INSTRUCTION MANUAL

Serial Number 7302-182.

TYPE 502A/ RM502A OSCILLOSCOPE

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070-0382-02

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

CONTENTS

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

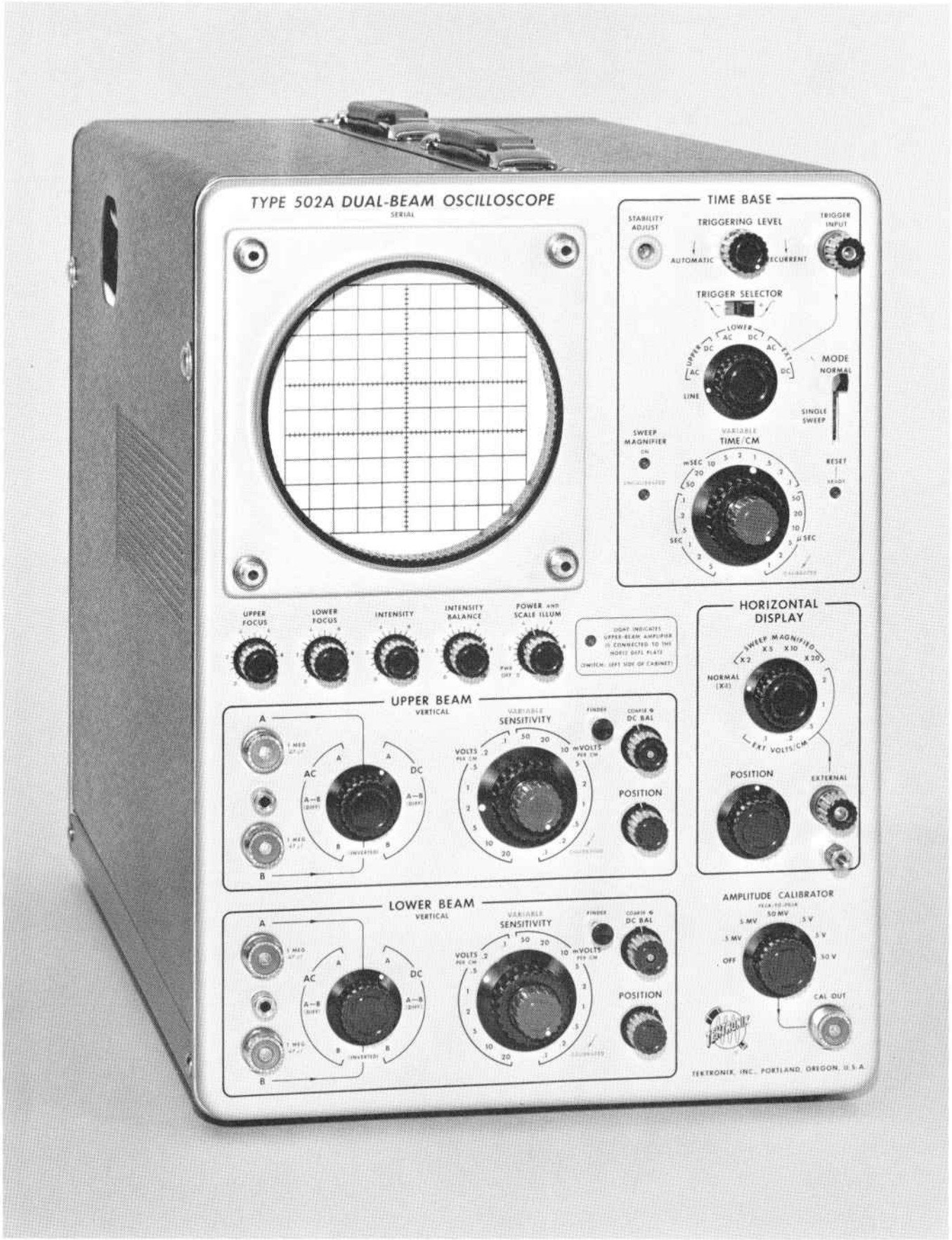


Fig. 1-1. Type 502A Oscilloscope.

SECTION 1
CHARACTERISTICS

General

The Type 502A Oscilloscope—or its rackmount counterpart, the Type RM502A[1]—provides linear dual-beam displays with a wide range of sweep rates combined with high input sensitivity. In addition, it may be used to provide dual-beam X-Y displays at medium sensitivities, and single-beam X-Y displays at high sensitivities.

The instrument has two identical, differential vertical amplifiers, one for each beam. They may be operated with single-ended inputs for conventional operation, or with differential inputs for cancellation of common-mode signals.

Single time-base generator and horizontal amplifier circuits are shared by both beams to provide simultaneous horizontal deflection. When single-beam X-Y operation is desired, the horizontal deflection plates are connected to the upper beam vertical amplifier by means of an internal switch.

[1]**The information given in this Instruction Manual applies to both the Type 502A and the Type RM502A. Essentially, the two instruments are identical except that the Type RM502A has been adapted for rackmounting in a standard 19-inch cabinet rack. Rackmounting instructions, a mechanical parts list, and dimensional drawing for the Type RM502A are provided in Section 10.**

ELECTRICAL CHARACTERISTICS

Upper and Lower Beam Vertical Amplifiers

Characteristic	Performance Requirement	Supplemental Notes
Sensitivity (Deflection Factor) Range		
Calibrated (Switched)	.1 mV/CM to 20 V/CM	17 steps in a 1-2-5 sequence
VARIABLE	$\geq$2.5:1	Extends minimum sensitivity to $\approx$50 V/CM.
Accuracy		
.1 mV/CM	$\pm$3%	25°C to $\pm$5°C
.2 mV/CM to 20 V/CM	$\pm$2%	25°C to $\pm$5°C
Bandwidth (—3 dB) Upper Limits		
5 mV/CM to 20 V/CM	$\geq$1 MHz	With 4 centimeter reference.
.1 mV/CM	$\geq$100 kHz	With 6 centimeter reference. Bandwidth increases gradually as SENSITIVITY is changed from .1 mV/CM to 5 mV/CM.
Lower Limits		
DC-Coupled	DC (0 Hz)	For all settings of the SENSITIVITY switch.
AC-Coupled	$<$2 Hz	For all settings of the SENSITIVITY switch.
Transient Response	$\leq$2% overshoot, ringing, rounding, etc.	6 centimeter display.
Noise	$\leq$6 μV RMS	
Common-Mode Rejection Ratio DC-Coupled		
.1 mV/CM to 2 mV/CM	$\geq$50,000:1 (DC to 50 kHz)	+ and — 5 volt signal
5 mV/CM to .2 V/CM	$\leq$1/2 mm displayed signal (DC to 50 kHz)	(10 volts peak to peak if centered at 0 V)
.5 VCM to 20 mV/CM	Adjustable to: $\geq$5000:1 (DC to 1 kHz) $\geq$500:1 (1 kHz to 50 kHz)	+ and — 50 volt signal (100 volts peak to peak if centered at 0 V)
AC-Coupled	$\geq$2000:1 at 60 Hz	
Common-Mode Dynamic Range		
.1 mV/CM to .2 V/CM	+ and — 15 V (30 V peak to peak if centered at 0 V)	
.5 V/CM to 20 V/CM	+ and — 350 V (700 V peak to peak if centered at 0 V)	

Characteristic	Performance Requirement	Supplemental Notes
Maximum Input Voltage (DC + peak AC)		
.1 mV/CM to .2 V/CM	50 V (DC to 1 MHz)	
.5 V/CM to 20 V/CM	350 V (DC to 1 MHz)	
Input Resistance and Capacitance		
DC Resistance	1 Megohm ± 0.75%	
Shunt Capacitance	Input capacitance adjusted to combine with input resistance for ≈47 μs	Adjusted with 47 pF Input Capacitance Normalizer for ≤1.5% tilt or rounding of 1 kHz calibrator signal.
Input Grid Current	≤0.4 nanoamperes	
DC Drift		
vs. Time	≲400 μV/Hour	Averaged over 10 hours, ambient temperature and line voltage held constant.
vs. Temperature Change	≤300 μV/°C	
vs. Line Voltage Change	≤300 μV (105 V to 125 V AC)	
X-Y Phase Shift	≤1° for DC to 100 kHz signals	Checked with identical SENSITIVITY switch settings; Upper Beam connected to Horizontal deflection plates.
Vertical Signal Out		
Amplitude	≈2 V/CM of displayed signal	DC-coupled
Transient Response	≤5% peak-to-peak aberrations	

Horizontal Sweep

Time Base		
NORMAL (×1) Ranges	5 SEC/CM to 1 μSEC/CM	21 steps in a 1-2-5 sequence.
Accuracy	±3%	
MAGNIFIED Ranges	×2, ×5, ×10, ×20	For sweep rates which do not exceed the maximum calibrated rate of 1 μSEC/CM.
Accuracy	±5%	
VARIABLE (uncalibrated) Range	≥2.5:1	
Normal/Magnified Registration	Within 2 mm	

Triggering

Internal Triggering		
Sensitivity		
DC	2 mm signal; DC to upper bandwidth limit	See "Bandwidth" under Vertical Amplifier characteristics for specific bandwidth limits.
AC	2 mm signal; 50 Hz to upper bandwidth limit	
Sources	Upper Beam, Lower Beam, Line	
External Triggering		
Sensitivity		
DC	0.5 V to 10 V; DC to 1 MHz	
AC	0.5 V to 10 V; 50 Hz to 1 MHz	
Maximum Input Voltage	350 V	Combined DC + peak AC
Input Resistance	1 megohm ±5%	
Single Sweep Triggering	Requirements same as Normal Sweep	

External Horizontal Amplifier

Sensitivity		
Range	.1 V/CM to 2 V/CM	5 steps in 1-2-5 sequence
Accuracy	±5%	at 25°C ± 5°C
Frequency Response (3 dB down)	DC to 100 kHz	

Characteristic	Performance Requirement	Supplemental Notes
Input Resistance and Capacitance	≈1 megohm paralleled by ≈70 pF	70 microseconds
Maximum Input Voltage (DC + peak AC)	20 V	
Z Axis Input		
Sensitivity	25 volts peak to peak causes noticeable intensity modulation	
Frequency Range	Usable from ≈2 kHz to ≈1 MHz	AC-coupled to CRT cathode
Calibrator		
Range	Square-wave signal output at amplitudes of .5 MV to 50 V	In 6 steps
Accuracy	±3%	
Repetition Rate	1 kHz ± 30%	
Duty Cycle	Between 35% and 65%	
Output Resistance	2 kΩ	With calibrator at 5 volts. <2 kΩ in all other settings of the CALIBRATOR switch.

MECHANICAL CHARACTERISTICS

Dimensions	
Type 502A	15¾ inches high, 11½ inches wide, 22¾ inches deep.
Type RM502A	12½ inches high, 22¾ inches deep (4 inch additional depth recommended for circulation of cooling air). Designed for mounting in a standard EIA 19 inch rack on pull-out slides.
Construction	Anodized aluminum-alloy front-panel and chassis, three-piece blue vinyl painted aluminum-alloy cabinet.
Ventilation	Filtered forced air. A minimum of 2 inch unobstructed clearance around the instrument is recommended for adequate ventilation. Exhausted air should not be allowed to recirculate. Thermal cutout protects the instrument from overheating.
Connectors	UPPER BEAM A & B, LOWER BEAM A & B, Vertical Sig. Out, and CAL OUT are UHF connectors. EXTERNAL HORIZONTAL INPUT, TRIGGER INPUT, and External CRT Cathode are 5-way binding posts.

ADDITIONAL INFORMATION

Power Requirements

Line Voltage Range — The primary circuit of the power transformer can be connected to provide proper operation at any of the following line voltages:

Nominal Line Voltage (RMS)	Operating Range
110	99 V to 117 V
117[2]	105 V to 125 V
124	112 V to 132 V
220	198 V to 234 V
234[2]	210 V to 250 V
248	222 V to 264 V

[2]Normal Factory Connections

Line Frequency Range	50 Hz to 60 Hz
Power Consumption	
Maximum Watts	290 (Measured at 50 Hz Line
Maximum VA	315 Frequency)
Fuse Data	
110 V to 125 V	
50 Hertz	3.2 A, Slo-Blo Type 3AG
60 Hertz	4.0 A, Fast-Blo Type 3AG
220 V to 250 V	
50 Hertz	1.6 A, Slo-Blo Type 3AG
60 Hertz	2.0 A, Fast-Blo Type 3AG

ADDITIONAL INFORMATION *(cont)*

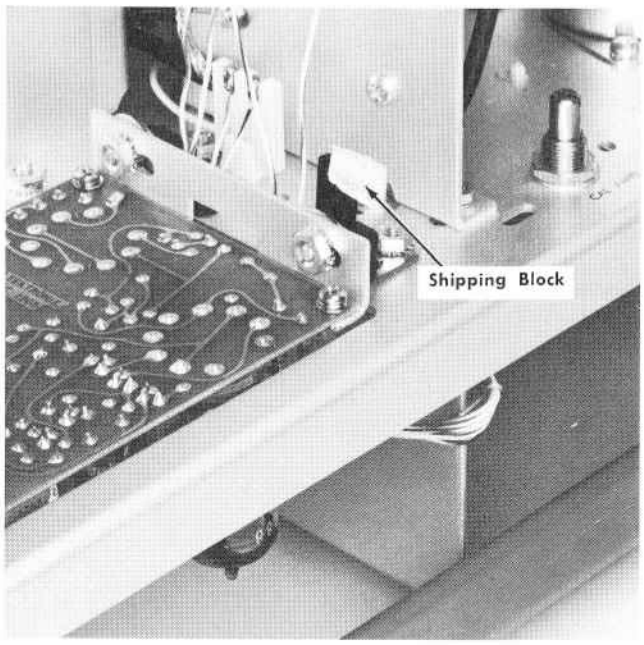
Cathode Ray Tube and Display

Tube Type	Type 5021 dual-gun cathode ray tube. Separate vertical deflection plates for each beam, horizontal deflection plates shared.
Phosphors	P2 (Standard), P7, P11, P31. (Other phosphors available on special order.)
Accelerating Potential	Approximately 3000 volts.
Unblanking	Intensity-modulated. Retrace unblanking DC-coupled from sweep generator; X-Axis unblanking AC-coupled from rear-panel CRT Cathode connector.
Graticule	
Type	External; variable edge lighting.
Display Area	10 cm by 10 cm with 1 cm^2 omitted from each corner. Each beam 8 cm by 10 cm, overlapping in the center 6 cm vertical area.
CRT Controls (Front-Panel)	
FOCUS	Separate adjustment for each beam.
INTENSITY	Common INTENSITY control, with INTENSITY BALANCE control to adjust relative brightness.

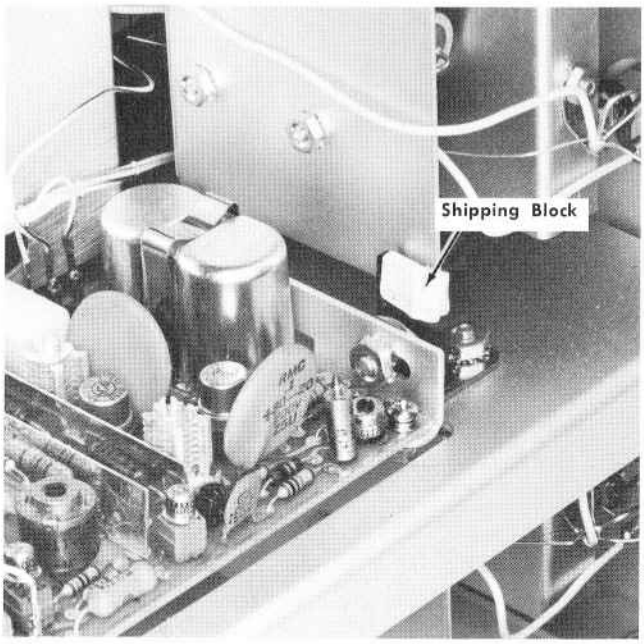
STANDARD ACCESSORIES

A list of Standard Accessories for the Type 502A will be found immediately following the Mechanical Parts List Illustrations. Standard Accessories for the Type RM502A are listed immediately following Section 10 (Rack-mounting).

SECTION 2
OPERATING INSTRUCTIONS



Right Side View



Left Side View

Fig. 2-1. The position of the shipping blocks for each vertical amplifier.

Shipping Blocks

It is very important to remove the shipping blocks from the vertical amplifiers prior to using the oscilloscope. The shipping blocks are narrow inserts, which are used to hold the vertical amplifiers firmly in place during shipment. A slight tug with a pair of pliers towards the outside of the instrument will remove the shipping block used on each vertical amplifier. See Fig. 2-1 for the shipping block positions.

The shipping blocks should be kept for future use.

Cooling

A fan maintains safe operating temperature in the Type 502A Oscilloscope by circulating air through a filter and over the components. Therefore, the instrument must be placed so that the air intake is not blocked. The air filter must be kept clean to permit adequate air circulation. If the interior temperature should rise too high for some reason, a thermal cutout switch will disconnect the power and keep it disconnected until the temperature drops to a safe value.

For proper air circulation, the bottom and side panels must be in place. Be sure the bottom panel is installed according to directions.

Power Requirements

The regulated power supplies in the Type 502A will operate with line voltages from 105 to 125 volts, at 117 nominal line volts, or from 210 to 250 volts at 234 nominal line volts. Proportionate line voltage variations apply when other nominal line voltage primary connections are made. For maximum dependability and long life the voltage should be near the center of this range. Fig. 2-2 shows the connections for the various line voltages. If the transformer connections are changed, be sure to change the wording on the Voltage Tag (mounted above the power connector at the rear of the instrument) to correspond.

Voltages outside of these limits, or poor line-voltage waveforms, may cause hum or jitter on the trace and may cause unstable operation. Be sure to check for proper line voltage if indications such as these are present.

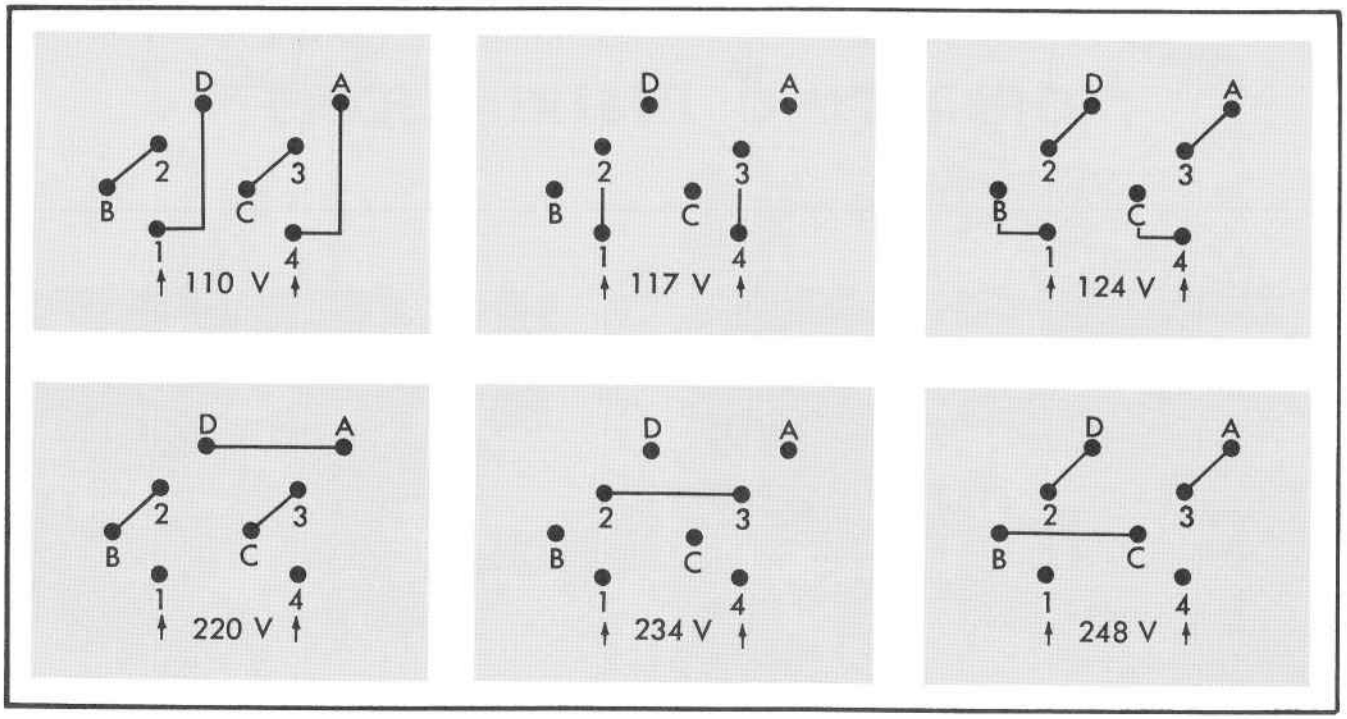


Fig. 2-2. The power transformer has two extra windings permitting nominal primary voltages of 110, 117, 124, 220, 234 or 248 volts, 50 or 60 hertz operation.

Fan Connections

The manner in which the fan is wired depends on the line voltage. For 110-124 or 220-248 volt operation, the fan is connected as shown in Fig. 2-3.

Fuse Requirements

Use a 4 A, 3AG, Fast-Blo fuse for 110, 117 or 124 volt 60 hertz operation; for 50 hertz use a 3.2 A., 3AG Slo-Blo fuse. For 220, 234 or 248 volt, 60 hertz operation use a 2 A, 3AG, Fast-Blo fuse; for 50 hertz use a 1.6 A, 3AG, Slo-Blo fuse.

Input Selection

On the Type 502A oscilloscope, you can connect single-ended inputs to either the A or B input connectors of the LOWER or UPPER BEAM amplifiers by rotating the Input Selector switches to the corresponding position. The choice of input connections will depend upon the display desired. Waveforms applied to input B are displayed in an inverted position on the face of the CRT while waveforms applied to input A are displayed in the normal upright position. (See Fig. 2-5.) If you are not aware of this difference in the input connectors, it is probable that you will improperly evaluate the results obtained from an input to the B connector.

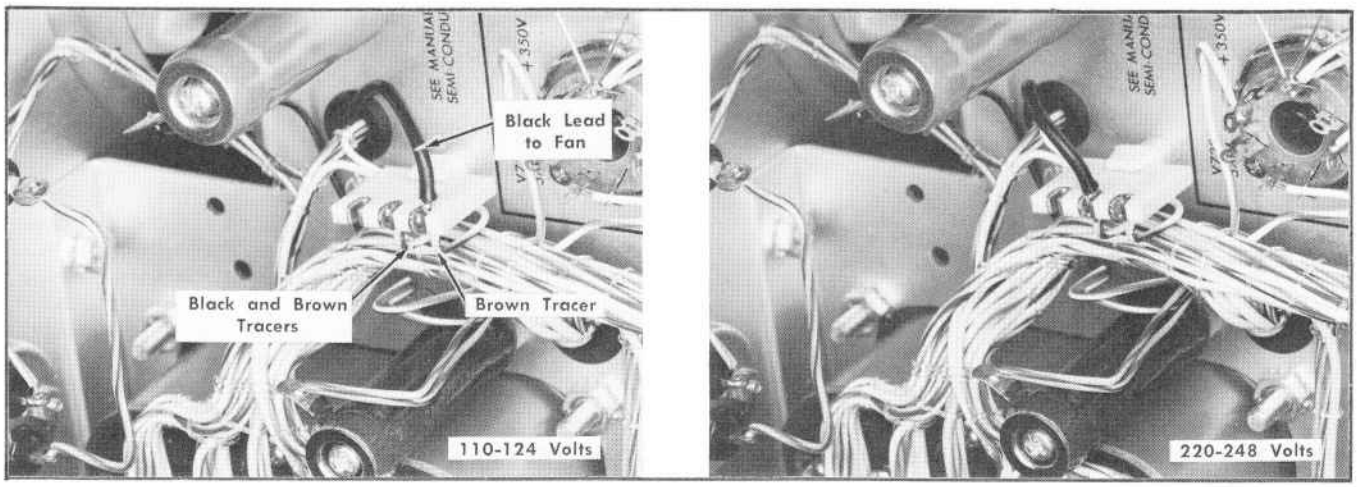
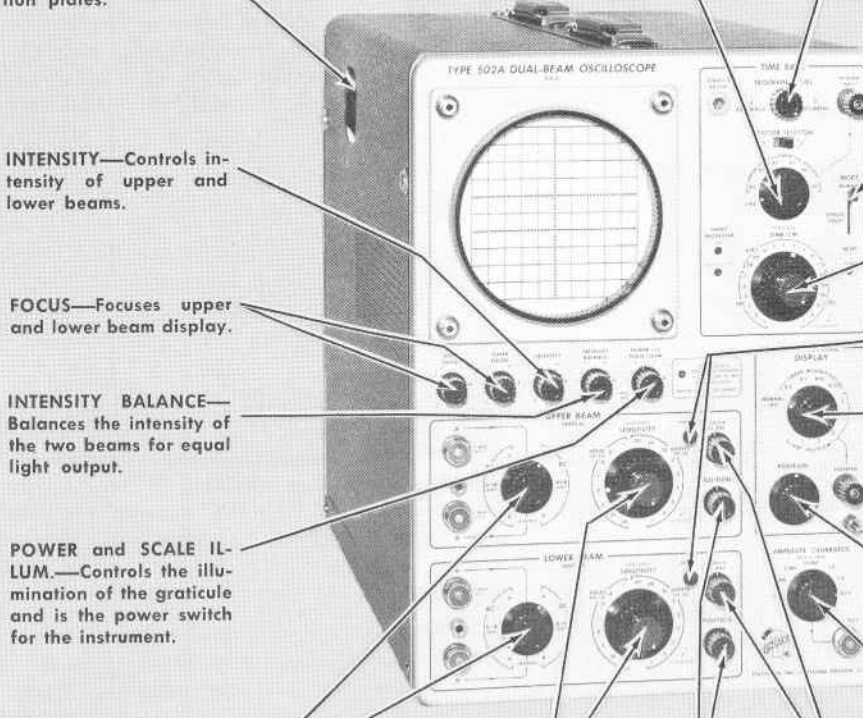


Fig. 2-3. Fan connections for the various line voltage connections.



TRIGGER SELECTOR—Determines whether triggering occurs on the rising portion (+ Slope) or falling portion (— Slope) of the triggering waveform. Also selects AC or DC mode.

TRIGGERING LEVEL—Selects the voltage point on the triggering waveform where the sweep is triggered. Also selects AUTOMATIC or RECURRENT operation.

HORIZ PLATE SEL. SWITCH (on side of Type 502A)—Connects Time-Base signal or Upper-Base Amplifier signal to horizontal deflection plates.

MODE—Provides means of obtaining single sweep of display across the face of the crt.

INTENSITY—Controls intensity of upper and lower beams.

TIME/CM—Selects desired sweep rate.

FINDER—Reduces vertical amplifier gain by 100 times to enable the trace to appear on the crt.

FOCUS—Focuses upper and lower beam display.

INTENSITY BALANCE—Balances the intensity of the two beams for equal light output.

HORIZONTAL DISPLAY—Selects 1, 2, 5, 10 or 20 times horizontal magnification of the displayed waveform. Also controls horizontal sensitivity for external inputs applied at the external connector.

POWER and SCALE ILLUM.—Controls the illumination of the graticule and is the power switch for the instrument.

POSITION—Positions both upper and lower beams horizontally.

AMPLITUDE CALIBRATOR—Controls amplitude of the calibrator square waves at the CAL OUT connector.

INPUT SELECTOR—Connects inputs from selected input connector(s) to vertical amplifier and also selects either AC or DC coupling of the input signal.

SENSITIVITY—Selects the sensitivity of the vertical amplifier.

POSITION—Positions trace vertically.

DC BALANCE—Balance vertical amplifier on high ranges of sensitivity control. The screwdriver COARSE adjustment is reached through a hole in the knob.

Fig. 2-4. Functions of the Type 502A front panel controls.

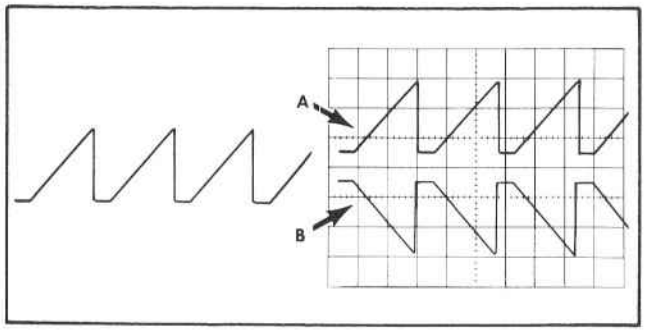


Fig. 2-5. Inputs to the vertical amplifiers. Waveforms applied to input connector A are displayed in the upright position, while waveforms applied to input connector B are inverted.

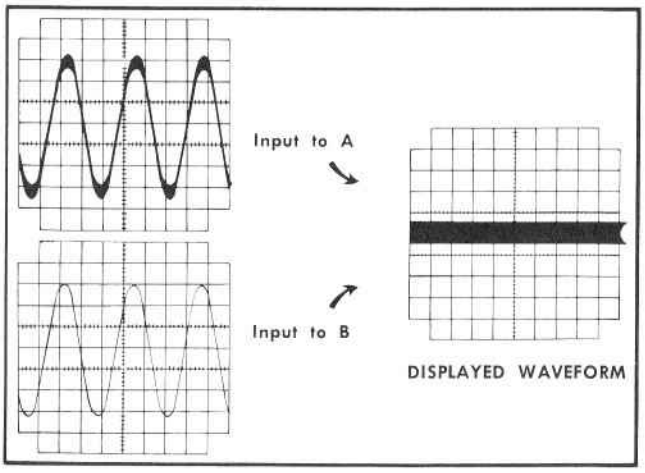


Fig. 2-6. Rejection of a common mode signal by the differential amplifier. The waveform applied to input connector B is inverted and algebraically added to the waveform applied to input connector A. The resultant waveform is displayed on the screen of the CRT.

Differential inputs must be connected to both the A and B input connectors of one amplifier. In the A and B positions of the input selector switch, the corresponding waveforms are displayed on the CRT. In the A-B (DIFF) position, the B input is algebraically added to the A input and the difference is displayed (See Fig. 2-6.) This feature permits you to eliminate common mode signals within specified limits.

Input Coupling

Input signals to the vertical amplifiers can be either AC or DC coupled by placing the Input Selector switch in the corresponding positions. DC coupling applies both the AC and DC components of the input signal to the vertical amplifier circuits. This permits you to measure the DC voltage level as well as the amplitude of the AC component. It is sometimes neither necessary nor desirable to display the DC component. In such cases AC coupling should be used. With AC coupling, a capacitor is placed in series with the input connector to block the DC component while at the same time allowing the AC component to be displayed.

Input Connections

Here are some precautions you should observe in connecting your oscilloscope to the signal source:

1. Avoid errors in readings due to stray electric or magnetic coupling between circuits, particularly in the leads connected to the input connector. In general, unshielded leads of appreciable length are unsuited for this use. When shielded leads are used, the shields should be grounded to the input connector shield and to the chassis of the equipment being tested. Coaxial cables are recommended for many purposes. Special care must be taken in the high sensitivity ranges of the oscilloscope due to the low signal level and high amplifier gain.

2. As nearly as possible, simulate actual operating conditions in the equipment being tested. The equipment should have a load on it which is approximately equal to the load encountered in normal operation.

3. Consider the effect of loading upon the signal source due to the input circuit of the oscilloscope. The circuit at the input connectors can be represented by a resistance of 1 megohm shunted by a capacitance of 47 pF. With a few feet of shielded cable, the capacitance may well be 100 pF or more. In many cases, the effects of these resistive and capacitive loads are not negligible, and to minimize them, you might want to use a probe in the manner described in the next section.

Use of Probes

An attenuator probe lessens both capacitive and resistive loading, at the same time reducing sensitivity. When making amplitude measurements with an attenuator probe, be sure to multiply the observed amplitude by the attenuation of the probe.

A P6006 Probe is furnished as an accessory to the Type 502A Oscilloscope. Connected to the INPUT connector of the Type 502A, the probe presents an input characteristic of 10 megohms shunted by approximately 9 picofarads and has an attenuation ratio of 10:1. The maximum voltage which may be applied to the probe is 600 volts. Exceeding this rating, either in peak-to-peak AC volts or DC volts, may result in damage to the components inside the probe body.

If the waveform being displayed contains fast changing portions, it is generally necessary to clip the ground lead of the probe to the chassis of the equipment being tested. Select a ground point which is near the probe connection.

Probe Adjustment

An adjustable capacitor, which is built into the probe body, is used to compensate for slight variations in input capacitance from one instrument to another. To insure the accuracy of pulse and transient measurements, this adjustment should be checked frequently.

To make this adjustment, set the AMPLITUDE CALIBRATOR and SENSITIVITY controls on the Type 502A to display a signal of suitable amplitude. Touch the probe tip to the CAL OUT connector and adjust the TIME/CM control to display several cycles of the waveform.

Loosen the locking sleeve several turns. (See Fig. 2-7). Now while holding onto the knurled part near the cable, turn the probe body until a flat top is obtained on the square-wave waveform. See Fig. 2-8. The locking sleeve should now be tightened. After the locking sleeve has been tightened,

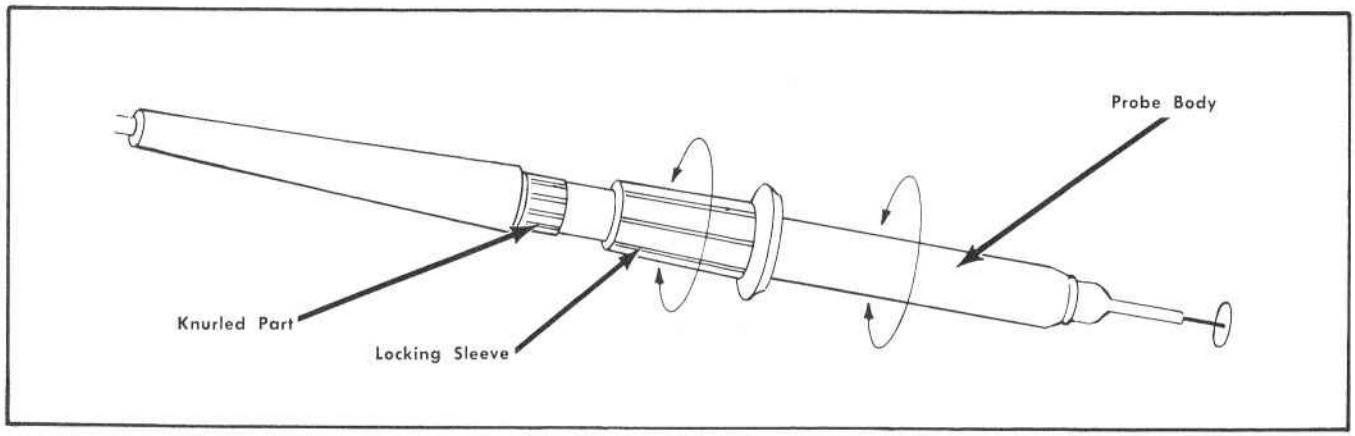


Fig. 2-7. Location of locking sleeve and knurled parts on the P6006 Probe.

the probe compensation should be checked once more to insure that the compensation did not change when the locking sleeve was tightened.

Triggered Operation

In order to obtain a stable display of some recurrent waveform, it will be necessary for you to trigger the horizontal sweep at the correct instant of time. This will insure that the sweep will start at the same point on the observed waveform for each cycle of operation. The sweep should be triggered either by some waveform bearing a fixed time relationship to the observed waveform or by the observed waveform itself. Either method will produce the desired stable display. If the waveform which is applied to the Upper Beam and the waveform which is applied to the Lower Beam have a definite time relationship to each other it is possible to trigger from either beam and obtain simultaneously a stable display of both waveforms.

The following instructions tell you how to select the proper triggering signal for various applications of your oscilloscope. These instructions also provide information about the advantages and limitations of each triggering configuration. You should attempt to become thoroughly familiar with all of the various triggering configurations in order to obtain maximum use from your instrument. A thorough knowledge of the triggering configurations will allow you a greater selection of triggering methods when you are confronted with a definite triggering problem.

How to select the triggering signal source

1. To trigger the sweep from the waveform displayed on the Upper Beam, set the TRIGGER SELECTOR switch at UPPER AC or UPPER DC.

2. To trigger the sweep from the waveform displayed on the Lower Beam, set the TRIGGER SELECTOR switch at LOWER AC or LOWER DC.

3. To trigger the sweep at the power line frequency, set the TRIGGER SELECTOR switch to LINE. This mode of triggering will normally be used when you are observing a waveform which bears a fixed time relationship to the power line frequency.

4. To trigger the sweep from some external waveform bearing a definite time relationship to the observed wave-

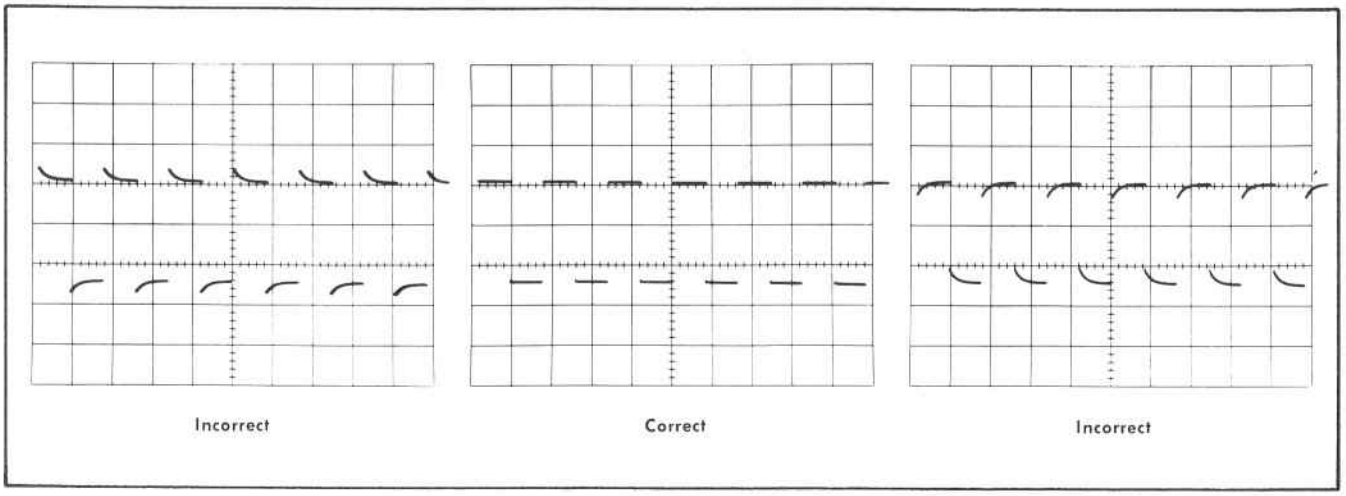


Fig. 2-8. The P6006 Probe is adjusted for a flat-topped square-wave display of the Calibrator waveform.

form, connect the external waveform to the TRIGGER INPUT connector and set the TRIGGER SELECTOR switch at EXT AC or EXT DC.

External triggering provides definite advantages over other configurations of triggering in certain cases. With external triggering, the triggering signal generally remains essentially constant in amplitude and shape. It is thereby possible to observe the shaping and amplification af a signal by each stage of a circuit without resetting the triggering controls for each observation. Also time and phase relationships between the waveforms at different points in the circuit can be seen. If, for example, the external triggering signal is derived from the waveform at the input to a circuit, the time relationship and phase of the waveforms at each point in the circuit are automatically compared to the input signal by the display presented on the face of the CRT.

Automatic Mode

Automatic triggering is obtained by rotating the TRIGGERING LEVEL control fully counterclockwise to the AUTOMATIC position. This provides a preset triggering level which is set to allow triggering at the average voltage point of the applied waveform. The sweep runs at approximately a 50 hertz rate when no triggering signals are applied. Automatic triggering can be used with triggering signals obtained from the LINE, UPPER, LOWER, or EXT positions of the TRIGGER SELECTOR switch but for most waveforms, it is useful only for triggering at frequencies above approximately 50 hertz. Automatic triggering saves considerable time in observing a series of waveforms since it is not necessary to reset the triggering level for each observation.

DC Coupling

DC coupling is selected in the UPPER DC, LOWER DC, and EXT DC positions of the TRIGGER SELECTOR switch. This coupling of the triggering signal is particularly useful in triggering from waveforms which are not adaptable to AC coupling, such as random pulse trains or very low frequency waveforms. Random pulse trains pose a special problem in the AC coupling since the random occurrence of the input waveforms causes the average voltage level to shift. This in turn may cause the triggering level to shift to an unstable point. This problem is not encountered with DC coupling since the triggering point is determined only by instantaneous voltage.

With DC coupling the triggering signal is obtained from either the Lower or the Upper Beam amplifiers, hence varying the respective vertical position controls will change the triggering point. For this reason, you may find it necessary to readjust the TRIGGERING LEVEL controls when you change the vertical position of the trace. If you desire to eliminate this effect, you can use AC coupling provided the triggering signal is otherwise suitable for this type of coupling. With DC coupling, the DC level of external triggering signals will also affect the triggering point. Generally, when the triggering signal is small compared to its DC level, AC coupling should be used.

AC Coupling

AC coupling is selected in the LINE, LOWER AC, UPPER AC, and EXT AC positions of the TRIGGER SELECTOR switch. This coupling provides stable triggering on virtually all types of waveforms. As a general rule, however, AC coupling is unsatisfactory for triggering with low amplitude waveforms at frequencies below approximately 15 hertz. This figure will vary depending upon the amplitude and shape of the triggering waveform and should not therefore be set as an absolute standard. Triggering at frequencies below 15 hertz can be accomplishd when higher amplitude triggering signals are used.

With AC coupling, the triggering point depends on the average voltage level of the triggering signals. If the triggering signals occur at random, the average voltage level will vary, causing the triggering point to also vary. This shift of the triggering point may be enough so that it is impossible to maintain a stable display. In such cases you should use DC coupling.

Trigger Slope

If you wish to trigger the sweep on the rising (positive slope) portion of the triggering waveform, place the TRIGGER SELECTOR switch at +. If you wish to trigger on the falling (negative slope) portion of the triggering waveform, place the TRIGGER SELECTOR switch at —.

Using the TRIGGERING LEVEL Control

In all positions except AUTOMATIC and RECURRENT, the TRIGGERING LEVEL control determines at which point on the triggering signal the sweep is triggered. Using this control, the sweep can be triggered at any point on the waveform so long as the slope of the waveform is great enough to provide stable triggering. With DC coupling, the sweep cannot be triggered with any degree of stability at the top of a square wave, for example, since the time that the voltage remains constant is comparatively long. As a result, the sweep triggers at random points along the top of the square wave producing considerable trace jitter.

You can use the same method to set the TRIGGERING LEVEL control for either type of coupling. After selecting the triggering slope, rotate the TRIGGERING LEVEL control fully counterclockwise to the AUTOMATIC position. Then rotate the TRIGGERING LEVEL control clockwise until the sweep no longer triggers. Continue to rotate the control in the clockwise direction until the sweep again triggers and a stable display is obtained. Further rotation of the control in the clockwise direction causes the sweep to trigger at more positive points on the triggering waveform. See Fig. 2-9.

