Wave Generator or Oscillator Cycles per Second	Cycles Normally Appearing on Screen
			FAST	MED.	SLOW	
Clockwise	Counter-clockwise	Clockwise	100,000	50,000	1,000	2 or less
			100,000	50,000	1,000	10 or more
Clockwise	Counter-clockwise	Clockwise	50,000	5,000	1,000	10 or less
			50,000	5,000	1,000	4 or more
Clockwise	Counter-clockwise	Clockwise	1,000	100	50	6 or less
			1,000	100	50	5 or more

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LOCATION 7-10 (FIGURE 7-10)		REF. TUBE	TER. V	SWEEP CON- TROL OF OSCILLOSCOPE UNDER TEST	DESCRIPTION
A	101-4 5	PULSE	K	101-4 5	SWEEP CON- TROL OF OSCILLOSCOPE UNDER TEST
	103-1 1 OR 2				
B	103-1 1	ACROSS DIODE	L	103-2 2	SAWTOOTH MULTIVIBRATOR
C	103-1 5	OUTPUT 2ND TRIODE	M	103-2 5	
D	103-1 6	CATHODE 2ND TRIODE	N	103-2 6 OR 3	
E	103-1 4	INPUT 2ND TRIODE	P	103-2 4	
F	102-2 4	INPUT 1ST TRIODE	NOTE: WAVE FORMS L, N AND P ARE SUBJECT TO WIDE VARIATIONS WITH SAWTOOTH FREQUENCY AND SYNCHRONIZING VOLTAGE. FAILURE TO REPRODUCE THESE WAVE FORMS IS THEREFORE NOT NECESSARILY INDICATIVE OF TROUBLE.		
G	102-2 6	OUTPUT 1ST TRIODE	Q	105 1	START - STOP
H	102-2 8	START-STOP OUTPUT	R	105 2	
J	108 10	UNBLANK- ING PULSE TO CATHODE RAY TUBE	S	105 5	
			T	105 3 OR 6	
* AS VIEWED ON ANOTHER SIMILAR OSCILLOSCOPE UTILIZING HIGH IMPEDANCE PROBE, INTERNAL SYNCHRONIZATION, MEDIUM-SPEED SAWTOOTH SWEEP, AND ADJUSTING IMAGE SIZE AND ATTEN- UATION CONTROLS AS REQUIRED FOR DEFLECTIONS SHOWN. ** START-STOP SWEEP TRIGGERED BY VOLTAGE PULSES OCCURRING 2,000 TIMES PER SECOND AND CONNECTED TO "SIGNAL INPUT" OR "EXT. SYNC." OF OSCILLOSCOPE UNDER TEST. SAWTOOTH SWEEP SYNCHRONIZED WITH 2,000 CYCLE SINE WAVE.					

Section V
Paragraphs 9-13

throughout this channel, the wave shape should remain a faithful reproduction of the input wave. In running down trouble in the signal channel, it is often useful, however, to use another oscilloscope to trace the signal from the input to the point where it disappears, which is probably near the seat of trouble.

12. TUBE COMMENT.

Twelve vacuum tubes are employed as follows:

Quantity	Type Designation		Function
	JAN Type	VT Type	
4	JAN-6AK5	—	Cathode follower coupling amplifier synchronizing-pulse amplifier 1st and 2nd stages of signal amplifier.
2	JAN-6AG7	VT-247	Output of signal amplifier. Start-stop generator.
2	JAN-6SL7GT	VT-229	Saw-tooth generator. Sweep amplifier.
1	JAN-6SN7GT	VT-231	Start-stop generator.
1	JAN-5Y3GT/G	VT-197-A	Full-wave rectifier — plate voltage supply.
1	JAN-6X5GT/G	VT-126-B	Half-wave rectifier — cathode-ray tube supply.
1	JAN-2AP1	—	To display image of signal voltage.

13. NORMAL VOLTAGES OF TUBE TERMINALS TO CHASSIS.

a. TUBE SOCKET VOLTAGE DIAGRAM.—With all tubes in their proper places and a power supply of 115 volts at 60 cycles, the voltage between tube terminals and chassis (ground) should produce readings as indicated in figure 5-5 when using a Weston Analyzer, Model 772, or an instrument of equivalent impedance.

WARNING

In checking these voltages, precautions should be taken against accidental shock.

Note

Check the illumination of the scale and reference lines on the plexiglas before replacing cover, and, if necessary, readjust position of pilot light.

10. FOCUSING ADJUSTMENT.

a. Screwdriver-adjustable resistor R165, located on the sweep amplifier assembly, figure 7-8, enables the average potential of the horizontal deflecting plates to be adjusted over the range necessary to compensate for differences in cathode-ray tubes. (Refer to sec. IV, par. 4f(5).)

b. Whenever a cathode-ray tube is replaced, R165 should be readjusted.

c. If possible, make the adjustment with the oscilloscope controls set for a fast start-stop sweep, utilizing timing oscillations set up by a half-, or one-microsecond pulse as the testing image.

d. Rotate the screwdriver control of R165 slightly and then adjust the "FOCUS" control for best focus.

e. Repeat this procedure until the sharpest possible focus is obtained, then leave R165 in the position which permitted this sharpest focus to be obtained by adjustment of the outside "FOCUS" control.

Note

If a short signal pulse is not available to energize the start-stop sweep, a reasonable focus adjustment may be obtained by using the saw-tooth sweep, but in any event, it is necessary to have a vertical as well as a horizontal deflection of the beam in making this focusing adjustment.

11. NORMAL WAVE FORMS.

a. The normal wave forms of the voltages to ground at significant points in the sweep channel are given in figure 5-4, as observed and photographed on another similar oscilloscope, utilizing the probe input. The sweep control conditions of the oscilloscope under observation are given in the figure together with the required conditions for the observing oscilloscope.

b. If a second oscilloscope is available, a comparison of the wave shapes actually found in a defective oscilloscope with corresponding wave shapes in this table will often facilitate the location and diagnosis of trouble. No wave shapes are shown for the signal channel since,

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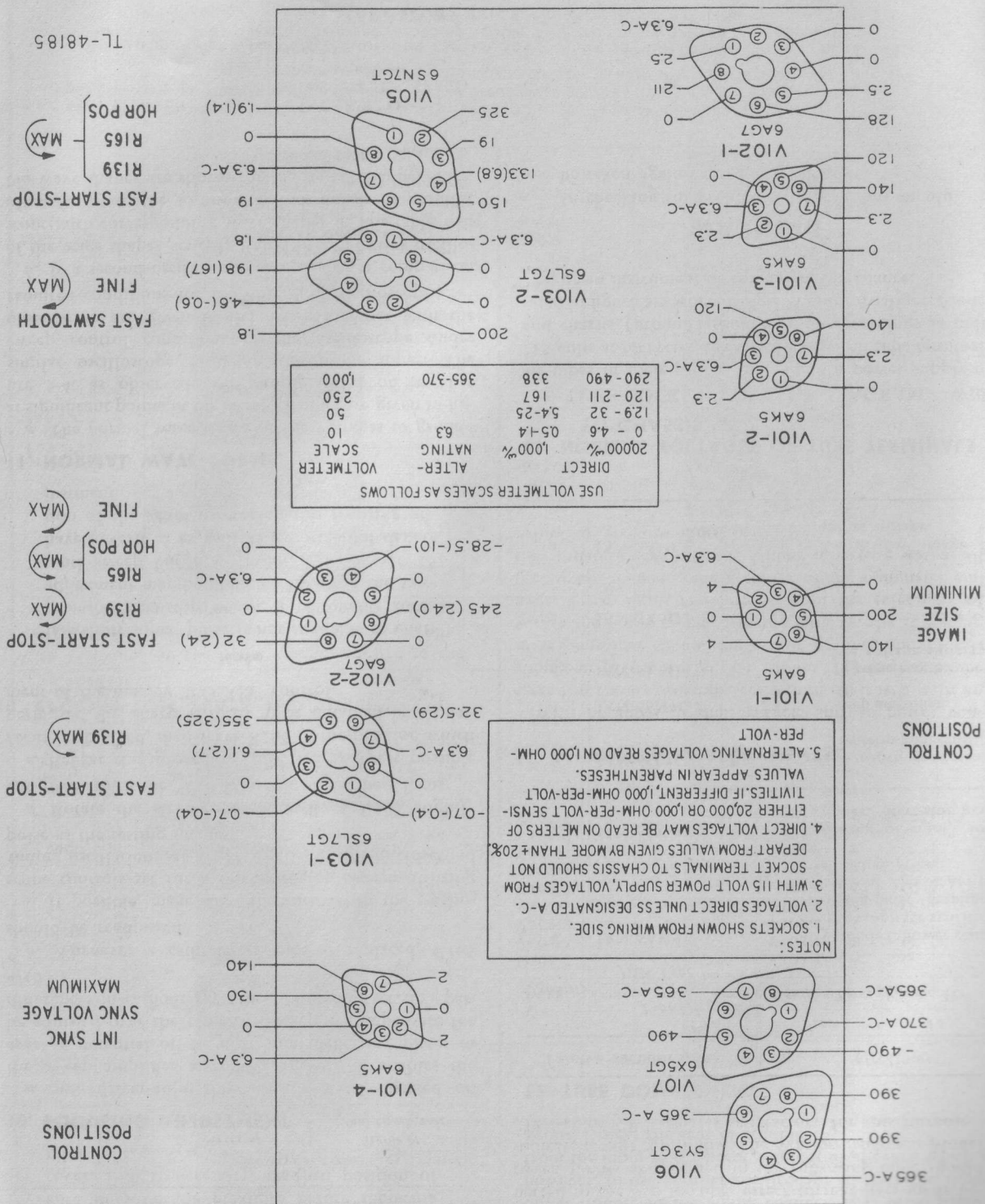


TABLE OF OHMMETER MEASUREMENTS

Ohmmeter Scale	See Note	Measure		Resistance
		From	To	
Equip. Term.	Equip. Term.	Term.	Term.	
V101-1	1	G	G	2.7 meg.
V101-1	2	G	G	1,070
V101-1	3	G	G	1
V101-1	5	G	G	45,200
V101-2	1	G	G	2.6 meg.
V101-2	2	G	G	210
V101-2	3	G	G	1
V101-2	5	G	G	40,900
V101-3	1	G	G	220,000
V101-3	2	G	G	200
V101-3	3	G	G	21,200
V101-3	5	G	G	75
V102-1	1	G	G	79
V102-1	2	G	G	1
V102-1	4	G	G	902,000
V102-1	5	G	G	75
V102-1	6	G	G	39,000
V102-1	8	G	G	21,200
V102-2	1	G	G	88,700
V102-2	4	G	G	5.5
V102-2	5	G	G	96,000
V102-2	6	G	G	194,000
V102-2	7	G	G	2,300
V102-2	8	G	G	1
V103-1	1	G	G	1 meg.
V103-1	5	G	G	134,000
V103-1	6	G	G	150,000
V103-1	7	G	G	700,000
V103-1	8	G	G	1.1 meg.
V103-2	1	G	G	560
V103-2	2	G	G	165,000
V103-2	3	G	G	590
V103-2	4	G	G	560
V103-2	5	G	G	68,000
V103-2	6	G	G	220,000
V103-2	7	G	G	560
V103-2	8	G	G	236,000
V103-2	9	G	G	2
V103-2	10	G	G	560
V103-2	11	G	G	1.1 meg.
V103-2	12	G	G	134,000
V103-2	13	G	G	150,000
V103-2	14	G	G	700,000
V103-2	15	G	G	1.1 meg.
V103-2	16	G	G	134,000
V103-2	17	G	G	150,000
V103-2	18	G	G	700,000
V103-2	19	G	G	1.1 meg.
V103-2	20	G	G	134,000
V103-2	21	G	G	150,000
V103-2	22	G	G	700,000
V103-2	23	G	G	1.1 meg.
V103-2	24	G	G	134,000
V103-2	25	G	G	150,000
V103-2	26	G	G	700,000
V103-2	27	G	G	1.1 meg.
V103-2	28	G	G	134,000
V103-2	29	G	G	150,000
V103-2	30	G	G	700,000
V103-2	31	G	G	1.1 meg.
V103-2	32	G	G	134,000
V103-2	33	G	G	150,000
V103-2	34	G	G	700,000
V103-2	35	G	G	1.1 meg.
V103-2	36	G	G	134,000
V103-2	37	G	G	150,000
V103-2	38	G	G	700,000
V103-2	39	G	G	1.1 meg.
V103-2	40	G	G	134,000
V103-2	41	G	G	150,000
V103-2	42	G	G	700,000
V103-2	43	G	G	1.1 meg.
V103-2	44	G	G	134,000
V103-2	45	G	G	150,000
V103-2	46	G	G	700,000
V103-2	47	G	G	1.1 meg.
V103-2	48	G	G	134,000
V103-2	49	G	G	150,000
V103-2	50	G	G	700,000
V103-2	51	G	G	1.1 meg.
V103-2	52	G	G	134,000
V103-2	53	G	G	150,000
V103-2	54	G	G	700,000
V103-2	55	G	G	1.1 meg.
V103-2	56	G	G	134,000
V103-2	57	G	G	150,000
V103-2	58	G	G	700,000
V103-2	59	G	G	1.1 meg.
V103-2	60	G	G	134,000
V103-2	61	G	G	150,000
V103-2	62	G	G	700,000
V103-2	63	G	G	1.1 meg.
V103-2	64	G	G	134,000
V103-2	65	G	G	150,000
V103-2	66	G	G	700,000
V103-2	67	G	G	1.1 meg.
V103-2	68	G	G	134,000
V103-2	69	G	G	150,000
V103-2	70	G	G	700,000
V103-2	71	G	G	1.1 meg.
V103-2	72	G	G	134,000
V103-2	73	G	G	150,000
V103-2	74	G	G	700,000
V103-2	75	G	G	1.1 meg.
V103-2	76	G	G	134,000
V103-2	77	G	G	150,000
V103-2	78	G	G	700,000
V103-2	79	G	G	1.1 meg.
V103-2	80	G	G	134,000
V103-2	81	G	G	150,000
V103-2	82	G	G	700,000
V103-2	83	G	G	1.1 meg.
V103-2	84	G	G	134,000
V103-2	85	G	G	150,000
V103-2	86	G	G	700,000
V103-2	87	G	G	1.1 meg.
V103-2	88	G	G	134,000
V103-2	89	G	G	150,000
V103-2	90	G	G	700,000
V103-2	91	G	G	1.1 meg.
V103-2	92	G	G	134,000
V103-2	93	G	G	150,000
V103-2	94	G	G	700,000
V103-2	95	G	G	1.1 meg.
V103-2	96	G	G	134,000
V103-2	97	G	G	150,000
V103-2	98	G	G	700,000
V103-2	99	G	G	1.1 meg.
V103-2	100	G	G	134,000
V103-2	101	G	G	150,000
V103-2	102	G	G	700,000
V103-2	103	G	G	1.1 meg.
V103-2	104	G	G	134,000
V103-2	105	G	G	150,000
V103-2	106	G	G	700,000
V103-2	107	G	G	1.1 meg.
V103-2	108	G	G	134,000
V103-2	109	G	G	150,000
V103-2	110	G	G	700,000
V103-2	111	G	G	1.1 meg.
V103-2	112	G	G	134,000
V103-2	113	G	G	150,000
V103-2	114	G	G	700,000
V103-2	115	G	G	1.1 meg.
V103-2	116	G	G	134,000
V103-2	117	G	G	150,000
V103-2	118	G	G	700,000
V103-2	119	G	G	1.1 meg.
V103-2	120	G	G	134,000
V103-2	121	G	G	150,000
V103-2	122	G	G	700,000
V103-2	123	G	G	1.1 meg.
V103-2	124	G	G	134,000
V103-2	125	G	G	150,000
V103-2	126	G	G	700,000
V103-2	127	G	G	1.1 meg.
V103-2	128	G	G	134,000
V103-2	129	G	G	150,000
V103-2	130	G	G	700,000
V103-2	131	G	G	1.1 meg.
V103-2	132	G	G	134,000
V103-2	133	G	G	150,000
V103-2	134	G	G	700,000
V103-2	135	G	G	1.1 meg.
V103-2	136	G	G	134,000
V103-2	137	G	G	150,000
V103-2	138	G	G	700,000
V103-2	139	G	G	1.1 meg.
V103-2	140	G	G	134,000
V103-2	141	G	G	150,000
V103-2	142	G	G	700,000
V103-2	143	G	G	1.1 meg.
V103-2	144	G	G	134,000
V103-2	145	G	G	150,000
V103-2	146	G	G	700,000
V103-2	147	G	G	1.1 meg.
V103-2	148	G	G	134,000
V103-2	149	G	G	150,000
V103-2	150	G	G	700,000
V103-2	151	G	G	1.1 meg.
V103-2	152	G	G	134,000
V103-2	153	G	G	150,000
V103-2	154	G	G	700,000
V103-2	155	G	G	1.1 meg.
V103-2	156	G	G	134,000
V103-2	157	G	G	150,000
V103-2	158	G	G	700,000
V103-2	159	G	G	1.1 meg.
V103-2	160	G	G	134,000
V103-2	161	G	G	150,000
V103-2	162	G	G	700,000
V103-2	163	G	G	1.1 meg.
V103-2	164	G	G	134,000
V103-2	165	G	G	150,000
V103-2	166	G	G	700,000
V103-2	167	G	G	1.1 meg.
V103-2	168	G	G	134,000
V103-2	169	G	G	150,000
V103-2	170	G	G	700,000
V103-2	171	G	G	1.1 meg.
V103-2	172	G	G	134,000
V103-2	173	G	G	150,000
V103-2	174	G	G	700,000
V103-2	175	G	G	1.1 meg.
V103-2	176	G	G	134,000
V103-2	177	G	G	150,000
V103-2	178	G	G	700,000
V103-2	179	G	G	1.1 meg.
V103-2	180	G	G	134,000
V103-2	181	G	G	150,000
V103-2	182	G	G	700,000
V103-2	183	G	G	1.1 meg.
V103-2	184	G	G	134,000
V103-2	185	G	G	150,000
V103-2	186	G	G	700,000
V103-2	187	G	G	1.1 meg.
V103-2	188	G	G	134,000
V103-2	189	G	G	150,000
V103-2	190	G	G	700,000
V103-2	191	G	G	1.1 meg.
V103-2	192	G	G	134,000
V103-2	193	G	G	150,000
V103-2	194	G	G	700,000
V103-2	195	G	G	1.1 meg.
V103-2	196	G	G	134,000
V103-2	197	G	G	150,000
V103-2	198	G	G	700,000
V103-2	199	G	G	1.1 meg.
V103-2	200	G	G	134,000
V103-2	201	G	G	150,000
V103-2	202	G	G	700,000
V103-2	203	G	G	1.1 meg.
V103-2	204	G	G	134,000
V103-2	205	G	G	150,000
V103-2	206	G	G	700,000
V103-2	207	G	G	1.1 meg.
V103-2	208	G	G	134,000
V103-2	209	G	G	150,000
V103-2	210	G	G	700,000
V103-2	211	G	G	1.1 meg.
V103-2	212	G	G	134,000
V103-2	213	G	G	150,000
V103-2	214	G	G	700,000
V103-2	215	G	G	1.1 meg.
V103-2	216	G	G	134,000
V103-2	217	G	G	150,000
V103-2	218	G	G	700,000
V103-2	219	G	G	1.1 meg.
V103-2	220	G	G	134,000
V103-2	221	G	G	150,000
V103-2	222	G	G	700,000
V103-2	223	G	G	1.1 meg.
V103-2	224	G	G	134,000
V103-2	225	G	G	150,000
V103-2	226	G	G	700,000
V103-2	227	G	G	1.1 meg.
V103-2	228	G	G	134,000
V103-2	229	G	G	150,000
V103-2	230	G	G	700,000
V103-2	231	G	G	1.1 meg.
V103-2	232	G	G	134,000
V103-2	233	G	G	150,000
V103-2	234	G	G	700,000
V103-2	235	G	G	1.1 meg.
V103-2	236	G	G	134,000
V103-2	237	G	G	150,000
V103-2	238	G	G	700,000
V103-2	239	G	G	1.1 meg.
V103-2	240	G	G	134,000
V103-2	241	G	G	150,000
V103-2	242	G	G	700,000
V103-2	243	G	G	1.1 meg.
V103-2	244	G	G	1

6. TO ASSEMBLE PROBE.

(1) Strip back insulation from about 1 inch of coaxial cable exposing copper woven shield. The inner conductor should extend about an inch beyond the end of the copper shield.

(2) Thread coaxial cable through item 5.
(3) Solder end of coaxial cable shield to flared end of spring.
(4) Slide item 5 along cable until flared end of coil spring is firmly against lip inside item 5.
(5) Heat item 5 allowing solder to run into the hole at the side and into the rear, thus fastening the spring and the cable firmly to the item.
(6) Put item 4 in place, being sure that the center conductor of the coaxial cable is long enough to come through this part.
(7) Solder capacitor C128 and resistor R101-1 to end of coaxial inner conductor. The other end of the capacitor should be soldered to the pigtail of the resistor and care should be taken to see that this pigtail is straight.

(8) Clean sleeve on assembly, item 1B, to assure free passage of resistor pigtail through sleeve.
(9) Screw assembly 1B into item 5 being sure that resistor pigtail is in sleeve.
(10) Slide clip, item 20, over end of sleeve, item 1B, and solder in place.
(11) Bend back end of resistor pigtail and solder to shank of clip.
(12) Replace rubber shield, item 11, with screws and washers, items 12 and 22.

(13) Replace protective covers, items 6 and 7.
c. TO REPLACE DEFECTIVE GROUND LEAD.
(1) Unscrew protective cover, item 7. Remove old section of ground lead and replace with new assembly being careful not to get solder in the threads.
(2) Replace protective cover, item 7.

17. KNOB SETTINGS.

If any of the control knobs are replaced, the following conditions must be met:

- "SWEEP SELECTOR"—With the switch in the up position the indicator shall point to "START-STOP."
- "SWEEP SPEED"—With switch in extreme clockwise position the indicator shall be at "FAST."
- "INPUT IMPEDANCE"—With switch at extreme clockwise position indicator shall be at 40.
- "ATTENUATION"—With switch at extreme clockwise position indicator shall be at 20.

18. REPAIR OF PROBE.—(See fig. 7-12.)

- TO DISASSEMBLE A DEFECTIVE PROBE.
(1) Remove screws, item 12, washers, item 22, and rubber shield, item 11.
(2) Unscrew and remove fibre protective covers, items 6 and 7.

(3) Using care, apply heat to base of clip, item 20, and remove.
(4) Holding soldering iron on sleeve, item 1B, keep parts sufficiently hot to cause solder to flow inside of sleeve. Hold part which is fastened to item 1B in a vise, if possible.
(5) While item 1B is heated, carefully unscrew item 5 exposing resistor, item 13, and capacitor, item 14.

(6) These items should be removed from coaxial conductor, or if the coaxial conductor is broken, from the broken end of the center conductor.

(7) Heat item 5, being careful not to get solder in the threads on the outside of item 5, and remove the coil protective spring. Clean solder from spring.

Notes for Ohmmeter Measurements

- "IMAGE SIZE" control R109 in extreme clockwise position. As the control is rotated counterclockwise, ohmmeter reading should decrease smoothly to a minimum value between 560 and 580 ohms. As the control reaches its extreme counterclockwise position, the ohmmeter reading should suddenly increase to a value between 17,400 and 27,600 ohms.
- Screwdriver control R126 in extreme clockwise position. As the control is rotated counterclockwise, the ohmmeter reading should increase smoothly, reaching a final maximum value of between 970,000 ohms and 1.5 megohms.
- CAUTION: Do not touch control R126 without first reading paragraph 5b.
- Switch S103-1 in "INT SYNC" position. "SYNC VOLTAGE" control in extreme clockwise position. As the control is rotated counterclockwise, the ohmmeter reading should increase smoothly, reaching a maximum value of between 4,200 and 6,200 ohms.
- "SWEEP SELECTOR" in "START-STOP" position. Check for both positions of "SYNC POLARITY" switch.
- "SWEEP SELECTOR" in "SAWTOOTH" position.
- Screwdriver control R139 in extreme clockwise position. As the control is rotated counterclockwise, the ohmmeter reading should increase smoothly to a maximum value of between 6,100 and 8,300 ohms.

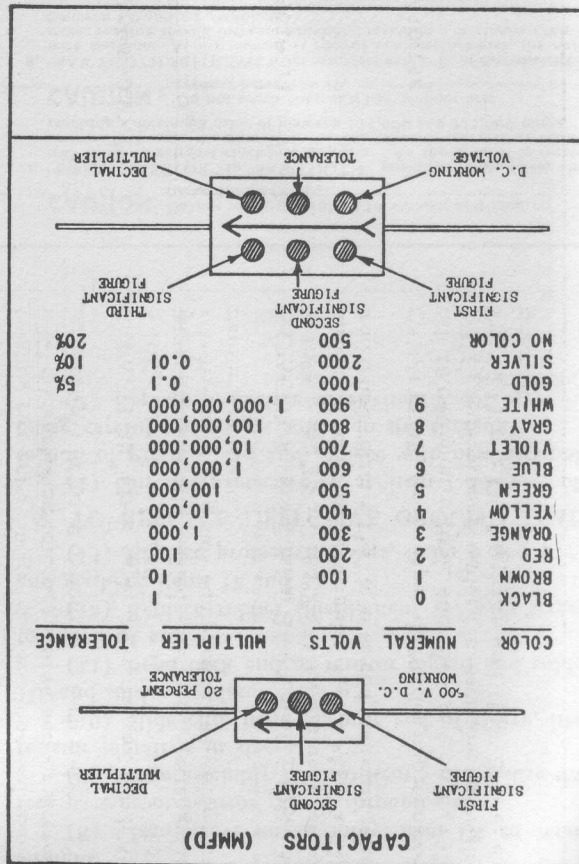
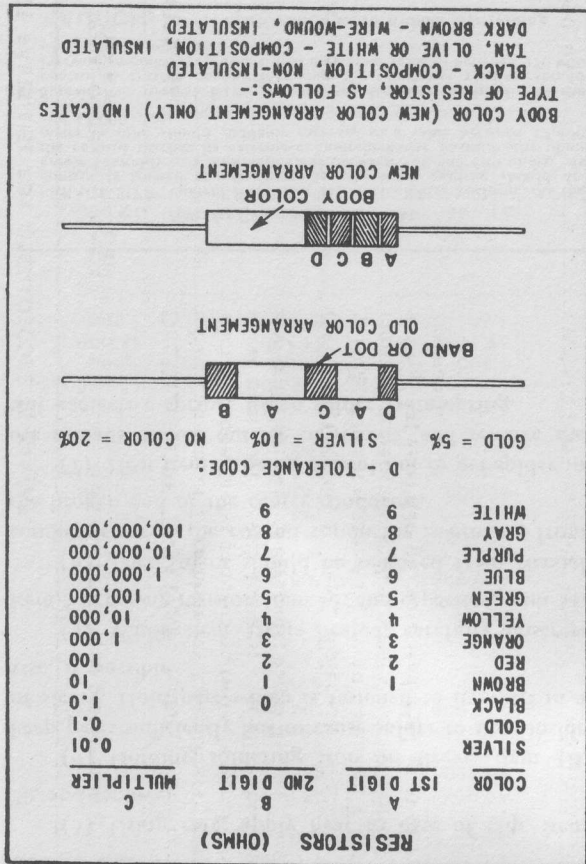
CAUTION: Do not touch control R139 without first reading paragraph 2d and g.

- "SWEEP SELECTOR" in "SAWTOOTH" position. Screwdriver control R165 in extreme clockwise position. As the control is rotated counterclockwise, the ohmmeter reading should increase smoothly, reaching a maximum value of between 175,000 and 225,000 ohms.
- CAUTION: Do not touch control R165 without first reading paragraph 10.
- "SAWTOOTH FREQUENCY" control, R145A & B, in extreme clockwise position. As the control is rotated counterclockwise, the ohmmeter reading should increase smoothly, reaching a maximum value of between 1.0 and 1.2 megohms.
- "SAWTOOTH FREQUENCY" control, R145A & B, in extreme clockwise position. As the control is rotated counterclockwise, the ohmmeter reading should increase smoothly, reaching a maximum value of between 4.2 and 6.3 megohms.
- "HORIZONTAL POSITION" control, R151, in extreme counterclockwise position. As the control is rotated clockwise, the ohmmeter reading should decrease smoothly to a minimum value of between 4,500 and 5,600 ohms.
- "SWEEP SPEED FINE" control R145C in extreme clockwise position. As the control is rotated counterclockwise, the ohmmeter reading should increase smoothly to a maximum value of between 1.5 and 1.9 megohms.

RMA COLOR CODES

SUPPLEMENTARY DATA

SECTION VI



1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP.

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK			4TH ECH	DEPOT STOCK
					1ST ECH	2D ECH	3D ECH		
101-199 series	3F4323-34A		OSCILLOSCOPE, TS-34A/AP: including one complete set of tubes; consists of 2" cathode-ray tube; central steel framework with adjustments and controls on two side panels and removable sheet steel covers with louvers; over-all dimen approx 20 ³ / ₄ " x 9" x 8" inclusive of eyeshade; wt 30 lb.						
C101-1 C101-2 C101-3 C101-4 C101-6 C101-7 C101-9 C101-10	3DA50-89		CAPACITOR, fixed: paper dielectric; oil-filled; 50,000 mmf $\pm$ 10%; 600 vdcw at -40°F (-40°C) to 185 $^{\circ}\text{F}$ (85 $^{\circ}\text{C}$) ambient temp; (hermetically sealed metal case; cylindrical; 1 ¹ / ₁₆ " diam x 1 ⁵ / ₁₆ " lg; axial #20 ga. wire lead 2 ¹ / ₂ " lg at ea end; moisture resistant).	8				*	*
C102-1 C102-2 C102-3 C102-4 C102-5 C102-6	3D9030V-6		CAPACITOR, variable: ceramic; 4 mfd, min; 30 mmf, max; 500 vdcw at -40°F (-40°C) to 212 $^{\circ}\text{F}$ (100 $^{\circ}\text{C}$); 2 silver plates formed by semi-circular silver coatings on fixed and movable ceramic elements; dimen 4 ¹ / ₆₄ " wd (one end rounded) x 5 ⁵ / ₆₄ " x 3/8" thk, including adjusting stud slotted for screwdriver; solder term project in plane of bottom at each end.	6				*	*
C107-1 C107-2	3DA500-30-97.27		CAPACITOR, fixed: paper dielectric; oil filled; 500,000 mmf $\pm$ 10%; 600 vdcw at -40°F (-40°C) to 185 $^{\circ}\text{F}$ (85 $^{\circ}\text{C}$) ambient temp; (hermetically sealed metal can; rectangular, 7/8" x 1" x 1 ³ / ₁₆ " lg; one lg side equipped w/two solder term 1" apart; moisture resistant).	2				*	*
C110-1 C110-2 C110-3	3K3010211		CAPACITOR, fixed: mica; 1,000 mmf $\pm$ 10%; 500 vdcw at -40°F (-40°C) to 185 $^{\circ}\text{F}$ (85 $^{\circ}\text{C}$) ambient temp; molded in insulating material; rectangular 9/32" x 53/64" x 53/64" lg; wire lead 0.040" diam x 1 ¹ / ₈ " lg at ea end; moisture resistant.	3				*	*
C112-1 C112-2 C112-3 C112-4 C112-5 C112-6	3DA10-158		CAPACITOR, fixed: paper dielectric; impregnated w/mineral oil; 10,000 mmf $\pm$ 20%; 400 vdcw at -50°F (46 $^{\circ}\text{C}$) to 185 $^{\circ}\text{F}$ (85 $^{\circ}\text{C}$) ambient temp; molded in insulating material; rectangular, 19/64" x 13/16" x 13/16" lg; wire lead 15/16" lg at ea end; moisture resistant.	6				*	*

* Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (contd).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK		3D ECH	4TH ECH	DEPOT STOCK
					1ST ECH	2D ECH			
C113-1	3K2047114		CAPACITOR, fixed: mica; 470 mmf $\pm 20\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{7}{32}$ " x $\frac{15}{32}$ " x $\frac{51}{64}$ " lg; wire lead 0.032" diam x $\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*
C115	3K2018111		CAPACITOR, fixed: mica; 180 mmf $\pm 10\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{7}{32}$ " x $\frac{15}{32}$ " x $\frac{51}{64}$ " lg; wire lead 0.032" diam x $\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*
C116-1 C116-2 C116-3	3K2010112		CAPACITOR, fixed: mica; 100 mmf $\pm 5\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{7}{32}$ " x $\frac{15}{32}$ " x $\frac{51}{64}$ " lg; wire lead 0.032" diam x $\frac{1}{8}$ " lg at ea end; moisture resistant.	3				*	*
C117	3K2047011		CAPACITOR, fixed: mica; 47 mmf $\pm 10\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{7}{32}$ " x $\frac{15}{32}$ " x $\frac{51}{64}$ " lg; wire lead 0.032" diam x $\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*
C118	3K3539211		CAPACITOR, fixed: mica; 3,900 mmf $\pm 10\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{11}{32}$ " x $\frac{53}{64}$ " x $\frac{53}{64}$ " lg; wire lead 0.040" diam x $\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*
C119	3K2018011		CAPACITOR, fixed: mica; 18 mmf $\pm 10\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{7}{32}$ " x $\frac{15}{32}$ " x $\frac{51}{64}$ " lg; wire lead 0.032" diam x $\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*
C121	3K3010212		CAPACITOR, fixed: mica; 1,000 mmf $\pm 5\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{9}{32}$ " x $\frac{53}{64}$ " x $\frac{53}{64}$ " lg; wire lead 0.040" diam x $\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*
C124	3DA250-77		CAPACITOR, fixed: paper dielectric oil filled; 250,000 mmf $\pm 20\%$; 600 vdcw at -40°F (-40°C) to 185°F (85°C); metal case, rectangular, $\frac{9}{16}$ " x $\frac{13}{4}$ " x $\frac{17}{8}$ " h; 2 solder term, 1" apart, project $\frac{9}{16}$ " from bottom which is equipped w/ $\frac{27}{16}$ " lg mounting bracket w/two 0.144" holes spaced $\frac{21}{8}$ " apart.	1				*	*

C125 C125A C125B	3DA500-140	CAPACITOR, fixed: dual unit; paper dielectric; oil filled; metal rectangular case, $\frac{9}{16}$ " x $1\frac{3}{4}$ " x $2\frac{1}{2}$ " h not including 3 solder term ea $\frac{9}{16}$ " h, spaced $\frac{1}{2}$ " apart and projecting from top; bottom of case equipped with a $2\frac{7}{16}$ " lg bracket having two 0.144" diam holes, spaced $2\frac{1}{8}$ " apart for mounting capacitor; 500,000 mmf $\pm 15\%$; 600 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp.	3	*	*
C126 C126-A C126-B	3DA250-78	CAPACITOR, fixed: dual unit; paper dielectric; oil filled; metal rectangular case $\frac{9}{16}$ " x $1\frac{3}{4}$ " x $1\frac{7}{8}$ " h not including 3 solder term ea $\frac{9}{16}$ " h, spaced $\frac{1}{2}$ " apart and projecting from bottom; bottom of case equipped with a $2\frac{7}{16}$ " lg bracket, having two 0.144" diam holes, spaced $2\frac{1}{8}$ " apart for mounting capacitor; 250,000 mmf $\pm 15\%$; 600 vdcw at 40°F (-40°C) to 185°F (85°C) ambient temp.	3	*	*
C127-1 C127-2	3DA500-139	CAPACITOR, fixed: paper dielectric; oil filled; metal rectangular case, $\frac{9}{16}$ " x $1\frac{3}{4}$ " x $1\frac{7}{8}$ " h, not including two solder term $\frac{9}{16}$ " h, spaced 1" apart and projecting from the bottom; bottom of case equipped with a $2\frac{7}{16}$ " lg bracket, having two 0.144" diam holes, spaced $2\frac{1}{8}$ " apart for mtg capacitor; 500,000 mmf $\pm 10\%$; 600 vdcw at 40°F (40°C) to 185°F (85°C) ambient temp.	2	*	*
C128-1 C128-2	3D9010-26.1	CAPACITOR, fixed: ceramic dielectric with silver coated plates; 10 mmf $\pm 5\%$; 500 vdcw -40°F (-40°C) to 212°F (100°C) ambient temp; temp coefficient ± 0 ; cylindrical, $\frac{7}{32}$ " diam x $\frac{7}{16}$ " lg; 20-ga. tinned copper axial lead, $1\frac{1}{2}$ " lg, at ea end; moisture resistant.	2	*	*
C129-1 C129-2	3K3020212	CAPACITOR, fixed: mica; 2,000 mmf $\pm 5\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular $\frac{9}{32}$ " x $5\frac{3}{64}$ " lg; wire lead 0.040" diam x $1\frac{1}{8}$ " lg at ea end; moisture resistant.	2	*	*
C130-1	3K2075012	CAPACITOR, fixed: mica; 75 mmf $\pm 5\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{7}{32}$ " x $1\frac{5}{32}$ " x $5\frac{1}{64}$ " lg; wire lead 0.032" diam $1\frac{1}{8}$ " lg at ea end; moisture resistant.	1	*	*
C131	3K2520112	CAPACITOR, fixed: mica; 200 mmf $\pm 5\%$; 500 vdcw; $1\frac{1}{16}$ " x $1\frac{5}{32}$ " x $\frac{7}{32}$ " thk; axial wire lead $1\frac{1}{8}$ " lg at ea end.	1	*	*

*Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (contd).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK 1ST ECH	2D ECH	3D ECH	4TH ECH	DEPOT STOCK
C132	3DB20-62		CAPACITOR, fixed: dual unit; 20-1,000 mmf $\pm 10\%$; etched plate polarized electrolytic; cylindrical metal case $1\frac{3}{8}$ " diam x $2\frac{3}{4}$ " diam x $2\frac{3}{4}$ " lg; three solder lug term $\frac{7}{16}$ " lg project from end of bushing.	1				*	*
C132A	3DB20-62		CAPACITOR: 20 mmf $\pm 10\%$; 150 vdcw; part of C132.	1				*	*
C132B	3DB20-62		CAPACITOR: 1,000 mmf $\pm 10\%$; 5 vdcw; part of C132.	1				*	*
C133	3DB60-5		CAPACITOR, fixed: dual unit; 20-60 mf $\pm 10\%$; etched plate; polarized electrolytic; cylindrical metal case $1\frac{3}{8}$ " diam x $3\frac{3}{4}$ " lg; three solder lug terminals $\frac{7}{16}$ " lg project from end of bushing.	3				*	*
C133A	3DB60-5		CAPACITOR: 20 mf $\pm 10\%$; 400 vdcw; part of C133.	1				*	*
C133B	3DB60-5		CAPACITOR: 60 mf $\pm 10\%$; 400 vdcw; part of C133.	1				*	*
C134	3DB40-47		CAPACITOR, fixed: dual unit; 40-20 mf $\pm 10\%$; cylindrical metal case $1\frac{3}{8}$ " diam x $2\frac{3}{4}$ " lg; three solder lug terminals $\frac{7}{16}$ " lg project from end of bushing.	3				*	*
C134A	3DB40-47		CAPACITOR: 20 mf $\pm 10\%$; 150 vdcw; part of C134.					*	*
C134B	3DB40-47		CAPACITOR: 40 mf. $\pm 10\%$; 350 vdcw; part of C134.					*	*
C135	3K3068112		CAPACITOR, fixed: mica; 680 mmf $\pm 5\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{7}{32}$ " x $1\frac{5}{32}$ " x $5\frac{1}{64}$ " lg; wire lead 0.040" diam x $1\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*
C136	3K2012112		CAPACITOR, fixed: mica; 120 mmf $\pm 5\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $\frac{7}{32}$ " x $1\frac{5}{32}$ " x $5\frac{1}{64}$ " lg; wire lead 0.032" diam x $1\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*
C137	3K3539212		CAPACITOR, fixed: mica; 3,900 mmf $\pm 5\%$; 500 vdcw at -40°F (-40°C) to 185°F (85°C) ambient temp; molded in insulating material; rectangular, $1\frac{1}{32}$ " x $5\frac{3}{64}$ " x $5\frac{3}{64}$ " lg; wire lead 0.040" diam x $1\frac{1}{8}$ " lg at ea end; moisture resistant.	1				*	*

F101-1 F101-2	3Z1927	FUSE: 2 amp; cartridge.	2				*	*
I101	2Z5933	PILOT LAMP: Mazda; miniature bayonet base; 12-16v; 0.22amp.	1	*				*
J101-1 J101-2	2Z8799-239	JACK, coaxial: silver plated; cylindrical, 0.620" diam x $\frac{3}{4}$ " lg, having $\frac{5}{8}$ -.24 thd $\frac{3}{8}$ " lg at one end and a 1" x 1" square plate $\frac{1}{64}$ " from opposite end, with four 0.125" diam holes for $\frac{23}{32}$ " x $\frac{23}{32}$ " mtg centers; polystyrene or equivalent insulation; phosphor-bronze jack 0.1065" inside diam, projects from mounting end; used w/D-166393 coaxial plug.	2				*	*
J102-1 J102-2	2Z8672.35	CONNECTOR: threaded metal shell, cylindrical approx $\frac{9}{16}$ " diam $\frac{3}{4}$ " lg, having a bakelite 2-contact socket insert; arranged for panel mounting by means of a coupling ring and a knurled locking nut; term project $\frac{1}{16}$ " from bottom of insert; for use with MC2M connector.	2				*	*
L101-1 L101-2	3CK318-21	COIL, choke: RF; 52 turns of 19/40 Litz single cotton-covered wire; honeycomb winding $\frac{1}{8}$ " thk on $\frac{1}{2}$ " standard bakelite bobbin with 2 soldering-lug terminals; inductance 50 μ h resonates with 100 mmf capacitor at 2.25 mc per sec; screw mounted through center hole of bobbin; 8-32 thd.	2				*	*
L103	3CK1987-105	COIL, retardation: 2,590 turns of #33 AWG E wire; 3.8 hy at 10v AC, 60 cycles per sec w/0.105 amp rated DC; Harvel No. 612C varnish impregnation; silicon steel core; uncased; mtg dimen $1\frac{1}{4}$ "; two soldering-lug term on phenol fiber strip supported by clamping bolts at side of coil; average d-c resistance 200 ohms at 68°F (20°C); 30v (operating) across term; working voltage to core 375v DC.	1				*	*
P102	6Z1727	CAP, cord-grip: composition insert in a metal shell, cylindrical $1\frac{1}{2}$ " diam x $\frac{9}{16}$ " w/a $\frac{1}{2}$ "-lg projecting cord grip at one end; two phosphor-bronze parallel blades project $\frac{3}{4}$ " from insert; 10 amp, 250v, 15 amp, 125v.	1				*	*
R101-1 R101-2 R101-3	3RC20BF395J	RESISTOR, fixed: composition; 3.9 meg $\pm 5\%$; $\frac{1}{2}$ w; molded bakelite, cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	3				*	*
R102	3RC20BF620J	RESISTOR, fixed: composition; 62 ohms $\pm 5\%$; $\frac{1}{2}$ w; molded bakelite, cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1				*	*

*Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (contd).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN 1ST ECH	STOCK 2D ECH	3D ECH	4TH ECH	DEPOT STOCK
R103	3RC20BF43J		RESISTOR, fixed: composition; 43,000 ohms $\pm 5\%$, $\frac{1}{2}$ w; molded bakelite, cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam. and $1\frac{1}{2}$ " lg at ea end.	1				*	*
R104	3RC20BF514J		RESISTOR, fixed: composition; 510,000 ohms $\pm 5\%$, $\frac{1}{2}$ w; molded bakelite, cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1				*	*
R105-1 R105-2 R105-3 R105-4	3RC30BE33K		RESISTOR, fixed: composition; 33,000 ohms $\pm 10\%$, 1w; molded bakelite; cylindrical, $\frac{7}{32}$ " diam x $\frac{9}{16}$ " lg; axial wire lead 0.040" diam and $1\frac{1}{2}$ " lg at ea end.	4				*	*
R106-1 R106-2 R106-3 R106-4 R106-9 R106-10 R106-11 R106-12	3RC30BE393K		RESISTOR, fixed: composition; 39,000 ohms $\pm 10\%$, 1w; molded bakelite; cylindrical, $\frac{7}{32}$ " diam x $\frac{9}{16}$ " lg; axial wire lead 0.040" diam and $1\frac{1}{2}$ " lg at ea end.	8				*	*
R107-1 R107-2 R107-3 R107-4 R107-6	3RC20BF222J		RESISTOR, fixed: composition; 2,200 ohms $\pm 5\%$, $\frac{1}{2}$ w; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	5				*	*
R108-1 R108-2 R108-3 R108-4	3RC20BE225M		RESISTOR, fixed: composition; 2.2 meg $\pm 20\%$, $\frac{1}{2}$ w; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	4				*	*
R109	2ZK7262-500		POTENTIOMETER: composition; 500 ohms $\pm 20\%$, 2w; linear taper; with single throw, single pole switch; 3 amp, 125v; shaft $\frac{1}{4}$ " diam x $\frac{5}{8}$ " lg; three resistor term and two solder switch term project from side and rear, respectively, of $1\frac{1}{16}$ " diam x $\frac{3}{4}$ " case.	1				*	*

R110	3ZK6011C3.1	RESISTOR, fixed: 113.1 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R111	3ZK6008J9.1	RESISTOR, fixed: 89.8 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R112	3ZK6007A1.1	RESISTOR, fixed: 71.4 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R113	3ZK6005A6-5.1	RESISTOR, fixed: 56.7 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R114	3ZK6004A5-5.1	RESISTOR, fixed: 45.1 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R115	3ZK6003E5-3.1	RESISTOR, fixed: 35.7 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R116	3ZK6002H8.1	RESISTOR, fixed: 28.5 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R117	3ZK6002B2-10.1	RESISTOR, fixed: 22.5 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R118	3ZK6001G7.1	RESISTOR, fixed: 17.9 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R119	3ZK6001D4-4.1	RESISTOR, fixed: 14.25 ohms $\pm 1\%$, $\frac{1}{4}w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*
R120	3Z6003E5-5	RESISTOR, fixed: 55 ohms $\pm 1\%$, $1w$; wire wound on bakelite core; phenol fibre insulation; tubular, $\frac{5}{16}$ " diam x 1" lg; axial wire lead 2" lg at ea end; moisture resistant.	1	*	*

* Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (contd).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK			4TH ECH	DEPOT STOCK
					1ST ECH	2D ECH	3D ECH		
R121	3RC20BE223M		RESISTOR, fixed: 22,000 ohms $\pm 20\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1				*	*
R122	3RC20BF275J		RESISTOR, fixed: 2.7 meg $\pm 5\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1				*	*
R123-1 R123-2	3RC20BF394J		RESISTOR, fixed: 390,000 ohms $\pm 5\%$, $\frac{1}{2}w$; composition; molded bakelite cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	2				*	*
R124-1	3RC20BF201J		RESISTOR, fixed: 200 ohms $\pm 5\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	4				*	*
R125-1 R125-2	3RC20BE824K		RESISTOR, fixed: 820,000 ohms $\pm 10\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	2				*	*
R126	2ZK7262-1000M.1		POTENTIOMETER: 1 meg $\pm 20\%$, 2w; composition; linear taper; shaft $\frac{1}{4}$ " diam x $\frac{5}{8}$ " lg w/screwdriver slot in end; three solder term on one side of $1\frac{1}{16}$ " diam x $\frac{9}{16}$ " cylindrical case, perpendicular to shaft; shaft locking type.	1				*	*
	2Z7274-51		POTENTIOMETER: 1 meg $\pm 20\%$, 0.4w; composition; linear taper; shaft $\frac{1}{4}$ " diam x $\frac{5}{8}$ " lg w/screwdriver slot; three term; cylindrical case $1\frac{5}{16}$ " diam x $\frac{1}{2}$ " lg; shaft locking type. or	1				*	*
R127	3RC20BF434J		RESISTOR, fixed: 430,000 ohms $\pm 5\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1				*	*
R128	3RC20BF432J		RESISTOR, fixed: 4,300 ohms $\pm 5\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.					*	*
R130-3 R130-4	3RC20BE105K		RESISTOR, fixed: 1 meg $\pm 10\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1				*	*