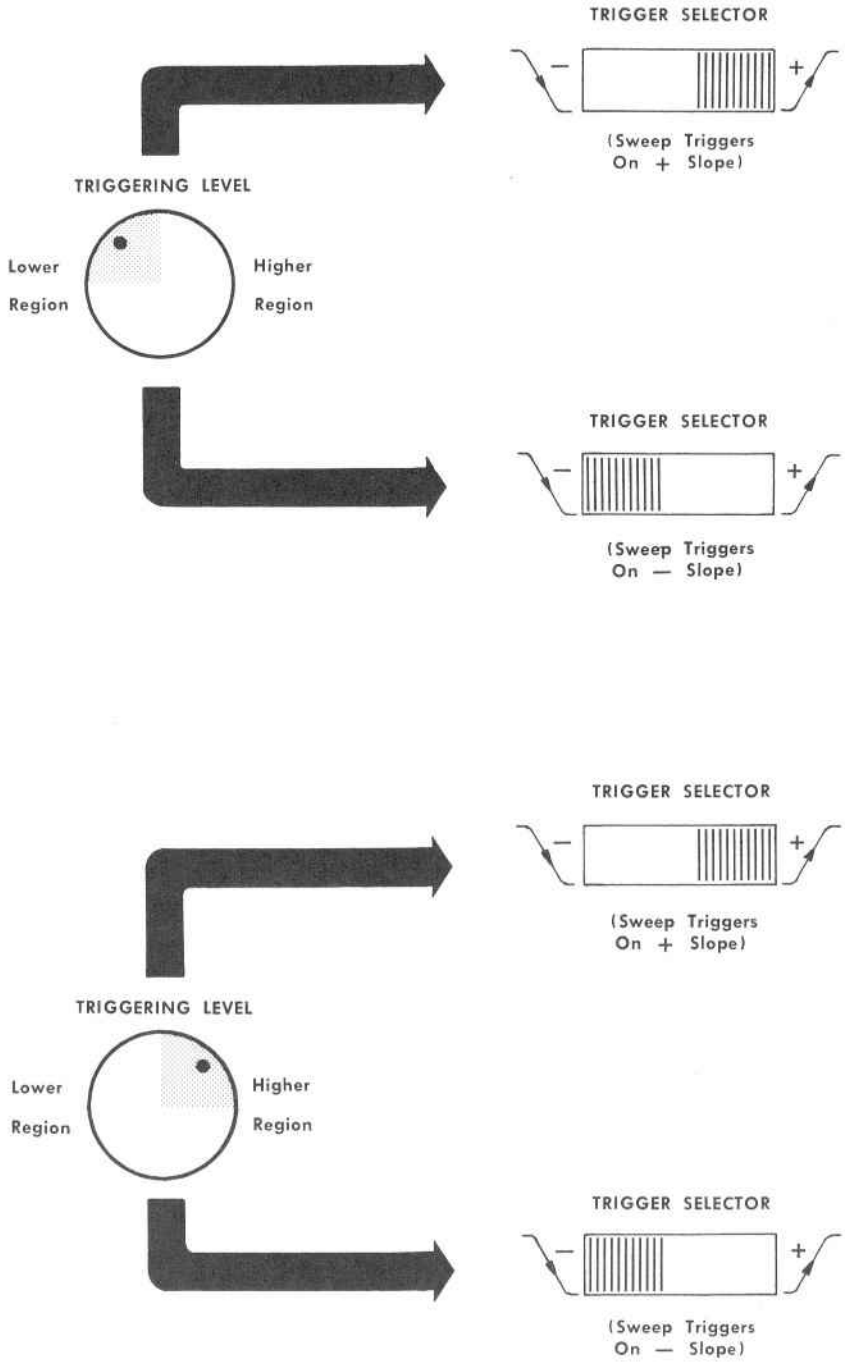
Free-Running Operation

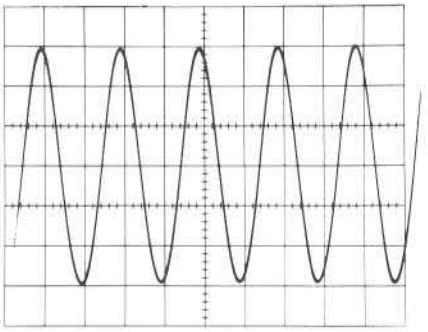
With the Type 502A, you can get a periodic, free-running sweep, independent of any external triggering or synchronizing signal, by rotating the TRIGGERING LEVEL control fully clockwise to the RECURRENT position. This permits you to observe the upper and lower beam traces without an input signal.

Magnifier

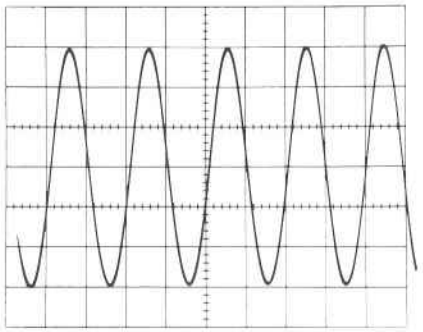
To expand a particular part of the display horizontally, first use the Horizontal POSITION control to position the

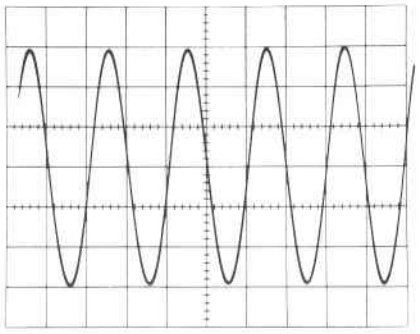
Note: In this illustration of the TRIGGERING LEVEL control, the AUTOMATIC and RECURRENT positions are not shown. The words "Higher Region" and "Lower Region" shown do not actually appear on the front panel, but refer to the relative graticule position at which triggering occurs.



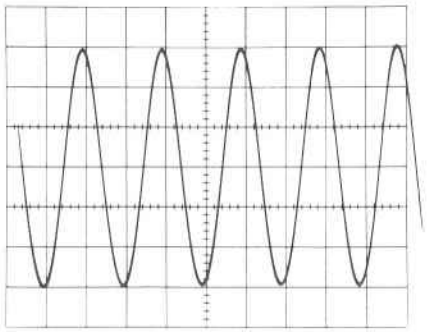


Waveforms obtained with the TRIGGERING LEVEL control set in the Lower Region





Waveforms obtained with the TRIGGERING LEVEL control set in the Higher Region



When the TRIGGERING LEVEL control is set in the lower region, the sweep is triggered on a lower portion of the waveform; when it is set in the higher region, the sweep is triggered on a higher portion of the waveform. The TRIGGER SELECTOR switch determines whether the sweep is triggered on the rising (+ Slope) portion, or the falling (— Slope) portion of the waveform.

Fig. 2-9. Effects of TRIGGERING LEVEL and TRIGGER SELECTOR control settings.

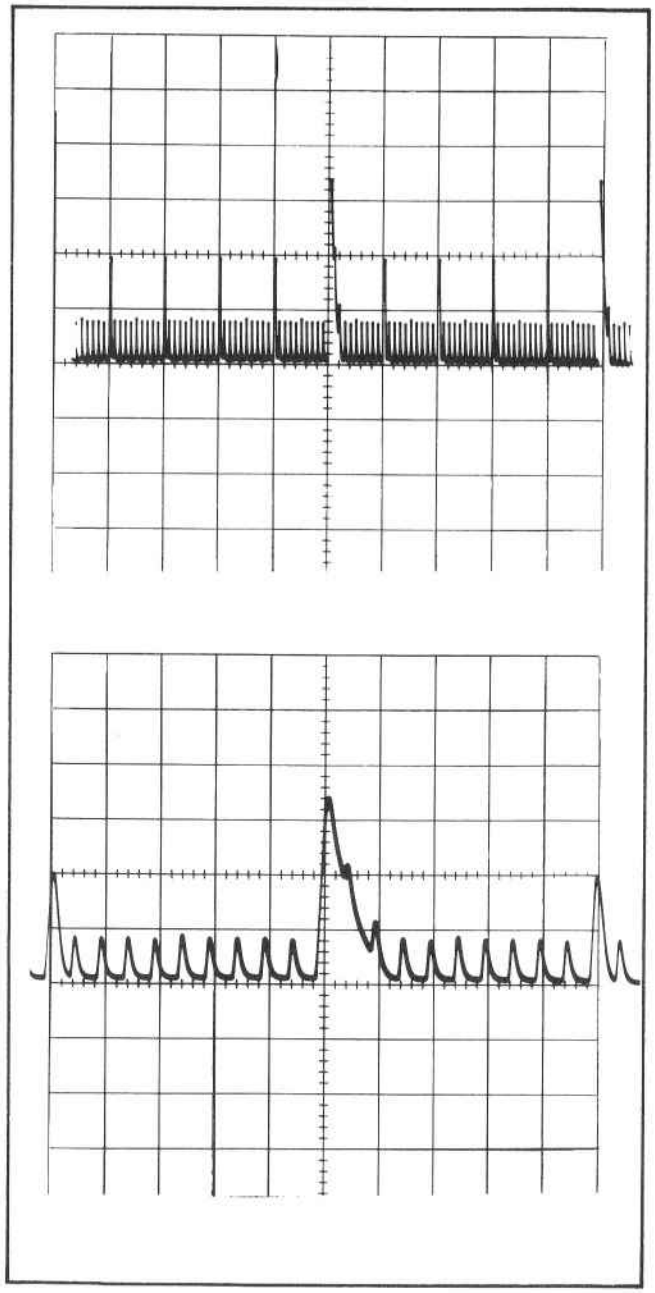


Fig. 2-10. Magnified sweep. The portion of the waveform at the vertical centerline remains stationary as the sweep is magnified. The displayed waveform is expanded left and right from the centerline. The lower waveform is a five times magnification of the upper waveform.

desired part of the display to the center of the graticule. Then turn the HORIZONTAL DISPLAY switch to the magnification desired. The portion of the display at the center of the graticule will then be expanded 2, 5, 10, or 20 times depending on the setting of the HORIZONTAL DISPLAY switch. At the same time, the SWEEP MAGNIFIER ON indicator lamp will light, indicating that the display has been expanded. Any portion of the original unmagnified display can then be shown by rotating the Horizontal POSITION control.

In magnified sweep operation, the sweep rate is multiplied by the magnification. This means that the time per centimeter indicated by the TIME/CM switch must actually be divided by the magnification to obtain the correct time required for the sweep to move one centimeter. For example, if the TIME/CM switch is set to 5 mSEC, and the magnifier is set at ×5, the true time per centimeter is 5 milliseconds divided by 5, or 1 millisecond per centimeter.

Magnified sweep rates are all calibrated within 5% accuracy so long as their true time per centimeter is 1 microsecond or more. Sweep rates faster than this are uncalibrated and may be nonlinear. The SWEEP MAGNIFIER UNCALIBRATED indicator lamp lights whenever the maximum calibrated sweep rate is exceeded, to indicate that the sweep is uncalibrated.

X-Y Operation

In the Type 502A, it is possible to horizontally deflect either or both of the beams across the CRT by means of an externally derived waveform, rather than by means of the internal sweep circuits. This permits the oscilloscope to be used for either dual- or single-beam X-Y curve tracing.

For many X-Y applications, the X-axis (horizontal) signal is applied to the Horizontal Amplifier by connecting the signal to the EXTERNAL HORIZONTAL Input connector. The horizontal deflection sensitivity is controlled by the setting of the HORIZONTAL DISPLAY switch, which has a maximum sensitivity of .1 VOLTS/CM. The HORIZ. DEF. PLATE SELECTOR switch must be in the TIME BASE AMP. position for all dual-beam X-Y applications.

By setting the HORIZ. DEF. PLATE SELECTOR switch to the UPPER BEAM AMP. position, the Upper Beam Amplifier output is connected to the CRT's horizontal deflection plates and the unused upper beam trace is automatically deflected off screen. In this single-beam mode of operation, the Y-axis signal is applied to the LOWER BEAM INPUT and the X-axis signal is applied to the UPPER BEAM INPUT, thus providing the X-axis with differential inputs, AC-DC coupling, .1 mVOLTS to 20 VOLTS/CM and VARIABLE sensitivities, and the same phase-shift and bandwidth characteristics as those seen by the Y-axis signal.

Voltage Measurements

Accurate voltage measurements of inputs to the vertical amplifiers can be made using the calibrated deflection factor feature of the Type 502A. The following instructions tell you how to use the oscilloscope for this purpose and how to obtain the greatest possible accuracy in your measurements. It is important that proper techniques be used in order that errors are not introduced in the results.

During voltage measurements, you should always display the waveform across as much of the CRT face as is possible since, as a general rule, the accuracy of your measurements will increase as the vertical size of the displayed waveform is increased. In measuring voltages, it is important to remember that the width of the trace may be an appreciable part of the overall measurement and care should be used that the trace width is not included in the vertical deflection readings you obtain. You should consistently make all readings from one side of the trace. If the bottom side of the trace is used for one reading, it should be used for all succeeding readings.

NOTE

Make sure the VARIABLE SENSITIVITY Control is in the CALIBRATED position prior to any vertical measurements, unless you have calibrated the instrument with the VARIABLE SENSITIVITY control.

How to measure the AC component of a waveform

For measuring the AC component of a waveform, AC coupling is normally used since it is usually not advantageous to display the DC component of the waveform being measured. AC component voltage measurements can usually be made with DC coupling also, but there is normally no particular advantage in doing so. To obtain peak-to-peak voltage measurement, perform the following steps.

1. To use the graticule, measure the vertical distance in centimeters from the level of the positive peak to the level of the negative peak.

2. Multiply the setting of the SENSITIVITY Control by the distance measured to obtain the indicated voltage.

3. Multiply the indicated voltage by the attenuation factor of the probe you are using to obtain the true peak-to-peak voltage.

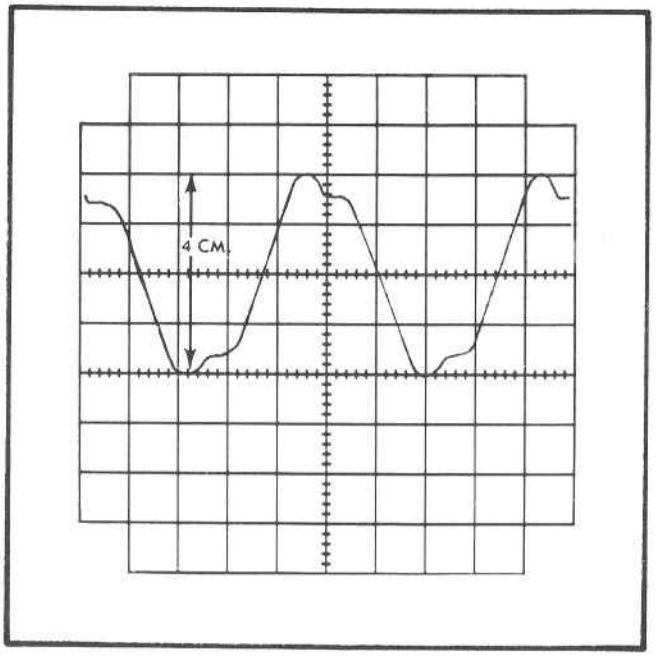


Fig. 2-11. Voltage measurement of the AC component of a waveform. The vertical distance between peaks is multiplied by the setting of the SENSITIVITY control and by the probe attenuation factor to obtain the voltage measurement.

As an example of this method, assume that using a 10× probe and a sensitivity of 1 volt per centimeter, you measure a total vertical distance between peaks of 4 centimeters. In this case then, 4 centimeters times 1 volt per centimeter gives you an indicated voltage of 4 volts peak to peak of sine wave. The indicated voltage times the probe attenuation factor of 10 then gives you the true peak-to-peak amplitude of 40 volts. The peak-to-peak sinusoidal voltage can then be converted to peak, RMS, or average voltage through use of standard conversion factors.

How to measure instantaneous voltages

The method used to measure instantaneous voltages is very similar to the method described previously for AC component voltage measurements. A reference line must be established on the CRT screen. The actual voltage measurement is taken with respect to this reference line. If for example the voltage measurement is to be made with respect to +100 volts, the reference line will correspond to +100 volts. In the following procedure the method is given for establishing this reference line as ground since measurements with respect to ground are by far the most common type made. The same general method may be used to measure voltage with respect to any other potential, so long as that potential is used to establish the reference line.

CAUTION

To prevent saturation of the vertical amplifiers, the peak voltage to ground at any amplifier input connector must not exceed 500 volts on the .5 to 20 VOLTS PER CM ranges and 7.5 volts on all other ranges.

To obtain a voltage measurement with respect to ground, perform the following steps.

1. To establish the reference line, DC couple the oscilloscope input, then touch the probe tip to the oscilloscope ground terminal and rotate the TRIGGERING LEVEL Control fully clockwise to the RECURRENT position.

2. Vertically position the trace to a convenient point on the face of the CRT. (This point will depend upon the polarity

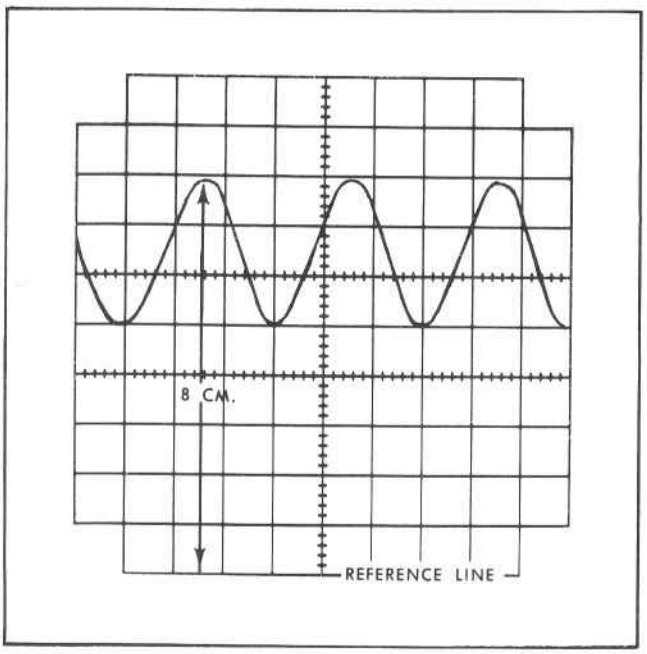


Fig. 2-12. Measuring the instantaneous voltage. The vertical distance from the point of measurement to a pre-established reference line is multiplied by the setting of the SENSITIVITY control and by the attenuation factor of the probe to obtain the voltage measurement.

and amplitude of the input signal, but it should always be chosen so that the trace lies along one of the major divisions of the graticule. The graticule division corresponding to the position of the sweep is known as the ground reference line. Do not adjust the VERTICAL POSITION control after this reference point has been established.)

3. Remove the probe tip from ground and connect the probe to the signal source. Adjust the TRIGGERING LEVEL control for a stable display.

4. Measure the vertical distance in centimeters from the point to be measured to the ground reference line by use of the graticule.

5. Multiply the setting of the SENSITIVITY control by the distance measured to obtain the indicated voltage.

6. Multiply the indicated voltage by the attenuation factor of the probe you are using to obtain the true voltage with respect to ground.

As an example of this method, assume that you are using a 10× probe and a sensitivity of 0.2 volts per centimeter and that after setting the reference line at the bottom of the graticule, you measure a distance of 8 centimeters to the point you wish to measure. In this case then, 8 centimeters times 0.2 volts per centimeter gives you an indicated voltage of 1.6 volts. Since the voltage point is above the ground reference line, the polarity is indicated to be positive. The indicated voltage times the probe attenuation factor of 10 then gives you the true voltage of positive 16 volts.

You should remember in determining the polarity of voltages measured in this fashion that inputs applied to the B input connectors are inverted on the face of the CRT. Consequently, the apparent polarity of these inputs is opposite the true polarity. To prevent possible confusion as to polarity it is usually best to use the A input connectors for voltage measurements.

Time Measurement

Accurate elapsed time or time interval measurements can be made by utilizing the calibrated time base feature of the Type 502A Oscilloscope. The sweeps are calibrated so that the beams are deflected across the screen at known rates. Since the beam travels completely across the screen in a known period of time, the time required for the beam to travel any portion of the distance can be determined. By measuring the horizontal distance between points on the displayed waveform, and by knowing the sweep rates, you can determine the time interval between the two points. For accurate measurements be sure the same reference point is used on both pulses and the VARIABLE TIME/CM control is in the CALIBRATED position. The method for measuring a time interval is as follows:

1. Using the graticule, measure the horizontal distance in centimeters between two points whose time interval you wish to find.

2. Multiply the distance measured by the setting of the TIME/CM control to obtain the apparent time interval.

3. Divide the apparent time interval by the magnification indicated by the setting of the HORIZONTAL DISPLAY switch to obtain the correct time interval.

Frequency Measurement

The frequency of a periodically recurrent waveform can be determined if the time interval (period) of one complete cycle of the waveform is known. This time interval can be measured by means of the procedure described in the preceding paragraph. The frequency of a waveform is the reciprocal of its time interval.

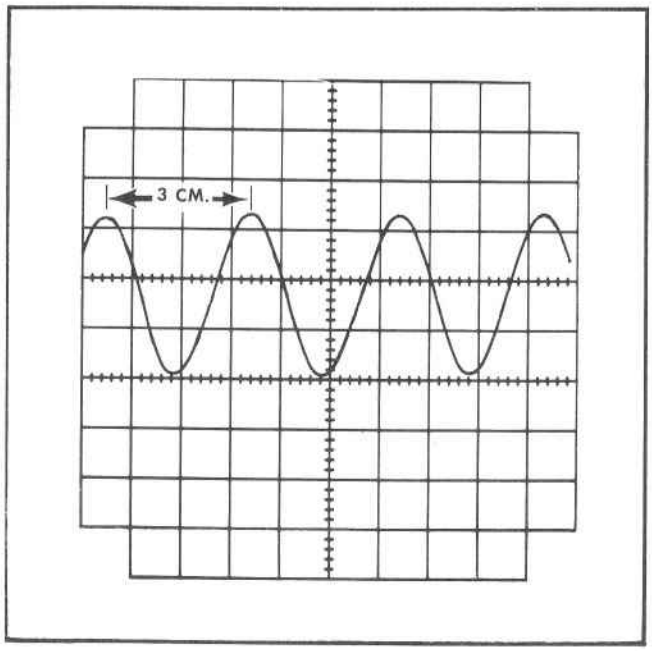


Fig. 2-13. Measuring the time interval (period) of one complete cycle of a periodically recurrent waveform. The horizontal distance in centimeters of one complete cycle (in this case 3 centimeters) is multiplied by the setting of the TIME/CM control and is divided by the sweep magnification to obtain the time inverval. The frequency of the waveform is the reciprocal of its time interval.

Using DC BAL and Trace FINDER Controls

It is best to disconnect the input signal, unless the approximate amplitude of it is known. If the amplitude of the input signal is known, then set the SENSITIVITY control for a CRT display of two or three centimeters and follow the instructions for no input signal.

With no input signal, turn the TRIGGERING LEVEL control to RECURRENT, the single sweep MODE switch to NORMAL and the INTENSITY control to a reasonable level. The above control settings are to insure that a trace can be seen, when it is found.

Set the VERTICAL POSITION control of the proper beam to its midrange position, with the SENSITIVITY control in the .2 VOLTS PER CM position. If no input signal is connected to the Type 502A, change the SENSITIVITY control to the .1 mVOLTS PER CM position and depress the trace FINDER button. The trace should now be seen on the CRT. Now turn DC BAL control in either direction until a "fast area" is seen. A "fast area" is an area of the DC BAL control where the trace will move a large distance for a very small movement of the DC BAL control.

When the "fast area" of the DC BAL control is found, the trace should be positioned in the center of this area with the DC BAL control. The trace FINDER button may now be released and the trace positioned to the proper place on the graticule.

If the trace shifts slightly between the different ranges of the SENSITIVITY control this may be cured by a very slight readjustment of the DC BAL control. The following procedure may be used to correct for this slight trace shift.

Set the free-running trace to a convenient horizontal graticule line with the SENSITIVITY control in the .2 VOLTS PER CM position. Rotate the SENSITIVITY control to the .1 m-VOLTS PER CM position and bring the trace back to the original horizontal graticule line with the DC BAL control.

NOTE

The "fast area" with the trace FINDER button depressed can only be easily seen on the higher sensitivity settings of the SENSITIVITY control.

Single Sweep

Single sweep is used to record waveforms which are not repetitive or waveforms which jitter too much for normal triggered-display photography.

To use the single sweep feature of the Type 502A, set the MODE switch to NORMAL. If the waveform is repetitive it should be connected to the input of the oscilloscope. If the waveform is not repetitive then an AMPLITUDE CALIBRATOR signal of the same amplitude as that of the expected signal should be used.

Adjust the trigger control to obtain a stable display of the input signal. In the case of a waveform that jitters, adjust the control to obtain the most stable display.

If a calibrator waveform was used to adjust the trigger control, disconnect the calibrator waveform from the input to the oscilloscope and connect the non-repetitive waveform source to the oscilloscope. Push the MODE switch to the RESET position. The READY light should now be lit. The Type 502A will now sweep once, on the first trigger received after the MODE switch is released; further signals will not cause the instrument to sweep.

If the waveform is repetitive leave the signal connected to the input connector of the oscilloscope. When a sweep is desired, push the MODE switch to RESET and let it return to the SINGLE SWEEP position. Upon the return of the MODE switch to the SINGLE SWEEP position, the sweep will sweep once. If another sweep is desired the MODE switch must again be pushed to the RESET position and returned to the SINGLE SWEEP position.

It may be quite convenient to use the READY light of the Single Sweep circuit as an indicator for photography. The READY light will light when the circuit is awaiting a trigger and will stay lit until the sweep has been completed. At the end of the sweep the READY light will go out and stay out until the circuit is reset for another sweep with the MODE switch.

INTENSITY BALANCE Control

The INTENSITY BALANCE control is used to adjust the intensity of both traces to the same level so that each will have the same relative writing rate, and will show the same amount on a photograph.

It may be necessary to readjust the INTENSITY BALANCE control each time the setting of the INTENSITY control is changed. This is due to the characteristics of a mono-accelerator CRT in which the triode characteristics for each CRT gun are slightly different.

AUXILIARY FUNCTIONS

Amplitude Calibrator

The Amplitude Calibrator is a source of accurately calibrated square waves at a frequency of approximately 1 kilohertz (+ or — 30%). The output amplitude is accurate within 3% of the AMPLITUDE CALIBRATOR switch settings for no load conditions. The primary function of the calibrator is to provide a convenient method for checking the calibration of the vertical-deflection system and for adjusting the probes. It can be used for other purposes, however, if it is kept in mind that the output impedance of the calibrator varies with the output-voltage settings.

Trace-brightness (intensity) modulation

To couple markers or other signals into the CRT cathodes for trace-brightness modulation, disconnect the ground strap at the rear of the instrument and apply the signal between the CRT CATHODE binding post and GND. This will simultaneously apply the signals to the upper and lower beam cathodes. At normal brightness, positive signals of about 25 volts will cut the beams off. Always replace the ground strap when you are not intensity modulating the beams.

Graticule illumination

The graticule lighting control, labeled POWER AND SCALE ILLUM, can be adjusted to suit the lighting conditions of the room. A light filter is supplied with the instrument which can be used for increased contrast. This filter should be mounted next to the CRT face so it does not block the light from the graticule lines.

The graticule of the Type 502A Oscilloscope can be illuminated so that it appears to have either red or white graticule markings. The markings can be quickly changed from white to red or from red to white by removing the graticule cover and inverting the graticule. As a general rule, white graticule lines are superior to red for photographic purposes.

Direct connection to CRT plates

In some applications, it may be desirable to connect a signal direct to one or more sets of CRT deflection plates—bypassing the internal oscilloscope amplifiers. This can be done in the Type 502A if certain precautions are observed. One of the precautions is to maintain the average DC voltage on the deflection plates at approximately +225 volts. If the average voltage is not maintained at approximately +225 volts, the CRT display may be defocused.

For many applications, AC coupling of the signal to the deflection plates is permissible. It has the advantage of allowing the use of front panel controls to position the display and permits the use of signals not having the required average voltage level. A diagram of this method of coupling is shown in Fig. 2-14. Here, the leads from the oscilloscope amplifier are removed and a resistor is connected between each lead and its respective CRT pin. A good value for this resistor in most cases is 1 megohm. The vertical deflection plate pins are located on the sides of the CRT neck and the horizontal deflection plate pins are located on the top of the neck.

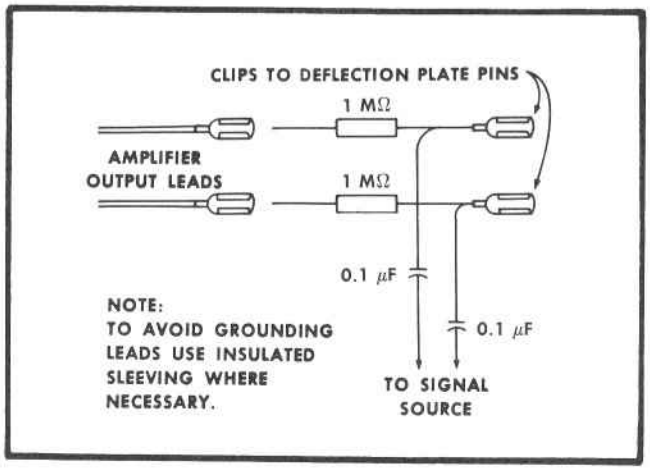


Fig. 2-14. Typical circuit for AC coupling to the CRT deflection plates.

A convenient method for connecting the resistors to the CRT pins is to use clips removed from standard miniature tube sockets. Before connecting the resistors to the leads from the amplifier, slip a piece of insulated sleeving (spaghetti) over the wire. Then, after making the connections, draw the sleeve back over the insulated resistor pigtail. This will prevent leads from accidentally shorting to the chassis. The CRT pins are easily bent and you must exercise care when making these connections to avoid breaking the glass seal.

CAUTION

Do not allow the leads from the oscilloscope amplifiers to touch the chassis when the power is on. A short circuit of this type can damage the amplifier circuits.

If it is desired to couple the signal directly to the CRT plates (DC coupling), it will be necessary to supply positioning voltages from the signal source. These voltages must also satisfy the requirement of an average level of +225 volts, mentioned previously. To DC couple the signal to the deflection plates, remove the leads from the CRT pins and fold them back, out of the way. Taping the ends of the wires will prevent accidental shorting to the chassis. Connect the external signal source to the pins of the CRT.

The vertical deflection factor of the CRT is approximately 13 volts per centimeter. The horizontal deflection factor is approximately 17 volts per centimeter.

SECTION 3
CIRCUIT DESCRIPTION

Introduction

The Type 502A is a dual-beam, high gain low-frequency, oscilloscope employing a dual-gun cathode ray tube. The CRT has two sets of independent vertical deflection plates, one of each of the two identical vertical amplifiers, and one set of common horizontal deflection plates. Simultaneous horizontal deflections of both beams is provided by a single time-base generator and horizontal sweep amplifier circuit. In addition, the upper-beam deflection amplifier can be connected to the horizontal deflection plates, so that the instrument may be employed as a single-beam X-Y oscilloscope; or, by means of the EXTERNAL HORIZONTAL INPUT circuit, the instrument may be used as a dual-beam X-Y oscilloscope, with both traces plotted on the same X axis.

Vertical Amplifiers

The Type 502A circuitry is arranged so that the instrument can be used in any of the several configurations. It may be used as a conventional single-beam oscilloscope by applying an input signal to either of the vertical deflection amplifiers or it may be used to examine two waveforms simultaneously by applying input signals to both vertical amplifier systems; either amplifier may be used in the differential mode to examine differences between two signals.

The Upper-Beam Vertical and the Lower-Beam Vertical Deflection Amplifiers are identical, so the description that follows applies to both.

Vertical Input Switching

The Input Selector switch SW401 determines the mode of operation for the Vertical Amplifier. When in any of the three positions marked AC, the signal is AC-coupled through C400 (for Input A) and/or C401 (for Input B). When in any of the three positions marked DC, the signal is DC-coupled to the input stages of the amplifier.

When switched to A or B, the unused input grid is grounded to eliminate the effect of its Nuvistor's capacitance on the amplifier's high-frequency response. Grounding the grid also prevents pickup of unwanted signals when single-ended operation is desired. For single-ended operation, it is usually best to connect the signal to INPUT A, since a signal connected to INPUT B will always be inverted.

When the Input Selector switch is set to A-B (DIFF), the Vertical Amplifier operates as a differential amplifier and the difference between the A and B signals is displayed.

The basic deflection factor of either Vertical Amplifier is 100 μV/cm. However, by means of an input attenuator and by varying the emitter load resistance and collector degeneration in later stages, the vertical sensitivity can be decreased to 20 volts per centimeter calibrated or 50 volts per centimeter uncalibrated.

In the straight-through (.1 mVOLTS PER CM to .2 VOLTS PER CM positions of the SENSITIVITY switch, the 1 megohm grid resistors constitute the input resistance of the input amplifiers. In the range from 0.5 VOLTS/CM to 20 VOLTS/CM, a $\times 100$ attenuator is connected into each input circuit. The bottom resistors in the dividers—R403D and E for Input A and R405D for Input B—shunt the grid resistors to create an equivalent resistance of 10 kilohms. This 10 kΩ equivalent resistance is in series with the 990 kΩ resistor in the upper end of the divider to produce a total input resistance of 1 megohm, the same input resistance we had in the $\times 1$ positions of the switch.

The capacitance values in the attenuators are also selected, to provide a constant input capacitance regardless of the setting of the SENSITIVITY switch. In the $\times 1$ position of the switch, the input capacitance is equal to the capacitance of C404 (for Input A) or C406 (for Input B) plus the stray capacitance of the wiring and other components in the circuit. C404 and C406 are adjusted with the SENSITIVITY switch set to one of the $\times 1$ positions so that the total capacitance for each input is 47 pF.

Setting the SENSITIVITY switch to an attenuator position reduces this input capacitance to a very small value by adding series capacitance (C403C and C405C). The capacitors at the attenuator inputs shunt this small capacitance and are adjusted to bring the total capacitance at the input connectors back to 47 pF again. Thus, an attenuator probe, when connected to either input and properly adjusted, will work into an RC time constant of 1 megohm times 47 pF regardless of the position of the SENSITIVITY switch.

Vertical Input Amplifier

Q414-V414 and Q514-V514 form a cascode differential amplifier stage. In order that the Type 502A will operate in a true differential manner over the wide dynamic range of the instrument, static and dynamic balances are closely controlled throughout the amplifier. In addition, constant current and bootstrap circuits are used to provide better common-mode rejection. See Fig. 3-1.

The cathodes of the input Nuvistor vacuum tubes are coupled together by the cathode degeneration resistors R418 and R518. At the junction of these resistors, longtail cathode current is supplied by Q438, a constant-current transistor. Q434 provides a negative feedback from the output of the input stage to Q438. This feedback signal stabilizes the DC output level of the stage at approximately +100 volts as measured at the collectors of Q414 and Q514.

By keeping the current constant at both cathodes, common-mode signals are largely prevented from appearing at the collectors of Q414 and Q514. In addition, this longtailing helps to maintain fixed gain and linearity with large input signals.

Common-mode signals at the grids will produce essentially no change in the division of the cathode current between

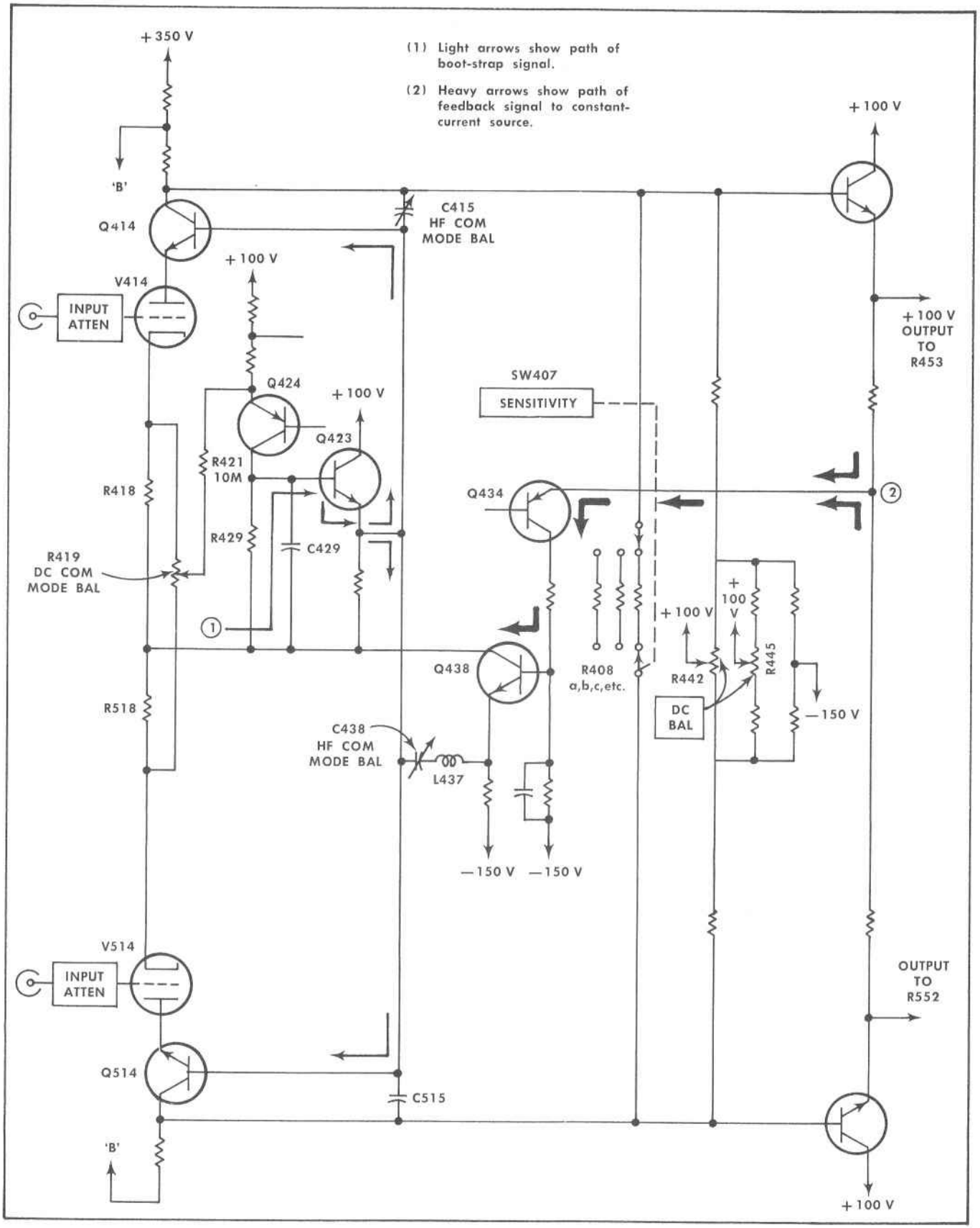


Fig. 3-1. Simplified diagram of input vertical amplifier. (1) Light arrows show path of boot-strap signal. (2) Heavy arrows show path of feedback signal to constant-current source.

the two sides. The common-cathode voltage will, however, follow the common-mode signal in the manner of a single cathode follower. To provide bootstrapping, this signal is coupled by C429 and R429 to the base of the bootstrap emitter follower Q423. The output signal at the emitter of Q423 will be nearly the same as the common-mode signal appearing at the input grids. This signal is applied to the bases of Q414 and Q514 so that the plate-to-cathode voltages on the input Nuvistors remain essentially constant. This bootstrap action, along with the constant-current action of Q438 and the feedback action of Q434, sets the operating conditions of the input amplifiers so that a common-mode signal will be canceled out.

C415 is adjusted to balance out the capacitive currents appearing at the outputs to provide high-frequency common-mode rejection; R419 is adjusted to balance out the resistive currents appearing at the outputs for low-frequency common-mode rejection.

C438 compensates for the common-mode capacitance found at various points in the signal path by injecting opposing current from the output of the bootstrap emitter follower Q423 into the emitter circuit of Q438. C438 is adjusted for minimum high-frequency common-mode signal at the outputs. It completes a positive feedback loop through C438, Q438, C429 and Q423. L437 dampens the tendency of this loop to oscillate.

Diodes D410 and D520 are connected between the grids and cathodes of the input Nuvistors to limit grid current during warmup.

When a large unbalanced signal is applied to the input of the Vertical Amplifier, a slight DC shift will occur due to the ~2.5 seconds time constant in the amplifier[1]. To compensate for this time-constant, a network consisting of C420 and R420 is connected between the plates of the Nuvistors.

The SENSITIVITY switch sets the gain of the input amplifier by connecting precision resistors R408A, R408B, etc. in shunt with the Q414-Q514 collector load resistors. In the .1 mV/CM position, no resistor is switched in and the gain is approximately 30 times. D408 and D409 are placed across R408 to protect the following stages from damaging overloads if excessive voltages are applied to the input connections.

DC BAL controls R442 and R445 adjust the relative DC levels at the collectors of Q414 and Q514 so that there will be no current flow through R408. With this configuration, a change in R408 will not affect the DC level at the output of the stage and therefore will not affect the position of the trace's baseline on the CRT.

Emitter followers Q453A & B provide a high impedance load for the input paraphase amplifier so that gain-setting by R408 will not be affected by the load of the second amplifier stage. Transistor pairs using common heat shields are used for the emitter-follower pair and the amplifier pair to reduce unbalance caused by thermal differences. When a change in the characteristics occurs in one transistor because of a change in temperature, the other transistor of the pair will be equally affected. Additional thermal stability is introduced by R461-C461 and R561-C561.

Current for Q453A & B is supplied through R452 and R552 from Q434, which also couples the negative feedback signal from Q453A & B to Q438 to set the input amplifier operating levels.

[1]This is sometimes referred to as "slump". See Jacob Millman and Herbert Taub, "Pulse and Digital Circuits", McGraw-Hill, New York, 1962. Page 120.

Output Vertical Amplifier

The push-pull signal from emitter-followers Q453A and B is amplified in the second amplifier stage of Q464A and B. Variable sensitivity is obtained by the use of degenerative common-emitter coupling. In the CAL position of the VARIABLE SENSITIVITY control R466, SW466 is closed to short out R466 so the gain of the stage is maximum. As the control is rotated a few degrees counterclockwise, SW466 is opened so the control can be used to vary the amount of emitter degeneration and thus control the gain of the stage.

Vertical positioning of the trace is accomplished through the action of the POSITION control R469. As the control is rotated in either direction from its midrange position, the control varies the relative DC biasing on Q474 and Q574 by increasing the current applied to the base of one transistor while decreasing the current applied to the other.

The gain of the output driver stage of Q474 and Q574 is set by R475, a common-emitter degeneration control. In the Upper-Beam Amplifier circuit, when the amplifier is connected to the horizontal deflection plates by SW489, this resistor is paralleled by R478 to change the gain to compensate for the decreased sensitivity of the horizontal deflection plates as compared to the vertical deflection plates.

Q474 and Q574 drive the final stage of the amplifier, a hybrid push-pull cascode amplifier with common-emitter degeneration. R485 and C485 provide high-frequency equalization to compensate for distributed and CRT capacitance.

V484A and B are used for the final amplifier stage to provide the high output voltages needed to drive the CRT deflection plates. The potential at the grids of both triodes is held constant by zener diode D471.

When internal triggering of the Time-Base Generator is desired (TRIGGER SELECTOR in either of the UPPER or LOWER positions), a sample of the vertical-output signal is used to develop the triggering pulse. This sample, obtained from the plate circuit of V484A, is coupled through a frequency-compensated voltage divider to V493A, a cathode follower which drives the Time Base Trigger and VERTICAL SIG OUT circuitry. DC Trig control R491 is adjusted to set the cathode voltage of V493A to zero when triggering with DC coupling and with the beam positioned at its respective zero-center graticule line.

The VERT SIG OUT cathode follower V493B is direct coupled to the output of V493A to provide a vertical signal output of approximately 2 volts per centimeter of deflection (dependent upon the actual CRT sensitivity).

Depressing the trace FINDER button SW496 decreases the gain of the output stage to bring the track back onto the CRT if a high amplitude input signal or a misadjusted DC BAL control has moved it off the screen.