R131	3RC20BF750J	RESISTOR, fixed: 75 ohms $\pm 5\%$, $\frac{1}{2}$ " w; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1	*	*
R133	2ZK7262-5M.7	POTENTIOMETER: 5,000 ohms $\pm 20\%$, 2w; composition; linear taper; shaft $\frac{1}{4}$ " diam x $\frac{5}{8}$ " lg; three solder term on side of $1\frac{1}{16}$ " diam x $\frac{9}{16}$ " cylindrical case, perpendicular to shaft.	1	*	*
	2ZK7269.149	POTENTIOMETER: 5,000 ohms $\pm 20\%$, 1w; composition; linear taper shaft $\frac{1}{4}$ " lg; 3 term; enclosed body $1\frac{1}{8}$ " diam x $\frac{1}{2}$ " lg. or	1	*	*
R134-1 R134-2 R134-3	3RC20BE563K	RESISTOR, fixed: 56,000 ohms $\pm 10\%$, $\frac{1}{2}$ " w; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	3	*	*
R135	3RC20BE472M	RESISTOR, fixed: 4,700 ohms $\pm 20\%$, $\frac{1}{2}$ " w; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1	*	*
R136-1 R136-2 R136-3	3RC20BE104K	RESISTOR, fixed: 100,000 ohms $\pm 10\%$, $\frac{1}{2}$ " w; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	3	*	*
R137-1 R137-2 R137-3 R137-4	3RC30BE224M	RESISTOR, fixed: 220,000 ohms $\pm 20\%$, 1w; composition; molded bakelite; cylindrical, $\frac{7}{32}$ " diam x $\frac{9}{16}$ " lg; axial wire lead 0.040" diam and $1\frac{1}{2}$ " lg at ea end.	4	*	*
R138	3RC20BE332K	RESISTOR, fixed: 3,300 ohms $\pm 10\%$, $\frac{1}{2}$ " w; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1	*	*
R139	2ZK7262-5M.6	POTENTIOMETER: 5,000 ohms $\pm 20\%$, 2w; composition. linear taper; shaft $\frac{1}{4}$ " diam x $\frac{5}{8}$ " lg w/screwdriver slot in end; three solder term on side of $1\frac{1}{16}$ " diam x $\frac{9}{16}$ " cylindrical case, perpendicular to shaft; shaft locking type.	1	*	*
	2Z7269.150	POTENTIOMETER: 5,000 ohms, $\pm 20\%$, 1w; composition; linear taper; shaft $\frac{1}{4}$ " diam x $\frac{5}{8}$ " lg w/screwdriver slot; 3 term; cylindrical, $1\frac{1}{8}$ " diam x $\frac{1}{2}$ " lg; shaft locking type. or	1	*	*

*Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (condl).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK			4TH ECH	DEPOT STOCK
					1ST ECH	2D ECH	3D ECH		
R141	3RC20BE564K		RESISTOR, fixed: 560,000 ohms $\pm 10\%$, $\frac{1}{2}w$, composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1				*	*
R142-4 R142-5 R142-6	3RC30BE104K		RESISTOR, fixed: 100,000 ohms $\pm 10\%$, 1w, composition; molded bakelite; cylindrical, $\frac{7}{32}$ " diam x $\frac{9}{16}$ " lg; axial wire lead 0.040" diam and $1\frac{1}{2}$ " lg at ea end.	3				*	*
R143-1 R143-2	3RC20BF561J		RESISTOR, fixed: 560 ohms $\pm 5\%$; $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	2				*	*
R144-1 R144-2	3RC30BE184K		RESISTOR, fixed: 180,000 ohms $\pm 10\%$, 1w; composition; molded bakelite; cylindrical, $\frac{7}{32}$ " diam x $\frac{9}{16}$ " lg; axial wire lead 0.040" diam and $1\frac{1}{2}$ " lg at ea end.	2				*	*
R145	2Z7286.12		POTENTIOMETER: three sect: one sect 5 meg, two sect 1 meg ea; 2w ea sect; 3 term ea; linear taper; enclosed body $1\frac{1}{16}$ " diam x $1\frac{3}{16}$ " lg, $\frac{1}{4}$ " diam flatted type shaft $\frac{5}{8}$ " lg.	1				*	*
R145A	2Z7286.12		POTENTIOMETER: 5 meg $\pm 20\%$, part of R145.	1				*	*
R145B	2Z7286.12		POTENTIOMETER: 1 meg $\pm 10\%$, part of R145.	1				*	*
R145C	2Z7286.12		POTENTIOMETER: 1 meg $\pm 20\%$; part of R145.	1				*	*
R146	3RC20BF124J		RESISTOR, fixed: 120,000 ohms $\pm 5\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1				*	*
R150-1 R150-2	3RC20BE155M		RESISTOR, fixed: 1.5 meg $\pm 20\%$, $\frac{1}{2}w$; composition; molded bakelite; cylindrical, $\frac{9}{64}$ " diam x $\frac{3}{8}$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	2				*	*
R151	2ZK7262-50M.4		POTENTIOMETER: 50,000 ohms $\pm 20\%$, 2w; composition; linear taper; shaft $\frac{1}{4}$ " diam x $\frac{5}{8}$ " lg; three solder term on side of $1\frac{1}{16}$ " diam x $\frac{9}{16}$ " cylindrical case, perpendicular to shaft; flatted shaft.	1				*	*
OR									

	2Z7270.174		POTENTIOMETER: 50,000 ohms, $\pm 20\%$, 1w; composition; linear taper; flatted type shaft $1/4$ " diam x $5/8$ " lg; 3 term; enclosed body $1 1/8$ " diam x $1 1/2$ " lg.	1			*	*
R152-2 R152-3	3RC20BF512J		RESISTOR, fixed: 5,100 ohms $\pm 5\%$, $1/2$ w; composition; molded bakelite; cylindrical, $9/64$ " diam x $3/8$ " lg; axial wire lead 0.032" diam and $1 1/2$ " lg at ea end.	2			*	*
R153	3RC20BF622J		RESISTOR, fixed: 6,200 ohms $\pm 5\%$, $1/2$ w; composition; molded bakelite; cylindrical, $9/64$ " diam x $3/8$ " lg; axial wire lead 0.032" diam and $1 1/2$ " lg at ea end.	1			*	*
R155	3Z5415.8		RESISTOR, fixed: 1,500 ohms $\pm 10\%$, 10w; wire wound $1 1/2$ " lg, #219 term, #750 mtg.	1			*	*
R156	3RC20BE473K		RESISTOR, fixed: 47,000 ohms $\pm 10\%$, $1/2$ w; composition; molded bakelite; cylindrical, $9/64$ " diam x $3/8$ " lg; axial wire lead 0.032" diam and $1 1/2$ " lg at ea end.	1			*	*
R158	3RC20BE224M		RESISTOR, fixed: 220,000 ohms $\pm 20\%$, $1/2$ w; composition; molded bakelite; cylindrical, $9/64$ " diam x $3/8$ " lg; axial wire lead 0.032" diam, and $1 1/2$ " lg at ea end.	1			*	*
R159	3RC20BE123K		RESISTOR, fixed: 12,000 ohms $\pm 10\%$, $1/2$ w; composition; molded bakelite; cylindrical, $9/64$ " diam x $3/8$ " lg; axial wire lead 0.032" diam and $1 1/2$ " lg at ea end.	1			*	*
R160-1 R160-2	3RC20BF683J		RESISTOR, fixed: 68,000 ohms $\pm 5\%$, $1/2$ w; composition; molded bakelite; cylindrical, $9/64$ " diam x $3/8$ " lg; axial wire lead 0.032" diam and $1 1/2$ " lg at ea end.	2			*	*
R161	2ZK7262-100M.4		POTENTIOMETER: 100,000 ohms $\pm 20\%$, 2w; composition, linear taper; shaft $1/4$ " diam x $5/8$ " lg; three solder term on side of $1 1/16$ " diam x $9/16$ " cylindrical case, perpendicular to shaft; flatted shaft.	1			*	*
		or						
	2Z7271.22		POTENTIOMETER: 100,000 ohms $\pm 20\%$, 1w; composition; linear taper; flatted type shaft $1/4$ " diam x $5/8$ " lg; 3 term; enclosed body $1 1/8$ " diam x $1 1/2$ " lg.	1			*	*
R161-1 R162-2 R162-3	3RC30BF564J		RESISTOR, fixed: 560,000 ohms $\pm 5\%$, 1w; composition; molded bakelite; cylindrical, $7/32$ " diam x $9/16$ " lg; axial wire lead 0.040" diam and $1 1/2$ " lg at ea end.	3			*	*

* Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (contd).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK		3D ECH	4TH ECH	DEPOT STOCK
					1ST ECH	2D ECH			
R164	2ZK7262-1500M		POTENTIOMETER: 1.5 meg $\pm 20\%$, 2w; composition; linear taper; shaft $1/4$ " diam x $5/8$ " lg; three solder term on side of $1/16$ " diam x $9/16$ " cylindrical case, perpendicular to shaft; flatted shaft.	1				*	*
			or						
	2Z7274-50		POTENTIOMETER: 1.5 meg $\pm 20\%$, 1w; composition; linear taper; flatted type shaft $1/4$ " diam x $5/8$ " lg; 3 term; enclosed body $1 1/8$ " diam x $1/2$ " lg.	1				*	*
R165	2ZK7263-40		POTENTIOMETER: 50,000 ohms $\pm 20\%$, 2w; composition; linear taper; shaft $1/4$ " diam $5/8$ " lg w/screwdriver slot in end; three solder term on one side of $1/16$ " diam x $9/16$ " cylindrical case, perpendicular to shaft; shaft locking type.	1				*	*
R166	2ZK7262-50M.5		POTENTIOMETER: 50,000 ohm $\pm 20\%$, 2w; composition; linear taper; shaft $1/4$ " diam x $215/16$ " lg; three solder term on side of $1/16$ " diam x $9/16$ " cylindrical case, perpendicular to shaft; flatted shaft.	1				*	*
			or						
	2Z7270.175		POTENTIOMETER: 50,000 ohms $\pm 20\%$, 1w; composition; linear taper; flatted type shaft $1/4$ " diam x $215/16$ " lg; 3 term; enclosed body $1 1/8$ " diam x $1/2$ " lg.	1				*	*
R167	3RC20BF203J		RESISTOR, fixed: 20,000 ohms $\pm 5\%$, $1/2$ w; composition; molded bakelite, cylindrical, $9/64$ " diam x $3/8$ " lg; axial wire lead 0.032" diam and $1 1/2$ " lg at ea end.	1				*	*
R168	3RC41BE121K		RESISTOR, fixed: 120 ohms $\pm 10\%$, 2w; composition; molded bakelite; cylindrical, $11/32$ " diam. x $125/32$ " lg; axial wire lead 0.036" diam and $1 1/2$ " lg at ea end.	1				*	*
R169-1 R169-2 R169-3 R169-4 R169-5	3RC30BE154K		RESISTOR, fixed: 150,000 ohms $\pm 10\%$, 1w; composition; molded bakelite; cylindrical, $7/32$ " diam x $9/16$ " lg; axial wire lead 0.040" diam and $1 1/2$ " lg at ea end.	5				*	*

R170-1	3RC30BF621J	RESISTOR, fixed: 620 ohms $\pm 5\%$, 1w; composition; molded bakelite; cylindrical, $7/32$ " diam x $9/16$ " lg; axial wire lead 0.04" diam and $1\frac{1}{2}$ " lg at ea end.	4	*	*
R170-2					
R170-3					
R170-4					
R171	3RC20BF152J	RESISTOR, fixed: 1,500 ohms $\pm 5\%$, $1/2$ w; composition; molded bakelite; cylindrical, $9/16$ " diam x $3/8$ " lg; axial wire lead 0.032" diam and $1\frac{1}{2}$ " lg at ea end.	1	*	*
S101	3Z9825-57.2	SWITCH, rotary: 2 pole, 4 position, single sect; bakelite insulation; $1\frac{7}{8}$ " diam x $3\frac{3}{4}$ " lg over-all; non-shorting contacts; shaft 0.248" diam x $2\frac{15}{16}$ " lg w/flat $5/8$ " lg; bushing $3/8$ -32 x $3/8$ " lg; washer and hex nut included for mtg; solder lug term.	1	*	*
S102	3Z9825-66.56	SWITCH, rotary: one pole, 11 position, single sect; bakelite insulation $1\frac{7}{8}$ " diam x $3\frac{3}{4}$ " lg over-all; non-shorting contacts; shaft 0.248" diam x $2\frac{15}{16}$ " lg w/flat $5/8$ " lg; bushing $3/8$ -32 x $3/8$ " lg; washer and hex nut included for mtg; solder lug term.	1	*	*
S103-1	3Z9859-22.1	SWITCH, toggle: light duty; wiping type contacts; fibre insulation; over-all $1\frac{1}{16}$ " x $1\frac{5}{32}$ " x approx $2\frac{3}{32}$ " h, including 6 projecting term on bottom; molded plastic case; lever operated; mtg bushing $1\frac{3}{64}$ " lg w/a $1\frac{5}{32}$ -32 thd; DPDT 3 amp at 250v, 6 amp at 125v.	6	*	*
S103-2					
S103-3					
S103-4					
S103-5					
S103-6					
S104	3Z9825-57.1	SWITCH, rotary: 2 pole, 3 position, 2 sect; bakelite insulation; $1\frac{7}{8}$ " diam x $4\frac{5}{16}$ " lg over-all; non-shorting contacts; shaft 0.248" diam x $3\frac{1}{16}$ " lg w/flat $5/8$ " lg; bushing $3/8$ -32 x $3/8$ " lg; washer and hex nut included for mtg; solder lug term.	1	*	*
T101	2ZK9900.4	TRANSFORMER, pulse: unpotted, two toroidal windings; 150 turns of #33 AWG EN wire on ea winding; molybdenum perm-alloy core $1\frac{1}{2}$ " lg, OD $1\frac{3}{16}$ " and ID $1\frac{3}{32}$ "; single-side (stud) mtg; case dimen $1\frac{5}{16}$ " x $1\frac{3}{16}$ " x $2\frac{5}{16}$ " h, exclusive of terms and studs; 2 mtg studs $5/8$ " apart along $1\frac{5}{16}$ " dimen.	1	*	*

*Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (contd).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK	3D ECH	4TH ECH	DEPOT STOCK
T102	2ZK9613-53		TRANSFORMER, power: unpotted, 50 to 1,200 cps; 125v amp; 115v pri; six windings; sec'd winding ratings: 3-5, 720v at 0.115 amp; 5-6, 6.3v at 0.6 amp; 7-8, 5.05v at 2 amp; 9-10, 6.3v at 3.8 amp; 11-12, 6.3v at 0.6 amp; average d-c resistance of windings at 68° F (20° C): 1-2, 3.2 ohms; 3-5, 200 ohms; 5-6, 0.30 ohms; 7-8, 0.10 ohms; 9-10, 0.050 ohms; 11-12, 0.34 ohms; Harvel #612C varnish impregnation; uncased; single-sided stud mtg 3/16" x 23/4" on centers; 12 soldering lug term, six on ea of two phenol fibre strips held under heads of screws ending in mtg studs; windings 1-2 and 11-12 electrostatically shielded from ea other and from all other windings; working voltage to core: 1-2 grounded; 3-5-6, 510v peak; 7-8, 375v DC; 9-10 grounded; 11-12, 450v DC term #4 center tap on 3-5.	1			*	*
V101-1 V101-2 V101-3 V101-4	2J6AK5		TUBE: JAN-6AK5.	4	*			*
V102-1 V102-2	2J6AG7		TUBE: JAN-6AG7.	2	*			*
V103-1 V103-2	2J6SL7GT		TUBE: JAN-6SL7GT.	2	*			*
V105	2J6SN7GT		TUBE: JAN-6SN7GT.	1	*			*
V106	2J5Y3GT/G		TUBE: JAN-5Y3GT/G.	1	*			*
V107	2J6X5GT/G		TUBE: JAN-6X5GT/G.	1	*			*
V108	2J2AP1		TUBE: JAN-API: 2" cathode-ray tube.	1	*			*
Z101	2Z6840-35		NET WORK: delay; consists of 11 button mica capacitors per ESL-664225, 75 mmf, and a D-166659retardation coil; assembled in a hermetically sealed rectangular metal case approx 63/4" x 27/32" x 1 1/32" h excluding mtg studs and terms; two mtg studs on top, 0.190"-3.2 x 1/2" h, 53/4" between centers; four soldering terms ea 5/8" lg projecting from top; impedance 555 ohms, band width 5 mc, delay 0.5, μ sec, capacitance 30 mmf; moisture resistant.	1				*