For single-beam applications where equal horizontal and vertical-deflection factors are desirable, the UPPER BEAM amplifier is connected to the CRT horizontal deflection plates by placing the HORIZ DEF PLATE SELECTOR switch SW489 in the UPPER BEAM AMP position (see Fig. 3-2). This provides a sensitivity of 0.1 millivolts per centimeter to 20 volts per centimeter and differential input for both horizontal and vertical deflection. Only the lower beam will be displayed on the CRT; the upper beam will be deflected

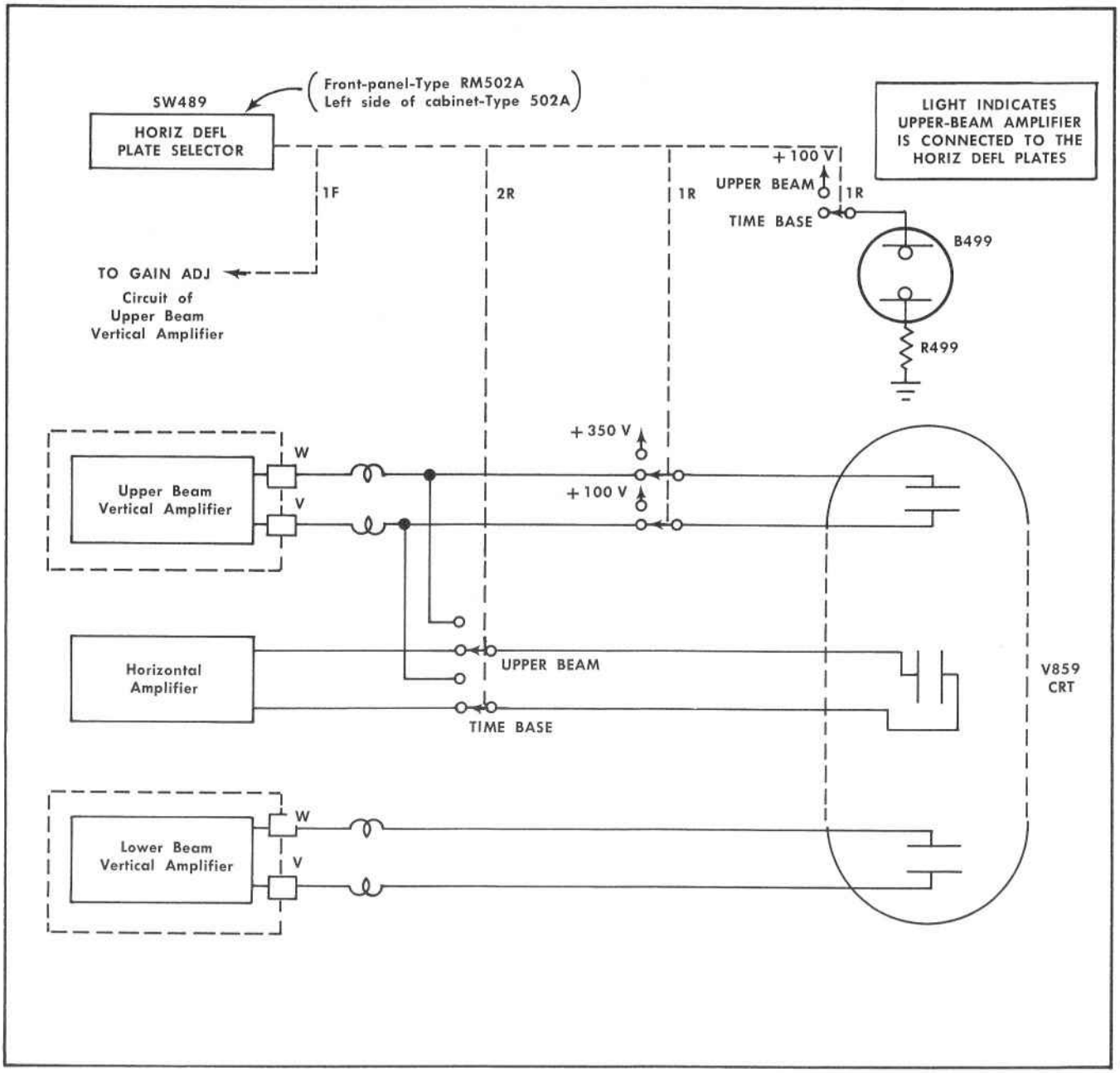


Fig. 3-2. CRT deflection plate switching.

off the screen by applying +350 volts to the upper deflection plate and +100 volts to the other deflection plate. Panel light B499 indicates when the Upper Beam amplifier is connected to the horizontal deflection plates.

TIME-BASE TRIGGER

The Time-Base Trigger circuit consists of a triggering-signal amplifier V24 and a multivibrator (Schmitt Trigger) circuit V45. The function of the trigger circuitry is to produce a negative-going rectangular pulse at the plate of V45A whose repetition rate is the same as that of the triggering signal. This negative step is then differentiated to produce a negative spike (trigger) to trigger the Time-Base Generator in the proper time sequence. A positive spike is also produced by the differentiation process, but this spike is not used.

The signal from which the rectangular output is produced may emanate from one of four sources. When the TRIGGER SELECTOR switch is in the LINE position, a 6.3-volt signal at the power line frequency is used for this application. When the switch is in the UPPER or LOWER position (AC or DC), the signal is obtained from the Upper or Lower Beam Vertical Amplifier, respectively. In the EXT position (AC or DC), the signal is obtained from an external source through a front-panel connector (TRIGGER INPUT). In any of the

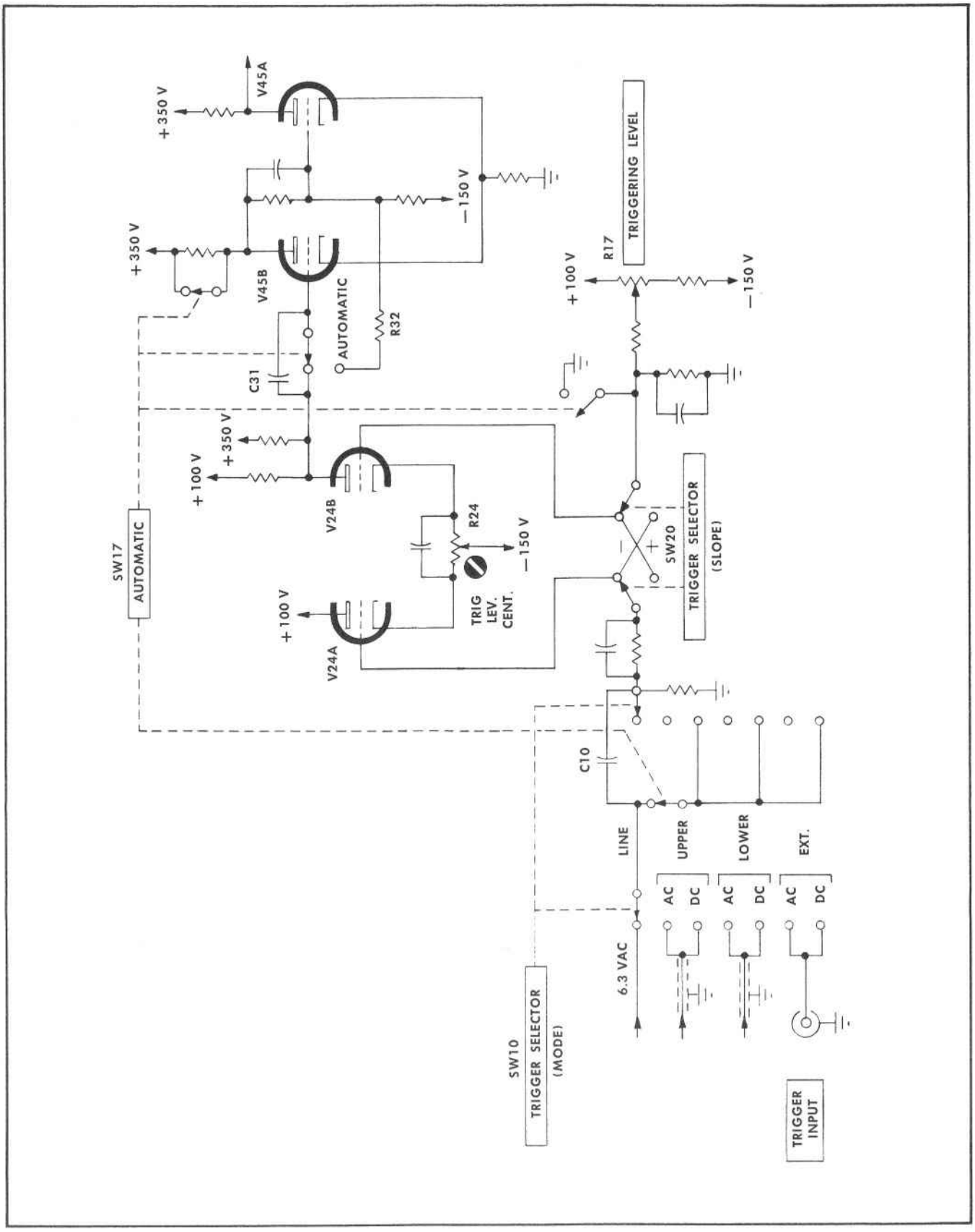


Fig. 3-3. Simplified Sweep Trigger Circuit.

DC positions of the TRIGGER SELECTOR switch the signal is coupled directly from its source to the SLOPE switch SW20. In any of the AC positions, the signal is coupled through C10 and then to SW20.

Although the output of the Trigger Multivibrator is always a negative rectangular pulse, the start of the pulse may be initiated by either the rising (positive-going) or falling (negative-going) portion of the triggering signal. To see how this is accomplished the operation of the Trigger Multivibrator will be described first.

In the quiescent state, that is, ready to receive a signal, V45B is conducting and its plate voltage is down. This holds the grid of V45A below cutoff, since the two circuits are AC-coupled. With V45A in a state of cutoff its plate voltage is up, hence no output is being produced.

A negative-going signal is required at the grid of V45B to force the Trigger Multivibrator into its other state in which a trigger pulse can be produced. However, since the signal at the grid of V45B is an amplification of the triggering signal, it contains both negative- and positive-going portions.

The negative-going portion of the signal will drive the grid of V45B in the negative direction, and the cathodes of both tubes will follow the grid down. At the same time the plate voltage of V45B starts to rise, which causes the grid voltage of V45A to rise. With the grid of V45A going up and its cathode going down, V45A starts to conduct. As V45A starts conducting its cathode starts going up; hence the cathode of V45B starts going up. With the grid of V45B down and its cathode up, V45B cuts off. And since V45A is conducting, its plate voltage drops, creating a negative step in the output. This transition occurs very rapidly, regardless of how slowly the grid signal of V45B falls.

When the signal at the grid of V45B starts in the positive direction, just the opposite chain of events will occur. V45B will start conducting again, which in turn will drive the grid of V45A below cutoff. This will cause the voltage at the plate of V45A to rise, which in turn will complete the negative step-voltage output from the Trigger Multivibrator circuit.

The Trigger Input Amplifier V24 amplifies the triggering signal that in turn is used to drive the Trigger Multivibrator. The amplified signal is always taken from the plate of V24B, but the grid of either tube (V24A or V24B) can be connected to the input circuit. When the Slope switch SW20 is in the — position the grid of V24A is connected to the input circuit and the grid of V24B is connected to a bias source adjustable by means of the TRIGGERING LEVEL control R17. With this configuration V24 is a cathode-coupled amplifier, and the signal at the output plate is in phase with the signal at the input grid. The circuit operation is then as follows: With the Slope switch in the — position, triggering of the Time-Base Generator will occur on the falling (negative-going) portion of the triggering signal. Since a negative-going signal is required at the grid of V45B to drive the Triggering Multivibrator into the other state of its bistable operation, this signal must be of the same polarity as the original signal at the input circuit.

However, when it is desired to trigger the Time-Base Generator on the rising or positive-going portion of the triggering signal the signal at the grid of V45B must be opposite in polarity to that at the input circuit. This is accomplished by placing the Slope switch in the + position. With this arrangement the grid of V24B is connected to the input circuit and the grid of V24A is connected to the bias source. This eliminates V24A from the amplifier circuit and V24B becomes a plate-loaded amplifier. The output waveform will therefore be opposite in polarity to the grid waveform.

The TRIG LEVEL CENT control R24 determines the division of current through both tubes, and is adjusted so that the quiescent voltage at the plate of V24B lies in the center of the hysteresis of the Trigger Multivibrator. The TRIGGERING LEVEL control R17 is adjusted to vary the bias on the tube to which it is connected. This in turn varies the quiescent voltage at the plate of V24B about the level established by the TRIG LEVEL CENT control. The operator can select the point on the waveform at which he wishes to trigger the Time-Base Generator.

When the Time-Base Trigger circuit is switched into the automatic mode of triggering (TRIGGERING LEVEL control turned counterclockwise), the AUTOMATIC switch SW17 converts the Trigger Multivibrator from a bistable configuration to a recurrent (free-running) configuration. This is accomplished by coupling the grid circuit of V45A to the grid circuit of V45B via R32. In addition, the DC coupling between the Trigger Input Amplifier and the Triggering Multivibrator is removed when the switch is in this position. The automatic free-running mode is not to be confused with action of the RECURRENT switch, SW17 shown on the Time-Base Generator diagram, which causes the Sweep-Gating Multivibrator to free-run.

The addition of R32 to the circuit causes the Triggering Multivibrator to free-run in the absence of a triggering signal. For example, assume the grid of V45B is just being driven into cutoff. The voltage at the plate of V45B starts to rise, carrying with it the voltage at the grid of V45A. Since the two grids are coupled through R32, this causes the voltage at the grid of V45B to start rising. The time-constant of the R32-C31 network is such that it takes about 0.01 second for the voltage at the grid of V45B to rise exponentially from its starting point, below cutoff, to a point where plate current can start.

As V45B starts to conduct its plate voltage drops, which in turn lowers the voltage at the grid of V45A. The voltage at the grid of V45B then starts dropping exponentially. When this grid drops below cutoff again, the circuit has completed one cycle of its approximately 50-hertz triangular waveform.

With the circuit configuration just described, the horizontal sweep can be triggered with repetitive signals, over a wide range of frequencies, without readjustment. When not receiving triggers, the sweep continues at approximately a 50-hertz rate. Thus, in the absence of any triggering signal, the sweep generates a reference base line.

TIME-BASE GENERATOR

The Time-Base Trigger produces a negative-going rectangular waveform which is coupled to the Time-Base Generator circuit. This waveform is differentiated in the grid circuit of V135A to produce sharp negative-going triggering pulses to trigger the Time-Base Generator in the proper

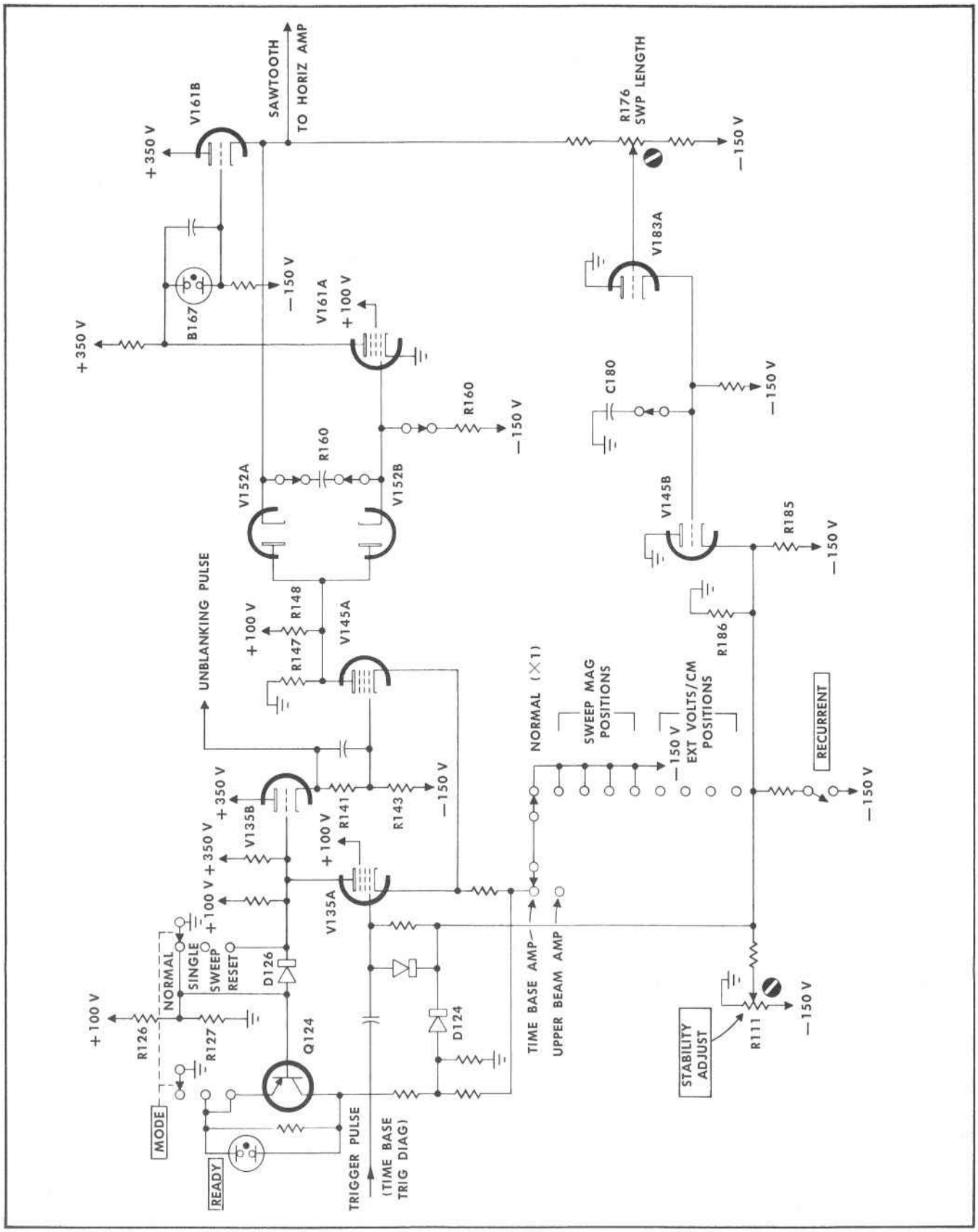


Fig. 3-4. Simplified Sweep Generator.

time sequence. Positive-going pulses are also produced in the differentiation process, but these are not used in the operation of the circuit.

The Time-Base Generator consists of four main circuits: a Lockout circuit, a bistable Sweep-Gating Multivibrator, a Miller Runup circuit, and a Hold-Off circuit. The main components in the Lockout circuit are the transistor Q124 and MODE switch SW126. The Multivibrator circuit consists of V135A, V145A, and the cathode-follower V135B. The essential components in the Miller Runup circuit are the Miller Runup Tube V161A, the Runup CF V161B, the Disconnect Diodes V152, the Timing Capacitor C160 and the Timing Resistor R160. The Hold-Off circuit consists of the Hold-Off CF's V183A and V145B, the Hold-Off capacitors C180 and C181 and the Hold-Off Resistors R181 and R180, A or B (shown on the Timing Switch diagram).

With the MODE switch in NORMAL, the quiescent state of V135A is conducting and its plate voltage is down. This cuts off V145A through the cathode-follower V135B, the voltage divider R141-R143 and the cathode resistor R144.

The quiescent state of the Miller Runup Tube is determined by a DC network between plate and grid. This network consists of the neon lamp B167, the grid-cathode impedance of the Runup CF and the Disconnect Diodes. The purpose of this DC network is to establish a voltage at the plate of the Miller Runup Tube of such a value that the tube will operate above the knee, and thus over the linear region, of its characteristic curve.

In the quiescent state the grid of the Miller Runup Tube rests at about —2 volts. There is about 25 volts bias on the Runup CF, and about a 60-volt drop across the neon lamp. This establishes a quiescent voltage of about +32 volts at the plate of the Miller Runup Tube.

A negative trigger pulse arriving at the grid of V135A will then cause the Sweep-Gating Multivibrator to switch rapidly to its other state. That is, V135A will be cut off and V145A will start to conduct. As V145A conducts its plate voltage, and the voltage at the plates of the Disconnect Diodes, moves negative. This cuts off the diodes.

The current available through the Timing Resistor (R160) is diverted into the Timing Capacitor (C160). This tends to force the grid of the Miller Runup Tube negative. As the grid of the Miller Runup starts negative the plate starts positive. This raises the voltage at the grid and cathode of the Runup CF. As the voltage at the cathode of the Runup CF rises it causes the voltage at the upper end of C160 to increase, which in turn prevents the grid of the Miller Runup Tube from going negative.

The Miller Runup Tube has a gain of about 200, so that a grid voltage change of only 0.75 volt produces a plate voltage change of 150 volts. Due to the feedback, as explained, the small negative change in grid voltage will provide a nearly linear runup of voltage at the cathode of the Runup CF.

Maintaining the voltage across the Timing Resistor (R160) nearly constant provides a nearly constant current into the Timing Capacitor (C160), which in turn causes a linear sawtooth output voltage to be generated.

The linear rise in voltage at the cathode of the Runup CF V161B is used as the sweep time base. Timing Capacitor C160 and Timing Resistor R160 are selected by means of the TIME/CM switch SW160. The Timing Resistor determines the current that charges the Timing Capacitor. By means of the Timing Switch, both the size of the capacitor being charged and the current charging the capacitor can be selected to cover a wide range of sweep rates. Thus, the timing circuit determines the rate at which the spot moves across the CRT.

The length of the sweep; that is, the distance the spot moves across the CRT, is determined by the setting of the SWP LENGTH control R176. As the sweep voltage rises linearly at the cathode of V161B, there will be a linear rise in the voltage at the arm of the SWP LENGTH control. This will increase the voltage at the grid and cathode of V183A and at the grid and cathode of V145B. As the voltage at the cathode of V145B rises, the voltage at the grid of V135A will rise. When the voltage at this point rises to a point where V135A comes out of cutoff, the Sweep-Gating Multivibrator will rapidly revert to its original state with V135A conducting and V145A cut off. The voltage at the plate of V145A will then rise, carrying with it the voltage at the plates of the Disconnect Diodes V152. The diodes then conduct and the lower half (V152B) provides a discharge path for the Timing Capacitor through R147 and R148, and through the resistance in the cathode circuit of V161B. The plate voltage of the Miller Tube now falls linearly, under feedback conditions essentially the same as when it generated the sweep portion of the waveform, except for a reversal of direction.

The resistance through which C160 discharges is much less than that through which it charges (the Timing Resistor). The capacitor current for this period will therefore be much larger than during the sweep portion, and the plate of the Miller Runup Tube will return rapidly to its quiescent voltage. This produces the retrace portion of the sweep sawtooth, during which time the CRT beam returns rapidly to its starting point.

The Hold-Off Circuit prevents the Time-Base Generator from being triggered during the retrace interval. In addition, the Hold-Off allows a finite time for the Time-Base circuits to regain a state of equilibrium after the completion of a sweep.

During the trace portion of the sweep sawtooth the Hold-Off Capacitor C180 charges through V183A as a result of the rise in voltage at the cathode of V183A. At the same time the grid of V135A is being pulled up, through the cathode-follower V145B, until V135A comes out of cutoff and starts conducting. As mentioned previously, this is the action that initiates the retrace. At the start of the retrace interval C180 starts discharging through the Hold-Off Resistor. The time-constant of this circuit is long enough, however, so that during the retrace interval, and for a short period of time after the completion of the retrace, C180 holds the grid of V135A high enough so that it cannot be triggered. However, when C180 discharges to the point where the cathode-follower V145B is cut off, it loses control over the grid of V135A and the grid returns to the level estabilshed by the STABILITY ADJUST R111. The amount of hold-off time required is determined by the sweep rate, i.e., by the size of the Timing Capacitor. For this reason the TIME/CM switch changes the time-constant of the Hold-Off Circuit simultaneously with that of the Timing Circuit.

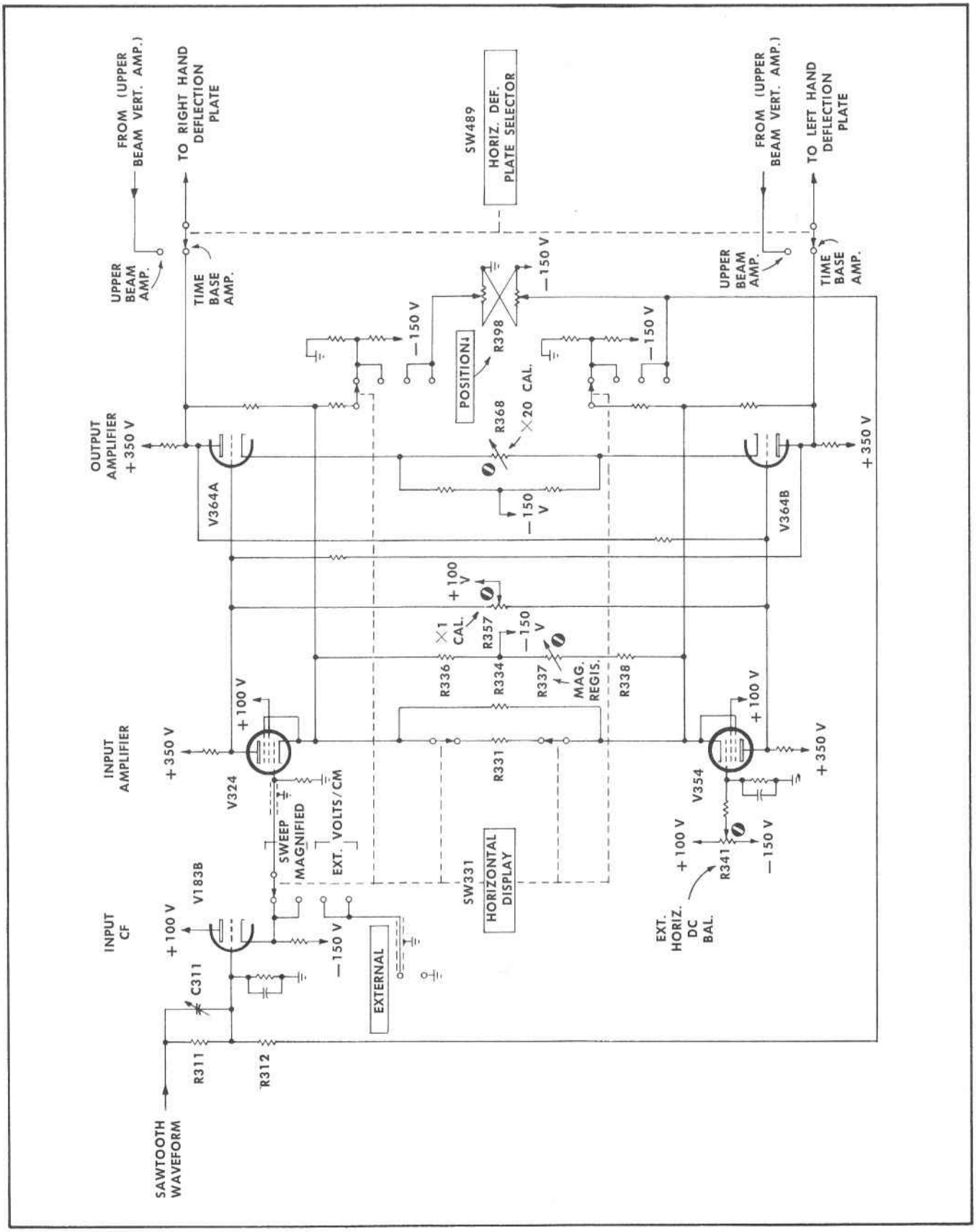


Fig. 3-5. Simplified Horizontal Amplifier.

The STABILITY ADJUST R111 regulates the DC level at the grid of V135A. This control should be adjusted so that the voltage at the grid of V135A is just high enough to prevent the circuit from free-running. Adjusted in this manner, a sweep can only be produced when a negative trigger pulse, from the Time-Base Trigger circuit, can drive the grid of V135A below cutoff. However, should a free-running sweep be desired, the TRIGGERING LEVEL control can be turned full right; this closes the RECURRENT switch and connects the grid circuit of V135A to the —150 volt supply through R116. This permits the grid of V135A to fall to cutoff immediately upon removal of the hold-off voltage, at which point the next sweep is initiated.

When the MODE switch is in the NORMAL position, as above, the emitter of Q124 is open, making it inoperative. Also the anode of D126 is grounded, preventing any effect upon the sweep generator circuit.

When the MODE switch is thrown to the SINGLE SWEEP position, the emitter of Q124 is connected to ground and the anode of D126 is connected to a small positive voltage. To consider the action of the circuit, assume that the MODE switch is in the RESET position and then allowed to return to SINGLE SWEEP.

In the RESET position, SW126 grounds the plate of V135A. This places the same potential on both the cathode of D126 and the emitter of Q125, which reverse biases Q124. As Q124 is reverse biased, the voltage at the collector goes negative and the READY light B124 will light when the collector voltage reaches about —60 volts. D124 is also reversed biased as its anode voltage goes negative. The reverse biasing of D124 prevents the collector voltage of Q124 from affecting the grid voltage of V135A until after the sweep.

The grid voltage of V135A will rest during this time at a level which will be determined by R111, R185 and R186. This voltage will be at a value which will allow an incoming trigger pulse to switch the Multivibrator and produce a sweep.

The negative going trigger pulse when it arrives will cause V135A to go into cutoff and V145A to come into conduction. The action of the Sweep Generator circuit as explained still applies.

As the sweep ends, the waveform through V145B turns V135A on and turns V145A off. When V135A comes into conduction, its plate will go slightly negative and forward bias D126. The current flow through D126, R126 and R127 will drop the voltage at the base of Q124 far enough negative, in relation to ground, to turn the transistor on. The voltage on the collector will now go positive towards ground and the READY light will go out. As the collector voltage of Q124 goes positive, D24 becomes forward biased and will control the voltage level on the grid of V135A. This voltage level will be held positive enough to prevent further triggers from switching the Sweep Gating Multivibrator. The circuit will remain in this condition until the MODE switch is either thrown to the RESET position again or put in the NORMAL position.

The positive rectangular pulse appearing at the cathode of V135B is coupled to the grid circuits of the CRT. This pulse, whose start and duration are coincident with the trace portion of the sweep sawtooth, unblanks the CRT and permits the trace to be observed.

The Time-Base Generator is inoperative when the UPPER BEAM Vertical Amplifier is connected to the horizontal-deflection plates. One section of the HORIZ DEF PLATE SELECTOR switch SW489 is located in the cathode circuit of the Multivibrator, and immobilizes this circuit for the application just described. The same circuit is immobilized, and in the same manner, when the HORIZONTAL DISPLAY switch is set to any of the EXT ranges. With this arrangement the horizontal deflection voltage is obtained through a front-panel EXTERNAL connector rather than from the Time-Base circuits.

HORIZONTAL AMPLIFIER

The Horizontal Amplifier consists of an Input Cathode-Follower, a cathode-coupled Input Amplifier stage, and a plate-loaded Output Amplifier to drive the horizontal deflection plates in the CRT.

The HORIZONTAL DISPLAY switch SW331 determines whether the input waveform is received from the Time-Base Generator or from an external source. When this switch is in either the NORMAL or the SWEEP MAGNIFIED position, the waveform is received from the Time-Base Generator. With this configuration the sweep sawtooth is coupled to the Input CF via the frequency-compensated voltage divider R311-R312. The Horizontal POSITION control R398 supplies a manually adjustable DC voltage to the grid of the Input CF V183B for horizontal positioning of the CRT beam. The Input CF isolates the Miller circuit from the Horizontal Amplifier and provides a low-impedance source to drive the switch capacitances and the Input Amplifier.

The Horizontal Amplifier is controlled by feedback networks much the same as the Vertical Amplifiers. This is illustrated in Fig. 3-5. A negative feedback loop extends from the plate circuit of the Output Amplifier to the cathode circuit of the Input Amplifier. The Output Amplifier, on the other hand, has a positive feedback loop between the plate circuit on one side and the grid circuit on the other.

The Input Amplifier is a cathode-coupled paraphase amplifier, which converts the positive-going sawtooth voltage, obtained from the Time-Base Generator to a push-pull output sawtooth voltage. The gain of the Input Amplifier is determined by the amount of resistance connected between the two cathodes, which in turn determines the degree of negative feed back applied to the stage. In the NORMAL position of the HORIZONTAL DISPLAY switch, R331 is not in the circuit and the cathode resistance is composed of R334 in parallel with the series combination of R336, R337, and R338. In any of the SWEEP MAGNIFIED positions, one of the R331 resistors is switched into the cathode circuit and shunts the total cathode resistance to a lower value. This decreases the amount of negative feedback applied to the stage and consequently increases the gain of the stage.

The function of the MAG REGIS control R337 is to insure that the waveform will be expanded symmetrically about the center of the CRT when the HORIZONTAL DISPLAY switch is changed from NORMAL to any of the SWEEP MAGNIFIED positions. This control DC-balances the amplifier so that the horizontal positioning of the beam will not be affected when the beam is positioned in the center of the CRT, as the value of R331 is changed. The ×1 CAL control R357 adjusts the plate-to-plate gain of the stage slightly to compensate for any circuit nonsymmetry. This control is

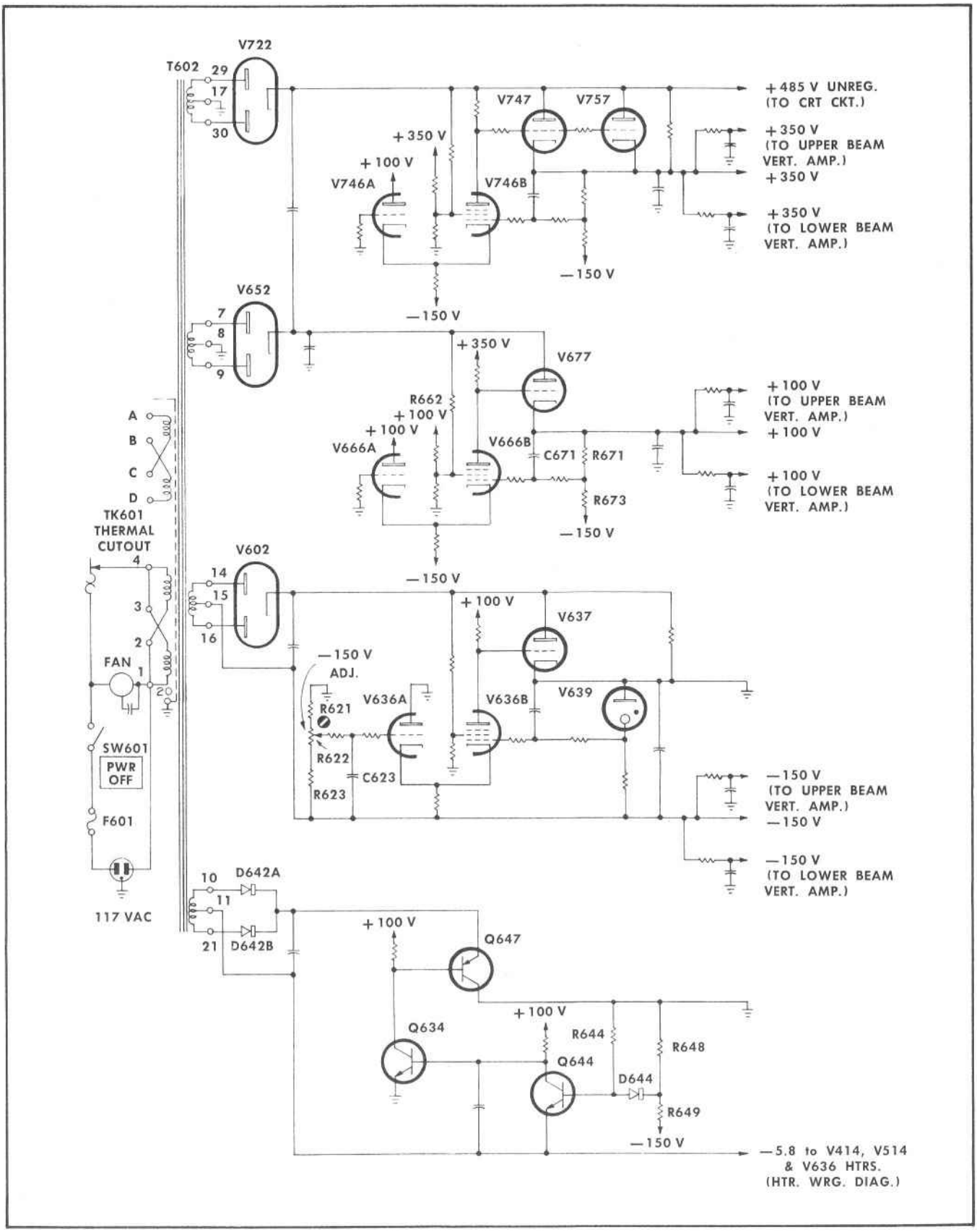


Fig. 3-6. Simplified Low-Voltage Power Supply.

most effective when the HORIZONTAL DISPLAY switch is in the NORMAL position.

The Output Amplifier, by virtue of its positive feedback network, is an extremely high-gain stage. The gain of the stage can be varied over a limited range with the ×20 CAL control R368 which varies the amount of cathode degeneration. This control is most effective when the HORIZONTAL DISPLAY switch is in the ×20 SWEEP MAGNIFIED position.

When the HORIZONTAL DISPLAY switch is in any of the EXT VOLTS/CM positions, the horizontal signal is coupled directly from the front-panel EXTERNAL connector to the grid circuit of the Input Amplifier. This action changes the configuration of the amplifier slightly. The Input CF is disdisconnected from the circuit, which changes the DC level at the cathodes of the Input Amplifier slightly. To compensate for this change an EXT HORIZ DC BAL control R341 is adjusted to equalize the cathode voltages.

In the external positions of the HORIZONTAL DISPLAY switch, the Horizontal POSITION control is disconnected from the input circuit and connected between the plates of the Output Amplifier.

POWER SUPPLY

Plate and filament power for the tubes in the 502A Oscilloscope is furnished by a single power transformer T602. The primary has two equal tapped windings; these may be connected in parallel for 117 volt operation, or in series for 234 volt operation. The primary of T602 also has two more windings which may be used as voltage bucking or aiding windings. These windings along with the two main primary windings may be used to allow the instrument to run on line voltages of 110, 117, 124, 220, 234 and 248, depending upon how all the windings are connected. The three main full-wave power supplies furnish regulated voltages of —150, +100 and +350 volts. The +350 volt supply also has an unregulated output of about +485 volts for the high-voltage power supply for the CRT. It is unnecessary to regulate this supply as the high-voltage power supplies have their own regulation circuits. In addition to the three main power supplies, a transistorized full-wave supply furnishes a regulated +5.8 volt output for the heaters in the Input Amplifier tubes in the Upper and Lower Beam Vertical Amplifiers.

Reference voltage for the —150 volt supply is furnished by a gas diode voltage-reference tube V639. This tube, which has a constant voltage drop, establishes a fixed potential of about —70 volts at the grid of V636B, one-half of a difference amplifier. The grid potential for the other half of the difference amplifier, V636A, is obtained from a divider consisting of R621, R622 and T623. R622, the —150 control determines the percentage of total voltage that appears at the grid of V636A and thus determines the total voltage across the divider. When this control is properly adjusted the output is exactly —150 volts.

Should the loading on the supply tend to change the output voltage, the voltage at the grid of V636A will change in proportion, and an error voltage will exist between the two grids of the difference amplifier. The error signal is amplified by V636B, whose plate is DC-coupled to the grid of the series tube V637. The error voltage appearing at the grid of V637 will change the drop across the tube and hence change the voltage at the plate of the tube. The change in voltage at the plate of V637, which will be in a direction to compensate for the change in output voltage, is coupled by the impedance of the rectifier V602 back to the output and thus pulls the output voltage back to its established —150 volts. C623 improves the gain of the feedback loop and thus increases the response of the circuit to sudden change in the output voltage.

The —150 volt supply serves as a reference for the +100 volt supply. The divider R671-R673 establishes a voltage of essentially zero at the grid of the amplifier V666B. The actual voltage at this grid will be equal to the bias voltage required by the stage. If the loading should tend to change the output voltage an error voltage will appear at the grid of V666B. This error voltage will be amplified and will appear at the grid of the series tube V677. The cathode of V677 will follow the grid and hence the output voltage will be returned to its established value of 100 volts. C671 improves the response of the circuit to sudden changes in the output voltage.

A small sample of the unregulated bus ripple appears at the screen of V666B through R662. The ripple signal which appears at the screen, which acts as an injector grid, will produce a ripple component at the grid of V677 which will be opposite in polarity to the ripple appearing at the plate of V677. This tends to cancel the ripple at the cathode of the tube, and hence reduces the ripple on the +100 volt bus. This same circuit also improves the regulation of the supply in the presence of line voltage variations.

The +350 volt supply functions in the same manner as the +100 volt supply. Rectified voltage from the cathode of V722 is added to the voltage supplying the +100 volt regulator, to supply voltage for the +350 volt regulator. As mentioned previously, the +350 volt supply also furnishes an unregulated output of about +485 volts for the CRT high-voltage supply.

The —5.8 volt supply works in essentially the same manner as the vacuum-tube supplies. The divider R648-R649 establishes a reference voltage at the base of Q644. D644 provides first order temperature compensation for the emitter-base junction of Q644. If we now assume that the output tends to go more negative, the emitter of Q644 will also go more negative since it is strapped directly to the output. The collector of Q644 will then go more negative, carrying with it the base of Q634. The collector of Q634 will then go up, carrying with it the base of Q647. The series-regulator transistor Q647 is essentially an emitter-follower, so the emitter will follow the base. Hence, the emitter of Q647 also goes up. This increase in the voltage at the emitter of Q647 will be coupled through the rectifiers, D642A and B, back to the output and will thus pull the output back up to its specified value.

CRT CIRCUIT

A single 40-kHz Hartley oscillator circuit furnishes energy for the three power supplies that provide voltages for the CRT. The main components of the Oscillator circuit are V800 and a portion of the primary of T801 tuned by C807.

The three half-wave rectifier circuits employ capacitor-input filters. Separate supplies are required for the grid and each of the cathode circuits of the CRT in order to provide DC-coupled unblanking to the CRT grids.

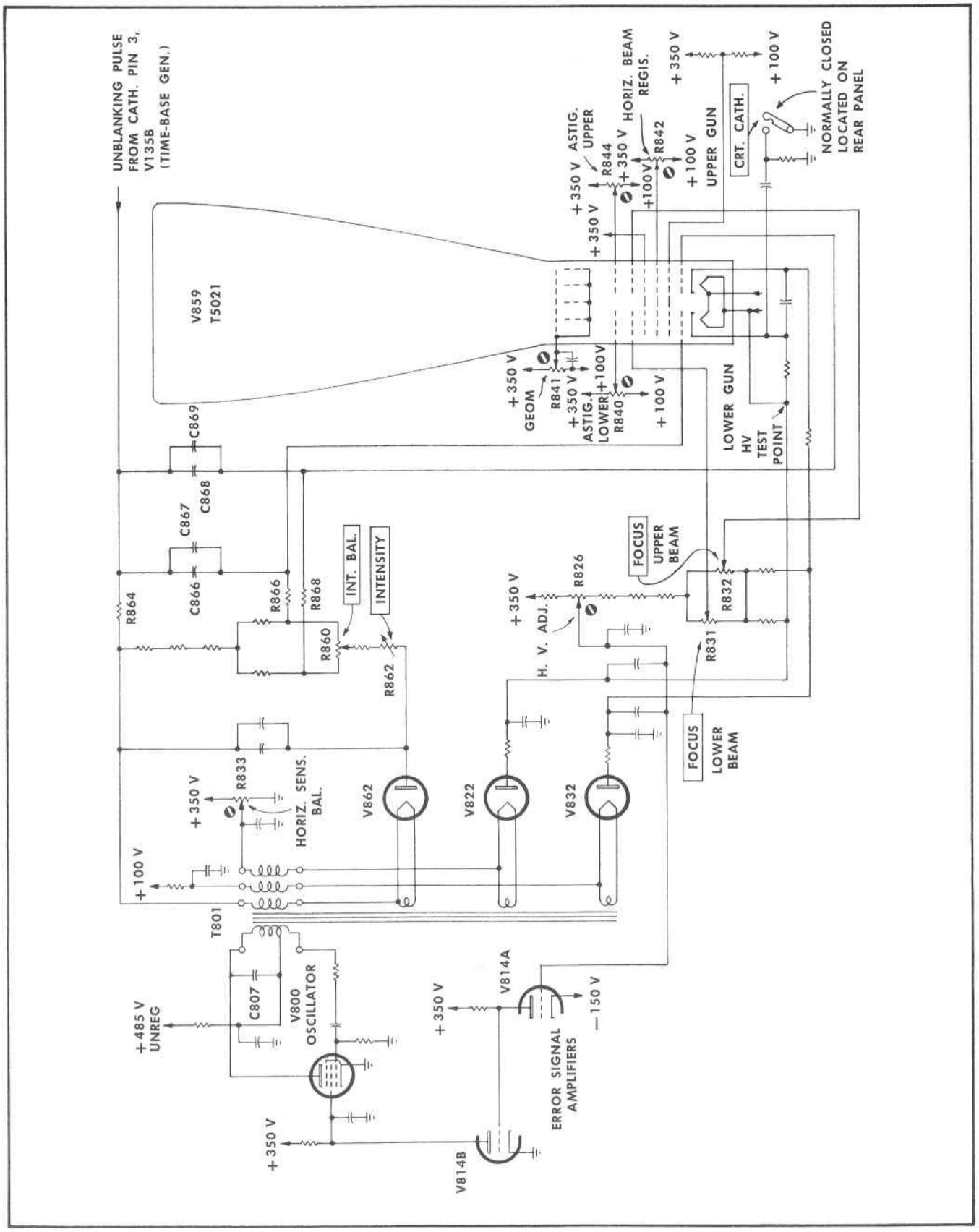


Fig. 3-7. Simplified CRT Circuit.

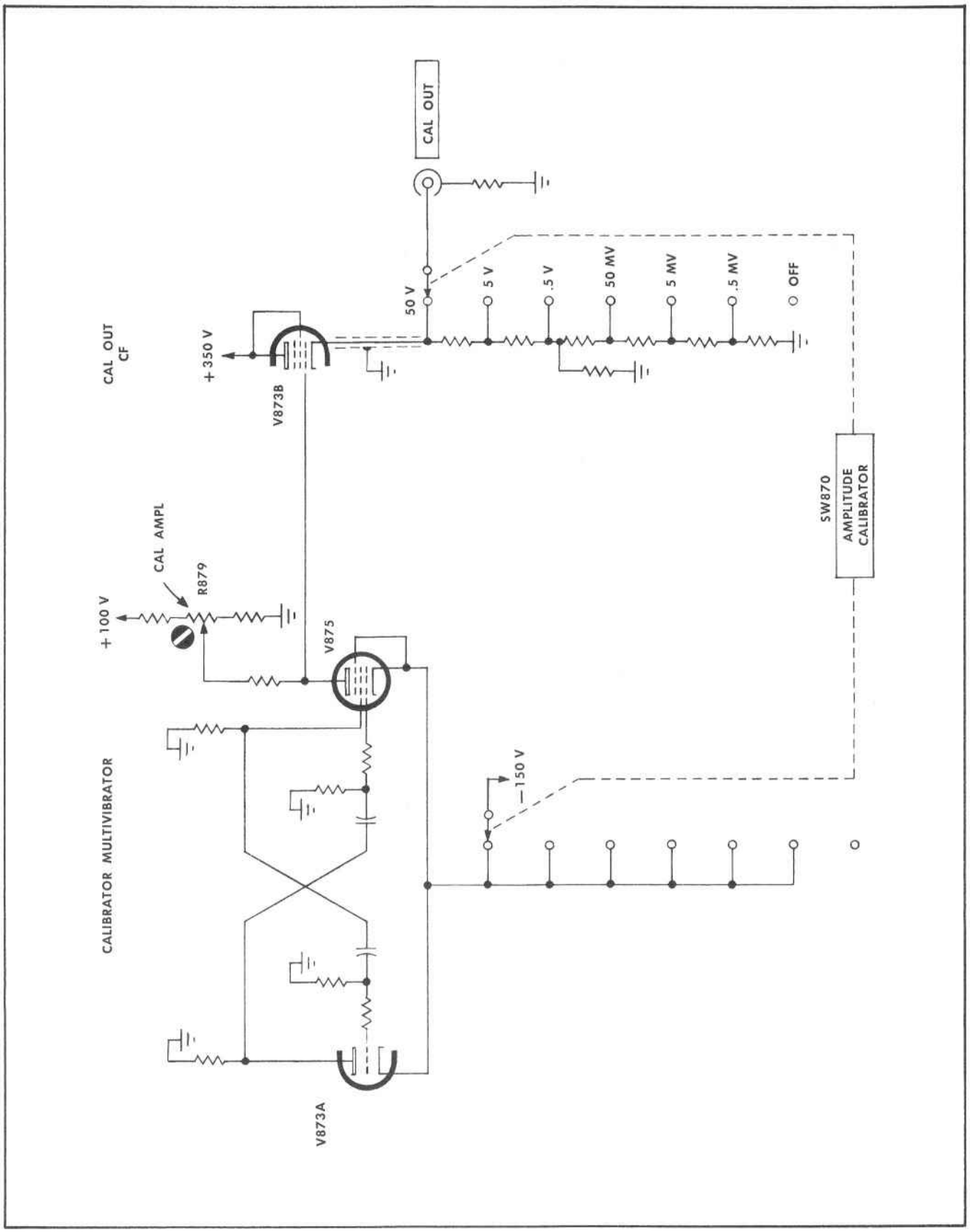


Fig. 3-8. Simplified Calibrator Circuit.

V822 and V832 supply about —2900 volts for the cathodes of the CRT. V862 supplies about —3100 volts for the grids (the actual voltage depends on the setting of the INTENSITY control.)

In order to maintain a constant deflection sensitivity in the CRT, and thereby maintain the calibration of the instrument, it is necessary that the accelerating potentials in the CRT remain constant. This is accomplished by regulating the three supplies by comparing a sample of the cathode voltage to the regulated +150 volt supply. This sample voltage, obtained from the arm of the HV Control R826, is applied to the grid of V814A; the cathode of this tube is connected to the —150 volt regulated supply. The error voltage is amplified by V814A and V814B; the output of V814B varies the screen voltage of the Oscillator tube and thus controls its output.

The HORIZ SENS BAL control R833 allows a more perfect balance of the sensitivity of the two horizontal beams. Varying this control can change the CRT cathode potentials by approximately 100 volts with respect to each other. This allows for a corresponding change in horizontal sensitivities of approximately + or — 3%.

The HORIZ BEAM REGIS will allow the beams to be brought into register; i.e., the sweep for each vertical amplifier will start at the same place on the CRT screen.

Unblanking

As mentioned previously, DC-coupled unblanking is accomplished by employing separate high-voltage supplies for the grids and cathodes. The cathodes supplies are tied to the LV power supply. The grid supply, on the other hand, is not tied to any other supply and is therefore floating. The unblanking pulses from the Time-Base Generator are transmitted to the grids of the CRT via the floating grid supply.

The stray capacitance in the circuit makes it difficult to move the floating supply fast enough to unblank the CRT in the required time. To overcome this, an isolation network composed of R864, C868, C869 and R868 for one grid circuit, and R864, C866, C867 and R866 for the other, is employed. By this arrangement, the fast leading edge of the unblanking pulse is coupled directly to the grids of the CRT via C866-C867 and C868-C869. For short-duration unblanking pulses (at the faster sweep rates) the power supply itself is not appreciably moved. For longer unblanking pulses, at the slower sweep-rates, however, the stray capacitance of the circuit is charged through R864. This holds the grids at the unblanked potential for the duration of the unblanking pulse.

Each gun of the CRT has its own FOCUS and ASTIGMATISM controls. A single control R841 adjusts the geometry of the display, and a single INTENSITY control R862 controls the brilliance of both beams. An INTENSITY BALANCE control R860 balances one grid voltage against the other so that the INTENSITY control will have an equal effect on both beams.

AMPLITUDE CALIBRATOR

The AMPLITUDE CALIBRATOR is a square-wave generator whose approximately 1-kHz output is available at a front-panel connector labeled CAL OUT. It consists of a Multivibrator V873A-V875 connected so as to switch the cathode-follower V873B between two operating states, cutoff and conduction.

During the negative portion of the multivibrator waveform the grid of V873B is driven well below cutoff and the cathode rests at ground potential. During the positive portion of the waveform the grid rises to slightly less than +50 volts. By means of the CAL AMPL (R879) control, the grid voltage can be adjusted so that the cathode voltage is exactly +50 volts when the AMPLITUDE CALIBRATOR knob is turned to the OFF position.

The Cal Out CF has a precision voltage divider for its cathode resistor. By means of the AMPLITUDE CALIBRATOR switch six calibrated peak-to-peak voltages, from .5 millivolt to 50 volts, are available.

NOTES

SECTION 4
MAINTENANCE

PREVENTIVE MAINTENANCE

Air Filter

Care must be taken to assure free ventilation of the Type 502A inasmuch as some of the components are operated at dissipation levels such that excessive interior temperatures will result without adequate air circulation. To assure free passage of air, the instrument must be placed so that the air intake is not blocked and the filter must be kept clean. Moreover, the side panels and bottom cover must be in place for proper air circulation. Do not remove the covers except during maintenance.

A washable filter is used at the air intake part of the instrument. Under normal operating conditions the filter should be inspected, and cleaned if necessary, every three to four months. More frequent inspection is required when the operating conditions are more severe.

The following cleaning procedure is suggested.

1. Flush loose dirt out of filter with a stream of hot water.

2. Prepare a hot water and mild soap or detergent solution. Wash the filter as you would wash a sponge so that the adhesive and dirt is loosened and floated off.

3. Rinse the filter and let it dry.

4. Dip or spray filter with fresh Filter Coat or Handi-Coater. These products are available from local representative of the Research Products Corporation and from most air conditioner suppliers.

Fan Motor

The fan motor bearings are sealed and should not require lubrication for the life of the motor.

Visual Inspection

You should visually inspect the entire oscilloscope every few months for possible circuit defects. These defects may include such things as loose or broken connections, damaged binding posts, improperly seated tubes or transistors, scorched wires or resistors, missing tube shields, or broken terminal strips. For most visual troubles the remedy is apparent; however, particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent, defects in the circuit. It is essential that you determine the cause of overheating before replacing heat-damaged parts in order to prevent further damage.

CORRECTIVE MAINTENANCE

Replacing parts on Ceramic Strips

Many of the components in your Tektronix instruments are mounted on ceramic terminal strips. The notches in these strips are lined with a silver alloy. Repeated use of excessive heat, or use of ordinary tin-lead solder will break the silver-to-ceramic bond. Occasional use of tin-lead solder will not break the bond if excessive heat is not applied.

If you are responsible for the maintenance of a large number of Tektronix instruments, or if you contemplate frequent parts changes, we recommend that you keep on hand a stock of solder containing about 3% silver. This type of solder is used frequently in printed circuitry and should be readily available from radio-supply houses. If you prefer, you can order the solder directly from Tektronix in one pound rolls. Order by Tektronix part number 251-0514-00.

Because of the shape of the terminals on the ceramic strips it is advisable to use a wedge-shaped tip on your soldering iron when you are installing or removing parts from the strips. Fig. 4-1 will show you the correct shape for the tip of the soldering iron. Be sure to file smooth all surfaces of the iron which will be tinned. This prevents solder from building up on rough spots where it will quickly oxidize.

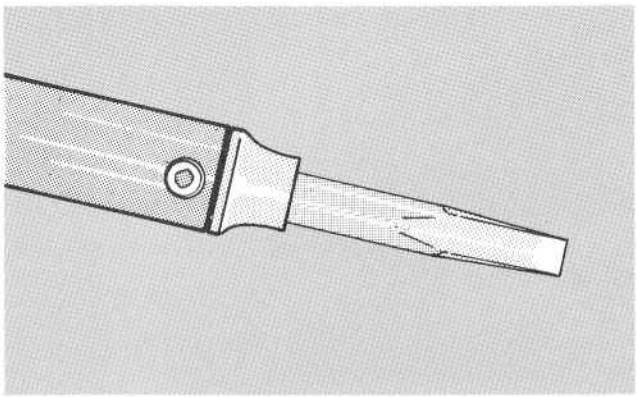


Fig. 4-1. Soldering iron tip properly shaped and tinned.

When removing or replacing components mounted on the ceramic strips you will find that satisfactory results are obtained if you proceed in the manner outlined below.

1. Use a soldering iron of about 75-watt rating.

2. Prepare the tip of the iron as shown in Fig. 4-1.

3. Tin only the first $\frac{1}{16}$ to $\frac{1}{8}$ inch of the tip. For soldering to ceramic terminal strips tin the iron with solder containing about 3% silver.

4. Apply one corner of the tip to the notch where you wish to solder (see Fig. 4-2).

5. Apply only enough heat to make the solder flow freely.

6. Do not attempt to fill the notch on the strip with solder; instead, apply only enough solder to cover the wires adequately, and to form a slight fillet on the wire as shown in Fig. 4-3.

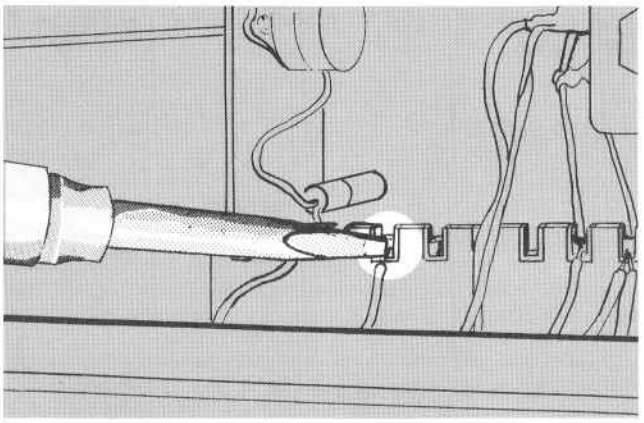


Fig. 4-2. Correct method of applying heat in soldering to a ceramic strip.

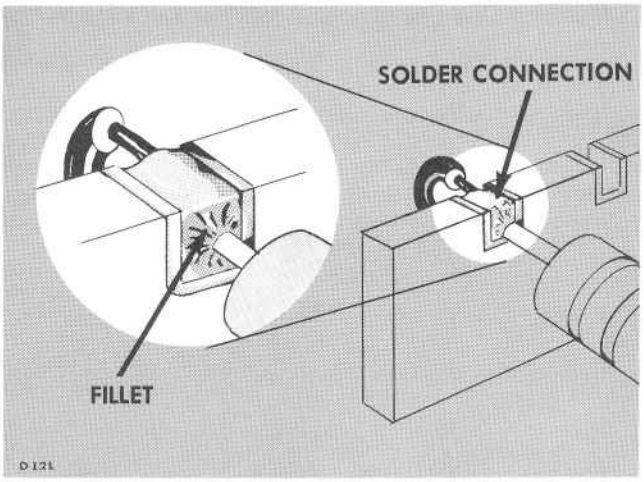


Fig. 4-3. A slight fillet of solder is formed around the wire when heat is applied correctly.

In soldering to metal terminals (for example, pins on a tube socket) a slightly different technique should be employed. Prepare the iron as outlined above, but tin with ordinary tin-lead solder. Apply the iron to the part to be soldered as shown in Fig. 4-4. Use only enough heat to allow the solder to flow freely along the wire so that a slight fillet will be formed.

General Soldering Considerations

When replacing wires in terminal slots clip the ends neatly as close to the solder joint as possible. In clipping the ends of wires take care the end removed does not fly across the room as it is clipped.

Occasionally you will wish to hold a bare wire in place as it is being soldered. A handy device for this purpose is a short length of wooden dowel, with ends shaped as shown in Fig. 4-5.

Replacing Ceramic Strips

Unsolder all connections, then use a $\frac{3}{8}$ inch diameter by 3 inch long plastic or hardwood dowel and a small (2 to

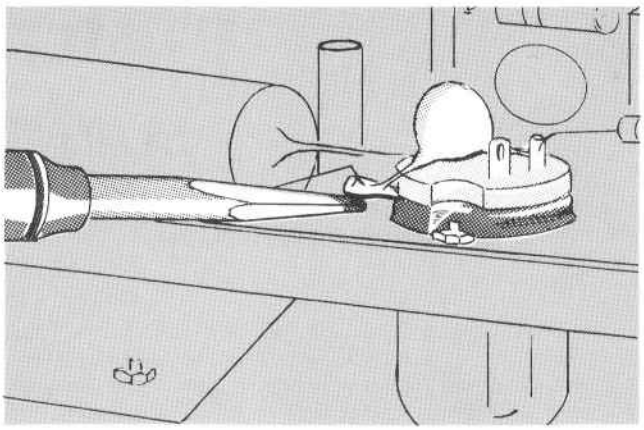


Fig. 4-4. Soldering to a terminal. Note the slight fillet of solder—exaggerated for clarity—formed around the wire.

4 oz.) mallet to knock the stud pins (see Fig. 4-6) out of the chassis. Place one end of the dowel on the end of the stud pin protruding through the chassis. Rap the opposite end of the dowel smartly with the mallet. When both studs of the strip have been loosened in this fashion, the strip is removed as a unit. The spacers will probably come out with the studs. If not, they can be pulled out separately. An alternative method of removing the terminal strip is to use diagonal cutters to cut off the sides of the studs. The ceramic strip is removed and the studs pulled from the chassis with a pair of pliers.

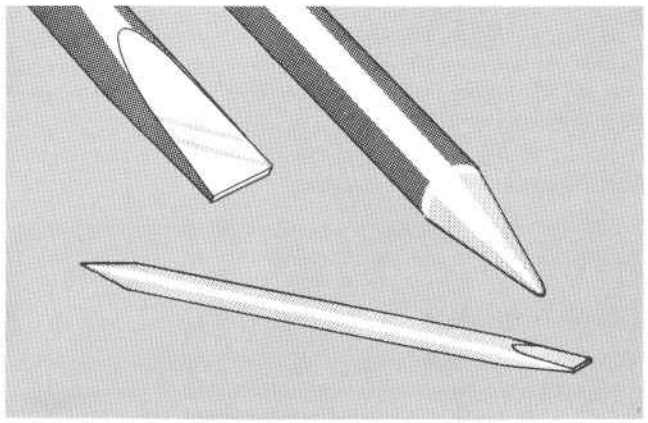


Fig. 4-5. A soldering aid constructed from a $\frac{1}{4}$ inch wooden dowel.

After the damaged strip has been removed, place the undamaged spacers in the chassis holes. Then, carefully press the studs into the spacers until completely seated. If necessary, use a soft mallet and tap lightly, directly over the stud area of the strip.

Replacing parts on Circuit Boards

Use ordinary electronic grade rosin core 60/40 solder and a 35- to 40-watt pencil soldering iron with a $\frac{1}{8}$ inch wide chisel tip. The tip of the iron should be clean and properly tinned for best heat transfer in a short time to the soldered

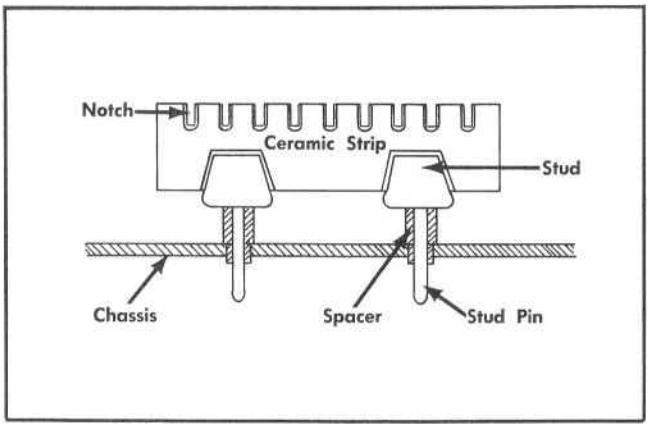


Fig. 4-6. Typical ceramic strip assembly.

connection. A higher wattage soldering iron, if used and applied for too long a time, ruins the bond between the etched wiring and base material by charring the glass-epoxy laminate. The step-by-step technique is as follows:

1. To remove a component, cut the leads near the body of the component. This frees the leads for individual unsoldering.

2. Grip the lead with needle-nose pliers. Apply the tinned tip of the soldering iron to the lead between the pliers and the board, then pull gently.

3. When the solder begins to melt, the lead will come out, leaving a clean hole. If the hole is not clean, use the soldering iron and a toothpick or a piece of enameled wire to open the terminal hole. Do not attempt to drill the solder out, or the through-hole plating might be destroyed.

4. Clean the leads on the new component and bend them to the correct shape. Carefully insert the leads into the holes from which the defective component was removed.

5. Apply the iron and a little solder to the connection to finish the solder joint.

Tube and Transistor Replacement

Tube and transistor failures are the most prevalent cause of circuit failure. For this reason, the first step in troubleshooting any circuit in the instrument is to check for defective tubes and transistors, preferably by direct substitution. Do not depend on tube and transistor testers to adequately indicate the suitability of a component for certain positions within the instrument. The criterion for usability is whether or not it works satisfactorily in the instrument. Be sure to return all good tubes and transistors to their original sockets; if this procedure is followed less recalibration of the instrument will be required upon completion of the servicing.

CAUTION

Do not remove or replace any tubes or transistors while power is applied to the instrument. Such operation may generate abnormal voltages or transients, resulting in damage to the circuit's components.

Also, do not operate the instrument with any tubes or transistors out of their sockets, since such operation may change the voltage and current supplied to another circuit. This is especially true of the cascode tube-transistor and balanced push-pull amplifier circuits.

When replacing a tube or transistor in the instrument, check first to see that components through which it draws current have not been damaged. Shorted tubes and transistors will sometimes overload and damage load resistors. These damaged components can generally be located by a visual inspection of the wiring. If no damaged components are apparent, and if the replacement does not restore operation, it will be necessary to make measurements or other checks within the circuit to locate the trouble.

Component Numbering

The component number of each resistor, inductor, capacitor, vacuum tube, control and switch is shown on the circuit diagrams. The following chart lists the component numbers associated with each circuit:

All numbers less than 100	Time-Base Trigger
100 series	Time-Base Generator
300 series	Horizontal Amplifier
400 and 500 series	Upper and Lower Beam Vertical Amplifiers
700 series	Low-Voltage Power Supply
800 series	CRT Circuits, High Voltage and Amplitude Calibrator

Switch wafers shown on the schematic diagrams are coded to indicate the position of the wafers on the actual switches. The number position of the code refers to the wafer number on the switch assembly. Wafers are numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

TROUBLESHOOTING

Although the Type 502A is a complex instrument, it can be thought of as consisting of six main circuits, in addition to the Calibrator circuit. These are the:

1. Low-Voltage Power Supply.
2. CRT Circuit and High-Voltage Power Supply.
3. Vertical Amplifiers.
4. Time-Base Trigger Circuit.
5. Time-Base Generator.
6. Horizontal Amplifier.

The first circuit to check, for practically any type of trouble, is the Low-Voltage Power Supply. Because of the circuit configuration employed, it is possible for an improper power supply voltage to affect one circuit more than the others. For example, if the gain of the Vertical Amplifier

should decrease slightly, while the other circuits appear to be functioning normally, this could be due to an improper supply voltage and not to any condition originating in the Vertical Amplifier. In cases of this type time can be saved by checking the power supply first.

On the other hand, the CRT display can often be used to isolate trouble to one particular circuit when trouble obviously exists in that circuit. If there is no vertical deflection, for example, when the intensity and horizontal deflection appear to be normal, it is apparent that a trouble exists in the Vertical Amplifier and this circuit should be investigated first.

TROUBLESHOOTING THE LOW-VOLTAGE POWER SUPPLY

Proper operation of every circuit in the Type 502A Oscilloscope depends on proper operation of the Low-Voltage Power Supply. The regulated voltages must remain within their specified tolerances for the instrument to maintain its calibration.

For wrong output voltage

If the graticule lamps and the fan do not operate when the power switch is turned on, check the power switch, the fuse, and the line voltage. If your instrument is wired for 220, 234 or 248 volt operation, also check the thermal cutout switch. (If your instrument is wired for 110, 117 or 124 volt operation, the fan will run even though the thermal cutout switch may be open.) If the fuse is not blown and the line voltage is correct, next check the primary windings of the power transformer.

If both the graticule lamps and the fan operate correctly, the primary circuit of the power transformer is operating normally and the trouble lies somewhere in the secondary circuits.

If only one of the outputs of the Low-Voltage Power Supply is zero, the trouble is probably due to a defective rectifier, series regulator, or power transformer secondary winding, although this trouble can also be caused by a short across the output. To determine which circuit element is defective, measure the secondary voltage of the transformer and the voltage at the output of the rectifier. The cause of the trouble can be determined by voltage readings obtained.

Important power supply voltages are marked on the power supply schematic diagram. These voltages may be used to perform checks on the power supply operation. One cause of improper regulation by a power supply is incorrect loading of the supply. To check power supply loading, shut off the power and check the resistance of the power supply output bus to ground.

Approximate resistances to ground of the low-voltage power supplies are given in Table 4-1. Test points are shown in Fig. 4-7.

For failure of the regulated power supplies to regulate at all correct voltages

If any or all of the supplies fail to regulate at the proper voltages, first check the line voltage. The supplies are designed to regulate between 105 and 125 volts (or 210 and 250 volts), with the design center at 117 volts (or 234 volts), RMS. (There are similar line voltage ranges for the other nominal line voltages). Improper line voltage may cause one or all of the supply voltages to be off.

TABLE 4-1

Power Supply Resistances

SUPPLY	APPROX RESISTANCE TO GROUND	TEST POINT
—150 V	3.5 kΩ	C602B (Shell)
+100 V	4 kΩ	V677 (Pin 1)
+350 V	9 kΩ	V757 (Pin 1)
Power Line	∞	T602 (Term 1 or 4)
6.3 V AC	50 Ω	T602 (Term 18 or 19)
—5.8 V AC	2.5 Ω	T602 (Term 11)

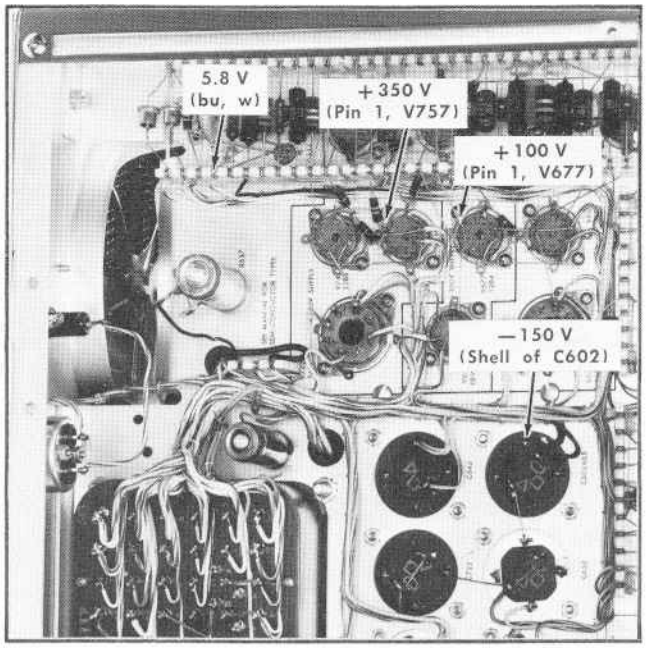


Fig. 4-7. Low voltage power supply test points.

All the low voltage power supplies are dependent upon the —150 volt supply for regulation, and consequently, a change in the regulation point of all the supplies is indicative of a defective —150 volt supply. If the output voltage of the —150 volt supply is off by only a small amount, it may be possible to readjust the —150 Control for the proper voltage. In any event it will be necessary to recalibrate the instrument according to the procedures given in the Calibration Procedure section of this manual.

If none of the preceding checks determine the cause of the trouble, the cause of the improper regulation is probably a change in value of one or more of the resistors or capacitors composing the voltage divider networks. The resistance networks in the grid circuits of V746B, V666B and B636A and the base circuits of Q644 are particularly critical since

they determine the output voltage of their respective power supplies. Use resistance checks to isolate the defective part or parts. Th following information may be used as a quick index to troubleshooting the Low-Voltage Power Supply.

If the output voltage is high with excessive ripple, check:

1. For high line voltage

2. The amplifier tubes and transistors (V746, V666, V636, Q644 and Q634)

3. For insufficient loading

If the output voltage is high with normal ripple, check:

1. For proper resistance values in the dividers (R751 and R753; R671 and R673; R621, R622 and R623; and R648 and R649)

If the output voltage is low with excessive ripple, check:

1. For low line voltage

2. The series regulator tubes and transistor (V747, V757, V677, V637, or Q647)

3. For excessive loading

4. Open or leaky filter capacitors

5. Rectifiers (V722, V652, V602, or D642A,B)

If the output voltage is low with normal ripple, check:

1. The resistance values in the dividers

2. The capacitors across the dividers

If the output voltage is normal with excessive ripple, check:

1. Filter capacitors at the output of the rectifiers and at the regulated output

2. AC bypass capacitors in the grid circuits of the regulator amplifiers

3. Regulator amplifiers (screen grid circuits)

TROUBLESHOOTING THE CRT CIRCUIT

For troubles which affect both beams

The intensity, calibration, focus, and geometry of the CRT display depend on the proper operation of the high-voltage power supply in the CRT Circuit. In general, troubles occurring in the high-voltage power supply will produce similar effects on both beams.

If no high voltage (or insufficient high voltage) is available from either the grid or cathode supplies, a defective oscillator circuit or excessive loading is probably the cause. The oscillator can be quickly checked by placing a neon bulb against V800, the oscillator tube. If the bulb glows, the oscillator is operating and the trouble is likely to be in the secondary windings of T801 if there is no high voltage, or in the regulator circuit (V814), if the high voltage is abnormally low.

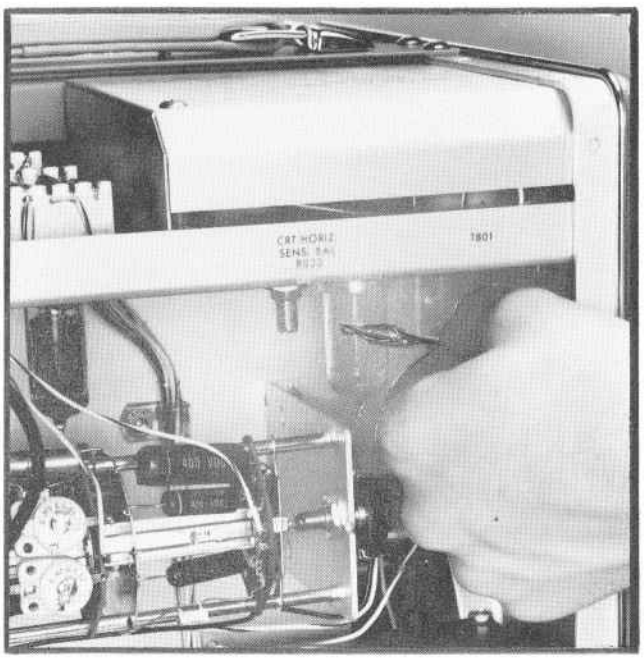


Fig. 4-8. Checking operation of the high voltage oscillator circuit by means of a neon bulb.

It is unlikely that all three rectifier tubes would simultaneously be defective.

If the neon bulb does not glow, the oscillator is not operating. If replacement of the oscillator tube V800 and the regulator tube V814 does not clear up the trouble, check the components of the oscillator circuit including the primary and secondary windings of transformer T801.

If the proper output voltage is obtained from at least one of the high voltage supplies, the oscillator circuit need not be checked. In this case, you can check the rectifier and components associated with the inoperative supply. If the proper output voltages are obtained from all the H.V. supplies and the circuit is still not operating correctly, check the voltage dividers which control the intensity and focus of the beams. If these are also normal, the trouble will likely be the CRT itself or its cathode circuitry. Badly misfocused and distorted displays can be caused by an open Geom Control or a loose connection at the neck of the CRT.

If the high voltage appears to be abnormal, as evidenced by decreased or increased horizontal and vertical deflection sensitivity, the regulator circuit (V814) should be checked. If this tube or any component of this circuit is changed, the setting of the HV Control (R826) should be checked and adjusted if necessary according to the procedure given in the Calibration Procedure section of this manual.

For troubles which affect only one beam

Troubles which affect only one beam will generally be caused by defects in the intensity and focus voltage dividers, by the Astigmatism Controls, or by the CRT. These parts (except for the CRT) can be checked by voltage and resistance measurements. If the circuit checks out satisfactorily, replace the CRT.

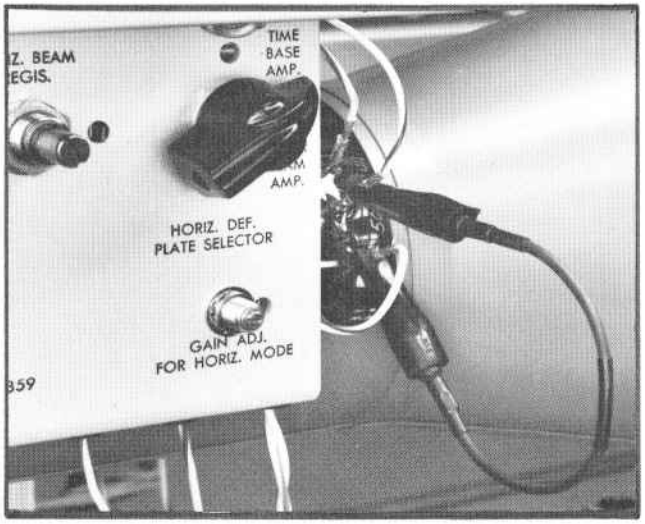


Fig. 4-9. Checking for unbalance in the upper beam vertical amplifier by shorting the vertical deflection plates together.

TROUBLESHOOTING THE VERTICAL AMPLIFIERS

For no spot or trace

If a trace (or spot) is visible when the vertical deflection plates are externally shorted together, but disappears when the short is removed, the Vertical Amplifier is in a state of DC unbalance. To determine the cause of this condition, short the plates of the output stage (V484A and V484B) together. If the trace does not appear, one side of the circuit, between the output stage and the CRT is open. A continuity check with an ohmmeter is perhaps the best way to determine which side is open. On the Upper Beam Vertical Amplifier, check particularly the connections at the HORIZ DEF PLATE SELECTOR switch, SW489.

If the trace does appear when the plates of the output stage are shorted together, the circuit between this point and the CRT pin connection is normal. The trouble then lies somewhere in the Vertical Amplifier ahead of the plate circuit of the output stage. To locate the defective stage, move the shorting strap back point by point, between corresponding points on opposite sides of the circuit. As you short between the points, in turn, the spot should return on the screen as each connection is made. You may have to readjust the DC BAL controls when shorting between grids of the input stage. When you reach a point where the spot does not return to the screen, the stage immediately following this point is at fault. The trouble may be caused by a defective tube, transistor, resistor, or capacitor. Fig. 4-11 shows the location of the components mounted on the circuit boards.

For insufficient or no vertical deflection

Insufficient vertical deflection indicates a change in the gain characteristics of the Vertical Amplifier. If the change is small, the Vertical Amplifier can usually be recalibrated for gain. Refer to the Calibration Procedure for this.

If the change in gain is more pronounced or if there is no vertical deflection at all, the tubes and transistors should be checked first. Then check for components which will affect the gain of both sides of the amplifier without unbalancing the amplifier.

Insufficient vertical deflection will also be caused if the upper or lower frequency limit of the amplifier is exceeded.

For waveform distortion

Waveform distortion can be divided into two categories . . . low frequency and high frequency. If a square wave is applied to an input of the oscilloscope, the type of distortion can be determined by the shape of the displayed waveform. High frequency distortion will primarily affect the leading edge and trailing edge of the applied square wave while low frequency distortion will primarily affect the mid-portion of the waveform.

Waveforms showing low frequency distortion and two types of high frequency distortion are shown in Fig. 4-10. The shape of these waveforms will vary widely however, with the cause of the distortion and the frequency of the applied wave. A nominal amount of low frequency distortion is normal for very low input frequencies when AC coupling is used, and a nominal amount of high frequency distortion is normal at the upper frequency limits of the instrument.

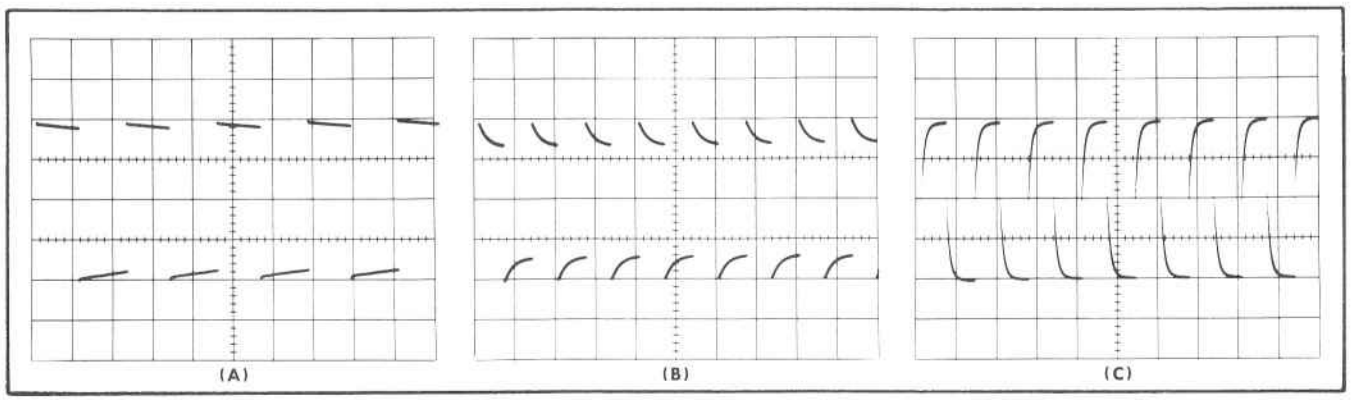


Fig. 4-10. Frequency distortion: (a) Low frequency distortion of a 20 hertz square wave due to attenuation of the low frequency component of a waveform. (b) High frequency distortion of a 1200 hertz square wave due to excessive boost of the high frequency components of the waveform. (c) High frequency distortion of a 1200 hertz square wave due to attenuation of the high frequency components of the waveform.

It is only when this distortion is excessive in the normal frequency range of the instrument that it constitutes a trouble.

Low frequency distortion is usually caused by a change in the time constant of the input coupling circuit. If tubes become gassy, their resultant grid current will establish a time constant network which will affect the low frequency response of the circuit.

High frequency response can be affected considerably by an improperly adjusted probe. Consequently, in any case of high frequency distortion you should first check the probe adjustment. Refer to the Operating Instructions for the compensation procedure. Other factors which can affect the high frequency response of the vertical amplifier are mainly related to the high frequency compensation networks.

An overshoot waveform shown accentuated in Fig. 4-10 is the result of excessive high frequency compensation. This can be caused by a tube condition known as cathode interface. If this type of distortion is detected, you should check the tubes in the amplifier. If tube replacement does not completely correct the trouble, you should then check the adjustment and operation of the high frequency compensation circuits.

For improper triggering

Improper triggering can be caused by a defective trigger pickoff circuit. The trouble may be caused either by a faulty cathode follower, V493, or by a defective component in the circuit.

TROUBLESHOOTING THE TIME-BASE TRIGGER

If the trouble occurs in some but not all positions of the TRIGGER SELECTOR switch, the trouble is likely due to a defective TRIGGER SELECTOR switch or input coupling circuit. If the trouble occurs in all positions of the TRIGGER SELECTOR switch, either the trigger input amplifier or the trigger multivibrator will be at fault. You should check tubes V24 and V45.

NOTE

All voltages in this section are measured with a 20,000 ohms-per-volt voltmeter.

To determine which stage is defective, rotate the TRIGGERING LEVEL control fully counter-clockwise to the AUTOMATIC position. With no triggering signal, the sweep should appear on the CRT. If the sweep does not appear, the trigger multivibrator is defective. If the sweep does appear, either the trigger input amplifier or the trigger multivibrator may be at fault.

A check on the trigger input amplifier circuit may be made as follows: With the TRIGGERING LEVEL Control still in the AUTOMATIC position, measure the voltage at the plate, pin 6, of V24B. This voltage should be approximately +96 volts. If the voltage is incorrect, the trigger input amplifier circuit is defective. The trouble will probably exist in the resistors or switches of the circuit.

If the voltage measured is correct, rotate the TRIGGERING LEVEL Control completely through its range while monitoring the voltage at pin 6 of V24B. The voltage should vary between approximately 34 and 135 volts. An incorrect voltage range indicates a defective trigger input amplifier or TRIGGERING LEVEL Control. If the voltage range is correct, the trouble will be in the trigger multivibrator. A trouble in the multivibrator will probably be due to defective resistors. The voltage divider network between the plate of V45A and the grid of V45B is particularly critical.

TROUBLESHOOTING THE TIME-BASE GENERATOR

For free-running operation

If the Time-Base Generator free runs when the TRIGGERING LEVEL Control is not in the RECURRENT or AUTOMATIC positions this is due to astable operation of the sweep gating multivibrator. This trouble will probably be due to defective resistors in the grid circuit of V135A (resistors R185, R186, or R111) or in the grid circuit of V145A (resistors R141 or R143).

For no horizontal sweep

If the Time-Base Generator is not producing a sawtooth waveform when the TRIGGERING LEVEL Control is in the RECURRENT position, some defect in the circuit is causing the output to remain at some fixed voltage. A clue to the cause of this trouble can be obtained by measuring the plate voltage of the Miller tube, V161A. The voltage reading obtained will probably be either approximately +300 volts or approximately +30 volts. A reading of +300 volts indicates that the Miller stage has run up and has not been reset, while a reading of +30 volts indicates that the Miller stage is not being allowed to run up. The condition that actually exists will depend on the type of trouble occurring in the circuit. The two conditions of plate voltage will be handled separately in the following paragraphs.

Miller Stage is Run-up

If the voltage at the plate of the Miller tube, V161A, is high, the tube is cut off. This can result from any one of the following conditions: (1) Disconnect Diodes do not conduct, (2) Sweep-Gating Multivibrator does not reset, (3) Hold-off Cathode Followers do not reset the Sweep-Gating Multivibrator and (4) Runup Cathode Follower does not drive the Hold-Off Cathode Follower. The defective stage can be detected by a series of systematic voltage measurements. When an improper voltage reading is obtained, this will indicate the defective stage.

Check the voltage at the grid of the Miller tube. If the reading is only a few volts negative, the Disconnect Diodes are probably conducting normally and can be eliminated as a possible cause of the trouble. If the voltage is more negative than —50 volts, however, the diodes are not conducting. Check V152 and resistors R147 and R148.

Measure the voltage at the output of the Time-Base Generator (pin 3 of V161B). If this voltage is approximately +250 volts, the Runup Cathode Follower stage may be assumed to be operating correctly. If this voltage is low, however, the stage is defective and its grid and cathode circuits should be checked.