3F4325-34/L1	LENS ASSEMBLY: consists of double convex glass lens 8", focal lg 1 3/8" x 2 7/16" w/ends rounded on 1 7/32" radius.	1	*
2Z8308-13	TUBE SHIELD ASSEMBLY: consists of tube made of 0.062" iron sheet, 1 3/16" over-all lg; 2 7/16" diam for 7" from one end then shaped to elongated oval 3 1/8" x 1 1/4" at other end; open end of oval welded to 0.05" C.R. steel face plate 5 3/4" x 2 23/32" over-all; chromate finish.	1	*
2Z560-2	BASE, tube shield: tubular, 0.015" C.R. steel 0.8" diam x 7 1/16" h including 4 ears at top, 2 ears projecting to 0.905" diam; oval base flange 1 1/8" x 1 3/16" w/two 0.137" mtg holes spaced 0.875" between centers.	1	*
3F4325-34A/P2	BEARING: nickel-plated steel; round rod, 59/64" lg x 1/8" diam.	1	*
3F4325-34/C1	BRASS COLLAR; 1 3/16" OD; 1/2" ID, 3/16" thk w/two 0.138"-32 x 1/8" sockethead, cup-point setscrews 90° apart.	1	*
2Z3022-18	CAP ASSEMBLY: consists of a silver-plated brass shell 3/4" diam x 9/16" lg; one end closed w/a #0.112"-40 tapped hole at center 5/16" d; other end has 5/8"-27, NF2 female thd 3/32" d; two parallel silver-plated #0.082" diam cont pins project approx 1 1/32" from thd end; pins are 3/16" between centers and are attached to a disk which rotates freely inside of shell.	1	*
3Z1087	CLIP, alligator: steel; 2" lg x 1/4" wd x 3/8" h; fine meshing teeth on jaws; round thumb grip; one soldering ferrule for wire connection; 3/8" max jaw opening.	1	*
3ZK1087-4	CLIP: cadmium-plated steel; 1 1/2" lg x 5/16" wd w/3/8" jaw spread; No. 6-32 screw for wire connection.	1	*
1B818.89	CORD, power: 5 1/2 ft; rubber-covered; two-conductor; shielded.	1	*
3Z3285-2	HOLDER, fuse: cylindrical; molded black bakelite; 2" lg exclusive of 3/8" term at end; second term at side; thd on body with nut and neoprene washer for mtg; fits 1 1/2" mtg hold in any panel up to 5/16" thk; finger-operated knob 5/8" diam having bayonet-type socket attached to inner end of knob; normal carrying capacity is 15 amp.	1	*
2ZK5748.16	KNOB: black croplastic; cylindrical w/beaded head; 5/8" diam, 7 1/6" h, provided w/metal bushing to fit 1/4" shaft.	1	*

*Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (cont'd).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK			4TH ECH	DEPOT STOCK
					1ST ECH	2D ECH	3D ECH		
2ZK5748.16			KNOB: same as Crowe 6126, except knob has $\frac{1}{16}$ " white dot on face of knob on $\frac{3}{16}$ " radius.	1				*	*
2Z5748.4			KNOB: black molded plastic; pointer type in shape of flat top dome w/integral wedge shaped pointer; point of wedge rounded to bottom edge; $1\frac{1}{4}$ " lg x $\frac{5}{8}$ " h over-all; flush type insert to fit $\frac{1}{4}$ " shaft.	1				*	*
6L3506-32-2.3			NUT: hex; steel chromate finish; $\frac{3}{8}$ "-32; $\frac{3}{32}$ " thk; $\frac{5}{8}$ " across flats.	1				*	*
6L3508-28.3			NUT: hex; steel chromate finish; $\frac{1}{2}$ "-28; $\frac{3}{32}$ " thk; $1\frac{1}{16}$ " across flats.	1				*	*
6L3510-18-15.3			NUT: hex; steel chromate finish; $\frac{5}{8}$ "-18; $\frac{3}{32}$ " thk; $1\frac{1}{16}$ " across flats.	1				*	*
6L3410-27-12.3			NUT: round; steel chromate finish; 0.625"-27; $\frac{3}{16}$ " thk; $\frac{3}{4}$ " O.D.; outside knurled.	1				*	*
2Z8270-4			SCREEN ASSEMBLY, C.R.T: consists of $\frac{3}{16}$ " plexiglas disk $2\frac{1}{4}$ " diam w/felt washer $2\frac{5}{16}$ " OD, $1\frac{1}{16}$ " ID, $\frac{1}{4}$ " thk cemented on front face and felt washer $2\frac{5}{16}$ " OD, $1\frac{1}{16}$ " ID, $\frac{1}{8}$ " thk cemented on rear face; three holes tapped 0.112"-40 x $\frac{1}{8}$ " in edge of disk 120° apart; lines engraved on disk 0.001" d and 0.004" in wd as follows (centered on center of disk): vertical line $1\frac{7}{8}$ " lg w/four $\frac{1}{16}$ " horizontal cross-lines 0.05" apart on ea side of center; three horizontal lines, ea $1\frac{7}{8}$ " lg and $\frac{1}{4}$ " apart, middle one through disk center with 14 downward vert lines spaced $\frac{1}{16}$ " apart on ea side of center; (these vert lines extend downward $\frac{1}{32}$ ", except the 5th and 10th on ea side are $\frac{1}{16}$ " lg).	1				*	*
6L6632-7-1.81CS			SCREW: hex head; steel, chromate finish; 0.138"-32; $1\frac{5}{32}$ " lg over-all; $1\frac{1}{32}$ " lg thd; head $\frac{7}{16}$ " across flats, $\frac{1}{16}$ " thk; shoulder 0.178" diam x $\frac{1}{16}$ " lg.	1				*	*
6L6632-7-3.5S			SCREW: round head; nickel-plated steel; 0.138"-32; $\frac{3}{16}$ " lg over-all; $\frac{3}{16}$ " lg thd w/smooth shank 0.098" diam x $\frac{3}{16}$ " lg between under side of head and thd; head 0.250" diam x $\frac{7}{64}$ " thk.	1				*	*

2Z8306-6		SHIELD, tube: cylindrical; 0.015" C.R. steel, closed at one end; 1 $\frac{3}{16}$ " ID, 1 $\frac{3}{8}$ " lg; conical spring $\frac{9}{16}$ " lg mid inside top of shield.	1			*
2Z8681.4		SOCKET, c-r tube: steatite 1 $\frac{23}{32}$ " diam x $\frac{3}{4}$ " lg including phosphor-bronze term for 11-cont tube, arranged to mount in 1.625" hole.	1			*
2Z5883-50		SOCKET, lamp: bayonet-type shell $\frac{3}{4}$ " lg having 2 cont of tinned brass which project $\frac{9}{16}$ " at right angles to base; shell is attached to bottom of short leg of right angle mtg bracket, approx 1 $\frac{9}{32}$ " x $\frac{7}{16}$ " having an open-ended mtg slot approx $\frac{7}{8}$ " x $\frac{3}{16}$ ".	1			*
2Z8799-19		SOCKET, tube: mica-filled bakelite; 7-cont; cylindrical; 0.705" diam x 0.391" lg; solder term project from bottom equipped w/metal saddle clamp provided with a 0.105" diam hole at ea end spaced 0.875" between centers; over-all 0.735" x 1 $\frac{3}{32}$ " x 0.0579"; wax impregnated.	1			*
2Z8678.16		SOCKET, tube: oval: 1 $\frac{1}{4}$ " x 1 $\frac{25}{32}$ " x 1 $\frac{1}{16}$ " thk for 8-prong tube; molded insulating material with 2 mtg lugs on opposite sides of socket; mtg screw holes on 1 $\frac{1}{2}$ " centers, term extend approx $\frac{1}{4}$ " beyond insulating material.	1			*
3G1837-52		TUBE: molded phenolic: 1" diam x 1 $\frac{5}{8}$ " lg; hole at one end 4 $\frac{1}{64}$ " diam x $\frac{1}{2}$ " d, other end has female $\frac{7}{8}$ "-20 NPT; thd $\frac{1}{2}$ " d; SIGNAL INPUT stamped on two opposite sides.	1			*
6R57400-6		WRENCH, socket steel; hex, $\frac{1}{16}$ " across flats: "L" shaped; lg leg 1 $\frac{3}{4}$ " lg, short leg $\frac{9}{16}$ " lg.	1			*
6R57400		WRENCH, socket steel; hex, $\frac{5}{64}$ " across flat; "L" shaped; lg leg 1 $\frac{7}{8}$ " lg, short leg $\frac{39}{64}$ " lg.	1			*
1F4W1-30.120		CORD CG-72/U, coaxial: video patching cord; consists of 10 ft of coaxial cable equipped on ea end w/a D-166393 coaxial plug; cable consists of 16 strands of No. 30 AWG wire twisted to form a conductor, then insulated, shielded, and covered w/neoprene jacket; OD approx 0.425".	1			*

*Indicates stock available.

1. MAINTENANCE PARTS LIST FOR OSCILLOSCOPE TS-34A/AP (contd).

REF SYMBOL	SIGNAL CORPS STOCK NO.	MAJOR COMP	NAME OF PART AND DESCRIPTION	QUAN PER UNIT	ORGN STOCK		3D ECH	4TH ECH	DEPOT STOCK
	3E6000-152		CORD CX-152/U adapter: consists of two unequal lengths of type S rubber-covered 18 ga stranded wires 0.183" OD having one end of ea terminating in a two-cond Amphenol MC2M connector and the opposite end of ea wire equipped with a Mueller Electric Co. No. 45 clip and No. 47 rubber insulator lengths of exposed cables between the connector and rubber insulators are 8" and 6" respectively; longer wire has T1H2 engraved on red insulator and shorter wire has VPH1 engraved on black insulator.	1				*	*
	3E4036-180-2		CORD CX-150/U, power: consists of 15 ft lg of No. 18 ga, two-cond parallel plastic lamp cord equipped w/No. 8224 AH&H plug at one end, and at other w/AN-3106-22-10P connector.	1				*	*
	1F4W1-29.55		PROBE ASSEMBLY MX-50/AP: oscilloscope test probe; consists of a 43" lg of coaxial cable (AN/RG-7/U), 0.375" OD; one end equipped w/D-166393 plug, on the other end is a black fibre tube 1" OD x 23/8" lg; a brass alligator clip projects approx 2 1/4" from end of tube and encased in red rubber insulating cap 1 3/4" x 3/4" OD, from cable end of tube an 18 ga stranded wire w/black vinylite jacket projects approx 8" and terminates in another brass alligator clip encased in black rubber insulating cap; tube contains an AB EB 3955 resistor and an Erie NPOK 10 capacitor; approx over-all lg is 50".	1				*	*
	2Z2642.24		CLAMP: split cable clamp w/coupling ring; M-293; takes cable size 7/8" max and 5/16" min diam; metal shell 1 3/8" diam x 1 3/16" lg; coupling ring thd 1 3/16" -18; two clamp screws 8/32" x 7/8".	1				*	*
J103	6Z3150-10		CONNECTOR: 1 3/8" cylindrical, composition; body arranged for double-T-contact plug, equipped w/metal cap having adjustable cord grip projecting 1/2" from end; over-all lg 2" body provided w/13/32" diam cord hole; 15 amp, 125v; 10 amp, 250v.	1				*	*
J104	2Z7226-P243		CONNECTOR, plug: aluminum; cylindrical, 2 1/4" lg over-all consists of a coupling ring for 1 3/4" -18 thd and removable back shell w/17/16" -18 thd at one end; contains a black bakelite 4-pin insert; moisture resistant.	1				*	*

P101-1	2Z71226-259A	PLUG, coaxial: silver-plated; cylindrical, metal shell $2\frac{3}{32}$ " diam x $1\frac{17}{32}$ " lg; having a coupling w/ $\frac{5}{8}$ "-2.4 inside thd at one end; opposite end has a $\frac{7}{16}$ "-1.4 inside thd $1\frac{1}{32}$ " lg; equipped w/single conductor pin insert in polystyrene insulation; for use w/D-162865 coaxial jack.	6	*	*
P101-2					
P101-3					
P101-4					
P101-5					
P101-6					
P103-1	2Z7112.21	PLUG, coaxial: 2 cadmium-plated spring, brass cont; chrome-plated brass shell and coupling ring; plug $1\frac{3}{8}$ " lg x $1\frac{1}{16}$ " OD, has attached cord protector spring $\frac{3}{4}$ " lg.	2	*	*
P103-2					

*Indicates stock available.

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SECTION VII
PHOTOGRAPHS AND DRAWINGS

Fig. 7-2. Oscilloscope TS-34A/AP—Bottom Rear View with Covers Removed

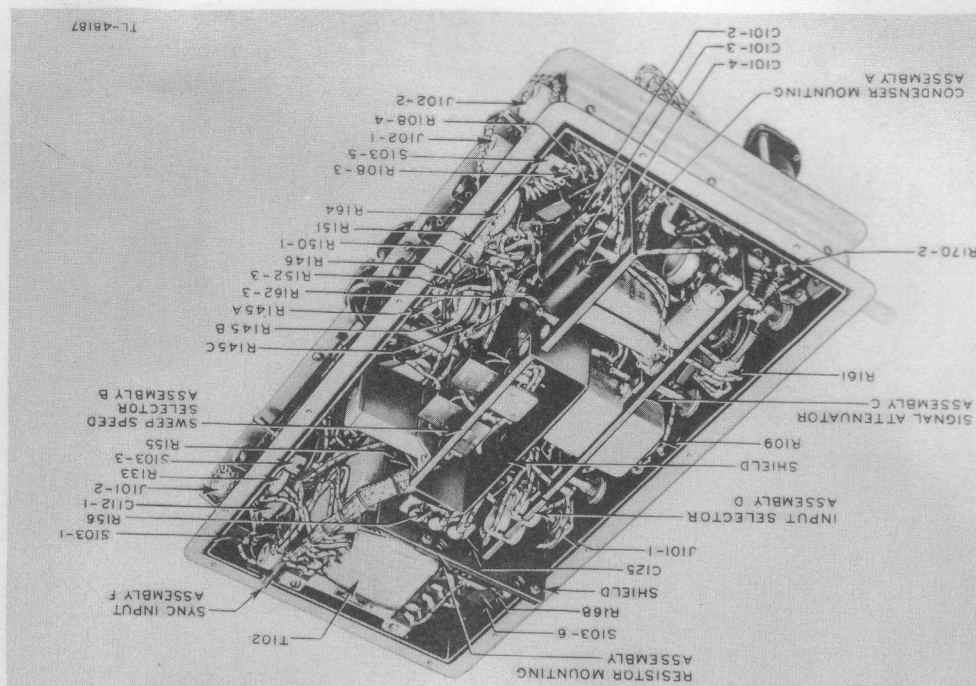
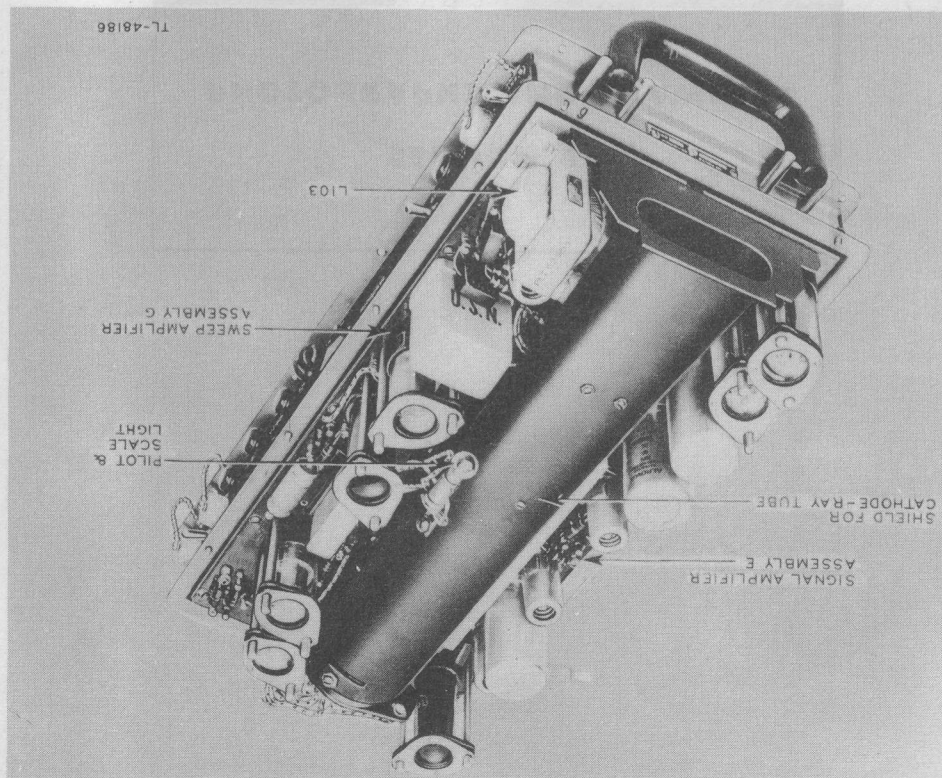