Next, measure the grid to cathode voltage of the Hold-Off Cathode Follower, V183A and V145B. Both of these

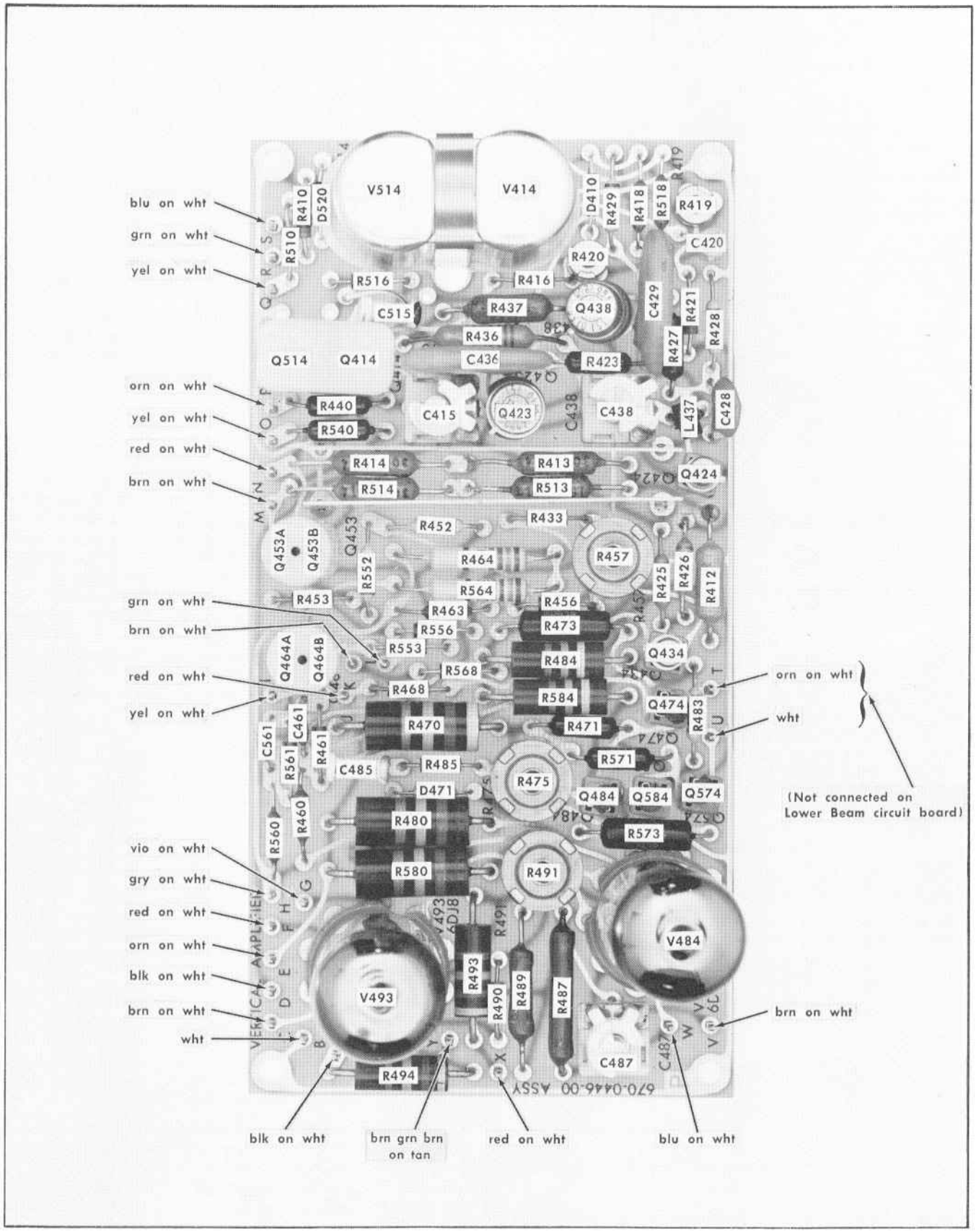


Fig. 4-11. Vertical Amplifier circuit board.

readings should be approximately —4 volts if the cathode followers are operating correctly. If either or both of these voltages are incorrect, check the hold-off capacitor and the resistors in the cathode circuits of the two stages.

If the previous checks gave correct results, the voltage at the grid of V135A should be sufficient to reset the multivibrator (more positive than —35 volts). If this is so, and the multivibrator still does not reset, the trouble must lie in that stage. Check the voltages at the plates of V135A, V135B, and V145A, and the resistors in the cathode circuit of V135B.

Miller Stage will not run up

Low voltage at the plate of the Miller tube indicates that the tube is conducting quite heavily and is not being allowed to perform its normal runup operation. If this trouble exists on only a few ranges of the TIME/CM switch the trouble is likely to be an open timing resistor. If the trouble exists on all ranges of the TIME/CM switch, the trouble is probably due to a defective Sweep-Gating Multivibrator stage.

To check the Sweep-Gating Multivibrator, monitor the voltage at the junction of R114 and R116 and adjust the STABILITY ADJUST Control for a reading of —70 volts on the voltmeter. With this voltage, the Sweep-Gating Multivibrator and the sweep should free run. If the multivibrator does not switch, check the resistances which make up the stage.

If the voltage at the junction of resistors R114 and R116 remains relatively constant as the STABILITY ADJUST Control is rotated, a defect in cathode follower V145B may be causing the stage to effectively regulate the voltage at this point. If such is the case, the probable cause of this condition is a shorted holdoff capacitor. If the voltage does not adjust to the proper level, check the resistors in the grid circuit of V135A.

For nonlinear sweep

A nonlinear sweep voltage will be generated if the current charging the Timing Capacitor does not remain constant. If the nonlinearity exists at all sweep rates, a defective Miller tube is the probable cause of the trouble. If the nonlinearity occurs only at certain sweep rates, the Miller tube or a leaky Timing Capacitor is the probable cause.

For insufficient horizontal deflection

If the horizontal trace starts at the left-hand side of the screen, but does not extend to the right-hand side, the Hold-Off circuit is resetting the Sweep-Gating Multivibrator before the sweep is complete. If the sweep cannot be adjusted to normal length with the SWP LENGTH Control R176, the resistance in the cathode circuit of V161B should be checked.

Single Sweep will not perform properly

If D126 opens, the Time-Base Generator will still operate normally when the MODE switch is in the NORMAL position. However, when the instrument is set up for Single Sweep operation, the circuit will not lock out at the end of the sweep. This, of course, means that each incoming trigger will produce another sweep across the CRT.

If on the other hand D126 becomes shorted or leaky, then the Time-Base Generator will not produce a sweep even though the Single sweep circuit seems to be resetting all right. If this condition exists the plate voltage of V135A should be checked. It should normally be approximately +138 volts when the Time-Base Generator is producing a sweep; however, when the Time-Base Generator is not producing a sweep the plate voltage of V135A will normally be approximately +4 volts.

D124 being opened will also cause the Single Sweep circuit not to lock out, even though the READY light seems to operate normally.

When D124 is shorted or leaky it will cause the Time-Base Generator to free-run since the grid of V135A is pulled negative. The TRIGGERING LEVEL Control will have little or no effect upon the free-running Time-Base Generator.

TROUBLESHOOTING THE HORIZONTAL AMPLIFIER

For no spot or trace

If both beams are visible when the horizontal deflection plates are externally shorted together, but disappear when the short is removed, the horizontal amplifier is in a state of unbalance. The procedure for troubleshooting the Horizontal Amplifier is somewhat the same as that explained previously for troubleshooting the Vertical Amplifiers for unbalance. Corresponding points on opposite sides of the Horizontal Amplifier circuit should be progressively shorted together until a point is reached where the beams do not return to the face of the CRT. The stage immediately following this point is the one which is defective. Check for open resistors in the cathode and plate circuits.

For insufficient or no horizontal deflection

If the gain of the Horizontal Amplifier decreases, the trace will not extend to the left and right sides of the CRT screen. In addition, the sweep timing will no longer be calibrated on any range of the TIME/CM switch. If the change in sweep timing and sweep length is slight, it may be possible to correct this trouble by adjusting the high voltage and the ×1 CAL and ×20 CAL Controls according to the instructions contained in the Calibration Procedure.

If the decrease in gain of the Horizontal Amplifier is more pronounced, or if there is no sweep at all, check for components which will affect the gain but not the balance of the amplifier. The input cathode follower, V183B, should be checked as one of the first steps. Also, the common resistances in the cathodes of the amplifier stages should be checked.

NOTES

SECTION 5
PERFORMANCE CHECK

Introduction

This section of the manual provides a means of rapidly checking the performance of the Type 502A without performing the complete calibration procedure and without adjusting any internal controls. Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments as given in the Calibration Section of this manual.

In the Performance Check procedure, the steps are arranged in the sequence used in the Calibration Section. When following this procedure, leave the controls set to the positions they were in at the end of the previous step unless specific instructions are given to change their settings. Input signal voltages should remain connected to the instrument until specific instructions are given to disconnect them or until another signal is applied to the same connector.

EQUIPMENT REQUIRED

The following equipment is required for a complete performance check. Equipment specifications given here are the minimum requirements for making the performance check. All test instruments are assumed to be calibrated and operating within their rated specifications. If substitute equipment is used, it must meet or exceed the specifications listed below for the recommended equipment.

1. Test oscilloscope. Tektronix Type 422. Minimum alternate requirements: Bandwidth from DC to 10 MHz; sweep rates from 10 ms/cm to 0.1 ms/cm; vertical input deflection factors from 10 mV/cm to 2 V/cm; voltage and timing accuracy within 3%; AC and DC vertical input coupling.

2. Variable autotransformer (e.g., General Radio Variac Type W10MT3). Minimum requirements: Output voltage variable from 105 volts to 125 volts AC RMS for 115 volt operation, or 210 volts to 250 volts AC RMS for 230 volt operation; output power rating at least 0.3 kVA.

3. Time-mark generator, Tektronix Type 184. Minimum alternate requirements; Time-mark output of 1 μs to 5 s markers in a 1-5-10 sequence; accuracy within 0.1%.

4. Sine-wave generator (e.g., General Radio Type 1310-A). Minimum requirements: Output signal of 10 Hz to 1 MHz, accuracy within 5%; constant-amplitude output variable between 0.1 volts and 50 volts, peak to peak.

5. Square-wave generator, Tektronix Type 106. Minimum alternate requirements; Output frequencies of 1 kHz and 10 kHz; risetime $\leq$20 nanoseconds; output amplitude variable between 50 millivolts and 100 volts.

6. 47 pF input time-constant Normalizer (with UHF connectors). Tektronix Part Number 012-0001-00. (This item was formerly listed by Tektronix as a 47 pF input time-constant standardizer.)

7. Standard Amplitude Calibrator (SAC), Tektronix Part Number 067-0502-00. +DC, —DC, 1 kHz square-wave signals; output amplitudes of 5 mV to 50 V in a 1-2-5 sequence with accuracy within 0.25%.

8. 4-way input connector (special for Type 502A), Tektronix Part Number 067-0114-00. (If this connector is not available, the patch cords and T-adapter listed below can be used, but the procedure will not be as convenient.)

9. Coaxial cables (2), 50-ohm 42-inch with UHF connectors, Tektronix Part Number 012-0001-00.

10. Patch cords, 18-inch with banana plug tips; 3 red (Tektronix Part Number 012-0031-00) and 1 black (Tektronix Part Number 012-0039-00).

11. Adapters: (a) UHF Female to BNC Male (two required), Tektronix Part Number 103-0032-00; (b) UHF Female to GR, Tektronix Part Number 017-0022-00; (c) UHF "T", 1 Male to 2 Female, Tektronix Part Number 103-0026-00.

12. Adjustment Tool: screwdriver, $\frac{1}{8}$-inch diameter tip.

PRELIMINARY PROCEDURE

1. Connect the test equipment to a suitable power source.

2. Set the autotransformer for the nominal line voltage indicated on the rear plate of the oscilloscope and connect the Type 502A to its output.

3. Allow at least 20 minutes warmup at 25° C $\pm$ 5° C before making any checks.

4. Preset the controls as follows:

FOCUS (Both)	Fully clockwise
INTENSITY BALANCE	Midrange
INPUT Selector (Both)	A DC
SENSITIVITY (Both)	2 VOLTS PER CM
VERTICAL POSITION (Both)	Midrange
TRIGGERING LEVEL	RECURRENT
MODE	NORMAL
TIME/CM	1 mSEC
HORIZONTAL DISPLAY	NORMAL (×1)
POSITION (HORIZ)	Midrange
HORIZ. DEF. PLATE SELECTOR	TIME BASE AMP
INTENSITY	Adjust for normal brightness

5. During the procedure that follows, periodically check the input AC voltage to the Type 502A and adjust the autotransformer as necessary to maintain the desired supply voltage, except when the high-voltage regulation is being checked.

6. Check the SCALE ILLUM control for smooth control of the graticule brightness. Both SCALE ILLUM bulbs should light.

CRT DISPLAY

1. Check CRT Supply Regulation

Requirement: No noticeable trace blooming within line voltage operating range.

a. Adjust both FOCUS controls for the sharpest display.

b. Set the HORIZONTAL DISPLAY switch to 2 EXT V/CM and position the focused spots to the graticule center lines. Reduce the intensity of the display if necessary to avoid burning the phosphor.

c. While observing the focused spots, change the line voltage through the operating range (see Table 5-1). The spots should not show any blooming.

TABLE 5-1

Nominal Line Voltage	Operating Range	
	Low Line	High Line
110	99	117
117[1]	105	125
124	111	132
220	198	234
234[1]	210	250
248	222	264

[1]Normal Factory Connections

d. Return the autotransformer to the nominal line voltage setting.

e. Set the HORIZONTAL DISPLAY switch to the NORMAL (×1) setting.

2. Check Action of INTENSITY BALANCE Control

Requirement: Control can be adjusted to obtain equal brightness of the two beams.

a. Adjust the INTENSITY and INTENSITY BALANCE controls so that both traces are barely visible.

b. Turn the INTENSITY control counterclockwise until the brightness of the display is normal. The two beams should still be matched in brightness.

3. Check CRT Geometry

Requirements: A horizontal trace positioned to the graticule center line should not deviate more than 1.5 mm from the line. A vertical trace should not deviate more than 1.5 mm from the vertical graticule lines in the center 8 centimeters of display.

a. Position each trace to its respective graticule reference line.

b. Neither trace should vary more than 1.5 mm above or below the graticule center line.

c. Apply 1 ms markers from the time-mark generator to the Type 502A through the 4-way input connector.

d. Adjust the POSITION and SENSITIVITY controls so that only the vertical portions of the markers are displayed.

e. Adjust the TRIGGER controls to obtain a stable display.

f. Check for $\leq$1.5 mm of curvature or slant of the vertical lines within the center 8 centimeters of the display (see Fig. 5-1).

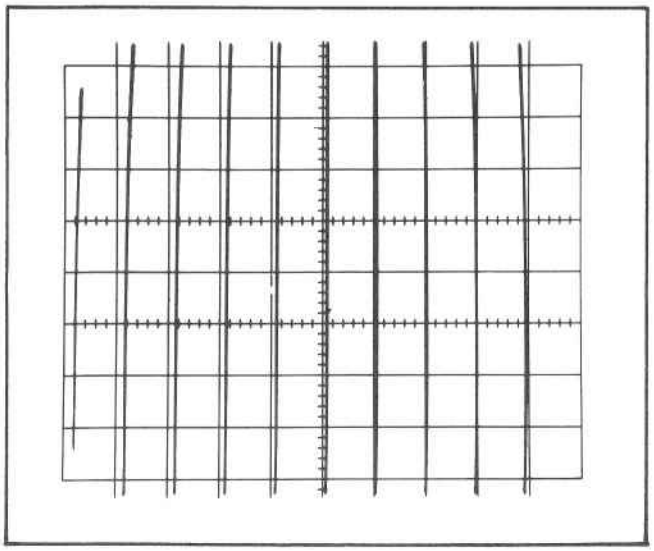


Fig. 5-1. CRT display showing bowing of vertical lines (step 3).

4. Check Beam Registration and Horizontal Sensitivity Balance

Requirements: If the same time markers are applied to both beams, the first markers must be aligned within 1 mm, the rest of the markers must be aligned within 2 mm.

a. Reset the following controls:

UPPER BEAM INPUT SELECTOR	B DC
LOWER BEAM INPUT SELECTOR	A DC
SENSITIVITY (Both)	2 VOLTS PER CM

b. Apply .1 ms and 1 ms markers to the 4-way input connector.

c. Adjust the TRIGGER, INTENSITY, and FOCUS controls for a sharp, stable display.

d. Position the traces so that the time-mark tips are touching (see Fig. 5-2).

e. Check display for the required trace alignments.

HORIZONTAL AMPLIFIER AND SWEEP CIRCUITS

Preset the following controls:

UPPER BEAM INPUT SEL	A DC

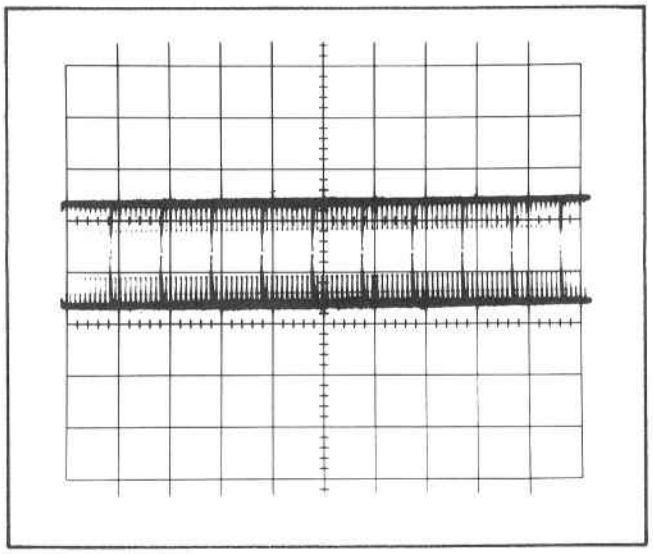


Fig. 5-2. CRT display for step 4.

UPPER BEAM SENSITIVITY	2 VOLTS PER CM
UPPER BEAM POSITION	Position the Upper Beam trace to the lower reference line.
LOWER BEAM POSITION	Position the Lower Beam trace off the screen.
TIME/CM	1 mSEC
TRIGGER SELECTOR	+ EXT AC
TRIGGER LEVEL	AUTOMATIC

NOTE

Unless directed otherwise, use the middle eight horizontal centimeters of the display when making horizontal gain and timing checks.

5. Check ×1 to ×20 Sweep Timing

Requirement: ≤5% (or 4 mm/8 cm) timing error for all magnified displays.

a. Connect the time-mark generator to the 4-way input connector and to the TRIGGER INPUT binding post.

b. Check the NORMAL (×1) to ×20 positions of the HORIZONTAL DISPLAY switch as directed in Table 5-2. Maximum timing error is ±4 mm in 8 centimeters.

TABLE 5-2

HORIZONTAL DISPLAY	Time Markers	Check For
×20	100 μs	1 mark/2 cm
×10	100 μs	1 mark/cm
×5	100 μs	2 marks/cm
×2	1 ms	1 mark/2 cm
×1	1 ms	1 mark/cm

6. Check Magnified Sweep Registration

Requirement: ≤2 mm display shift at graticule center when HORIZONTAL DISPLAY switch is changed from ×20 to ×1.

a. With the HORIZONTAL DISPLAY switch set to ×20, position one of the markers to the graticule center vertical line.

b. Change the HORIZONTAL DISPLAY switch to ×1 (NORMAL). The marker should not shift more than 2 mm.

7. Check Sweep Timing and Single-Sweep Operation

Requirement: ≤±3% (2.5 mm in 8 cm) timing error on all unmagnified sweeps.

a. Check sweep timing for an accuracy within ±2.5 mm over the center 8 centimeters of the display as directed in Table 5-3. Use SINGLE-SWEEP MODE for sweep rates slower than 50 ms/cm to check that READY neon lamp glows and trace sweeps only once when the MODE switch is depressed to the RESET position.

TABLE 5-3

TIME/CM	Time Markers	Markers/Cm
50 μSEC	50 μs	1
20 μSEC	10 μs	2
10 μSEC	10 μs	1
5 μSEC	5 μs	1
2 μSEC	1 μs	2
1 μSEC	1 μs	1
.1 mSEC	100 μs	1
.2 mSEC	100 μs	2
.5 mSEC	500 μs	1
1 mSEC	1 ms	1
2 mSEC	1 ms	2
5 mSEC	5 ms	1
10 mSEC	10 ms	1
20 mSEC	10 ms	2
50 mSEC	50 ms	1
.1 SEC[2]	100 ms	1
.2 SEC	100 ms	2
.5 SEC	500 ms	1
1 SEC	1 s	1
2 SEC	1 s	2
5 SEC	5 s	1

[2]Change to SINGLE-SWEEP.

b. Return the MODE switch to NORMAL.

8. Check VARIABLE TIME/CM Control Range

Requirement: ≤2.5:1 ratio.

a. Set the TIME/CM switch to 1 mSEC.

b. Set the time-mark generator for 10 mSEC markers.

c. Turn the VARIABLE TIME/CM control fully counterclockwise. The markers should not be more than 4 centimeters apart.

d. Remove the time-marker signal.

9. Check External Horizontal DC Balance

Requirement: $\leq$2 mm of horizontal display movement when the HORIZONTAL DISPLAY is rotated through its EXT VOLTS/CM range.

a. Ground the EXTERNAL HORIZ INPUT connector.

b. Rotate the HORIZONTAL DISPLAY switch through its EXT VOLTS/CM range. The spot should not move more than 2 mm.

c. Remove the ground from the connector.

10. Check External Horizontal Input Gain and Attenuator Accuracy

Requirement: Horizontal deflection within 5% of EXT VOLTS/CM setting.

a. Connect the SAC (Standard Amplitude Calibrator) square-wave output to the Type 502A EXTERNAL connector.

b. Check for 10 cm $\pm$ 5 mm of horizontal deflection in each EXT VOLTS/CM position of the HORIZONTAL DISPLAY switch as directed in Table 5-4:

TABLE 5-4

EXT VOLTS/CM	SAC Square-Wave Signal
2	20 V
1	10 V
.5	5 V
.2	2 V
.1	1 V

11. Check External Horizontal Input Bandwidth

Requirement: Not more than 3dB down at 100 kHz.

a. Apply a 10 kHz signal from the sine-wave generator to the EXTERNAL connector.

b. With the HORIZONTAL DISPLAY switch in the .1 EXT VOLTS/CM position, adjust the Amplitude control of the generator for exactly 6 centimeters of horizontal deflection.

c. Set the Frequency control of the generator to 100 kHz. The trace should be $\geq$4.2 centimeters in length.

d. Disconnect the sine-wave generator and set the HORIZONTAL DISPLAY switch to NORMAL ($\times$1).

VERTICAL AMPLIFIERS

Preset the following controls:

TRIGGERING LEVEL	RECURRENT
MODE	NORMAL
TIME/CM	2 mSEC
HORIZONTAL DISPLAY	NORMAL ($\times$1)
INPUT SELECTOR (Both)	A DC
VERTICAL POSITION (Both)	Align traces with the appropriate reference lines
SENSITIVITY (Both)	.2 VOLTS PER CM
HORIZ. DEF. PLATE SELECTOR	TIME BASE AMP

12. Adjust DC BALANCE Controls

Requirement: DC BALANCE controls can be adjusted so that there is no appreciable trace shift when the SENSITIVITY controls are moved.

a. Ground the input of the 4-way connector.

b. Set both DC BALANCE control knobs to midrange.

c. Set both COARSE DC BALANCE adjustments for no trace shift as the SENSITIVITY switches are rotated between .2 VOLTS PER CM and .1 mVOLTS PER CM.

d. Set the SENSITIVITY switches to .5 VOLTS PER CM.

e. Check that the traces do not shift appreciably when the VARIABLE SENSITIVITY controls are rotated through their range. (It will probably be necessary to readjust the DC BAL control knob settings for this check.)

13. Check Input Grid Current

Requirement: Input grid current not to exceed 0.4 nA.

a. Set both SENSITIVITY switches to .1 mVOLTS PER CM.

b. With the 4-way input connector still grounded, switch both INPUT SELECTOR switches from A DC to A AC, and from B DC to B AC. Neither trace should shift more than 4 centimeters.

14. Check for Excessive Noise

Requirement: Average random noise and hum should not exceed 30 microvolts.

a. Set both INPUT SELECTOR switches to A DC.

b. Set the TIME/CM switch to 10 mSEC.

c. With the 4-way input connector still grounded, check for $\leq$ 3 mm of deflection (see Fig. 5-3).

15. Check Vertical Drift

Requirement: Changing the line voltage through the operating range must not change the position of the trace more than the change produced by applying a 300 μV signal.

a. Change the output of the auto-transformer through the entire operating range of the oscilloscope (see Table 5-1).

b. Check the movement of the trace. It should not shift more than 3 centimeters above or below the original level.

c. Set the auto-transformer back to the correct nominal line voltage and remove the ground from the 4-way input connector.

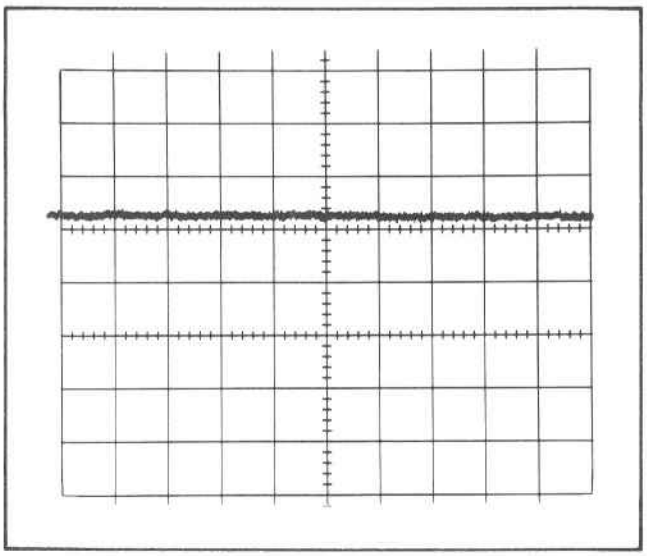


Fig. 5-3. CRT display showing random noise.

16. Check Vertical Deflection Accuracy

Requirement: Vertical deflection accuracy must be within 3% of the correct amplitude on the .1 mV/CM setting of the SENSITIVITY switch and within 2% for all other settings of the switch.

a. Connect the square-wave output of the SAC to the 4-way input connector.

b. Check the vertical deflection accuracy of all four vertical inputs as directed in Table 5-5:

TABLE 5-5

SENSITIVITY in VOLTS PER CM	Standard Amplitude Calibrator Output	Check for Display:
.1 mV	.5 mV	5 cm ± 1.5 mm
.2 mV	1 mV	5 cm ± 1.0 mm
.5 mV	2 mV	4 cm ± 0.8 mm
1 mV	5 mV	5 cm ± 1.0 mm
2 mV	10 mV	5 cm ± 1.0 mm
5 mV	20 mV	4 cm ± 0.8 mm
10 mV	50 mV	5 cm ± 1.0 mm
20 mV	.1 V	5 cm ± 1.0 mm
50 mV	.2 V	4 cm ± 0.8 mm
.1 V	.5 V	5 cm ± 1.0 mm
.2 V	1 V	5 cm ± 1.0 mm
.5 V	2 V	4 cm ± 0.8 mm
1 V	5 V	5 cm ± 1.0 mm
2 V	10 V	5 cm ± 1.0 mm
5 V	20 V	4 cm ± 0.8 mm
10 V	50 V	5 cm ± 1.0 mm
20 V	100 V	5 cm ± 1.0 mm

17. Check Range of VARIABLE SENSITIVITY Control

Requirement: $\geq$2.5:1.

a. Leave both SENSITIVITY switches set at 20 VOLTS PER CM.

b. Set both INPUT SELECTOR switches to A DC.

c. Set the SAC for a 100-volt square wave signal output.

d. Turn the VARIABLE SENSITIVITY controls fully counterclockwise and check for $\leq$ 2 centimeters of vertical deflection.

18. Check Common-Mode Dynamic Range

Requirement: + and — 15 volts from 0 volts.

a. Connect the sine-wave generator to the 4-way input. Set the generator for a 1 kHz sine wave and turn down its signal amplitude.

b. Set the Upper Beam INPUT SELECTOR switch to A-B (DIFF).

c. Set the Upper Beam SENSITIVITY switch to 10 mVOLTS PER CM.

d. Increase the output amplitude of the generator signal. The display should not "break up" (see Fig. 5-4) until the signal amplitude is at least 30 volts peak to peak.

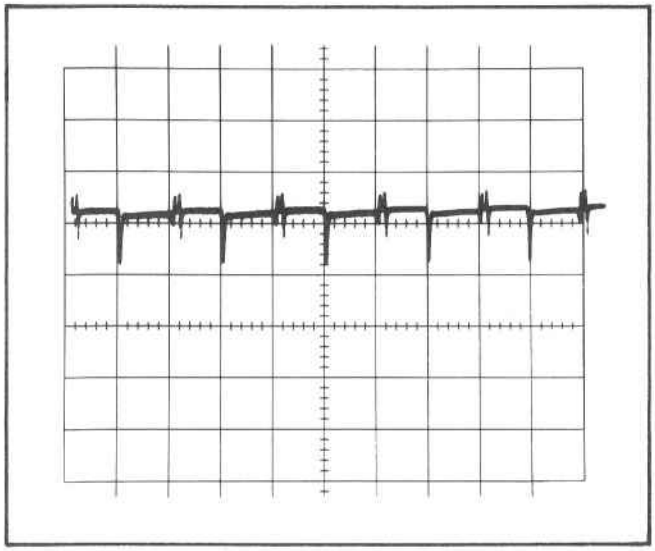


Fig. 5-4. CRT display showing effect of exceeding common-mode dynamic range limit (step 18).

e. Check the Lower Beam Amplifier dynamic range in the same way.

f. Remove the 4-way input connector and the sine-wave signal generator.

19. Check High-Frequency Compensation

Requirement: $\leq$2% aberrations at 10 kHz.

a. Connect the square-wave generator to the Upper-Beam A INPUT connector.

b. Reset the following controls:

Type 502A

INPUT SELECTOR (Both)	A DC
SENSITIVITY (Both)	10 mVOLTS PER CM
TIME/CM	20 μSEC

Square-Wave Generator

Frequency	10 kHz
Amplitude	6 cm display

c. Check that the aberrations on the top of the square wave do not exceed 1.2 mm (See Fig. 5-5).

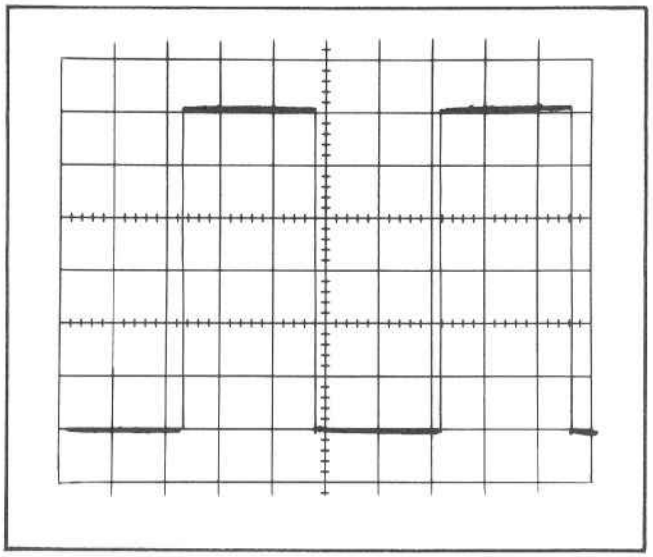


Fig. 5-5. Typical CRT display showing proper high-frequency response.

d. Move the signal to the Lower Beam A INPUT and repeat the above procedure for the Lower Beam.

20. Check Input Compensation

Requirement: $\leq$2% aberrations at 1 kHz.

a. Connect the 47 pF Normalizer between the input cable and the Upper Beam A INPUT connector.

NOTE

The Normalizer must be connected directly to the INPUT connector. If a BNC-to-UHF Adapter or the 4-way connector is used between the INPUT connector and the Normalizer, the display will be affected by the additional lead capacitance.

b. Set the TIME/CM switch to .2 mSEC.

c. Set both SENSITIVITY switches to .2 VOLTS PER CM.

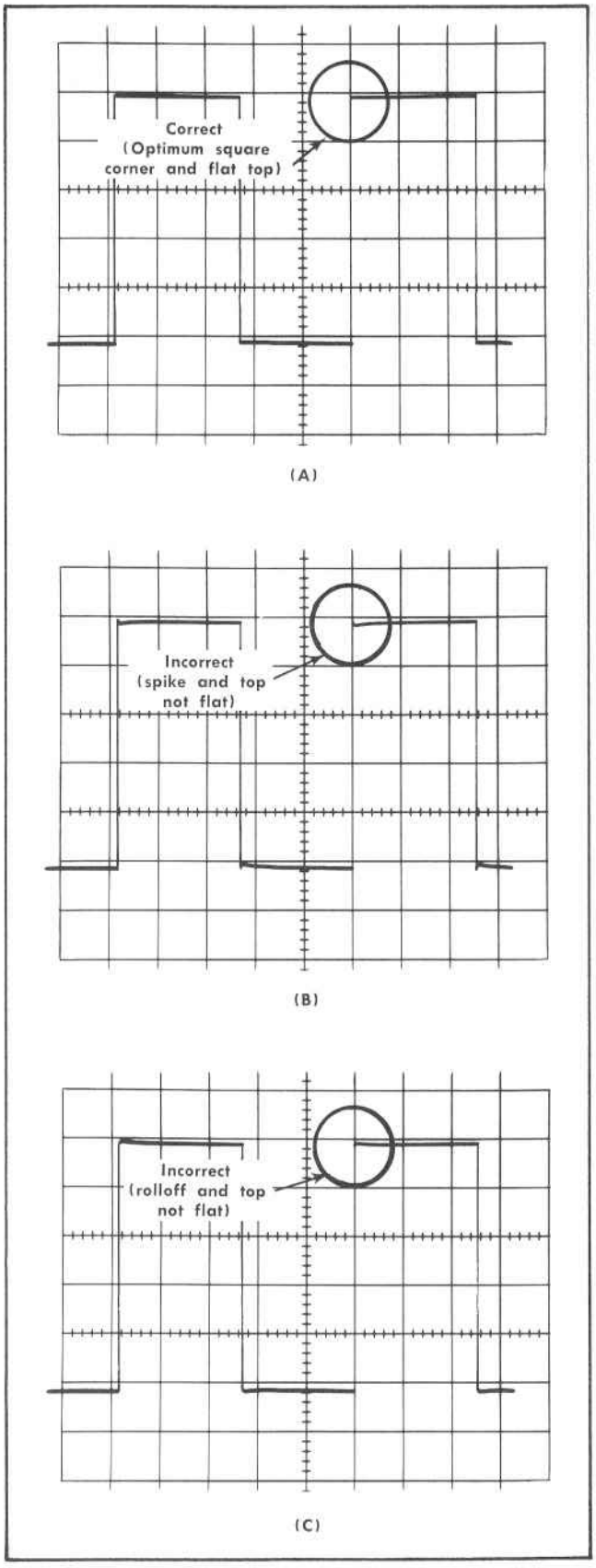


Fig. 5-6. (a) Typical CRT display showing correct input compensation and (b) and (c) incorrect compensation.

d. Adjust the square wave generator Amplitude control for a 5 centimeter display.

e. Check the display for $\leq$1.0 mm of tilt, rolloff, overshoot, or other aberrations (See Fig. 5-6).

f. Change the SENSITIVITY switch setting to .5 VOLTS PER CM and repeat steps (d) and (e).

g. Move the Normalizer to INPUT B and repeat the above procedures. Input B displays are inverted, so check the display at the bottom of the waveform.

h. Repeat the above steps for the Lower Beam Amplifier.

21. Check Common-Mode Rejection Ratio (CMRR)

Requirements:

.1 mV to 2 mV/CM: $\geq$50,000:1 for DC to 50 kHz, $\leq$10 volt peak-to-peak signal applied.

5 mV to .2 V/CM: $\leq$½ mm deflection for DC to 50 kHz, $\leq$10 Volt peak-to-peak signal applied.

.5 V to 20 V/CM: Adjustable to $\geq$5000:1 for DC to 1 kHz and $\geq$500:1 for 1 kHz to 50 kHz. $\leq$100 V peak-to-peak signal applied.

a. Connect the sine-wave generator to the Type 502A through the 4-way connector.

b. Adjust the generator for a 10-volt peak-to-peak signal.

NOTE

The recommended General Radio Type 1310-A Sine-Wave Generator has a constant-amplitude output. A substitute generator not having constant-amplitude output may be used. However, its output level will have to be monitored and reset each time the output frequency is reset for steps (d), (e), (i), and (j).

c. Set both INPUT SELECTOR switches to A-B DC.

d. Check the common mode rejection at 50 Hz and 50 kHz, setting the TIME/CM switch to .1 SEC for the 50 Hz display, and to 50 μSEC for the 50 kHz display. Check both beams at the same time. See Table 5-6 for the maximum deflection allowable.

TABLE 5-6

Setting (VOLTS PER CM) SENSITIVITY Switch	Maximum Deflection
.1 mV	2 cm
.2 mV	1 cm
.5 mV	4 mm
1 mV	2 mm
2 mV	1 mm
5 mV to .2 V	½ mm

e. Set the generator for a 50-Hz 50-volt peak-to-peak signal.

f. Set both SENSITIVITY switches to .5 VOLTS PER CM.

g. Set both INPUT SELECTOR switches to A-B DC.

h. Check for no discernible common-mode signal display (5000:1 CMRR = .2 mm deflection). A slight readjustment of R403E (mounted on the SENSITIVITY switch) may be necessary to meet this requirement. See Step 30 of the Calibration Procedure.

i. Apply a 50-kHz 50-volt peak-to-peak signal and check for $\leq$2 mm of common-mode signal. A slight readjustment of C405C (also mounted on the SENSITIVITY switch) may be necessary to meet this requirement. See Step 30 of the Calibration Procedure.

j. Apply a 1-kHz 50-volt peak-to-peak signal and again check for $\leq$2 mm of common-mode signal.

k. Change the signal frequency to 50 kHz and check for $\leq$2 mm of deflection ($\geq$500:1 CMRR).

22. Check Vertical Signal Output (Rear Panel Connector)

Requirement: $\approx$2 volts per centimeter of displayed signal; $\leq$5% of tilt, rolloff, other aberrations.

a. Connect the square-wave generator to the 4-way input connector.

b. Reset the following controls:

Type 502A

INPUT SELECTOR (Both)	A DC
SENSITIVITY (Both)	.2 VOLTS PER CM
TIME/CM	.5 mSEC

Square-Wave Generator

Frequency	1 kHz
Amplitude	2 centimeters of deflection

c. Position the traces to the respective upper and lower beam graticule center horizontal lines.

d. Connect the test oscilloscope probe to the rear panel Vertical Signal Out connectors; check for a test oscilloscope display of about 4 volts having $\leq$5% aberrations.

e. Disconnect the test oscilloscope probe from the Type 502A.

23. Check Gain of Upper-Beam Amplifier in Horizontal Mode

Requirement: Upper-Beam Horizontal Mode gain matches Lower-Beam Vertical gain within 2%.

a. Connect the sine-wave generator to the 4-way input connector.

b. Set the controls as follows:

Type 502A

HORIZ. DEF. PLATE SELECTOR	UPPER BEAM AMP
Upper-Beam INPUT SEL	A-B DC
Lower-Beam INPUT SEL	A DC
SENSITIVITY (Both)	.2 VOLTS PER CM

Sine-Wave Generator

Frequency	1 kHz
Amplitude	Adjust for exactly 8 cm of vertical deflection

c. Change the Upper-Beam INPUT SELECTOR switch to A DC and the Lower-Beam INPUT SELECTOR switch to A-B DC.

d. Check for 8 centimeters ±1.6 mm of horizontal deflection.

24. Check X-Y Phasing

Requirement: ≤1° phase shift for DC to 100 kHz.

a. Set both INPUT SELECTOR switches to A DC.

b. Check for a loop opening of ≤1.5 mm (see Fig. 5-7).

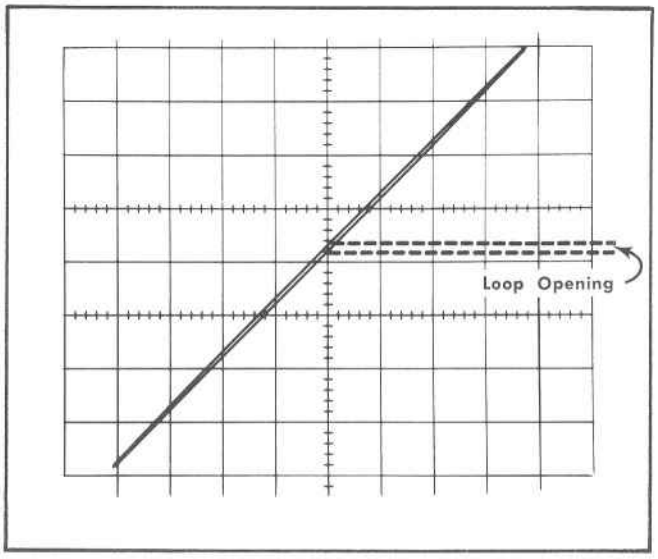


Fig. 5-7. CRT display for checking X-Y phasing (step 24).

c. Set both SENSITIVITY switches to .1 mVOLTS PER CM.

d. Set the sine-wave generator frequency control to 100 kHz. Set its amplitude control to provide 8 cm of vertical deflection. It may be necessary to insert an attenuator between the 4-way input connector and the sine-wave generator in order to reduce the display size to a usable level.

e. Check for a loop opening of ≤1.5 mm.

f. Check the X-Y phasing for all remaining SENSITIVITY switch settings in the same manner. Maintain 8 centimeters of vertical deflection at each setting except where the sine-wave generator cannot supply the required amplitude.

g. Return the HORIZ. DEF. PLATE SELECTOR switch to TIME BASE AMP.

25. Check Vertical Amplifier Bandwidth (3 dB Down)

Requirement: .1 mV/CM; DC to ≥100 kHz, 5 mV to 20 V/CM; DC to ≥ 1 MHz.

a. Reset the following controls:

Type 502A

INPUT SELECTOR (Both)	A DC
SENSITIVITY (Both)	.1 mVOLTS PER CM
Upper-Beam POSITION	Adjust for centered display
Lower-Beam POSITION	Move beam off the screen
TIME/CM	1 mSEC
TRIGGER	RECURRENT

Sine-Wave Generator

Frequency	1 kHz
Amplitude	6 cm of vertical deflection

b. Increase the signal frequency to 100 kHz. The amplitude of the display must be ≥4.2 centimeters.

c. Repeat the above procedure for the Lower-Beam Amplifier.

d. Set both SENSITIVITY switches to 5 mVOLTS PER CM.

e. Return the signal frequency to 1 kHz and adjust the generator Amplitude control for a 4-centimeter display on the Lower Beam.

f. Increase the sine-wave frequency to 1 MHz. The amplitude of the display must be ≥2.8 centimeters.

g. Repeat (e) and (f) for the Upper-Beam amplifier.

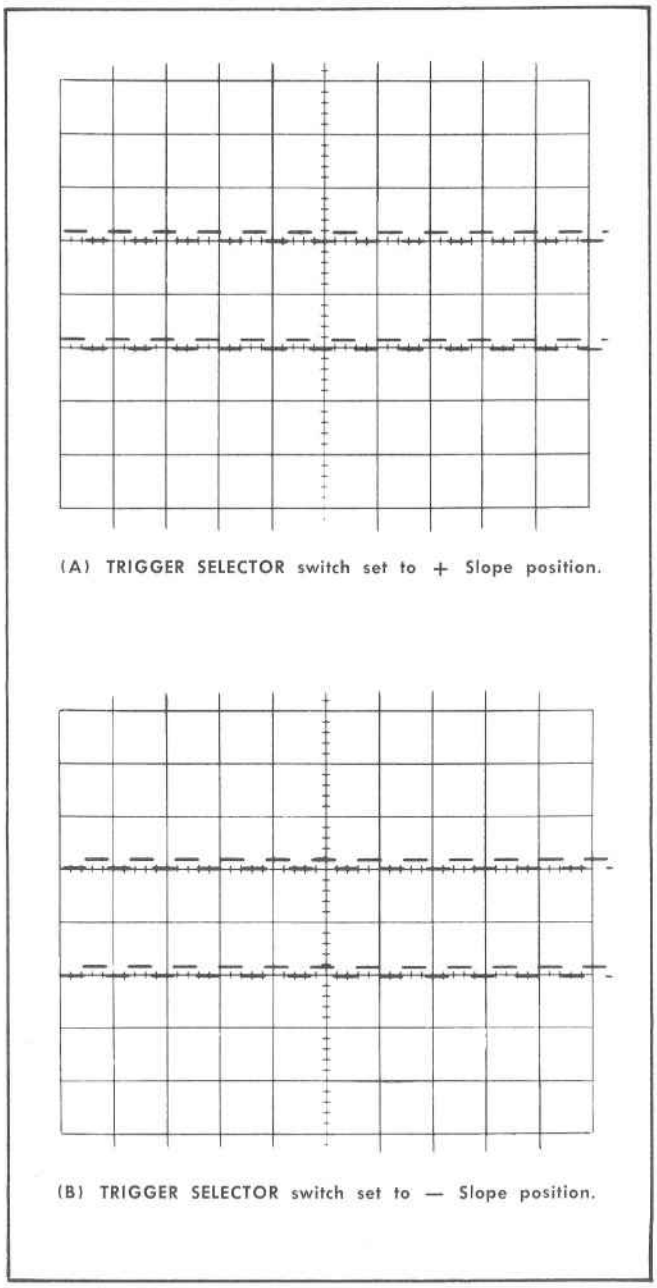
TRIGGERING

Preset the following controls:

INPUT SELECTOR (Both)	A DC
SENSITIVITY (Both)	1 VOLT PER CM
TRIGGERING LEVEL	RECURRENT
TRIGGER SELECTOR	+ UPPER AC
TIME/CM	.1 mSEC
MODE	NORMAL
HORIZONTAL DISPLAY	NORMAL (×1)
VERTICAL POSITION (Both)	Position both traces to their respective reference lines.

26. Check Internal Triggering

Requirement: Proper triggering on a 2 mm display for all INTERNAL TRIGGER positions of the TRIGGER SELECTOR switches.



(A) TRIGGER SELECTOR switch set to + Slope position.

(B) TRIGGER SELECTOR switch set to — Slope position.

Fig. 5-8. Typical CRT displays showing effect of TRIGGER SELECTOR SLOPE switch (step 26d).

a. Connect a 0.2-volt square-wave signal from the SAC to the 4-way input connector through a "T" adapter.

b. Check that a stable display can be obtained with the TRIGGER LEVEL control properly adjusted near midrange. The display should start on a positive slope when the TRIGGER SELECTOR slide switch is set to + and on a negative slope when the slide switch is set to — (see Fig. 5-8).

c. Repeat (b) for the UPPER AC, LOWER AC, and LOWER DC positions of the TRIGGER SELECTOR switch.

d. Set the TRIGGERING LEVEL control to AUTOMATIC and repeat the above checks.

27. Check External Triggering

Requirement: Proper triggering on a 0.5-volt signal applied to the EXTERNAL TRIGGER connector.

a. Connect a patchcord between the "T" adapter and the EXTERNAL TRIGGER connector.

b. Apply a 0.5-volt square-wave signal from the SAC to the "T" adapter.

c. Check that the display can be triggered with the TRIGGER SELECTOR switches in the + and — EXT AC and EXT DC positions. Slight adjustment of the TRIGGERING LEVEL control may be necessary.

d. Set the TRIGGERING LEVEL control to AUTOMATIC and repeat (c).

e. Remove the patch cord.

28. Check LINE Triggering

a. Reset the following controls:

TRIGGER SELECTOR	+ LINE
TIME/CM	.5 mSEC
SENSITIVITY (Upper Beam)	10 VOLTS PER CM

b. Connect the 10× probe to the "T" adapter and touch the probe tip to the hot side of the AC power line.

c. Check for a triggered display starting on a positive slope.

d. Change the TRIGGER SELECTOR slide switch to — and check that the display starts on a negative slope.

AMPLITUDE CALIBRATOR

Preset the following controls:

Type 502A

INPUT SELECTOR (Lower Beam)	A DC
TRIGGERING LEVEL	AUTOMATIC
TRIGGER SELECTOR	LOWER AC
TIME/CM	1 mSEC
CALIBRATOR	50 V

Standard Amplitude Calibrator (SAC)

Mode	+DC
Source	Mode Switch
Amplitude	50 Volts

29. Check AMPLITUDE CALIBRATOR Accuracy

Requirement: Voltage accuracy within 3% of the indicated value.

a. Ground the Lower Beam A INPUT connector.

b. Set the DC BAL control for minimum trace shift when the SENSITIVITY switch is rotated through its range.

c. Position the Lower Beam trace to the Lower Beam graticule reference line.

d. Use a coaxial cable to connect the SAC Output signal to the Lower Beam A INPUT connector.

e. Use another coaxial cable to connect the CAL OUT signal to the Lower Beam B INPUT connector.

f. Set the Lower Beam INPUT SELECTOR switch to A-B (DIFF).

g. Check the AMPLITUDE CALIBRATOR accuracy as directed in Table 5-7:

TABLE 5-7

AMPLITUDE CALIBRATOR	SAC Output	Lower Beam Sensitivity (PER CM)	Maximum Trace Shift From Reference Line
50 V	50 V	.5 VOLTS	3 centimeters
5 V	5 V	50 mVOLTS	
.5 V	.5 V	5 mVOLTS	
50 mV	50 mV	.5 mVOLTS	
5 mV	5 mV	.1 mVOLTS	1.5 centimeters
.5 mV	.5 mV	.1 mVOLTS	1.5 millimeters

h. Disconnect the SAC signal.

30. Check Calibrator Repetition Rate

Requirement: 1 kHz ± 30%.

a. Change the TIME/CM switch setting to .2 mSEC.

b. Set the AMPLITUDE CALIBRATOR and Lower Beam SENSITIVITY switch settings for a 4- to 5-centimeter signal.

c. Check for one cycle per 5 centimeters ± 1.5 centimeters.

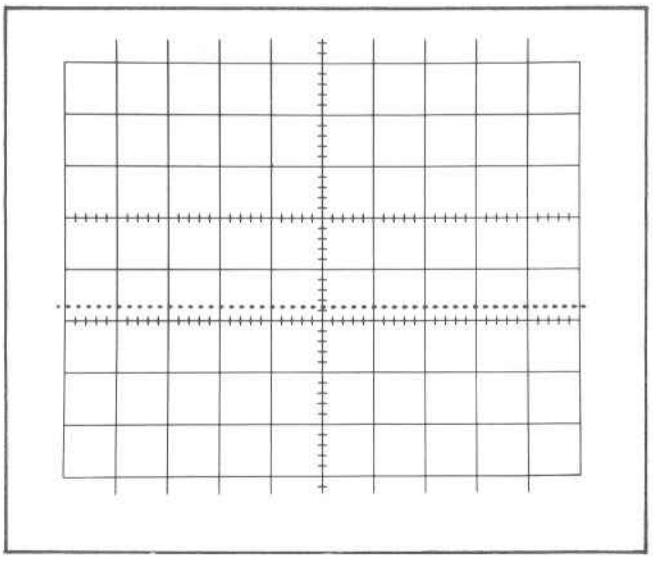


Fig. 5-9. Typical CRT display for Intensity Modulation Check (step 32).

31. Check Calibrator Symmetry

Requirement: 35% to 65% duty cycle.

a. Set the TIME/CM switch to .1 mSEC.

b. Adjust the VARIABLE TIME/CM control to obtain 1 cycle in 10 centimeters.

c. Check for 5 centimeters ± 1.5 centimeters for each half cycle.

Z-AXIS MODULATION

32. Check Intensity Modulation

a. Remove the grounding strap from the rear-panel CRT Cathode binding post.

b. Apply a 20-volt squarewave from the Standard Amplitude Calibrator to the binding post mentioned above.

c. The trace should appear as a broken line or row of dots (see Fig. 5-9). It may be necessary to turn the INTENSITY control slightly counterclockwise to obtain this display.

NEON INDICATORS

33. Check SWEEP MAGNIFIER Neon

a. Set the HORIZONTAL DISPLAY switch to each position.

b. Check that the SWEEP MAGNIFIER neon is illuminated in all magnified (×2 to ×20) positions and is not lit in the ×1 (NORMAL) and EXT VOLTS positions.

34. Check UNCALIBRATED (SWEEP/CM) Neon

a. The UNCALIBRATED neon must light whenever the sweep rate exceeds 12 microseconds per centimeter. Check as indicated in Table 5-8.

TABLE 5-8

SWEEP MAGNIFIED Position	TIME/CM Position
×2	1 μSEC
×5	1 μSEC and 2 μSEC
×10	1 μSEC through 5 μSEC
×20	1 μSEC through 10 μSEC

35. Check HORIZ. DEF. PLATE SELECTOR Neon

(This step does not apply to the Type RM502A.)

a. Set the HORIZ. DEF. PLATE SELECTOR switch to the UPPER BEAM AMP. position.

b. The neon next to the POWER AND SCALE ILLUM control should be lit.

c. Return the HORIZ. DEF. PLATE SELECTOR switch to the TIME BASE AMP position.

SECTION 6

CALIBRATION PROCEDURE

General Information

This instrument should not require frequent recalibration, but occasional adjustments will be necessary when tubes and other components are changed. Also, a periodic calibration is desirable from the standpoint of preventive maintenance.

Apparent failure of the instrument may be the result of improper calibration of one or more circuits. Consequently this section of the manual should be used in conjunction with the Maintenance Section during troubleshooting work.

In the instructions that follow, the steps are arranged in the proper sequence for a complete calibration of the instrument. Each numbered step contains the information required to make one adjustment or a series of related adjustments.

When following the procedure, leave the controls set to the positions they were in at the end of the previous step unless specific instructions are given to change their setting. Input signal voltages should remain connected to the instrument until specific instructions are given to disconnect them or until another input signal is applied to the same input connector.

In making a partial calibration, it will generally be necessary to refer to the calibration steps immediatey preceding the adjustment you wish to make to determine the proper settings for the controls not mentioned in that step. A list of the front-panel control settings is provided at major points in the procedure so a start can be made at any of those points.

Due to the interaction between adjustments in the horizontal or vertical amplifiers, single adjustments in these circuits usually cannot be made without affecting the rest of the amplifier. When amplifier adjustments are required, the entire amplifier should be rechecked. In addition, if either the —150 volt supply or the high voltage (CRT) power supply is adjusted, the entire instrument must be recalibrated.

In general, if you find that a circuit is out of calibration, it is best to recalibrate the entire circuit unless you are absolutely sure that it will not affect the other adjustments.

The location of test points and adjustments is shown in each step. Waveforms which may be helpful in determining the correct adjustment or operation are also shown.

EQUIPMENT REQUIRED

(See Figs. 6-1 and 6-2)

The following equipment or its equivalent is required for complete calibration of the the Type 502A. Specifications given are the minimum necessary for accurate calibration of the instrument. All test equipment is assumed to be correctly calibrated and operating within the original specifications. If any equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

1. Test oscilloscope. Tektronix Type 422. Minimum alternate requirements: Bandwidth from DC to 10 MHz; sweep rates from 10 ms/cm to 0.1 ms/cm; vertical input deflection factors from 10 mV/cm to 2 V/cm; voltage and timing accuracy within 3%; AC and DC vertical input coupling.

2. Oscilloscope probes. (a) 10× probe for test oscilloscope: Tektronix P6006, Tektronix Part Number 010-0127-00. (b) 10× probe for Type 502A: Tektronix P6006, Tektronix Part Number 010-0125-00.

3. AC-DC Voltmeter (e.g., Simpson Model 262). Minimum requirements: DC—sensitivity of at least 10,000 ohms/volt, accuracy within 1% for 100, 150 and 350 volts and within 3% for 2900 volts. AC—RMS reading; accuracy within 3% for 0-150 volts (0-250 volts for 210-250 volt operation).

4. Variable autotransformer (e.g., General Radio Variac Type W10MT3). Minimum requirements: Output voltage variable from 105 volts to 125 volts AC RMS for 115 volt operation, or 210 volts to 250 volts AC RMS for 230 volt operation; output power rating at least 0.3 kVA.

5. Time-mark generator, Tektronix Type 184. Minimum alternate requirements: Time-mark outputs of 1 microsecond to 5 second markers in a 1-5-10 sequence; accuracy within 0.1%.

6. Square-wave generator, Tektronix Type 106. Minimum alternate requirements: Output frequencies of 1 kHz and 10 kHz; rise time $\leq$20 nanoseconds; output amplitude variable between 50 millivolts and 100 volts.

7. Sine-wave generator (e.g., General Radio Type 1310-A). Minimum requirements: Output frequencies of 10 Hz to 1 MHz, accuracy within 5%; and constant-amplitude output variable between 0.1 volts and 50 volts peak to peak.

8. Standard amplitude calibrator (SAC), Tektronix Part Number 067-0502-00. +DC, —DC, and 1 kHz square wave signals; output amplitudes of 5 mV to 50 V in a 1-2-5 sequence with accuracy within 0.25%.

9. 4-way input connector (special for Type 502A), Tektronix Part Number 067-0114-00. (If not available, the patch cords and T-connector listed below as Items 13c and 14 can be substituted).

10. Coaxial cables (2), 50-ohm 42-inch with UHF connectors, Tektronix Part Number 012-0001-00.

11. 47 pF input time constant Normalizer with UHF connectors, Tektronix Part Number 011-0030-00. (This item was formerly listed by Tektronix as a 47 pF Input Time Constant Standardizer.)

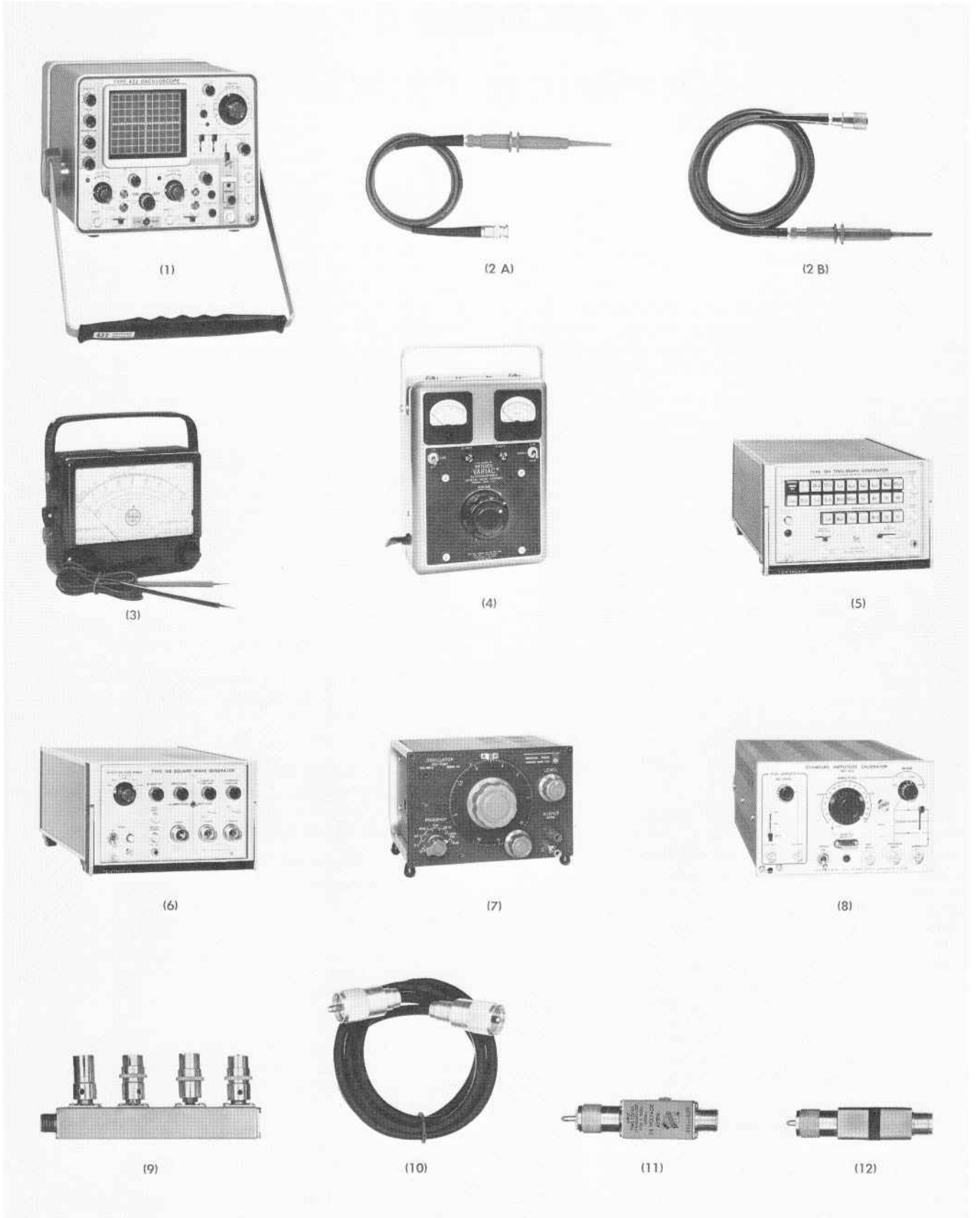


Fig. 6-1. Calibration equipment for the calibration of the Type 502A.

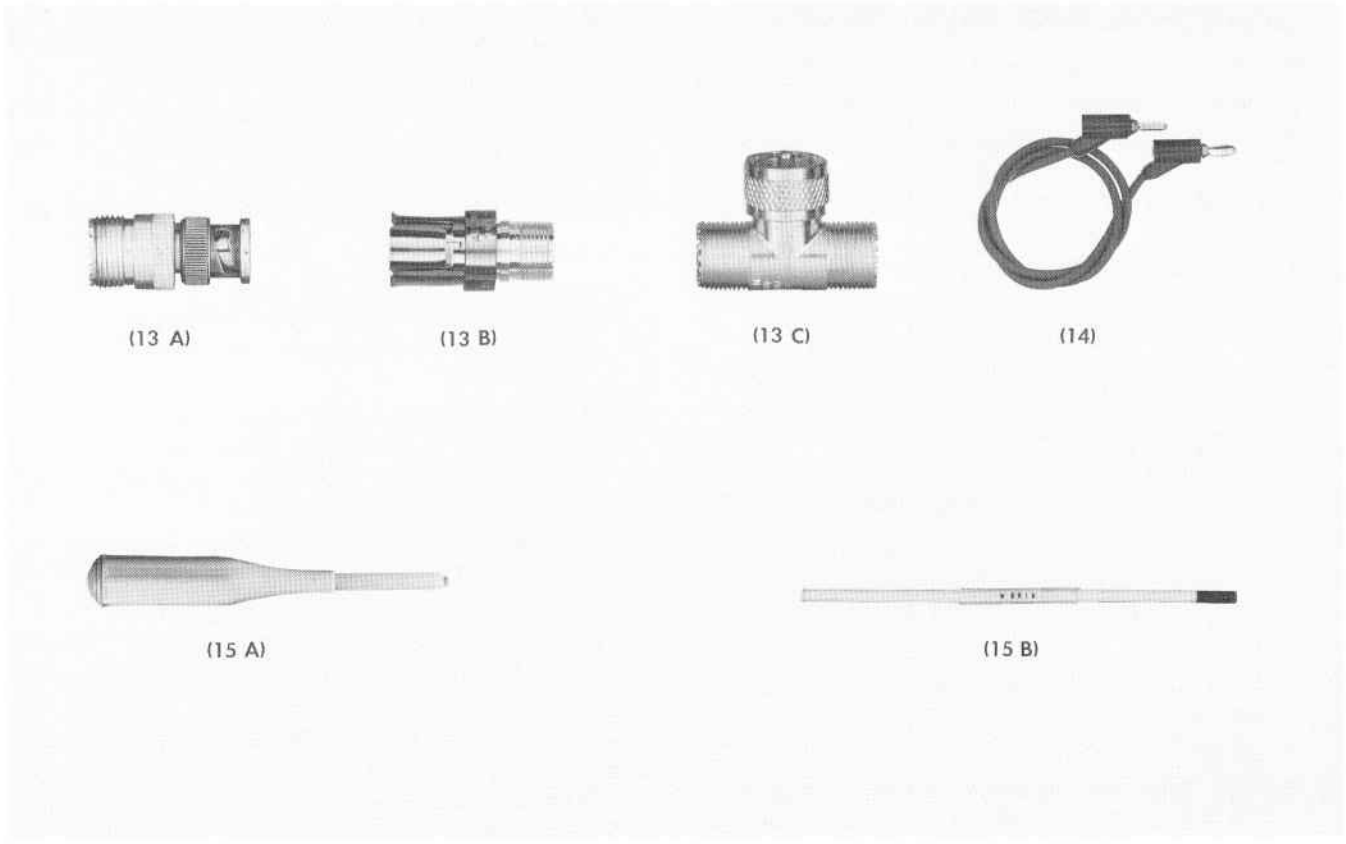


Fig. 6-2. Calibration equipment for the calibration of the Type 502A.

12. 10:1 attenuators (2) with UHF connectors, Tektronix Part Number 011-0031-00.

13. Adapters: (a) UHF Female to Male BNC (2), Tektronix Part Number 103-0032-00; (b) UHF Female to GR, Tektronix Part Number 017-0022-00; (c) UHF T (1 Male to 2 Female), Tektronix Part Number 103-0026-00.

14. Patch cords, 18 inch with banana plug tips; 3 red (Tektronix Part Number 012-0031-00) and 1 black (Tektronix Part Number 012-0039-00).

15. Adjustment tools: (a) Plastic, screwdriver type, Tektronix Part Number 003-000-00 (or Walsco No. 125); (b) alignment tool, plastic with recessed metal screwdriver tips. Tektronix Part Number 003-0003-00 (or Walsco No. 3519).

CALIBRATION RECORD AND INDEX

This abridged Calibration Procedure has been provided as an index for locating a specific section of the complete procedure. A brief explanation below each step is included so that an experienced calibrator can use the list as a condensed guide. Boxes are provided so each step can be checked off as it is completed. If desired, a check-off copy can be made prior to calibrating the instrument. When completed, it can be used as a record of the calibration.

Type 502A, Serial No. _____

Calibration Date _____

Calibrator _____

POWER SUPPLY

HORIZONTAL AND SWEEP CIRCUITS

☐ 9. Adjust ×1 to ×20 Sweep Timing.....Page 6-11
≤5% timing error for all magnified displays.

☐ 10. Adjust Norm/Mag Registration.....Page 6-12
≤2 mm display shift at graticule center when the HORIZONTAL DISPLAY switch is changed from ×20 to ×1.

☐ 11. Adjust Sweep Length.....Page 6-12
Adjust Swp Length adjustment for a trace length of 10.5 centimeters.

☐ 12. Check Range of POSITION Control.....Page 6-12
HORIZONTAL POSITION control must be able to move the trace past the graticule center in each direction.

☐ 13. Check and Adjust Timing; Check Single....Page 6-12
Sweep
≤3% timing error on all unmagnified sweeps.
READY neon lamp glows and trace sweeps only once when the MODE switch is depressed to the RESET position.

☐ 14. Check Range of VARIABLE TIME/CM.....Page 6-13
control
≥2.5:1 ratio

☐ 15. Adjust External Horizontal DC Balance....Page 6-13
≤2 mm of horizontal display movement when the HORIZONTAL DISPLAY switch is rotated through its EXT VOLTS/CM positions.

☐ 16. Check External Horizontal Input Gain.....Page 6-14
and Attenuator Accuracy
Horizontal deflection within 5% of EXT VOLTS/CM setting.

☐ 17. Check External Horizontal Display.....Page 6-15
Bandwidth
≤3 dB down at 100 kHz.

VERTICAL AMPLIFIERS

☐ 18. Adjust DC BALANCE Controls.....Page 6-16
Adjust DC BALANCE controls so that there is no appreciable trace shift when the SENSITIVITY controls are rotated.

☐ 19. Adjust DC Shift Compensation.....Page 6-16
Set the DC Shift adjustment for minimum drift when the SENSITIVITY switch is changed from .2 and .5 VOLTS/CM.

☐ 20. Check Input Grid Current.....Page 6-16
≤0.4 nA input grid current.

☐ 21. Check for Excessive Noise.....Page 6-16
≤30 μV of random noise and hum (average level).

☐ 22. Check Vertical Drift vs. Line-Voltage.....Page 6-16
Change
Changing the line voltage through the operating range must not change the position of the trace more than the change produced by applying a 300 μV signal.

☐ 23. Adjust Vertical Gain.....Page 6-17
Set both Vertical Gain controls with SENSITIVITY switches in the 10 mVOLTS PER CM position.

☐ 24. Check Vertical Sensitivity Accuracy.....Page 6-17
Within ±3% for .1 mV/CM, ±2% for all other sensitivities.

☐ 25. Check Range of VARIABLE SENSITIVITY...Page 6-17
Control
≥2.5:1 ratio.

☐ 26. Check Common Mode Dynamic Range.....Page 6-18
≥30 volts peak-to-peak common-mode dynamic range.

☐ 27. Adjust High-Frequency Compensation.....Page 6-19
Adjust the High-Frequency Compensation controls for ≤2% aberrations on a 10 kHz square-wave, 10 mV/CM.

☐ 28. Adjust Input Compensation.....Page 6-19
Adjust input compensation capacitors for ≤2% aberrations.

☐ 29. Adjust Amplifier Common-Mode Balance..Page 6-22
Apply a 10-volt 50 kHz sine wave and adjust R419, C415, and C438 for:
(.1 mV to 2 mV/CM) CMRR = ≥50,000:1.
(5 mV to .2 V/CM) ≤½ mm deflection.

☐ 30. Adjust Input Attenuator Common-Mode....Page 6-23
Balance
Apply a 50-volt 100-Hz sine wave signal and adjust R403E for a common-mode rejection ratio of ≥50,000:1 (.5 VOLTS PER CM Sensitivity).
Apply a 50-volt 50 kHz sine wave and adjust C405C for a CMRR of ≤500:1.

☐ 31. Adjust Level and Compensation of.....Page 6-24
Trigger Output and Vertical Signal Output
Set R491 for zero volts at Pin X of the Vertical Amplifier circuit boards.
Check the rear-panel Vertical Signal Out connectors for 2 volts per centimeter of displayed signal.

☐ 32. Adjust Gain of Upper-Beam Amplifier in..Page 6-26
Horizontal Mode
Match Upper-Peam Horizontal Mode gain to Lower Beam Vertical gain.

☐ 33. Adjust X-Y Phasing.....Page 6-26
Set C408 for ≤1° phase shift (≤1.4 mm/8 cm).
Readjust C496 for optimum response.

☐ 34. Check Bandwidth of Vertical Amplifiers....Page 6-27
.1 mV/CM—DC to ≥100 kHz
5 mV to 20 V/CM—DC to ≥1 MHz

TRIGGERING

☐ 35. Adjust STABILITY ADJUST Control.....Page 6-28
Set STABILITY ADJUST control midway between no sweep and free-run.

☐ 36. Adjust Trigger Level Centering.....Page 6-28
Adjust the TRIGGERING LEVEL control for zero volts on the center arm and adjust the Trig Level Cent Adjust for proper triggering on a 2 mm signal.

☐ 37. Check DC Triggering.....Page 6-29
Check for proper triggering with the TRIGGER SELECTOR switch in the UPPER DC and LOWER DC positions.

☐ 38. Check External Triggering.....Page 6-30
Check for proper triggering on a 0.5-volt signal applied to the EXTERNAL TRIGGER connector.

☐ 39. Check AUTOMATIC Triggering.....Page 6-30
Check for proper AUTOMATIC triggering on a 2 mm signal.

☐ 40. Check LINE Triggering.....Page 6-30
Check for proper LINE Triggering.

AMPLITUDE CALIBRATOR

☐ 41. Adjust Calibrator Amplitude.....Page 6-31
Voltage accuracy within 3% of the indicated value.

☐ 42. Check Calibrator Repetition Rate.....Page 6-32
1 kHz ±30%.

☐ 43. Check Calibrator Symmetry.....Page 6-32
35% to 65% duty cycle.

Z-AXIS MODULATION

☐ 44. Check Intensity Modulation.....Page 6-32
20-25 volts signal applied to the rear-panel CRT Cathode binding post causes significant change in intensity.

NEON INDICATORS

☐ 45. Check SWEEP MAGNIFIER Neon.....Page 6-32
SWEEP MAGNIFIER neon must light for all magnified sweeps.

☐ 46. Check Uncalibrated (Sweep/CM) Neon....Page 6-32
The UNCALIBRATED neon must light whenever the sweep rate exceeds 12 microseconds per centimeter.

☐ 47. Check HORIZ. DEF. PLATE SELECTOR ....Page 6-32
Neon
The neon next to the POWER switch should light whenever the HORIZ. DEF. PLATE SELECTOR switch is in the UPPER BEAM AMP position. (This step does not apply to the Type RM502A.)

PRELIMINARY PROCEDURE

1. Remove the side covers and the bottom dust plate.

2. Connect the autotransformer and other test instruments to a suitable power source.

3. Turn on the equipment and set the autotransformer for the nominal line voltage used by the Type 502A.

4. Set up the equipment as shown in Fig. 6-3. Allow at least 20 minutes warm-up time at 25° C ±5° C before making any checks or adjustments.

5. Preset the controls as follows:

INTENSITY	8 (or less if trace becomes too bright)
INPUT SELECTOR (Both)	A DC
SENSITIVITY (Both)	10 volts per cm
VERTICAL POSITION (Both)	Midrange
TRIGGERING LEVEL	AUTOMATIC
MODE (Trigger)	NORMAL
TIME/CM	1 mSEC
HORIZONTAL DISPLAY	NORMAL (×1)
POSITION (HORIZONTAL)	Midrange
HORIZ. DEF. PLATE SELECTOR (On left side of 502A)	TIME BASE AMP

6. During the calibration procedure, periodically check the input AC voltage to the instrument and adjust the autotransformer unit as necessary to maintain the nominal line voltage at the correct value (except when the power-supply regulation is being checked).

NOTES

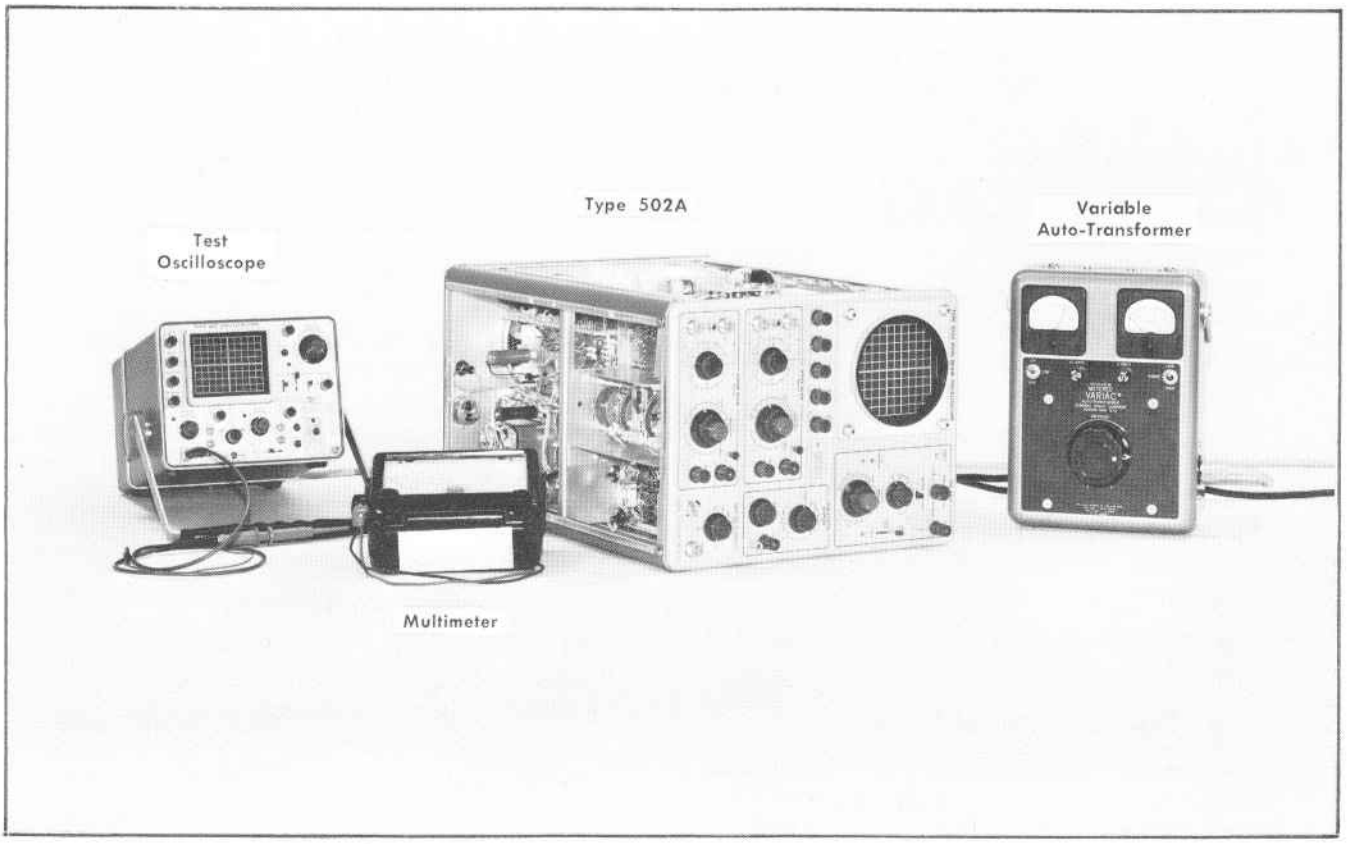


Fig. 6-3. Test equipment setup for the power supply calibration (steps 1 and 2).

POWER SUPPLY

1. Adjust —150 Volts

NOTE

Do not change the setting of the —150 Volt adjustment unless you are sure your voltmeter is accurate to ±1% at —150 volts. Also, unless the power supply voltages are actually out of tolerance (±3%) or you are planning to perform a complete recalibration of the instrument, the —150 Volt adjustment should not be changed.

a. Connect the DC voltmeter to the output of the —150 volt power supply (see Fig. 6-4).

b. Set the —150 Volts adjustment (see Fig. 6-5) for a reading of —150 volts on the meter.

2. Check Low-Voltage Power Supply

a. Use the voltmeter to check that the output voltages from the —5.8, +100, and +350-volt power supplies do not vary more than 3% from the correct values. (If either the +100-volt or the +350-volt supplies are out of tolerance, the —150 Volt adjustment may be reset slightly to bring all power-supply voltages within tolerance.)

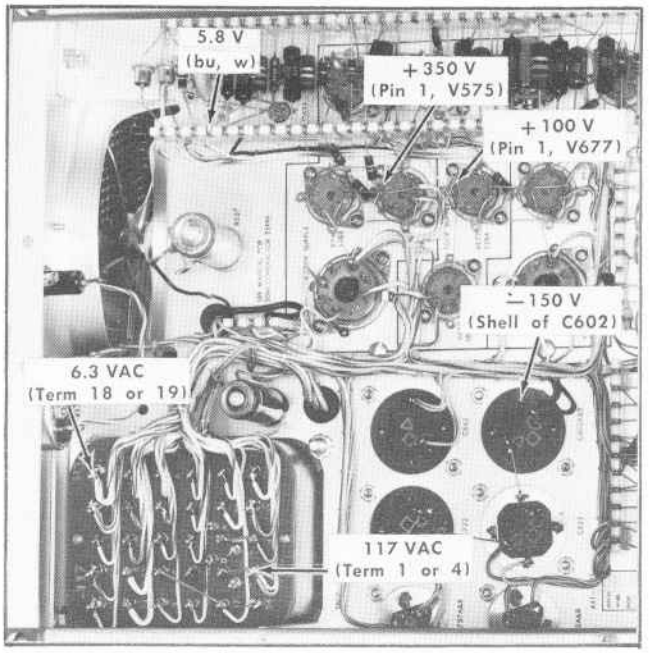


Fig. 6-4. Power Supply test points (steps 1 and 2).

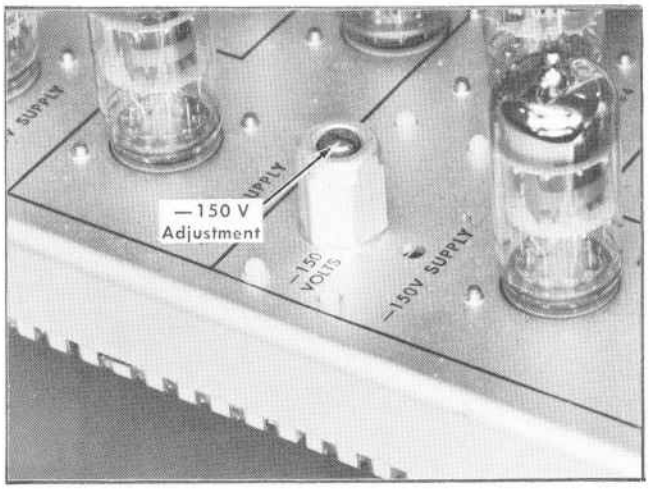


Fig. 6-5. Location of —150 Volts adjustment (step 1b).

b. Use the voltmeter to check the low-voltage power supply regulation while the line voltage is varied over the operating range (see Table 6-1). The four DC supplies must regulate within 3% of the correct DC voltages.

TABLE 6-1

Nominal	Operating Range	
Line Voltage	Low Line	High Line
110	99	117
117[1]	105	125
124	111	132
220	198	234
234[1]	210	250
248	222	264

[1]Normal Factory Connections

c. Using the test oscilloscope, check the ripple at the output of each power supply (see Table 6-2). The power supply ripple should remain about the same amplitude from low line to high line voltage.

d. Reset the autotransformer for the correct line voltage output.

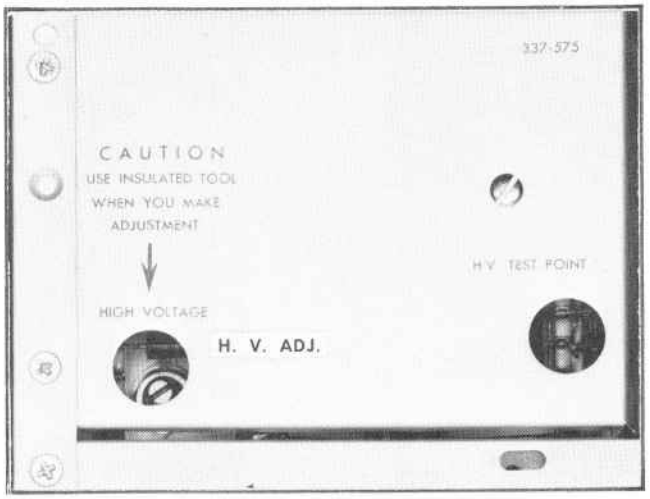


Fig. 6-6. Location of High-Voltage test point and adjustment (step 3).

TABLE 6-2

Supply	Typical Ripple Amplitude
—5.8 V	8 mV
—150 V	8 - 12 mV
+100 V	
+350 V	40 mV

e. Disconnect the test oscilloscope.

CATHODE RAY TUBE

3. Adjust —2900 Volt Supply

a. Connect the multimeter (set for —2900 volt reading) between ground and the High-Voltage Test Point (see Fig. 6-6).

b. Set the HV Adjust (see Fig. 6-6) for a meter reading of —2900 volts.

c. Disconnect the meter.

NOTES

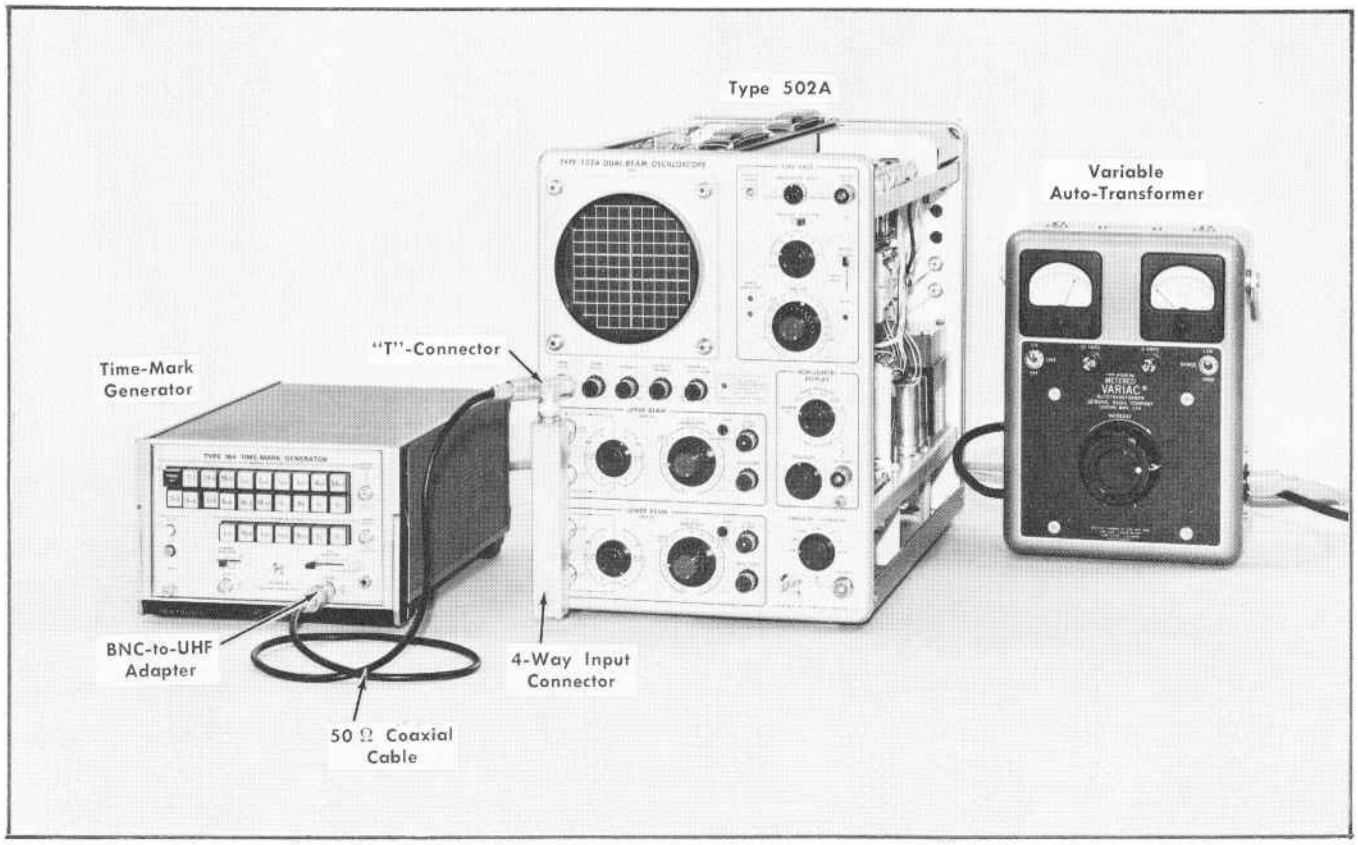


Fig. 6-7. Test equipment setup for steps 3 through 8.

4. Check High Voltage Regulation

a. Connect the equipment as shown in Fig. 6-7. (Do not depress any of the time-mark switches at this time.)

b. Set the HORIZONTAL DISPLAY switch to 2 EXT VOLTS/CM and position the focused spots onto the screen. Reduce the intensity of the beam if necessary to avoid burning the CRT phosphor.

c. While observing the focused spots, set the line voltage to low line setting shown in Table 6-1. The spots should not show any blooming as the line voltage is reduced.

d. Return the line voltage to the correct nominal voltage and set the HORIZONTAL DISPLAY switch back to the NORMAL (×1) position.

5. Check Action of INTENSITY and INTENSITY BALANCE Controls

a. Adjust the INTENSITY and INTENSITY BALANCE controls so that both traces are barely visible.

b. Turn the INTENSITY control clockwise until the brightness of the display is normal. The intensities of the traces should still be similar.

6. Adjust Astigmatism Controls ◐

a. Preset the following controls:

INPUT SELECTOR (Both)	A DC
SENSITIVITY (Both)	1 VOLT PER CM
TRIGGERING LEVEL	AUTOMATIC
TRIGGER SELECTOR	AC UPPER

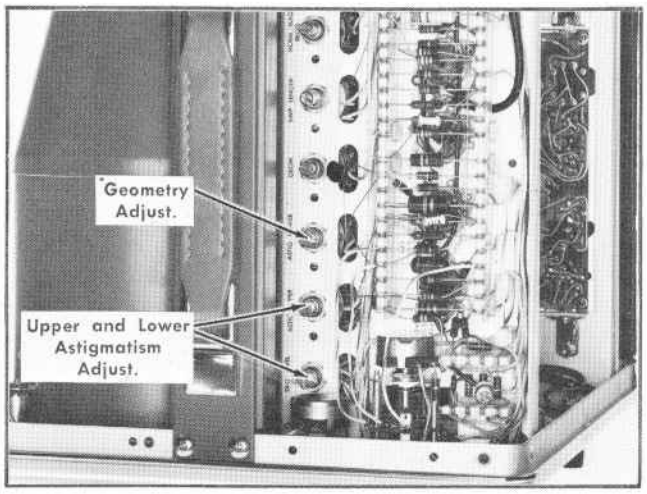


Fig. 6-8. Location of Astigmatism and Geometry adjustments. (steps 6 and 7).