Fig. 7-1. Oscilloscope TS-34A/AP—Front View of Top with Covers Removed



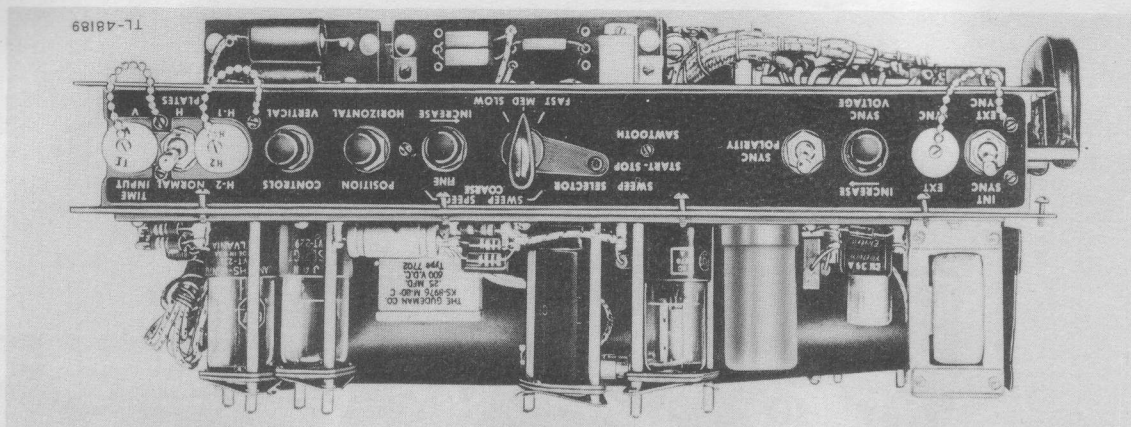
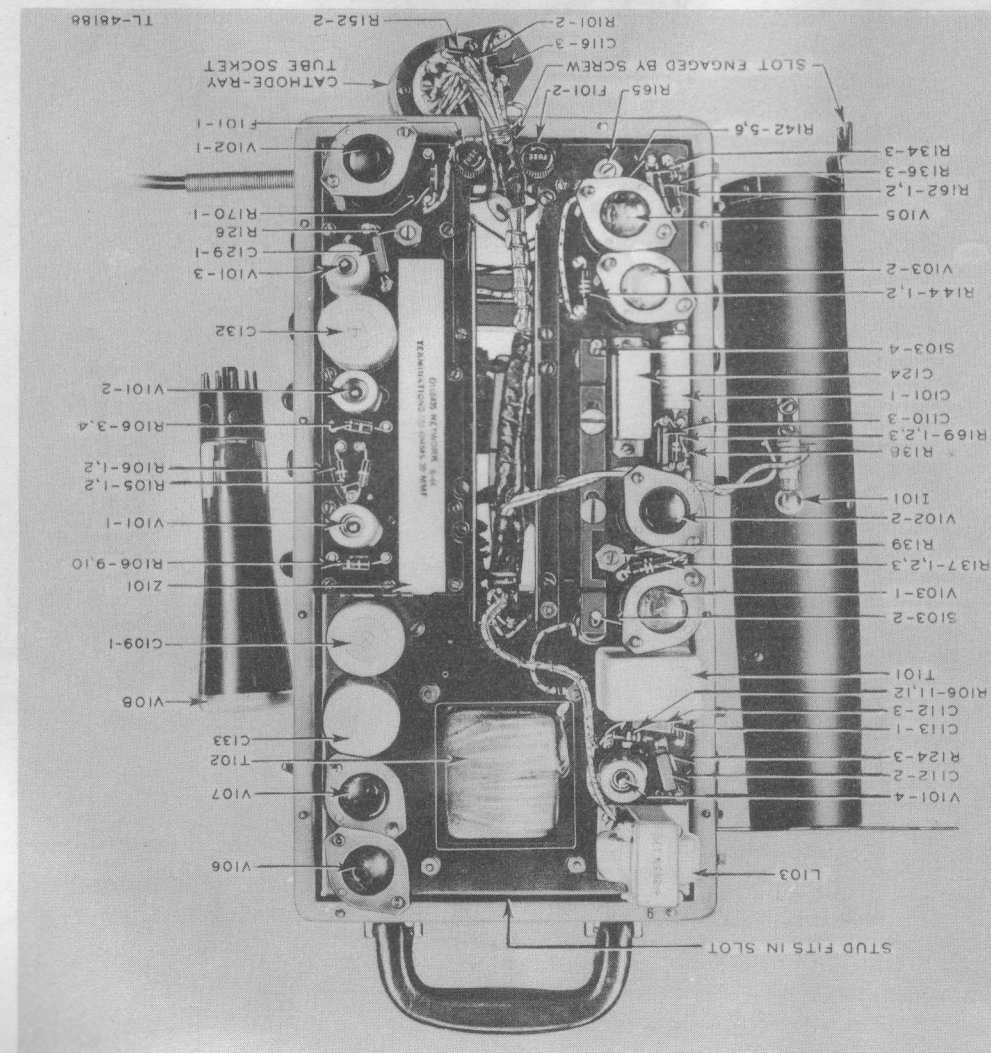


Fig. 7-5. Input Selector Assembly (D)

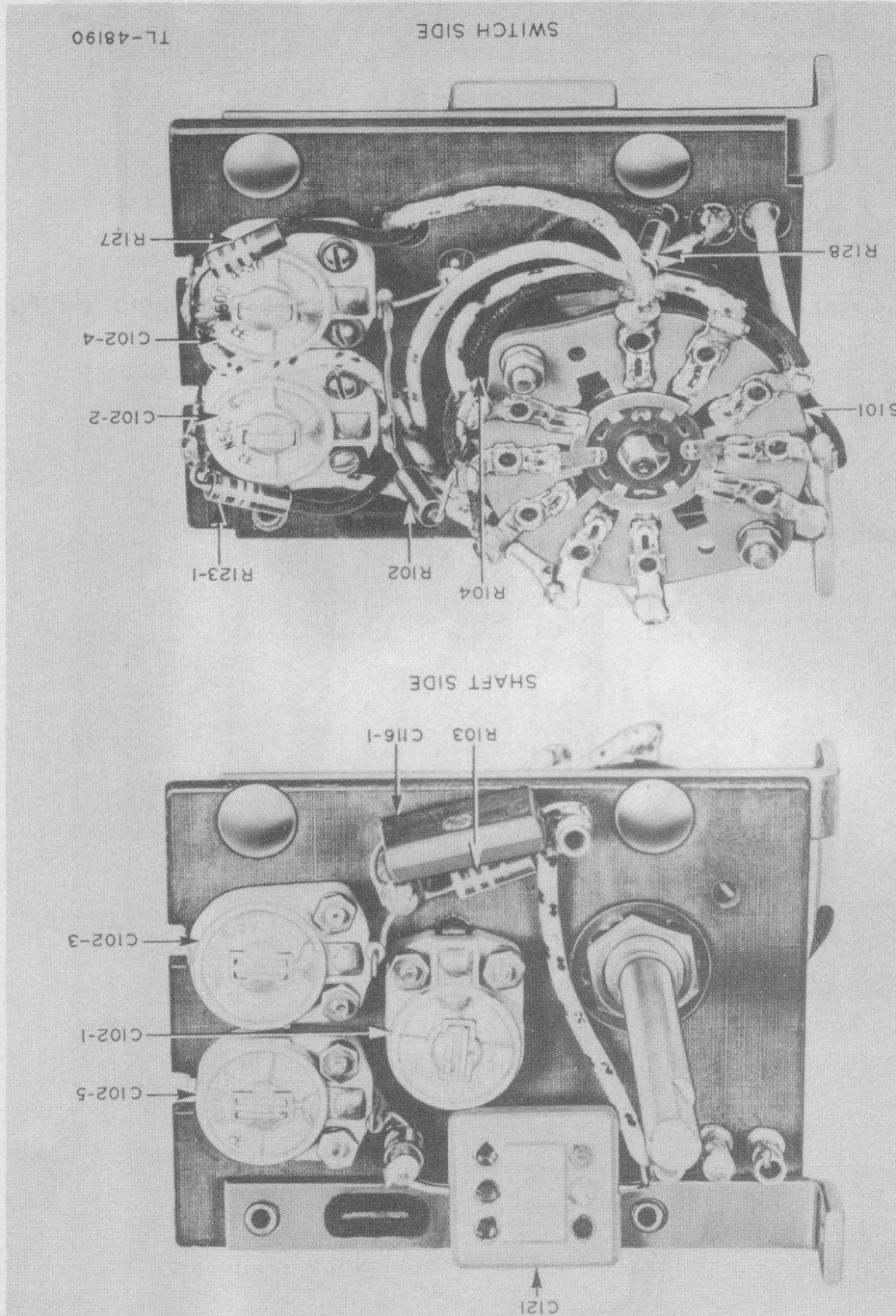
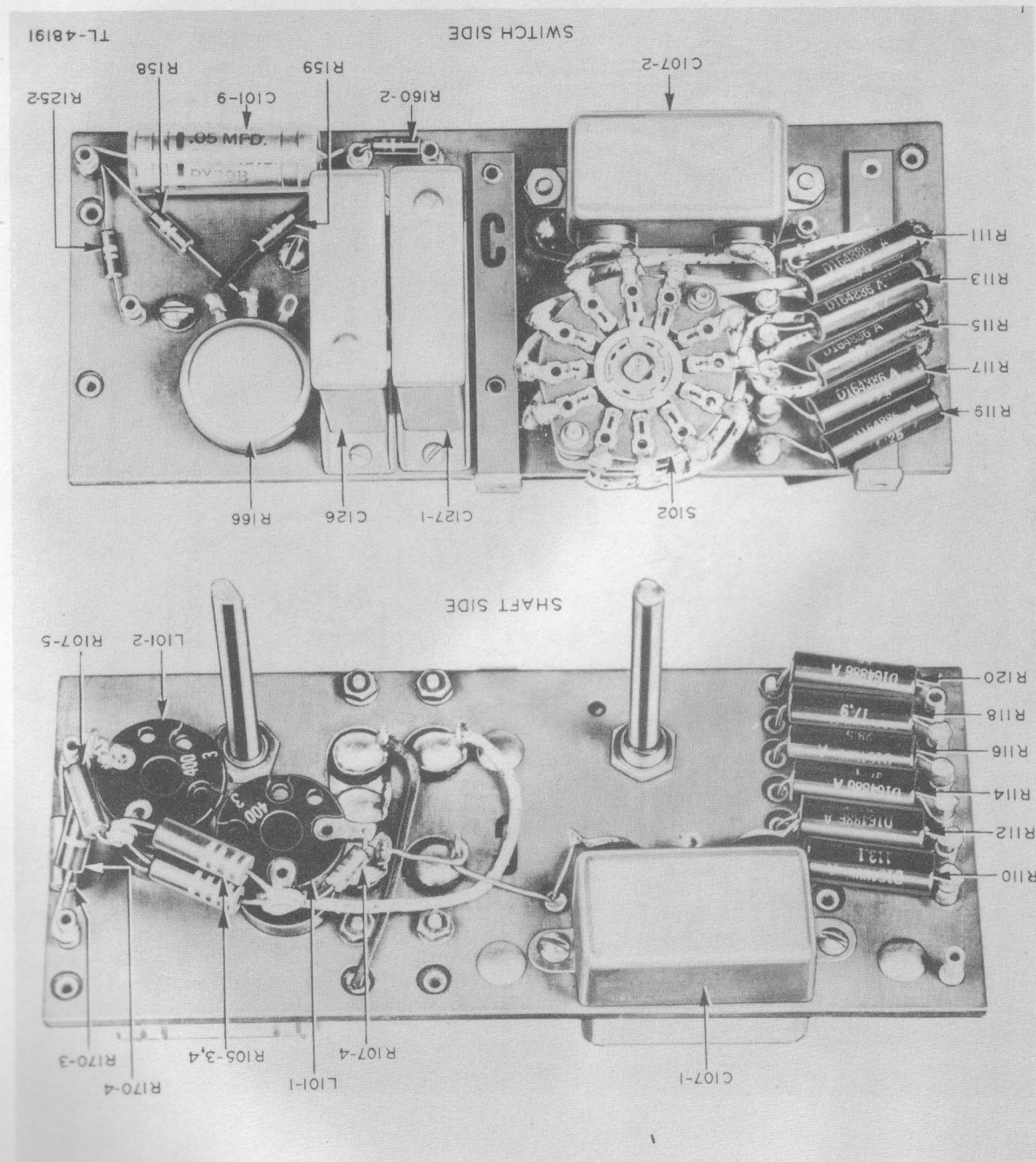


Fig. 7-6. Signal Attenuator Assembly (C)



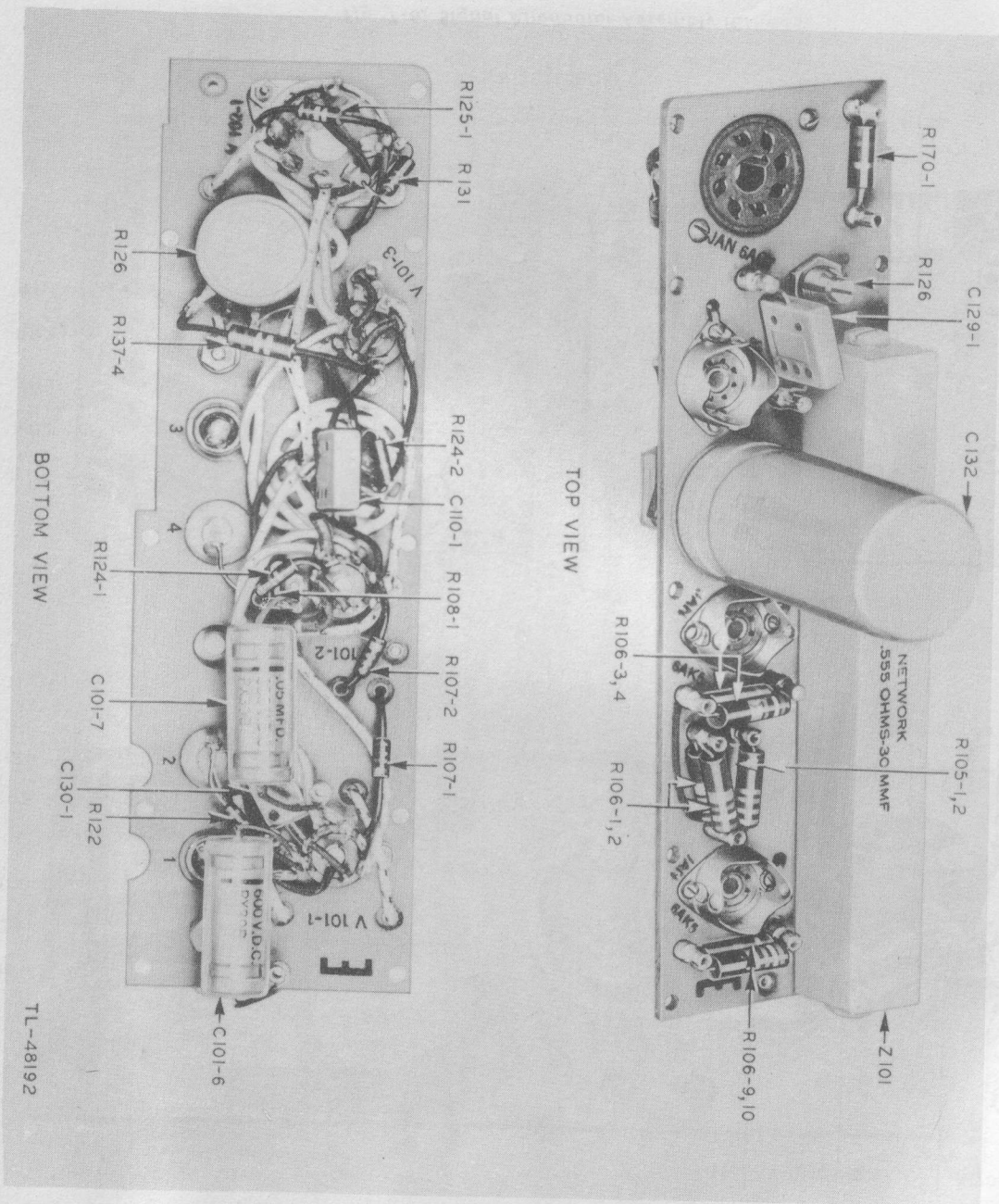


Fig. 7-7. Signal Amplifier Assembly (E)

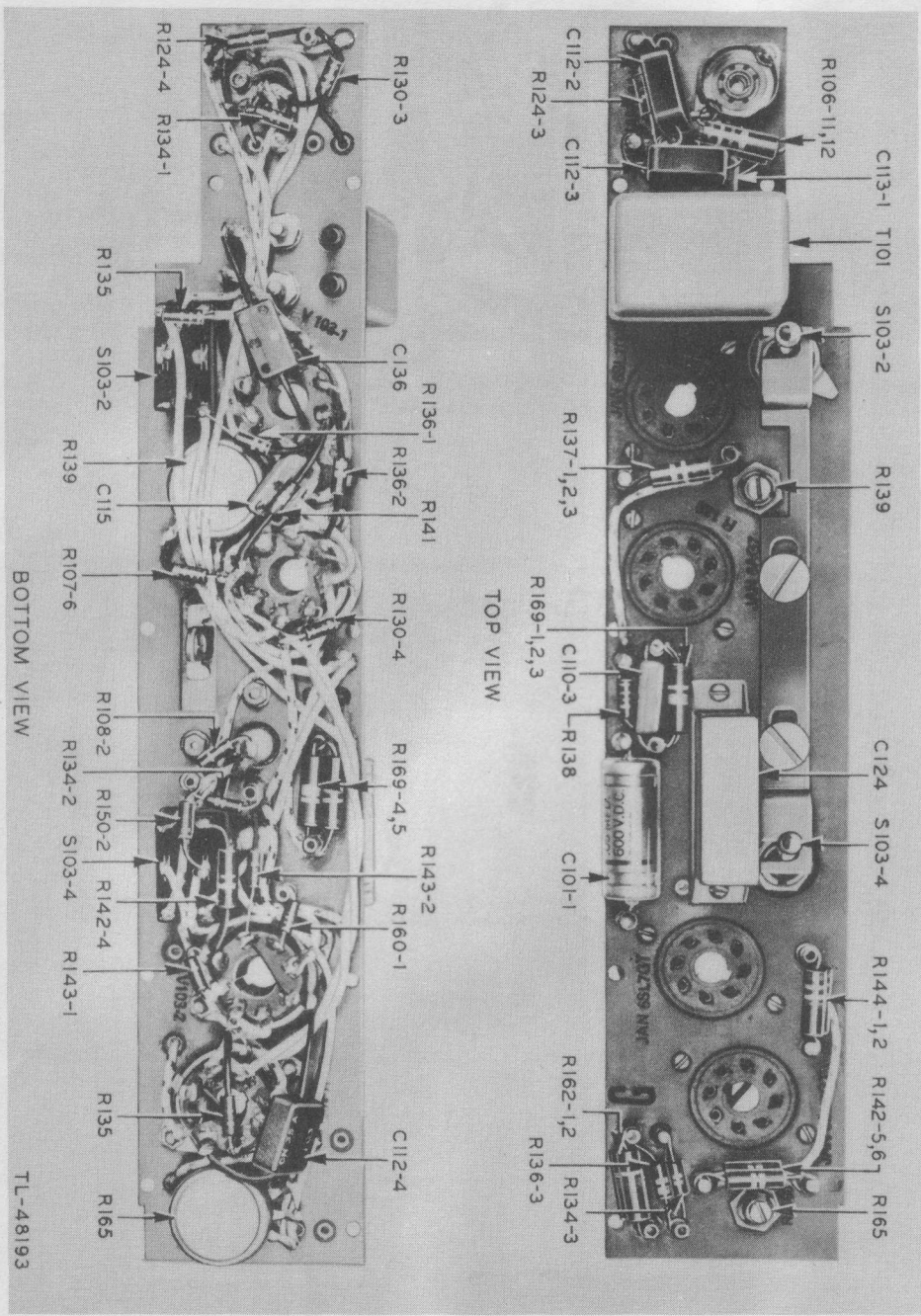


Fig. 7-8. Sweep Amplifier Assembly (G)

Fig. 7-9. Sweep Speed Selector Assembly (B) and Sync Input Assembly (F)

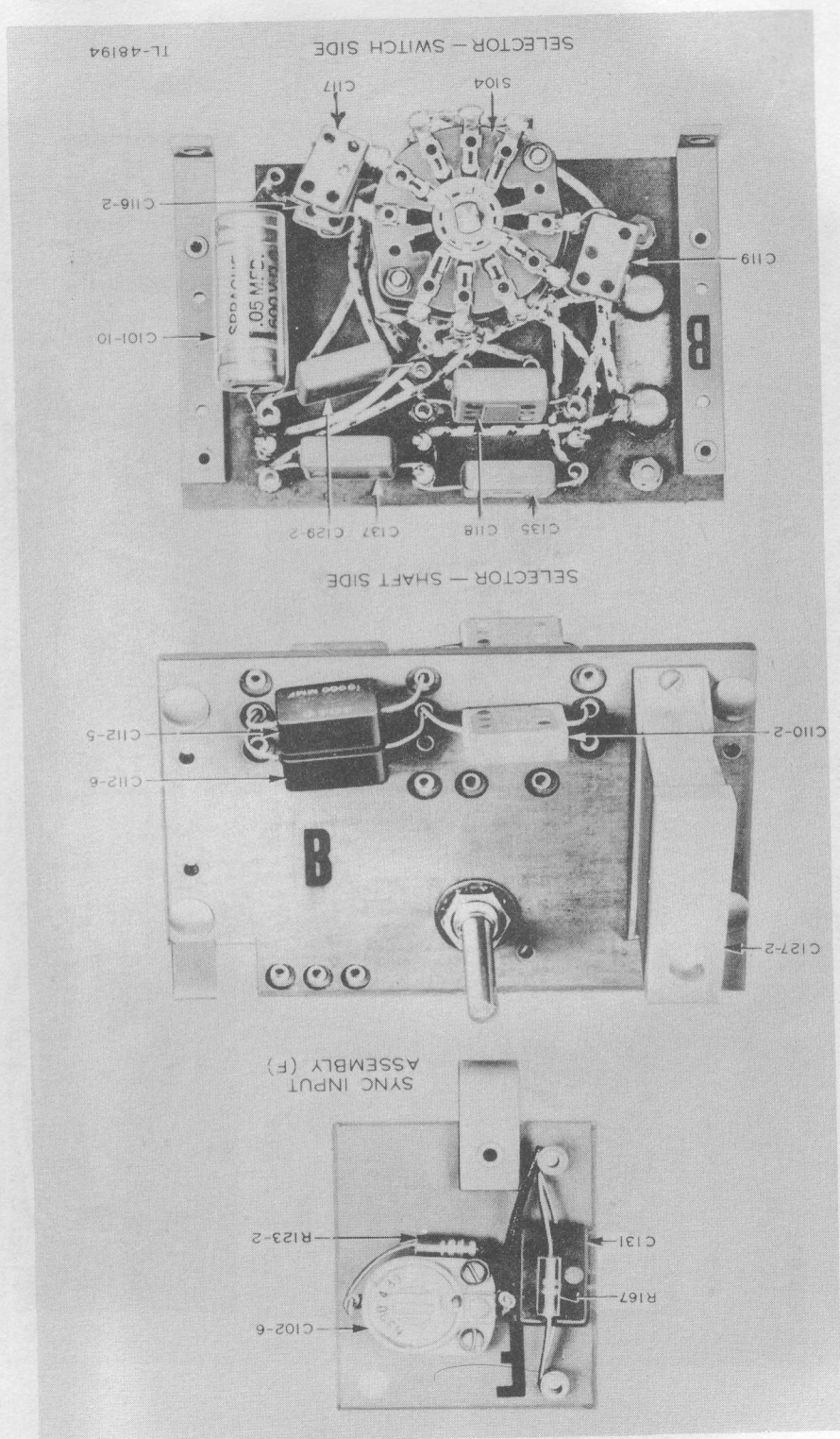


Fig. 7-10. Oscilloscope TS-34A/AP-5C

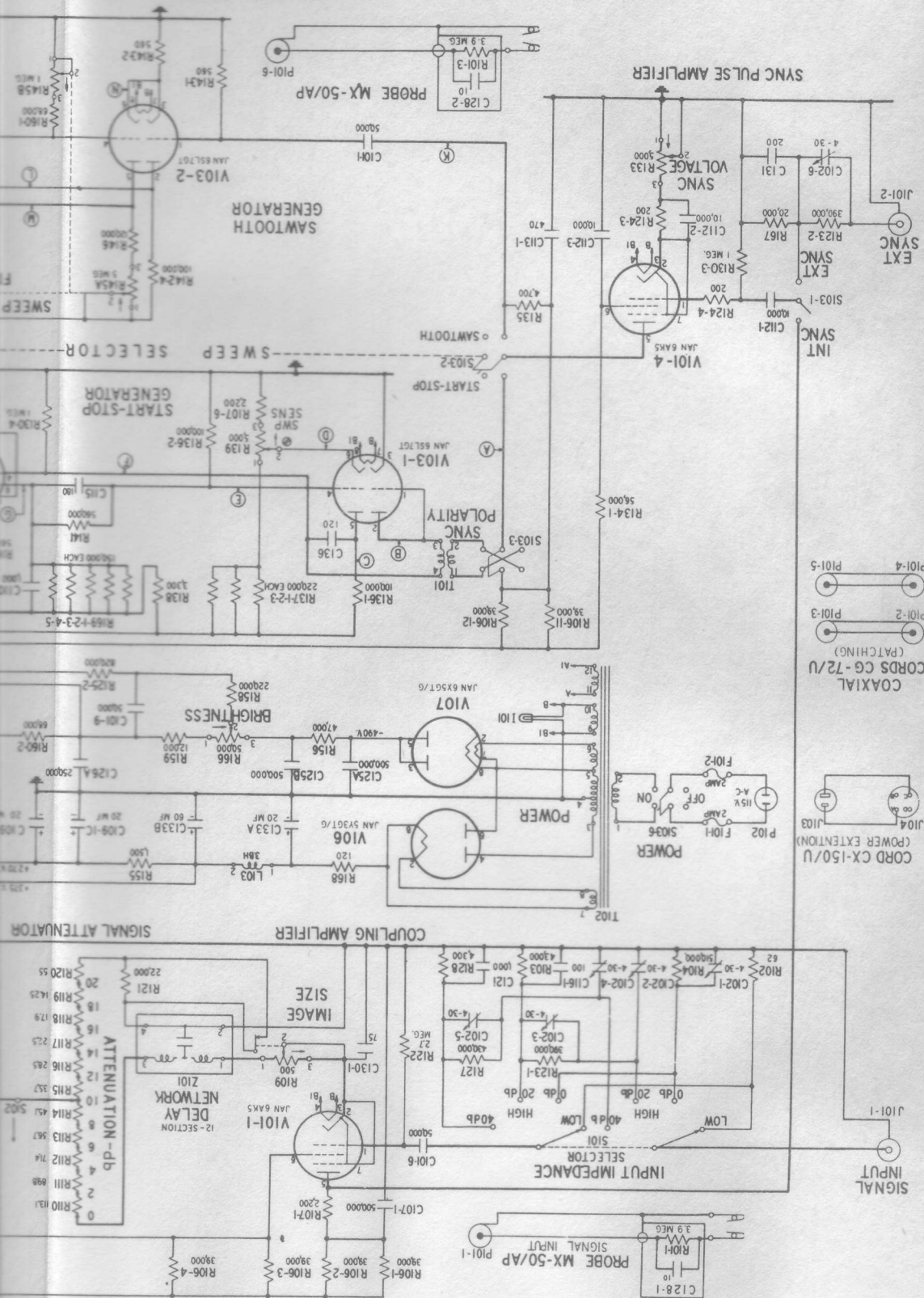
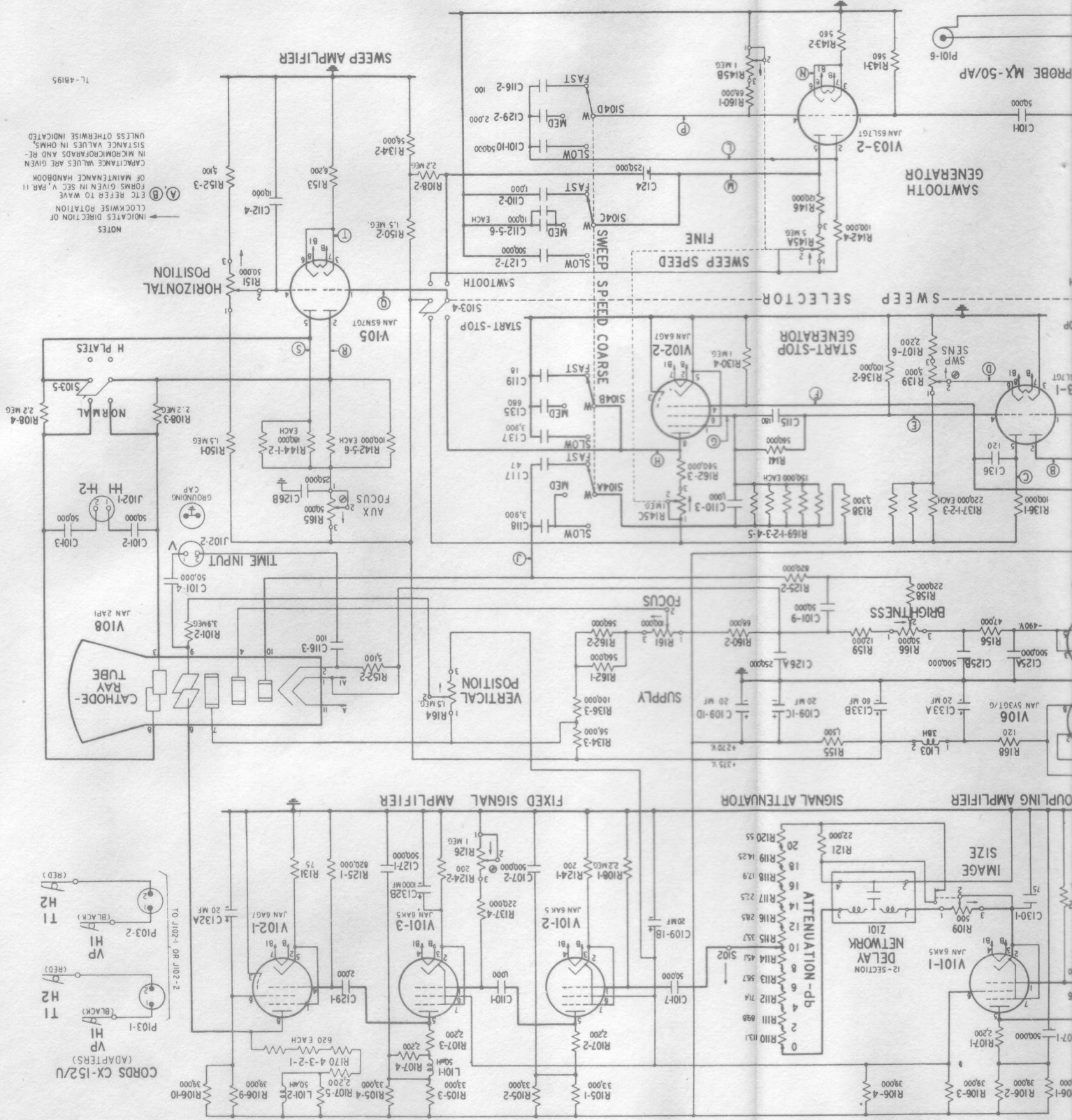