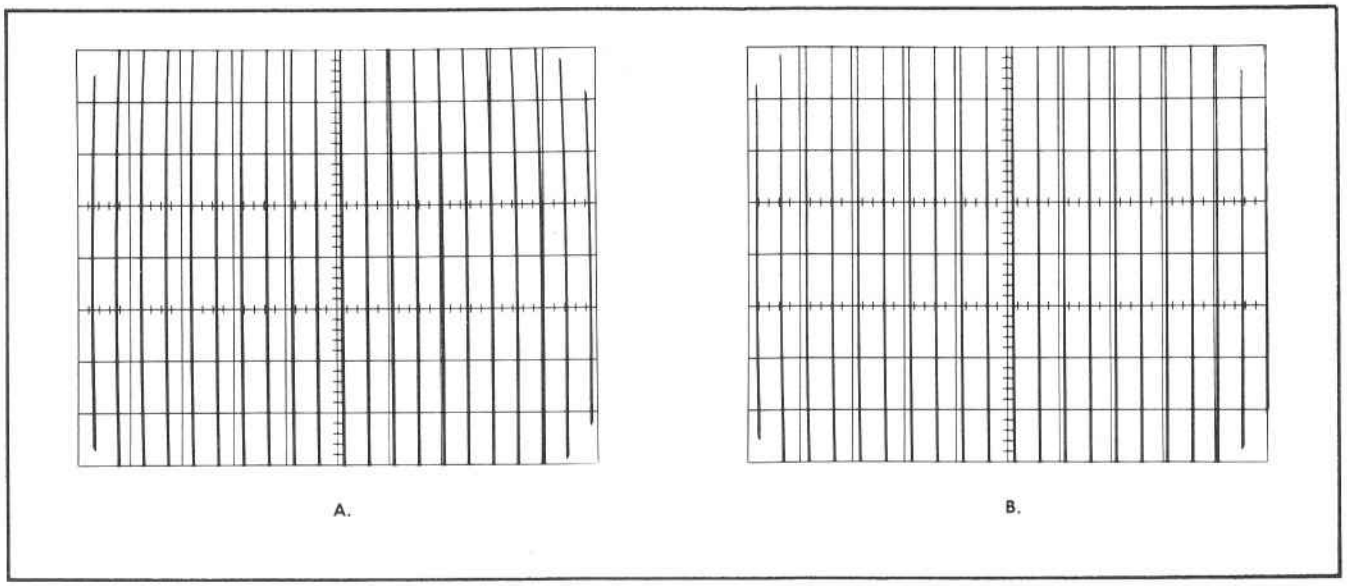


Fig. 6-9. Adjustment of the GEOM control. In waveform A the GEOM control is improperly set causing bowing of the vertical lines. In waveform B the bowing of the vertical lines has been reduced to a minimum by the proper adjustment of the GEOM control (step 7e).

TIME/CM	1 mSEC
HORIZONTAL DISPLAY	NORMAL (×1)
AMPLITUDE CALIBRATOR	5 V

b. Connect the AMPLITUDE CALIBRATOR signal to the Upper Beam A INPUT connector.

c. Center the display on the CRT.

d. Adjust the Astigmatism control (see Fig. 6-8) for the best display. It may be necessary to readjust the front-panel INTENSITY and Upper Beam FOCUS controls at the same time.

e. Move the CALIBRATOR signal to the Lower Beam A INPUT connector and repeat the above procedure for the Lower Beam trace.

7. Adjust CRT Geometry ◐

a. Set up the equipment as shown in Fig. 6-7.

b. Position the traces to the respective upper and lower beam graticule center horizontal lines.

c. If the traces are tilted with respect to the graticule lines, turn the red knob at the base of the CRT to align the traces with the graticule. Neither trace should vary more than 1.0 mm above or below the graticule line over the trace length.

d. Depress the 1 ms marker switch.

e. Position the traces and adjust the SENSITIVITY control so that only the vertical portions of the markers are displayed on the CRT.

f. Adjust the TRIGGERING LEVEL control to obtain a stable display.

g. Set the Geometry adjustment (see Fig. 6-8) for minimum curvature of the vertical lines at the sides of the display. (See Fig. 6-9.)

h. Check for $\leq$1.0 mm of curvature or slant of the vertical lines within the center 8 centimeters of the display.

8. Adjust Beam Registration and Horizontal Sensitivity Balance ◐

a. Set up the equipment as shown in Fig. 6-7.

b. Preset the following controls:

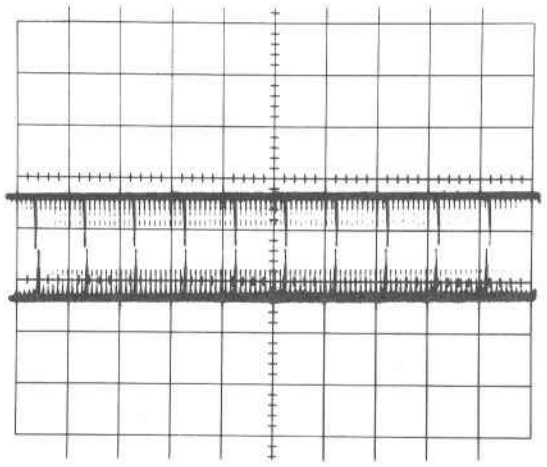
UPPER BEAM INPUT SELECTOR	B DC
LOWER BEAM INPUT SELECTOR	A DC
SENSITIVITY (Both)	2 VOLTS PER CM

c. Apply 0.1 ms and 1 ms markers.

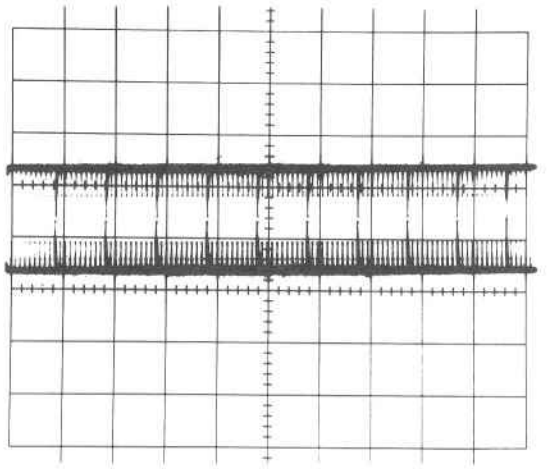
d. Adjust the TRIGGER controls so that the display is triggered on the 1 ms markers.

e. Position the traces so that the time-mark tips are touching (see Fig. 6-10A).

f. Set the Horiz. Beam Regis. adjustment R842 (see Fig. 6-11) so that the center time marker on one trace is aligned with the center time marker on the other.



A. Typical CRT display before adjustments are made (Step 8e).



B. Typical CRT display showing Horiz. Beam. Regis. and Horiz. Beam Sens. Bal. properly adjusted (Steps 8f and 8g).

Fig. 6-10. Typical CRT displays for step 8.

g. Set the Horiz. Sens. Bal. adjustment R833 (see Fig. 6-12) so that the sensitivity of the two beams is the same (See Fig. 6-10). (At this point in the calibration, the two beams are being matched to each other; do not try to make the time markers coincide with the graticule lines.)

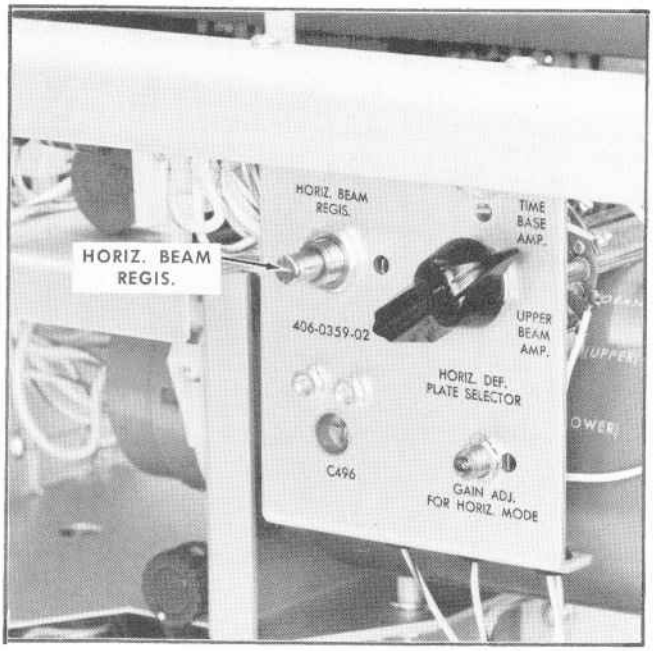


Fig. 6-11. Location of Horiz. Beam Regis. adjustment (step 8e)

h. The INTENSITY, INTENSITY BALANCE and FOCUS controls and the Horiz Sens. Bal. adjustment all interact with each other, so readjust all three as necessary to obtain the proper display.

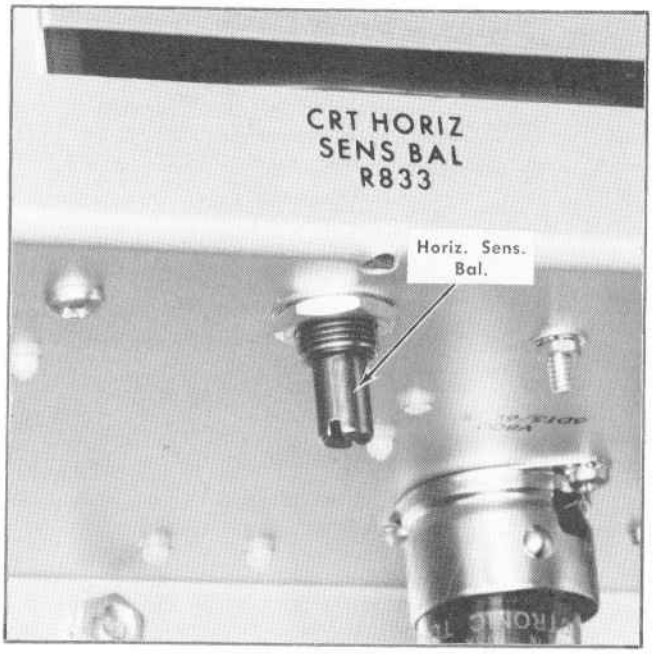


Fig. 6-12. Location of Horiz. Sens. Bal. adjustment (step 8f).

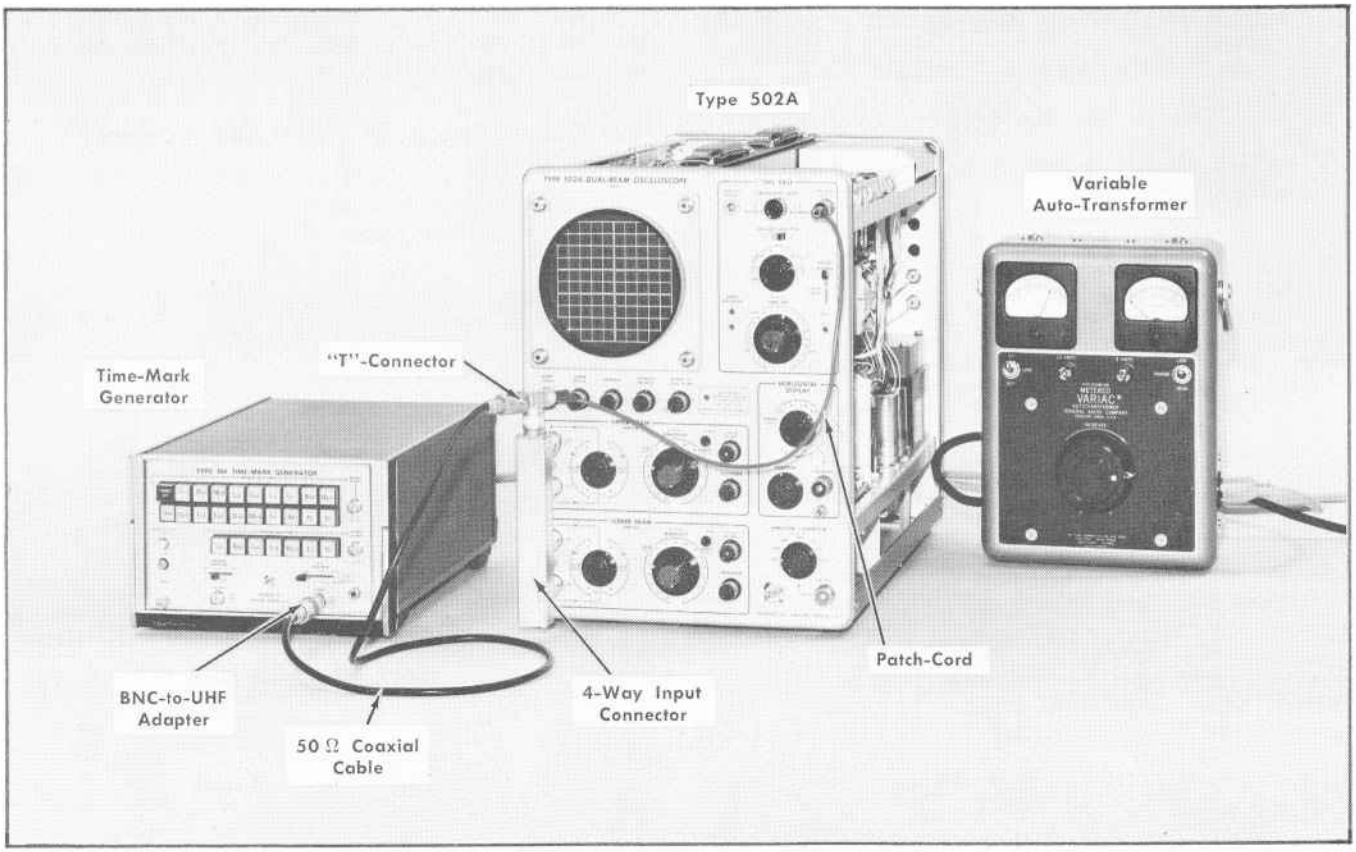


Fig. 6-13. Test equipment for steps 9, 10 and 11.

HORIZONTAL AND SWEEP CIRCUITS

NOTE

Unless directed otherwise, use the middle eight horizontal centimeters of the display when making horizontal gain and timing adjustments and checks.

9. Adjust ×1 to ×20 Sweep Timing

a. Set up the equipment as shown in Fig. 6-13.

b. Set the controls as follows:

TRIGGERING LEVEL	AUTOMATIC
TRIGGER SELECTOR	EXT AC
TIME/CM	1 mSEC
HORIZONTAL DISPLAY	×20
UPPER BEAM INPUT SELECTOR	A DC
UPPER BEAM POSITION	Position the Upper-Beam trace to the Lower-Beam graticule center horizontal line.
LOWER BEAM POSITION	Position the Lower-Beam trace off the screen.

c. Adjust and check the ×1 to ×20 magnified sweep accuracy as directed in Table 6-3. See Fig. 6-14 for the location of the adjustments.

TABLE 6-3

HORIZONTAL DISPLAY	Time Markers	Check or Adjust	For
×20	100 μs	×20 Cal	1 mark/2 cm
×1	1 ms	×1 Cal	1 mark/cm
×2	1 ms	Check	1 mark/2 cm (±4 mm in 8 cm)
×5	100 μs	Check	2 marks/cm (±4 mm in 8 cm)
×10	100 μs	Check	1 mark/cm (±4 mm in 8 cm)

f. Turn the HORIZONTAL POSITION control so that the right end of the trace is on the screen. There should be no jitter.

10. Adjust Norm/Mag Registration

a. Set the TIME/CM switch to .2 mSEC.

b. Apply 1 ms markers from the time-mark generator.

c. Set the Norm/Mag Regis adjustment (see Fig. 6-14) as directed in Table 6-4:

TABLE 6-4

HORIZONTAL DISPLAY Switch Setting	Adjust	To
×20	HORIZ POSITION Control	Place first marker at center graticule line.
×1	Norm/Mag Regis Adjustment	Reposition same marker to center graticule line.

d. The HORIZONTAL POSITION control and the Norm/Mag Regis adjustment interact, so repeat and adjust as necessary.

e. When both adjustments are satisfactory, set the HORIZ DISPLAY switch to NORMAL (×1).

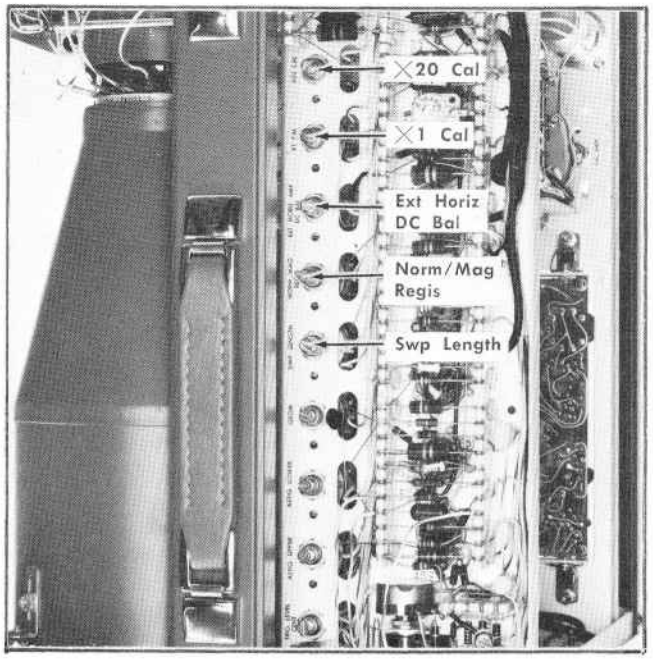


Fig. 6-14. Location of adjustments for steps 9, 10 and 11.

11. Adjust Sweep Length

a. Apply 1 mSEC and 100 μSEC time markers.

b. With the TIME/CM switch still in the 1 mSEC position, set the Swp Length adjustment R176 (see Fig. 6-14) for a trace length of 10.5 centimeters.

12. Check Range of POSITION Control

a. Turn the HORIZONTAL POSITION control fully clockwise and check that the start of the sweep is positioned to the right of graticule center.

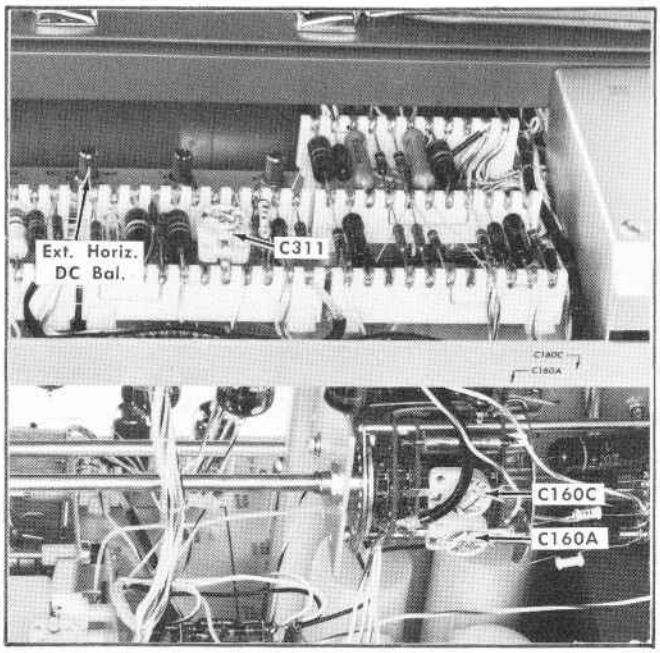


Fig. 6-15. Location of sweep timing adjustments (step 13c) and Ext. Horiz. DC Bal. (step 15).

b. Turn the HORIZONTAL POSITION control fully counterclockwise and check that the end of the sweep is positioned to the left of graticule center.

13. Check and Adjust Timing; Check Single-Sweep

a. Check sweep timing from .1 mSEC to 5 SEC for an accuracy of ±3% (±2.5 mm over middle 8 centimeters) as directed in Table 6-5. Use SINGLE SWEEP MODE for sweep rates slower than 50 ms/cm to check that READY neon lamp glows and trace sweeps only once when the MODE switch is depressed to the RESET position.

b. Return the MODE switch to NORMAL (from SINGLE SWEEP).

c. Adjust and check the faster sweep rates as directed in Table 6-6 for the same accuracy (±2.5 mm over the middle 8 centimeters). See Fig. 6-15 for the location of the adjustments.

TABLE 6-5

Slow Sweep Timing

TIME/CM	Time Marker	Marker/Cm
.1 mSEC	100 μs	1
.2 mSEC	100 μs	2
.5 mSEC	500 μs	1
1 mSEC	1 ms	1
2 mSEC	1 ms	2
5 mSEC	5 ms	1
10 mSEC	10 ms	1
20 mSEC	10 ms	2
50 mSEC	50 ms	1
.1 SEC	100 ms	1 (Change to Single Sweep)
.2 SEC	100 ms	2
.5 SEC	500 ms	1
1 SEC	1 s	1
2 SEC	1 s	2
5 SEC	5 s	1

14. Check Range of VARIABLE TIME/CM Control

a. Set the TIME/CM switch to 1 mSEC.

b. Set the time-mark generator for 10 ms markers.

TABLE 6-6

TIME/CM	Time Markers	Adjust or Check	Markers/cm
10 μSEC	10 μs	C160C	1
20 μSEC	10 μs	Check	2
50 μSEC	50 μs	Check	1
5 μSEC	5 μs	C160A[2]	1
1 μSEC	1 μs	C311[2]	1
2 μSEC	1 μs	Check	2

[2]C160A and C311 interact, so repeat these two adjustments until both are set satisfactorily.

c. Turn the VARIABLE TIME/CM control fully counterclockwise. The markers should not be more than 4 centimeters apart.

d. Remove the time-marker signal.

15. Adjust External Horizontal DC Balance ◐

a. Ground the EXTERNAL HORIZONTAL INPUT connector.

b. Set the Ext Horiz DC Bal adjustment R341 (see Fig. 6-15) for minimum shift of the beam while switching between the EXT VOLTS/CM positions of the HORIZONTAL DISPLAY switch.

c. Remove the ground from the EXTERNAL HORIZONTAL connector.

NOTES

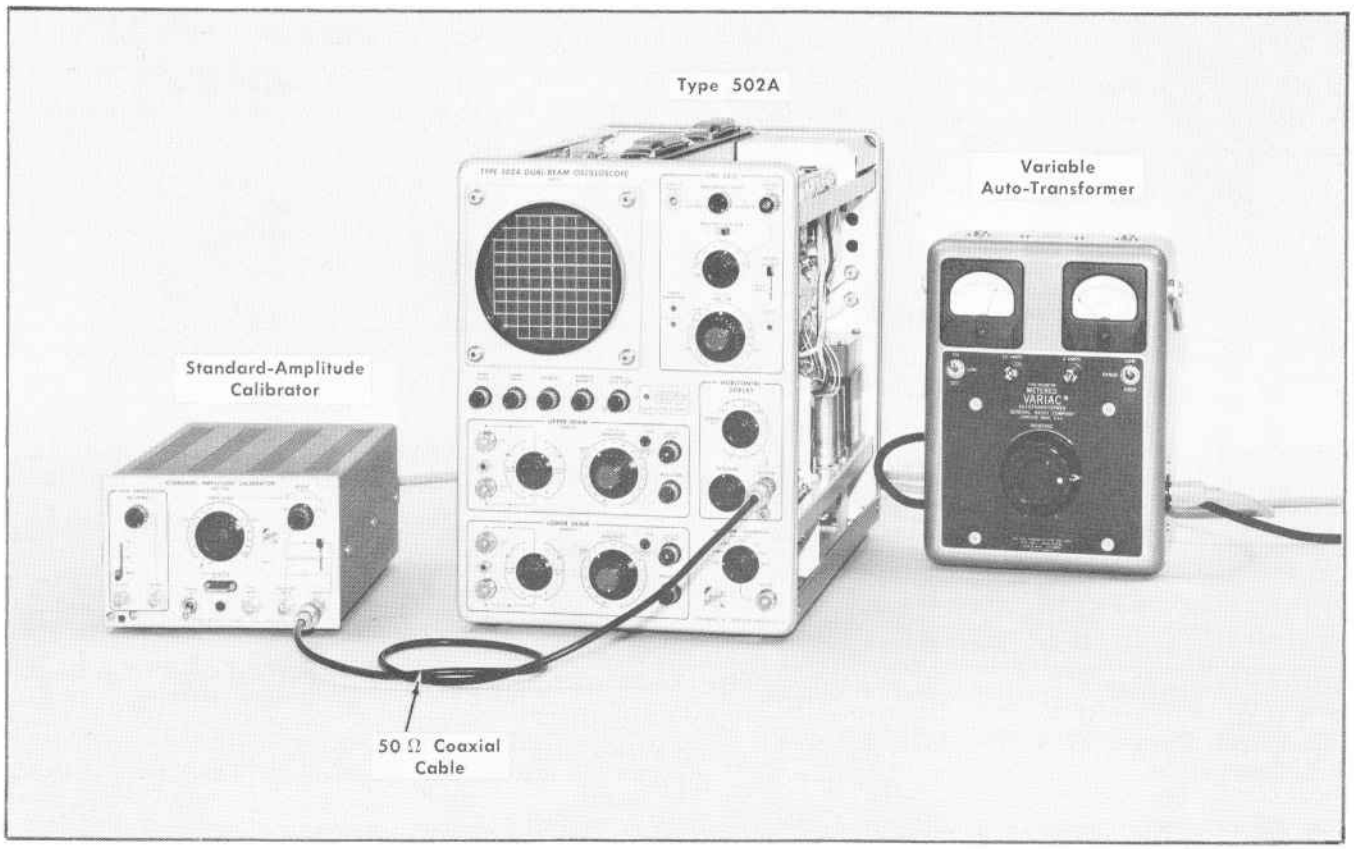


Fig. 6-16. Test equipment setup for checking External Horizontal Gain (step 16).

16. Check External Horizontal Input Gain and Attenuator Accuracy

a. Connect the test equipment as shown in Fig. 6-16. (It may be necessary to add a ground return between the SAC and the Type 502A.)

b. Check for 10 cm ±5 mm of horizontal deflection in each EXT VOLTS/CM position of the HORIZONTAL DISPLAY switch as directed in Table 6-7.

c. Remove the Standard Amplitude Calibrator signal.

TABLE 6-7

EXT VOLTS/CM	Standard Amplitude Calibrator Output
2	20 V
1	10 V
.5	5 V
.2	2 V
.1	1 V

NOTES

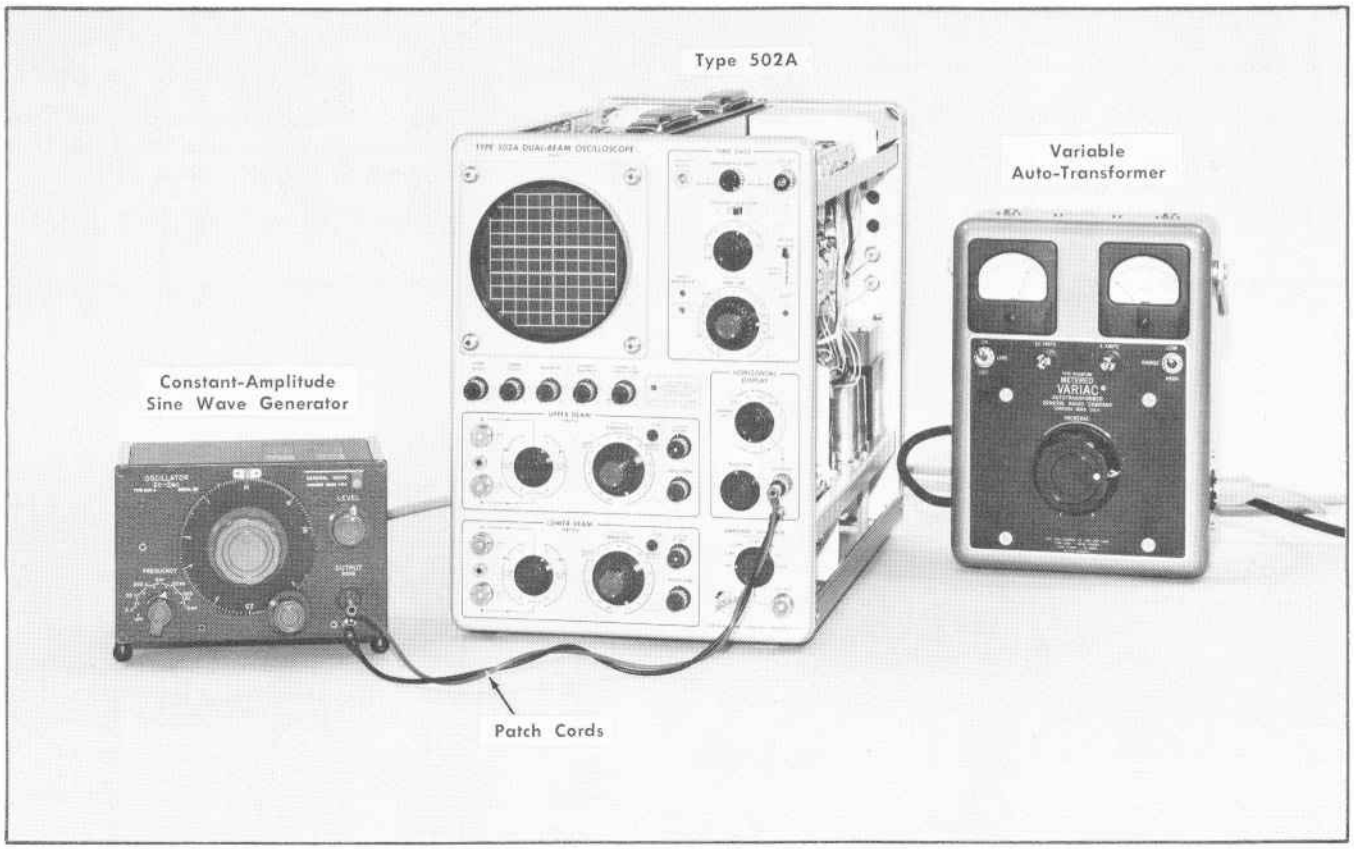


Fig. 6-17. Test equipment setup for checking External Horizontal bandwidth (step 17).

17. Check External Horizontal Display Bandwidth

a. Connect the test equipment as shown in Fig. 6-17.

b. Apply a 10 kHz signal from the sine-wave generator to the EXTERNAL HORIZONTAL INPUT connector.

c. With the HORIZONTAL DISPLAY switch in the .1 EXT VOLTS/CM position, adjust the Amplitude control of the generator for exactly 6 centimeters of horizontal deflection.

d. Set the Frequency control of the generator to 100 kHz. The trace should be $\geq$4.2 centimeters in length.

e. Disconnect the sine-wave generator and set the HORIZONTAL DISPLAY switch to NORMAL (×1).

VERTICAL AMPLIFIERS

Preset the controls as follows:

TRIGGERING LEVEL	RECURRENT
MODE	NORMAL
TIME/CM	2 mSEC
HORIZONTAL DISPLAY	NORMAL (×1)
INPUT SELECTOR (Both)	A DC
VERT POSITION (Both)	Align the traces with the appropriate graticule center horizontal lines
VERT SENSITIVITY (Both)	.2 VOLTS PER CM
HORIZ. DEF. PLATE SELECTOR	TIME BASE AMP

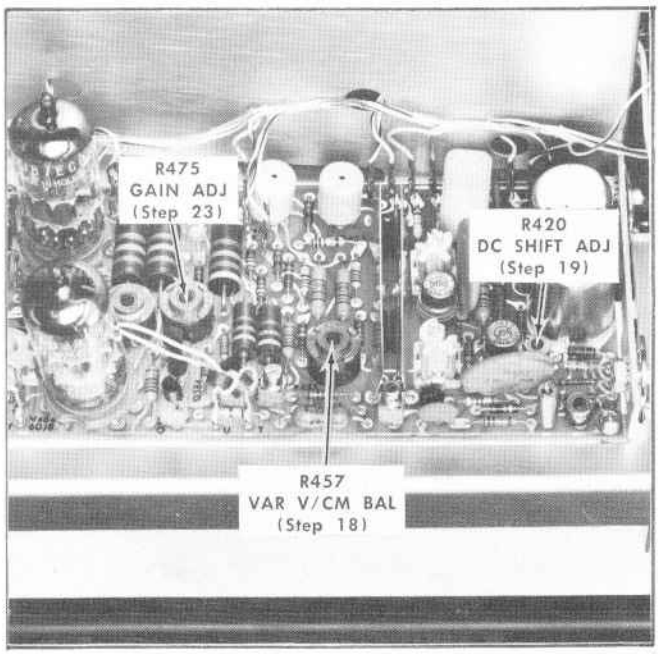


Fig. 6-18. Location of vertical amplifier adjustments (steps 18, 19 and 23).

18. Adjust DC BALANCE Controls

a. Ground the input to the 4-way connector.

b. Set both DC BAL knobs to midrange.

c. Set the Upper Beam COARSE DC BAL adjustment for no trace shift as the SENSITIVITY switch is rotated between .2 VOLTS PER CM and .1 mVOLTS PER CM.

d. Repostion the trace to the Upper Beam graticule center horizontal line and repeat the COARSE DC BAL adjustment.

e. Set the SENSITIVITY switch to .2 VOLTS PER CM.

f. Set the Variable V/CM Balance adjustment R457 (see Fig. 6-18) for no vertical shift of the trace when the VARIABLE SENSITIVITY control is rotated through its range.

g. Repeat (c) through (f) for the Lower Beam Amplifier.

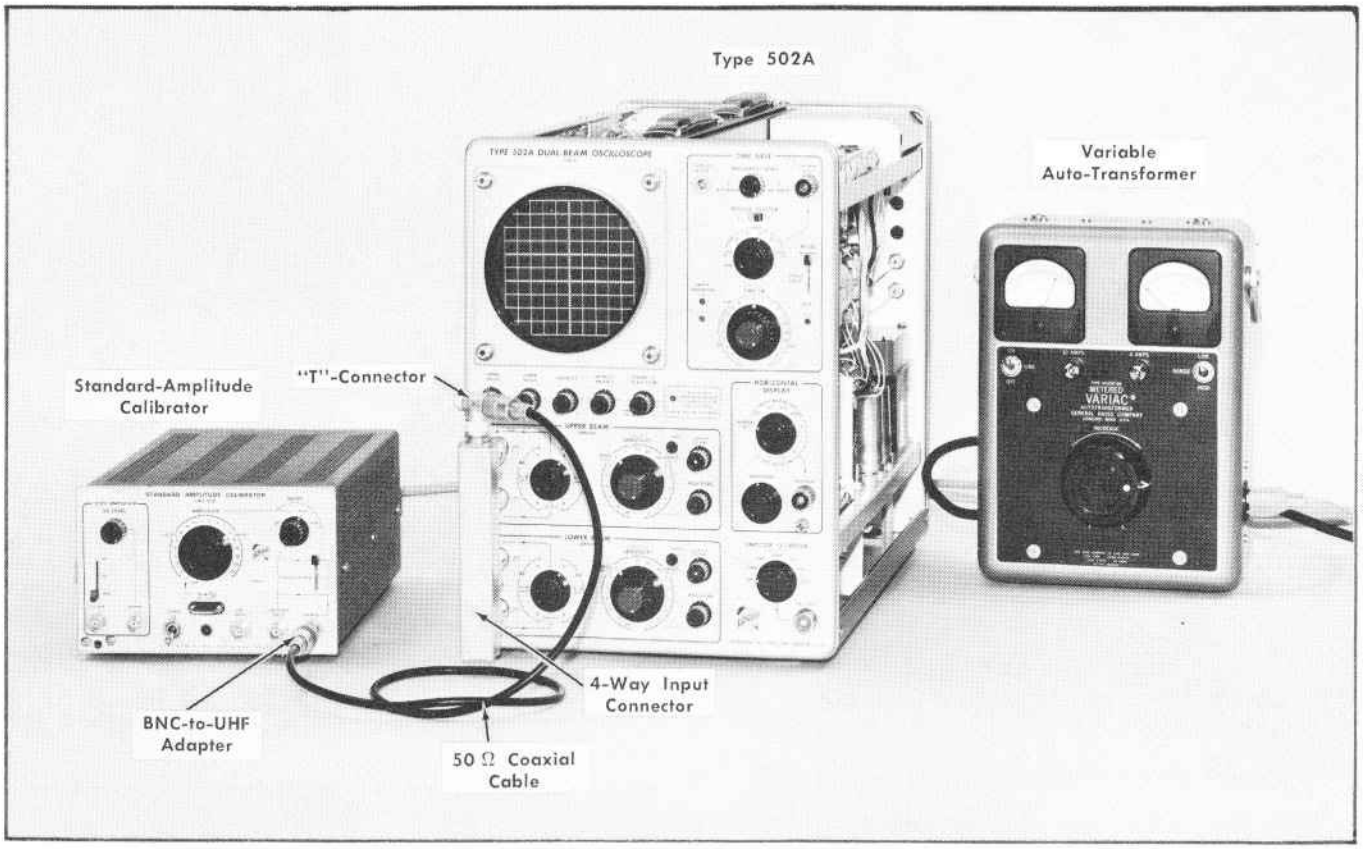


Fig. 6-19. Test equipment setup for steps 19 through 25.

19. Adjust DC Shift Compensation

a. Set up the equipment as shown in Fig. 6-19.

b. Set the controls of the SAC for a 2 volt square-wave signal.

c. While switching the SENSITIVITY switch back and forth between .2 and .5 VOLTS PER CM, set the DC Shift adjustment R420 (see Fig. 6-18) for minimum drift when switching to the .5 VOLTS PER CM position.

d. Repeat the above procedure for the other vertical amplifier.

20. Check Input Grid Current

a. Disconnect the SAC and ground the 4-way input connector.

b. Set both SENSITIVITY switches to .1 mVOLTS PER CM.

c. Switch the INPUT SELECTOR switches from A DC to A AC and from B DC to B AC. Neither trace should shift more than 3 centimeters.

21. Check for Excessive Noise

a. Ground the 4-way input connector.

b. Set both SENSITIVITY switches to .1 mVOLTS PER CM.

c. Average random noise level should not exceed 3 mm. (See Fig. 6-20.)

22. Check Vertical Drift vs. Line-Voltage Change

a. With the 4-way input connector still grounded, change the output of the auto-transformer through the line-voltage operating range (see Table 6-1.)

b. Check the movement of the trace. It should not shift more than 3 centimeters above or below the original level.

c. Set the autotransformer back to the correct (nominal) line voltage.

TABLE 6-8

SENSITIVITY in VOLTS PER CM	Standard Amplitude Calibrator Output	Check for Display:
.1 mV	.5 mV	5 cm ± 1.5 mm
.2 mV	1 mV	5 cm ± 1.0 mm
.5 mV	2 mV	4 cm ± 0.8 mm
1 mV	5 mV	5 cm ± 1.0 mm
2 mV	10 mV	5 cm ± 1.0 mm
5 mV	20 mV	4 cm ± 0.8 mm
10 mV	50 mV	5 cm ± 1.0 mm
20 mV	.1 mV	5 cm ± 1.0 mm
50 mV	.2 V	4 cm ± 0.8 mm
.1	.5 V	5 cm ± 1.0 mm
.2	1 V	5 cm ± 1.0 mm
.5	2 V	4 cm ± 0.8 mm
1	5 V	5 cm ± 1.0 mm
2	10 V	5 cm ± 1.0 mm
5	20 V	4 cm ± 0.8 mm
10	50 V	5 cm ± 1.0 mm
20	100 V	5 cm ± 1.0 mm

23. Adjust Vertical Gain

a. Set both SENSITIVITY switches to 10 mVOLTS PER CM. (Be sure that both VARIABLE SENSITIVITY controls are in the CALIBRATED position for Steps 23 and 24.)

b. Apply a 50 mV square wave signal from the Standard Amplitude Calibrator to the 4-way connector.

c. Set both INPUT SELECTOR switches to A DC.

d. Set both Vertical Gain Adjustments R475 (see Fig. 6-18) for exactly 5 centimeters of deflection for each beam.

24. Check Vertical Sensitivity

a. Check the sensitivity accuracy of both vertical amplifiers as directed in Table 6-8. Gain Adjustment R475 may be readjusted slightly if necessary to gring the displays within tolerance.

25. Check Range of VARIABLE SENSITIVITY Control

a. Leave both SENSITIVITY switches set at 20 VOLTS PER CM.

b. Set both INPUT SELECTOR switches to A DC.

c. Set the Standard Amplitude Calibrator for a 100 volt square wave.

d. Turn the VARIABLE SENSITIVITY controls fully counterclockwise and check for $\leq$2 centimeters of vertical deflection.

NOTES

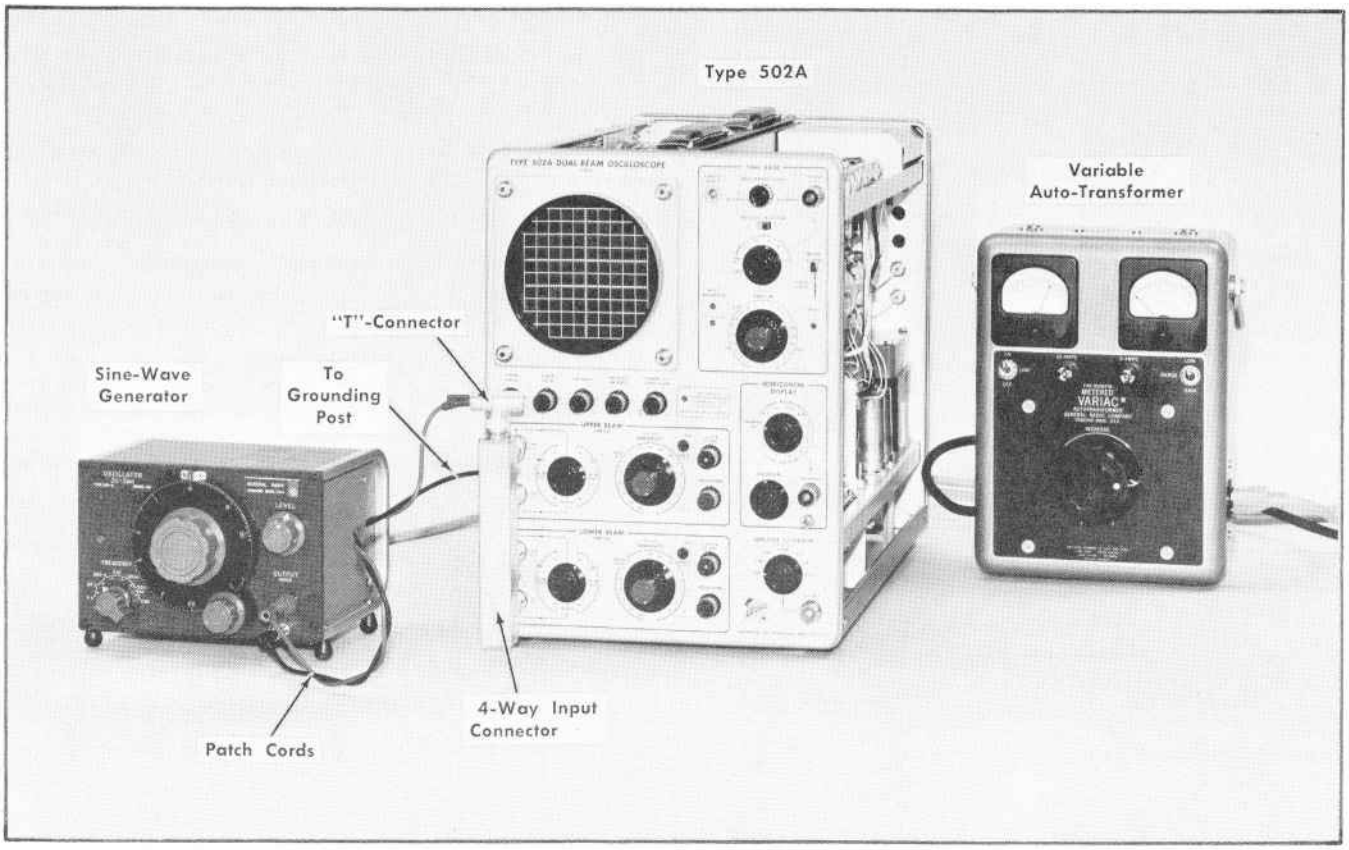


Fig. 6-20. Test equipment setup for checking and adjusting Common-Mode dynamic range (step 26).