Fig. 7-10. Oscilloscope TS-34A/AP—Schematic Circuit Diagram



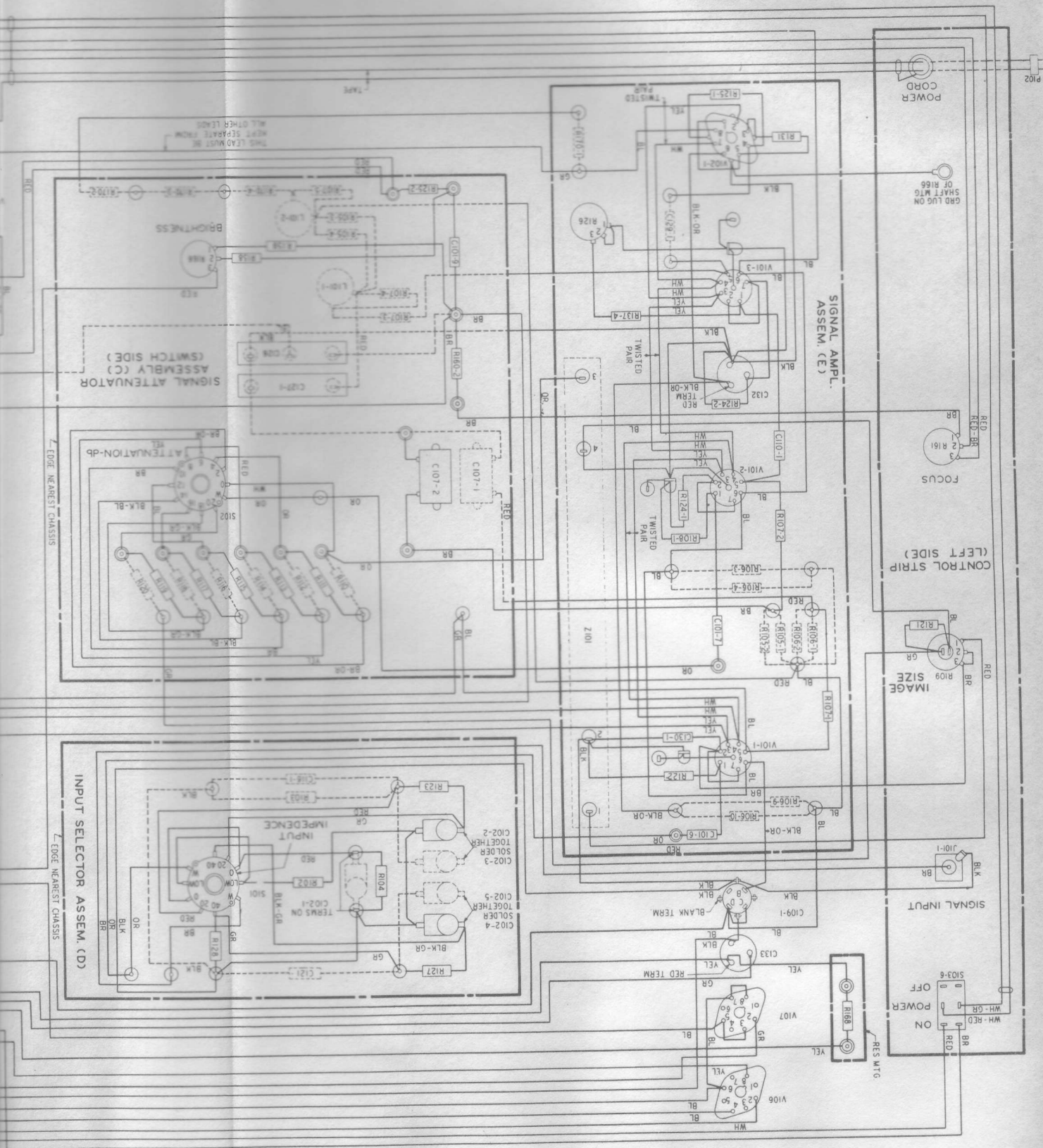
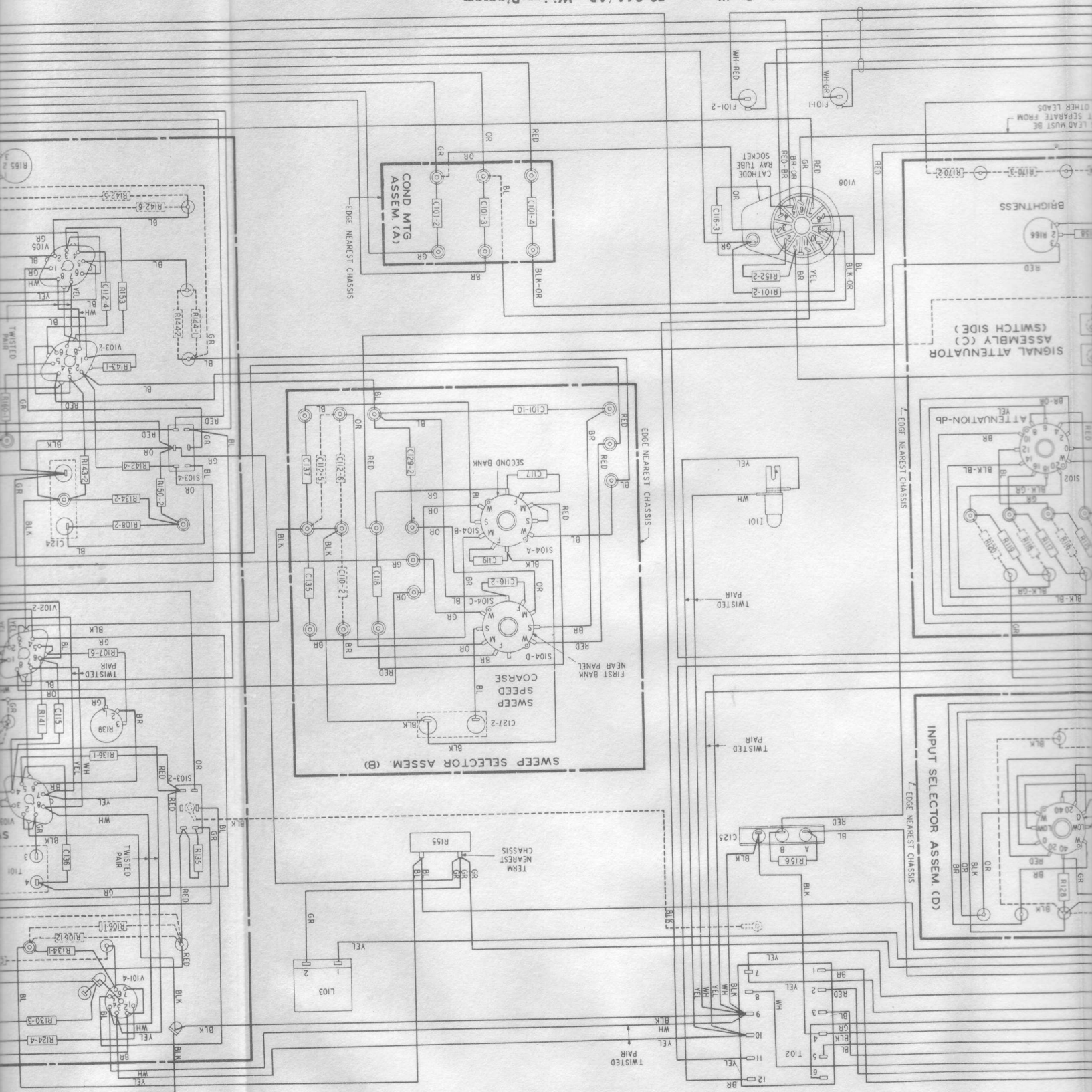
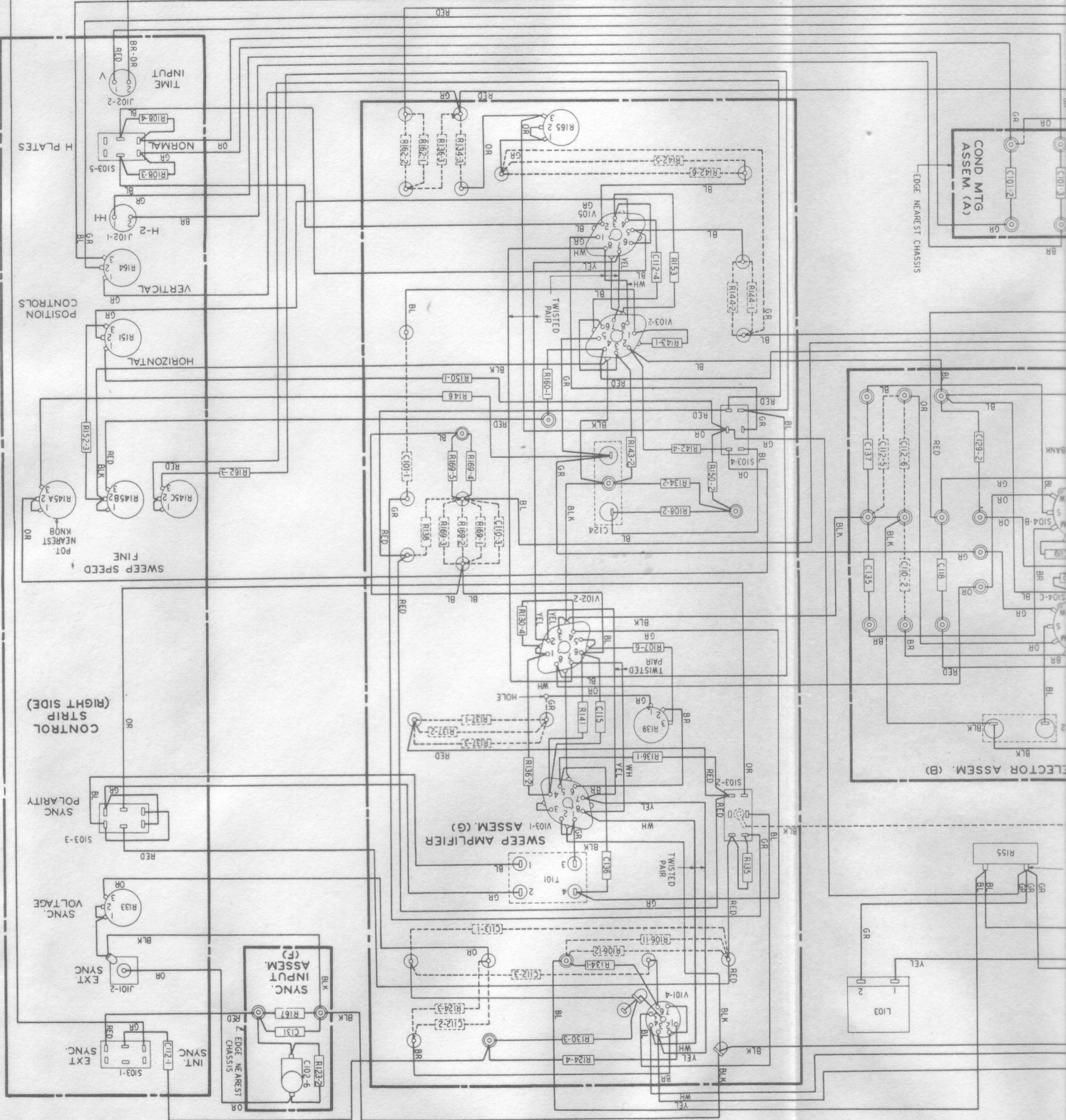


Fig. 7-11. Oscilloscope TS-34A/AP—Wiring Diagram



Section VII



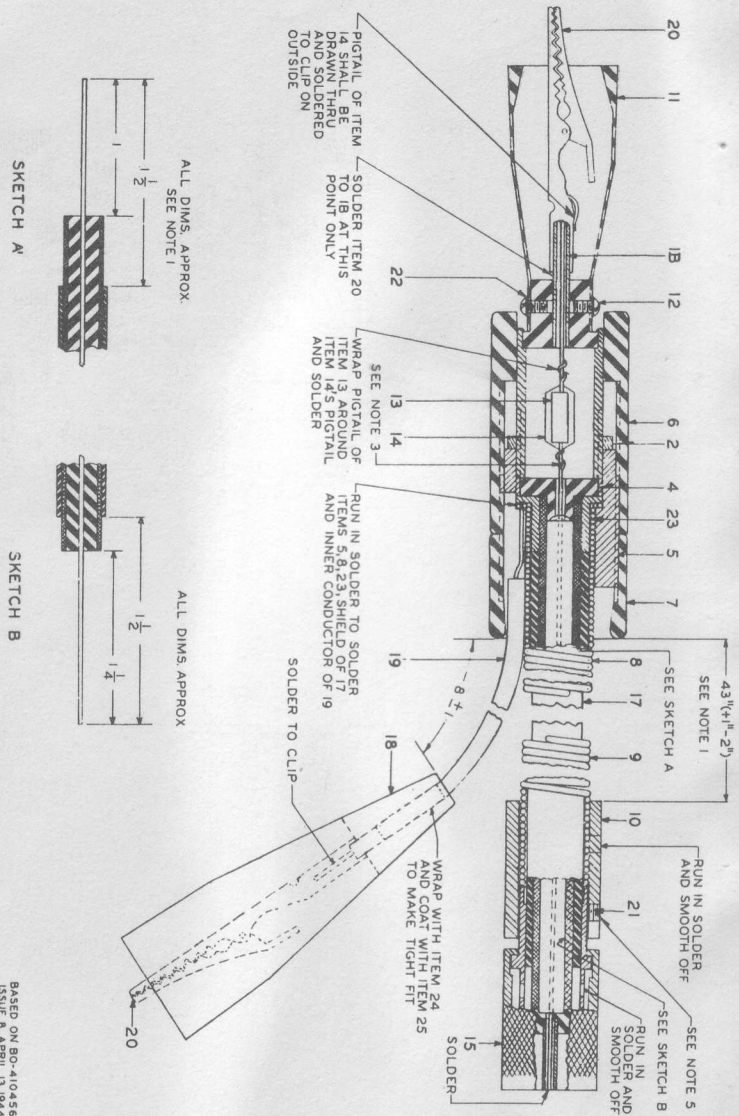


Fig. 7-12. Probe Assembly MX-50/AP

BASED ON BO-410456
ISSUE 8, APRIL 13, 1944

24	SHELLAC	
25	FRICTION TAPE - BLACK	
26	BUSHING	
27	NO. 2 BRASS WASHER	
28	SOCKET HEAD SET SCR CLIP PT ST, 1/8 X 3/2 X 1/8	
29	NO. 287 CLIP - ZIERICK MFG. CORP., N. Y., N. Y.	
30	WIRE - SEE NOTE 4	
31	40 BLACK INSULATOR	MUELLER ELEC. CO
32	3/40 X 5/16 LG. ARMOR	CLEVELAND, OHIO
33	ARMY-NAVY TYPE RC-7U	
34	PLUG	
35	NPOM COND. ERIE RESISTOR CORP., ERIE, PA.	
36	RC20B-395J, RESISTOR	LIST OF SUPPLIERS
37	NO. 2 X 1/8 Z TYPE SCR	KS-9460
38	STOVE HEAD	PARKER-HANFMAN CORP
39	INSULATOR	NEW YORK, N.Y.
40	ROD	
41	SPRING	
42	SPRING	
43	ROD	
44	TUBE	
45	ROD	
46	NO. 1276 GLYPAL	GEN. ELEC. CO
47	CEMENT	SCHENECTADY, N. Y.
48	TUBE ASSEMBLY	
49	ITEM	NAME
50		STOCKLIST

TL-38384

NOTES:
1. PREPARE ENDS OF CABLE, ITEM 17, AS SHOWN IN SKETCH A AND SKETCH B.
2. (DELETED)
3. CLIP SIGNAL OF ITEMS 13 AND 14, AT THIS POINT TO APPROXIMATELY 1/2 INCHES LONG, DRAW CABLE TIGHT, TWIST IT AROUND SIGNALS AND SOLDER.
4. ITEM 19 IS 18 GAUGE STRANDED 65/36 SUPER-AMERICAN FORMULATION SW GAGE CABLE, 1/8 INCH DIA. SUPPLEMENT THE JACKET OBTAINED FROM SUPER-AMERICAN ELECTRICAL INSULATION CO., BOSTON, MASS.
5. APPLY ITEM 3 TO THREADS OF ITEM 21.

Bunn