26. Check Common Mode Dynamic Range

a. Connect the equipment as shown in Fig. 6-20.

b. Set the Upper Beam INPUT SELECTOR switch to A-B (DIFF).

c. Set the generator for a 1 kHz signal and turn down its signal amplitude.

d. Set the Upper Beam SENSITIVITY switch to 10 mVOLTS PER CM.

e. Increase the output amplitude of the generator signal. The display should not "break up" (see Fig. 6-21) until the signal amplitude is at least 30 volts peak to peak.

f. Check the Lower Beam Amplifier dynamic range in the same way.

NOTE

The Common-Mode Dynamic Range Check described above serves as a check of the overall amplifier performance. If the distortion appears at input voltages below 30 volts peak to peak, correct the trouble before continuing with the calibration.

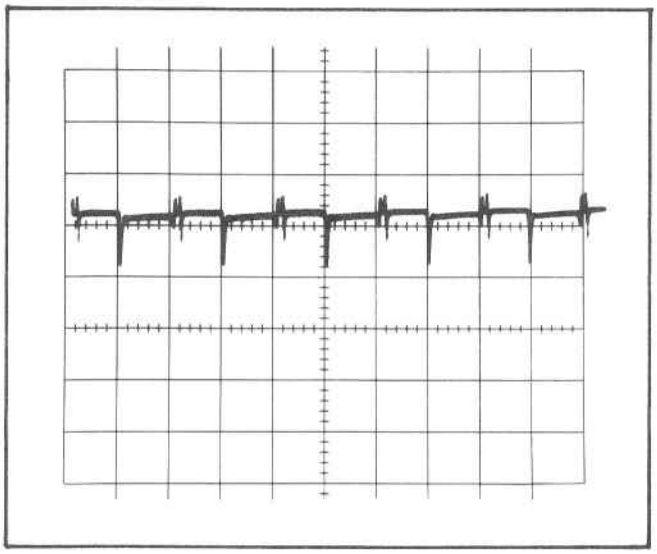


Fig. 6-21. CRT display showing effect of exceeding common-mode dymanic range limit (step 26).

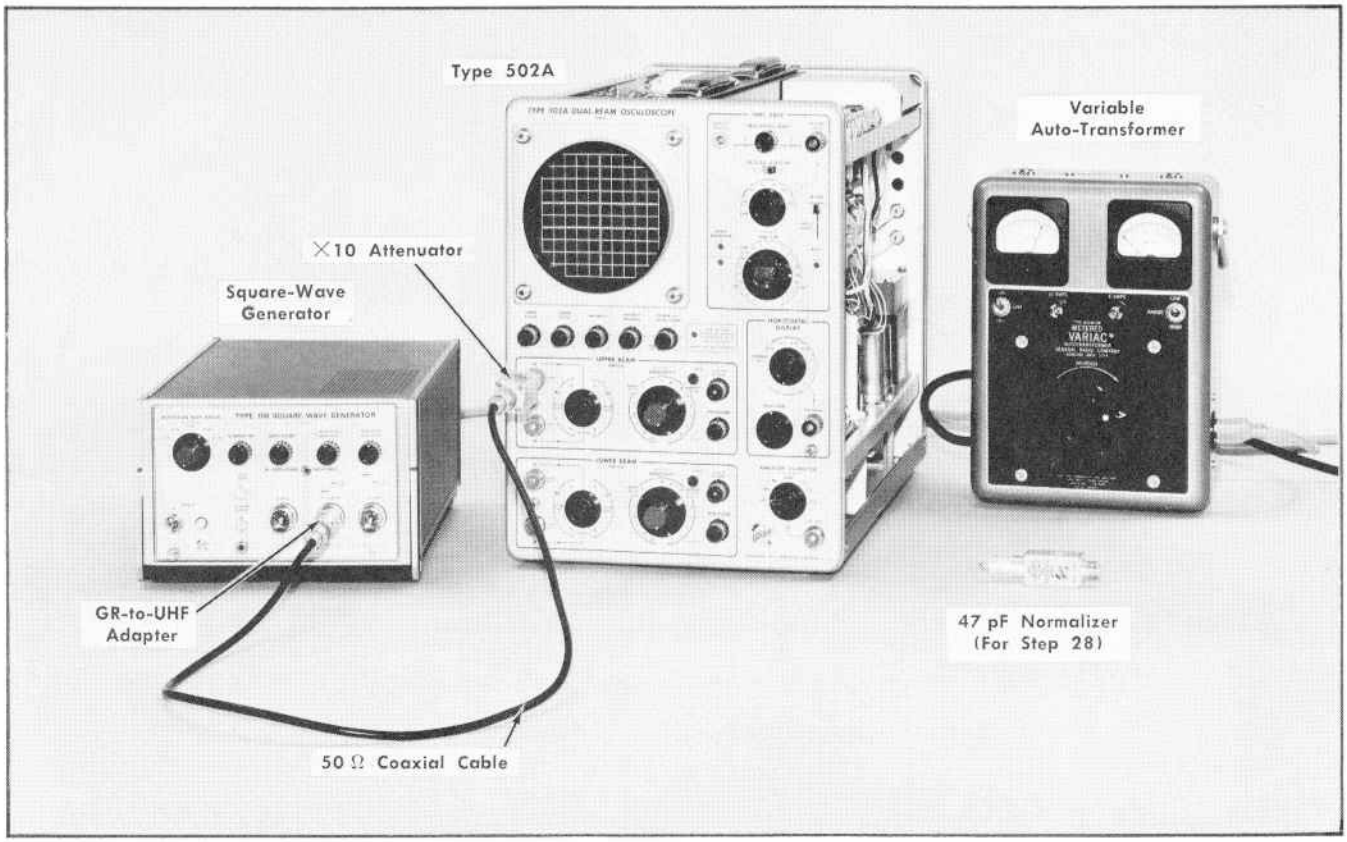


Fig. 6-22. Test equipment setup for adjusting HF compensation (step 27) and input compensation (step 28).

27. Adjust High Frequency Compensation

a. Connect the equipment as shown in Fig. 6-22.

b. Preset the following controls:

Type 502A

INPUT SELECTOR (Both)	A DC
SENSITIVITY (Both)	10 mVOLTS PER CM
TIME/CM	20 μSEC

Square-wave Generator

Frequency	10 kHz
Amplitude	6 cm display

c. Set the Upper Beam HF Compensation adjustment C496 (see Fig. 6-23A) for optimum response. Aberrations (tilt, overshoot, etc.) should not exceed 1.2 mm.

d. Move the signal to the Lower Beam A INPUT and repeat the above procedure for the Lower Beam C496 (see Fig. 6-23B).

28. Adjust Input Compensation

a. Connect the 47 pF Input Capacitance Normalizer between the input cable and the Upper Beam A INPUT connector.

NOTES

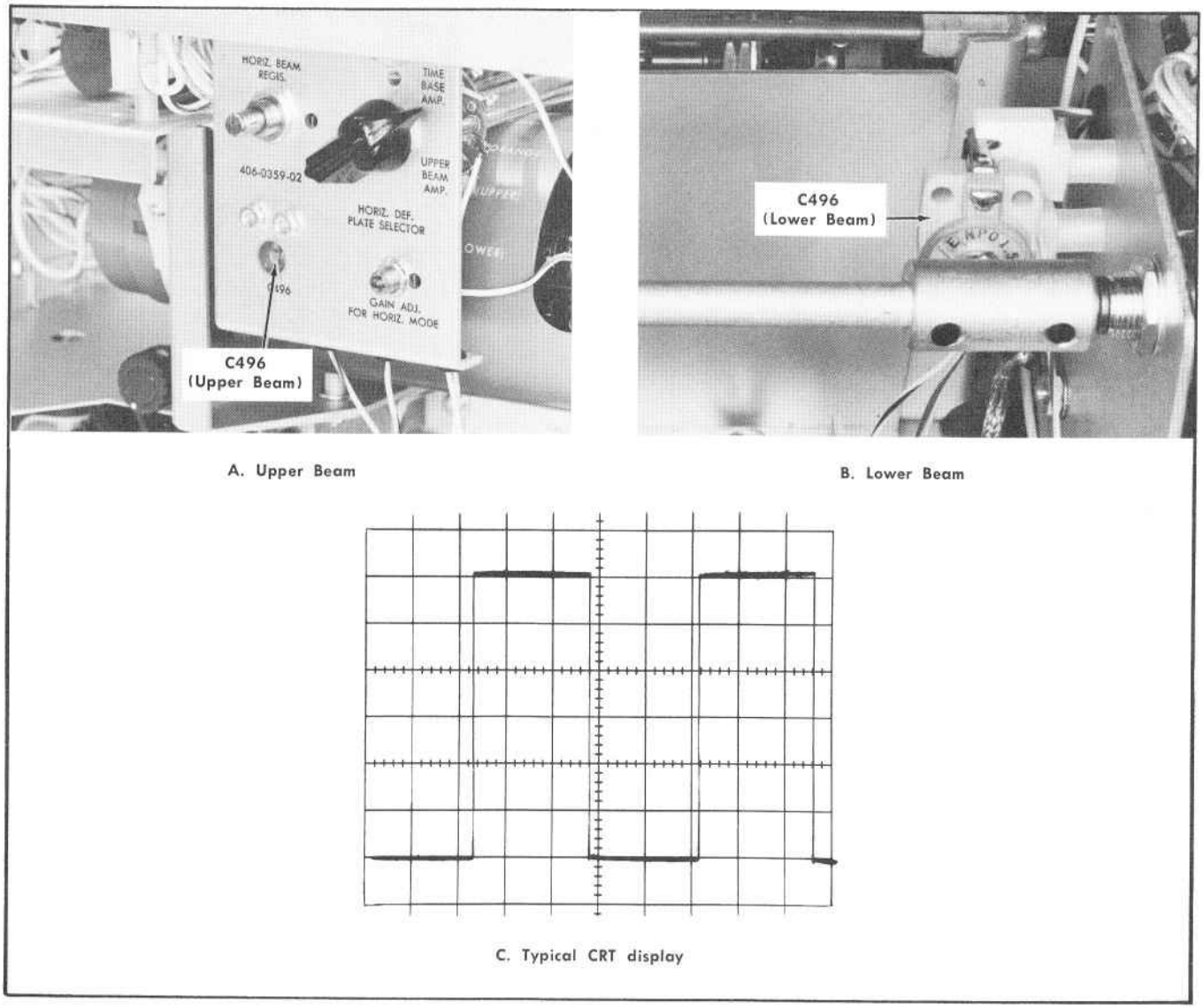


Fig. 6-23. Location of high-frequency compensation capacitors C496 and typical CRT display showing proper adjustment (step 27).

NOTES

NOTE

The 47 pF Normalizer must be connected directly to the A INPUT connector. If a BNC-to-UHF adapter or the 4-way connector is used between the INPUT connector and the Normalizer, the additional lead capacitance will cause C404 and C406 to be misadjusted.

b. Set the TIME/CM switch to .2 mSEC.

c. Set the square-wave generator for a 1 kHz output signal.

d. Adjust the Upper Beam input compensation capacitors (see Fig. 6-24A) as directed in Table 6-9. Connect the 47 pF Normalizer to the B INPUT connector for the B DC adjustments. Adjust the output of the generator for a 5 centimeter display each time the SENSITIVITY switch setting is changed.

TABLE 6-9

INPUT SELECTOR	SENSITIVITY (PER CM)	Adjust	For
A DC	.2 VOLTS	C404	Level flat-top
	.5 VOLTS	C403A	Level flat-top
		C403C	Square corner
B DC[3]	.2 VOLTS	C406	Level flat-top
	.5 VOLTS	C405A	Level flat-top
		C405C	Square corner

[3]**INPUT B displays are inverted—use the bottom of the waveform.**

e. Move the 47 pF Normalizer to the Lower Beam Amplifier and repeat the above adjustments. (See Fig. 6-24B for locations.)

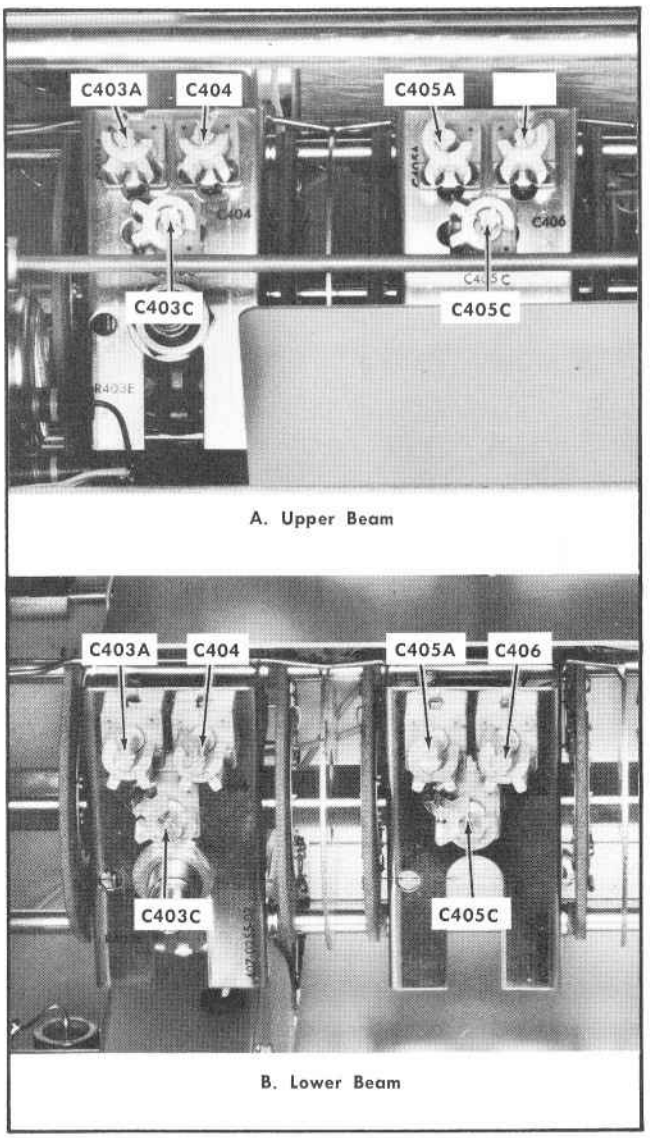


Fig. 6-24. Location of input compensation capacitors (step 24c).

NOTES

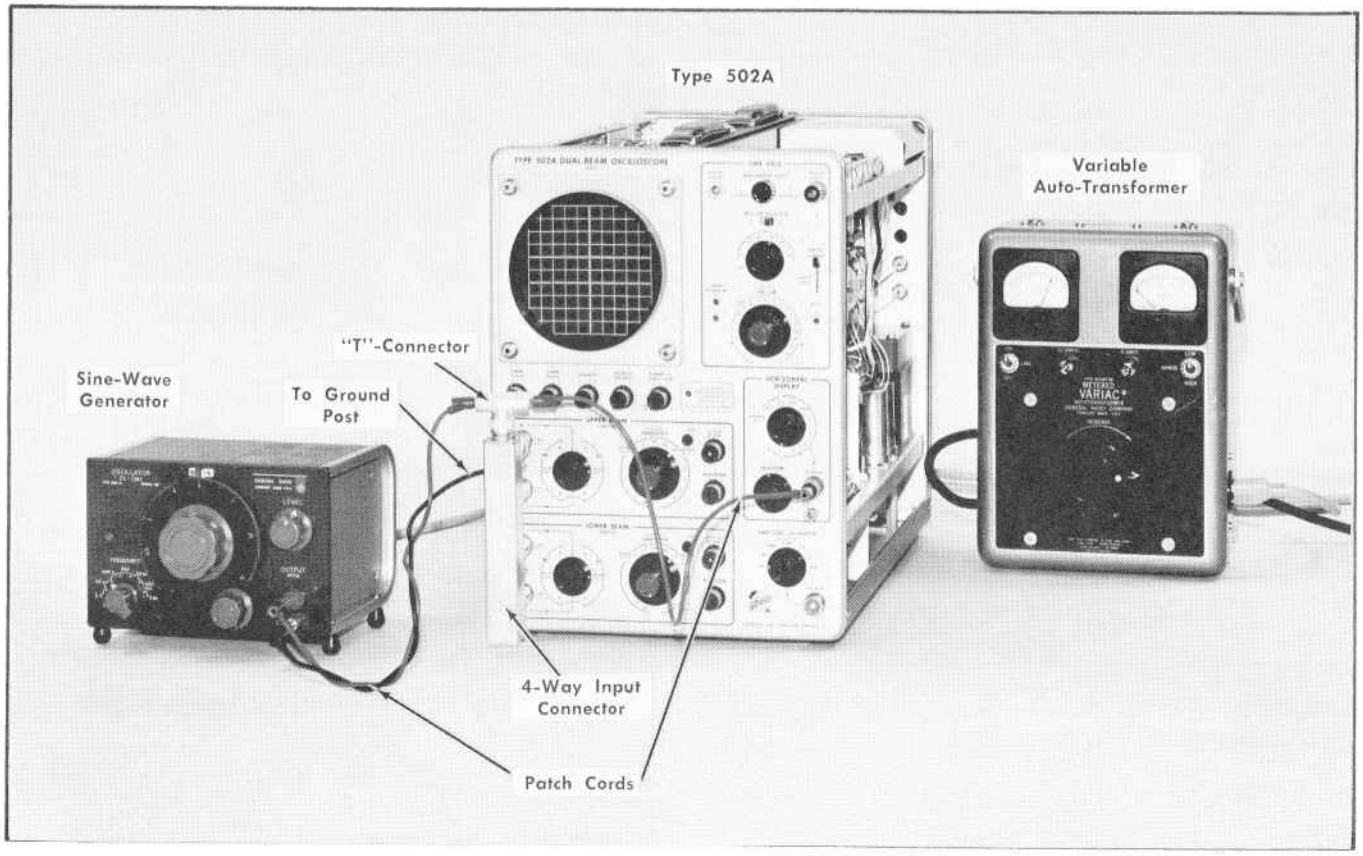


Fig. 6-25. Test equipment setup for adjusting and checking common-mode balance (step 29 and 30).

29. Adjust Amplifier Common-Mode Balance

(.1 mVOLTS PER CM to .5 VOLTS PER CM)

a. Set up the equipment as shown in Fig. 6-25.

b. Adjust the generator for a 50-Hz 10-volt peak-to-peak signal.

c. Set the TIME/CM switch to .1 mSEC.

d. Set both INPUT SELECTOR switches to A-B DC and position the Lower Beam display off the screen.

e. Adjust the Upper Beam Amplifier common-mode balance adjustments as directed in Table 6-10. (See Fig. 6-26 for the location of these adjustments.)

f. R419, C415, and C438 interact, so repeat the adjustments until all three are properly set.

g. Position the Upper Beam display off the screen, position the Lower Beam display on the screen, and adjust the Lower Beam common mode balance as directed in Table 6-10.

h. Readjust the signal generator to provide a 50-kHz 10-volt sine-wave signal.

i. Check both amplifiers as directed in Table 6-11.

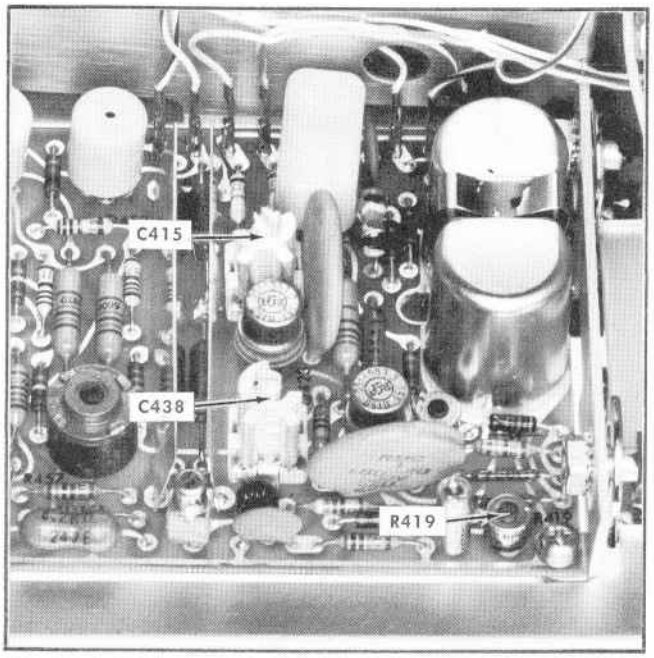


Fig. 6-26. Location of amplifier common-mode balance adjustments (step 29).

TABLE 6-10

SENSITIVITY (PER CM)	HORIZONTAL DISPLAY	Sine-Wave Frequency	Adjust	For
.1 mVOLTS	1 EXT VOLT/CM	50 Hz	R419	Minimum tilt
		50 kHz	C415	Minimum loop opening (See Fig. 6-27)
.2 VOLTS	NORMAL	50 kHz	C438	Minimum deflection

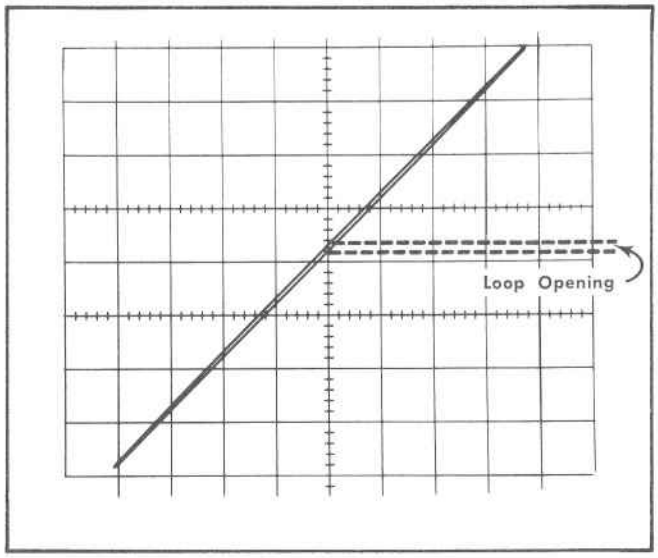


Fig. 6-27. Lissajous loop display for adjusting C415 (Table 6-10).

TABLE 6-11

SENSITIVITY (PER CM)	Maximum Deflection
.2 VOLTS to 5 mVOLTS	.5 mm
2 mVOLTS	1 mm
1 mVOLTS	2 mm
.5 mVOLTS	4 mm
.2 mVOLTS	1 cm
.1 mVOLTS	2 cm

30. Adjust Common-Mode Balance of Input Attenuator

(.5 to 20 VOLTS PER CM)

a. Preset the following controls:

Type 502A

INPUT SELECTOR (Both)	A-B DC
SENSITIVITY (Both)	.5 VOLTS PER CM
TIME/CM	10 mSEC

Sine-Wave Generator

Frequency	50 Hz
Amplitude	50 volts peak to peak

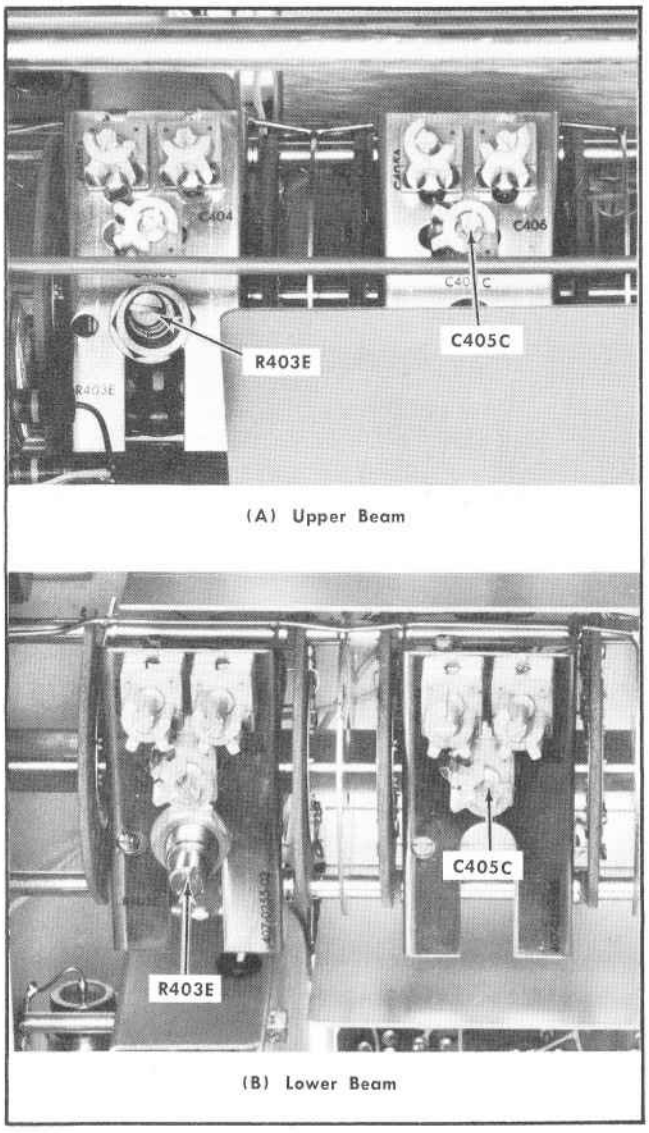


Fig. 6-28. Location of attenuator common-mode balance adjustments (step 30).

b. Adjust R403E on the Upper Beam SENSITIVITY switch (see Fig. 6-28) for minimum common-mode deflection of the Upper-Beam trace. When R403E is properly adjusted, there should be no discernible common-mode display (5000:1 CMRR = 0.2 mm deflection).

c. Change the sine-wave frequency to 50 kHz.

d. Change the TIME/CM switch to the .1 mSEC position.

e. Adjust C405C on the Upper Beam SENSITIVITY switch (see Fig. 6-28) for $\leq$2 mm of common-mode signal (500:1 CMRR). Note: C405C was previously adjusted in Step 28.

f. Change the sine-wave frequency to 1 kHz.

g. Change the TIME/CM switch to the 5 mSEC position.

h. Check for $\leq$2 mm of common-mode signal (500:1 CMRR).

i. Repeat (b) through (h) for the Lower Beam Amplifier.

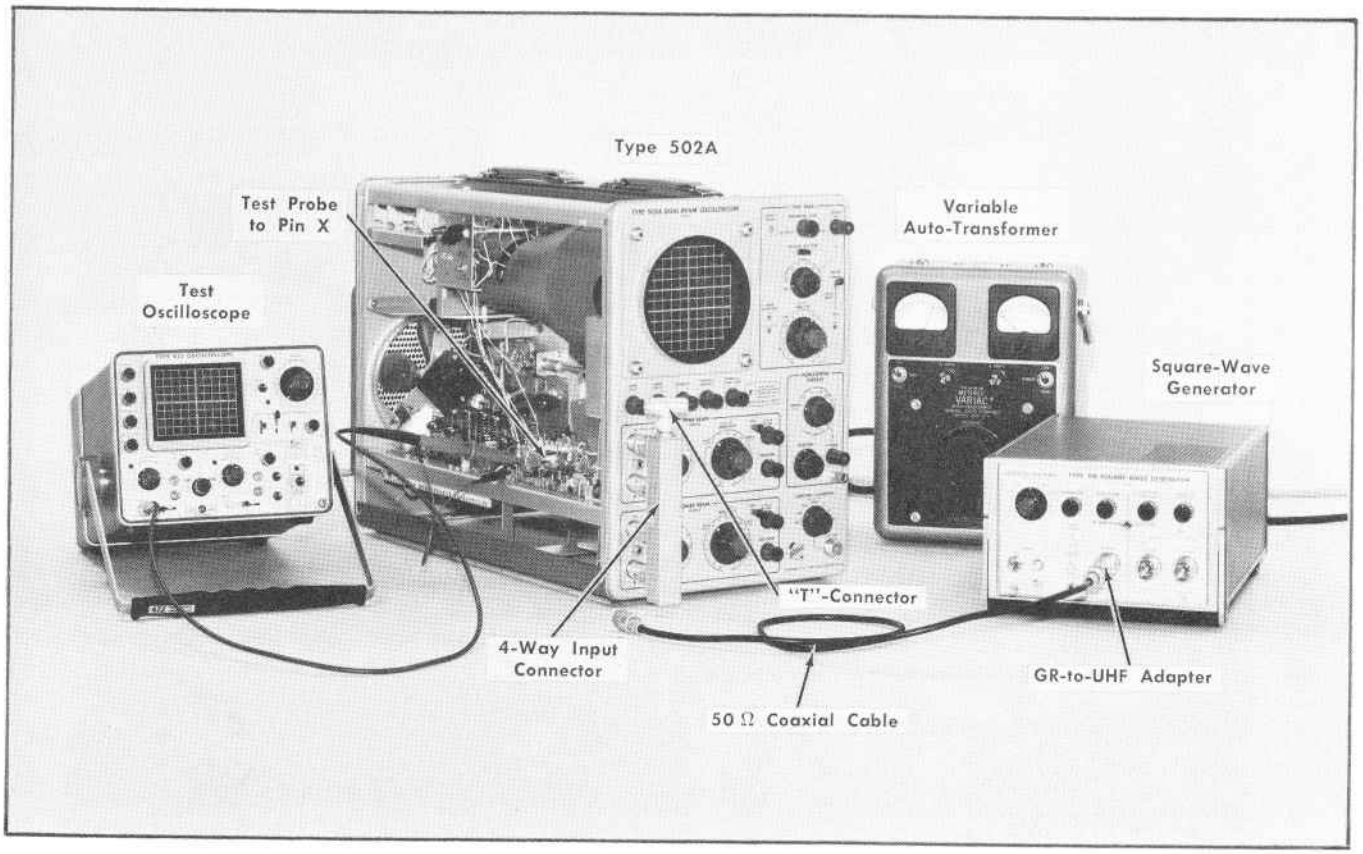


Fig. 6-29. Test equipment setup for adjusting trigger output (step 31).

31. Adjust Level and Compensation of Trigger Output and Vertical Signal Output

a. Set up the equipment as shown in Fig. 6-29. (Do not connect the square-wave signal to the Type 502A until step (e) below.)

b. Preset the following controls:

Type 502A

INPUT SELECTOR (Both)	A DC
SENSITIVITY (Both)	.2 VOLTS PER CM
TIME/CM	.5 mSEC

Square-Wave Generator

Frequency	1 kHz

c. Position the traces to the respective upper and lower beam graticule center horizontal lines.

d. Set R491 (see Fig. 6-30) for zero volts at Pin X.

e. Connect the generator to the 4-way connector and set its Amplitude control for a 5 centimeter display.

f. Move the test oscilloscope probe to the rear-panel Upper Beam Vertical Signal Out connector.

g. Check for a test oscilloscope display amplitude of about 10 volts.

h. Set C487 (see Fig. 6-30) for the best square-wave response on the test oscilloscope display.

i. Disconnect the square-wave generator.

j. Repeat (d) through (i) for the Lower Beam Amplifier.

k. Disconnect the test oscilloscope from the Type 502A.

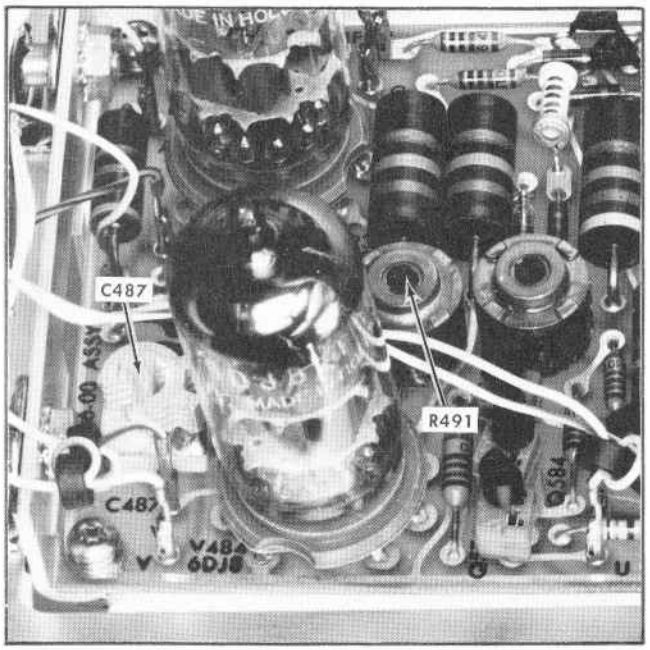


Fig. 6-30. Location of trigger output adjustments (step 31).

NOTES

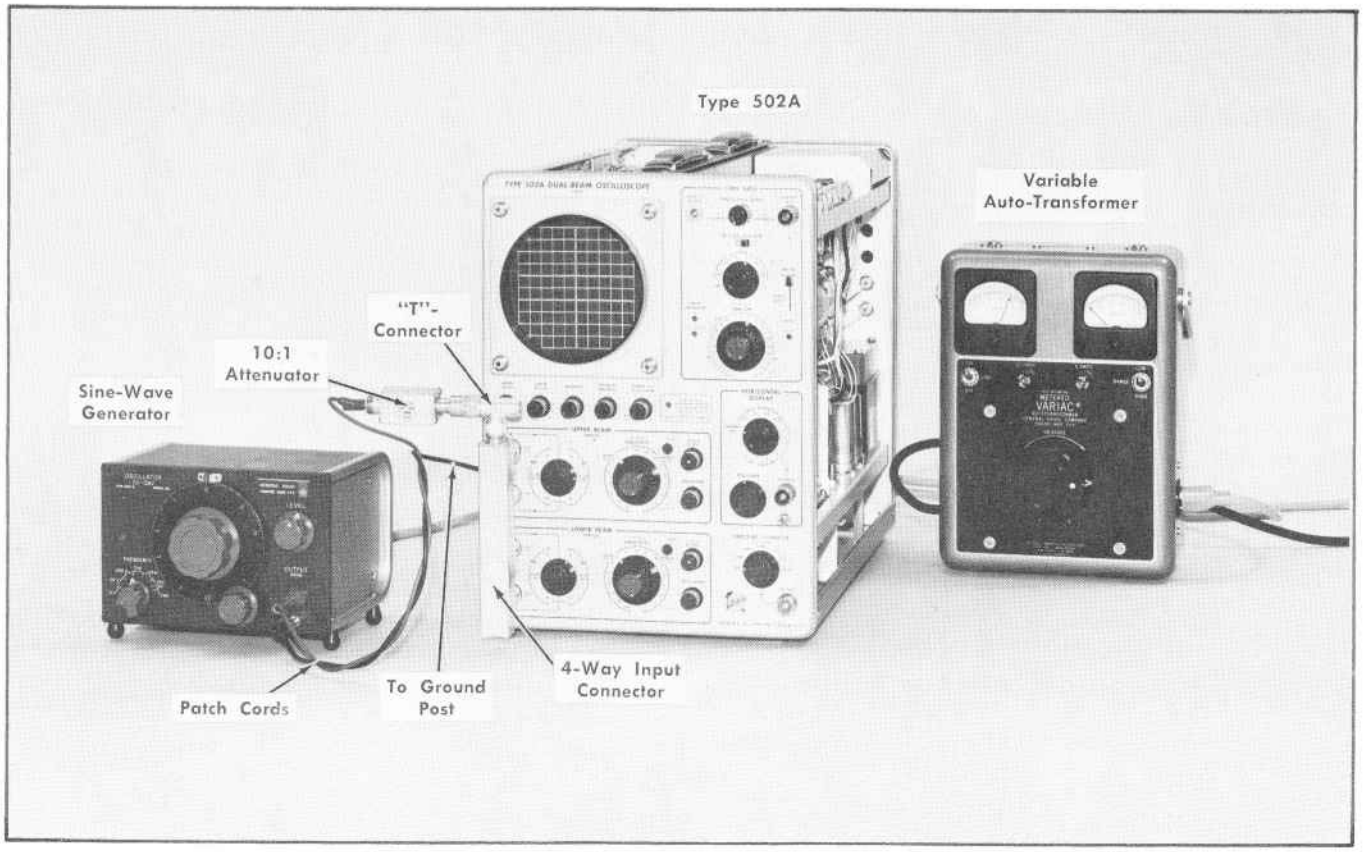


Fig. 6-31. Test equipment setup for steps 32 through 34.

32. Adjust Gain of Upper-Beam Amplifier in Horizontal Mode

a. Connect the equipment as shown in Fig. 6-31.

b. Set the controls as follows:

Type 502A

HORIZ DEF. PLATE SEL.	UPPER BEAM AMP.
Upper Beam INPUT SEL.	A-B DC
Lower Beam INPUT SEL.	A DC
SENSITIVITY (Both)	.2 VOLTS PER CM

Sine-Wave Generator

Frequency	1 kHz
Amplitude	Exactly 8 cm of vertical deflection

c. Reset the Upper Beam INPUT SELECTOR switch to A DC.

d. Reset the Lower Beam INPUT SELECTOR switch to A-B DC.

e. Adjust R478, Gain Adj. for Horiz. Mode (see Fig. 6-32) for exactly 8 centimeters of horizontal deflection.

33. Adjust X-Y Phasing

a. Set the sine-wave generator for 8 centimeters of a 100 kHz signal.

b. Set both INPUT SELECTOR switches to A DC.

c. If the loop opening (see Fig. 6-27) is more than 1.4 mm, dress the upper beam deflection plate leads to obtain minimum loop opening.

d. Set the Lower Beam INPUT SELECTOR switch to A-B DC.

e. Set both SENSITIVITY switches to .1 mVOLTS PER CM.

f. Set the sine-wave generator for 8 centimeters of a 100 kHz signal.

g. Set C408 (see Fig. 6-33) on both amplifiers for $\leq$1.4 mm loop opening. Maintain minimum capacitance on both capacitors while obtaining the desired results.

h. Check all positions of the SENSITIVITY switches for loop opening of $\leq$1.4 mm. Maintain 8 centimeters of deflection in each position except where the sine-wave generator cannot supply the amplitude required. Remove the 10:1 attenuator when it is no longer needed.

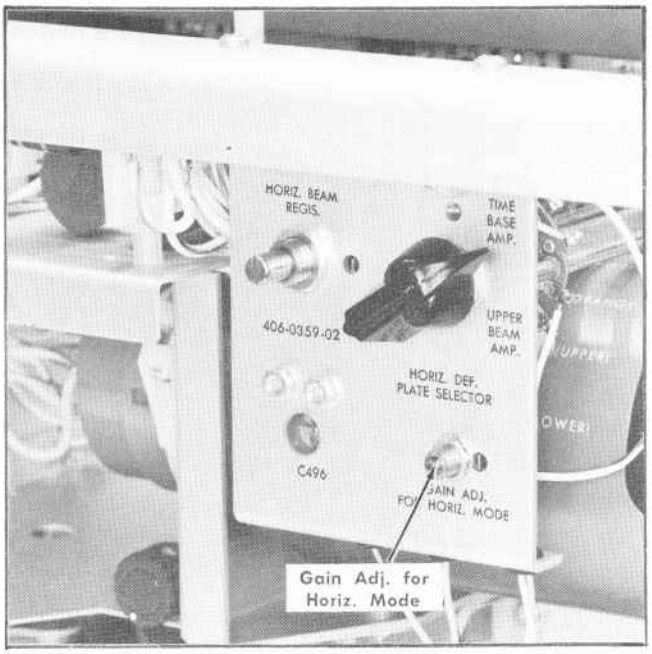


Fig. 6-32. Location of Gain Adj. for Horiz. Mode (step 29).

i. Return the HORIZ. DEF. PLATE SELECTOR switch to the TIME BASE AMP.

j. Set both SENSITIVITY switches to .1 mVOLT PER CM.

k. Connect the Fast-Rise Output of the square-wave generator to the 4-way input connector and adjust for a 6-centimeter 10-kHz signal.

l. Set the TIME/CM switch to 20 μSEC.

m. Touch up C496 (located next to HORIZ. DEF. PLATE SELECTOR switch) for optimum response. The initial adjustment of C496 was made in Step 27. Aberrations are not to exceed 1.2 mm.

34. Check Bandwidth of Vertical Amplifiers

a. Set up the equipment as shown in Fig. 6-31.

b. Preset the following controls:

Type 502A

INPUT SELECTOR (Both)	A DC
SENSITIVITY Both)	.1 mVOLTS PER CM
Upper Beam POSITION	Adjust for centered display
Lower Beam POSITION	Move beam off the screen
TIME/CM	1 mSEC
TRIGGER	RECURRENT

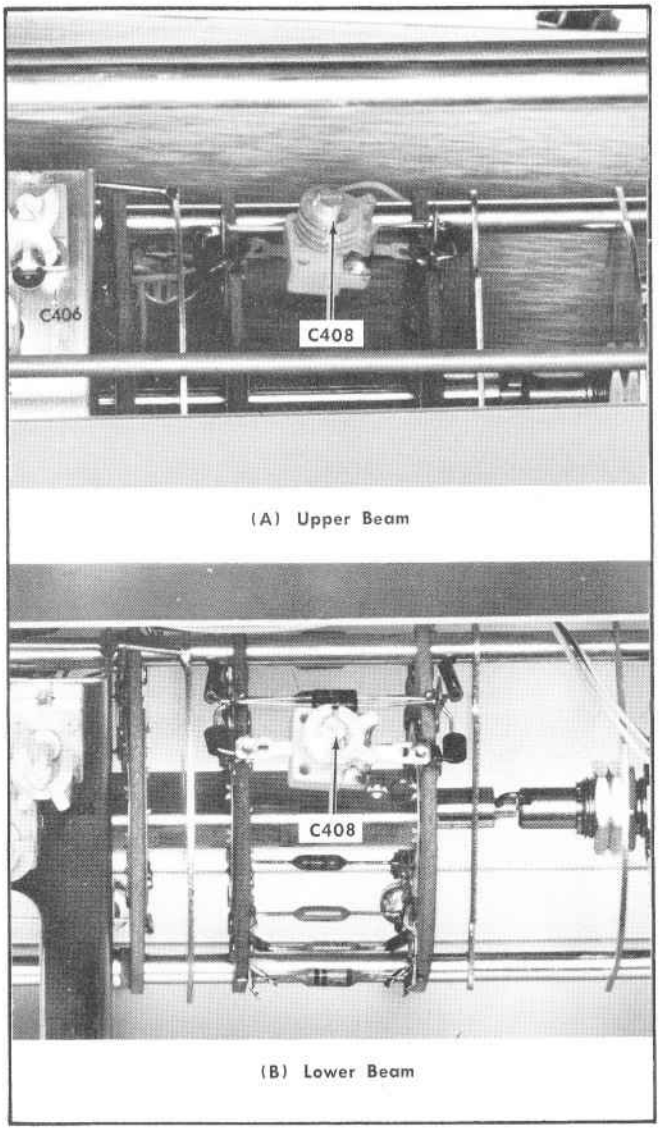


Fig. 6-33. Location of C408 (step 33a).

Sine-Wave Generator

Frequency	1 kHz
Amplitude	6 cm vertical deflection

c. Increase the signal frequency to 100 kHz. The amplitude of the display must be $\geq$4.2 centimeters.

d. Repeat the above procedure for the Lower Beam Amplifier.

e. Set both SENSITIVITY switches to 5 mVOLTS PER CM.

f. Return the signal frequency to 1 kHz and adjust the generator amplitude control for a 4 centimeter display on the Lower Beam.

g. Increase the sine-wave generator frequency to 1 MHz. The amplitude of the display must be $\geq$2.8 centimeters.

h. Repeat (f) and (g) for the other amplifier.

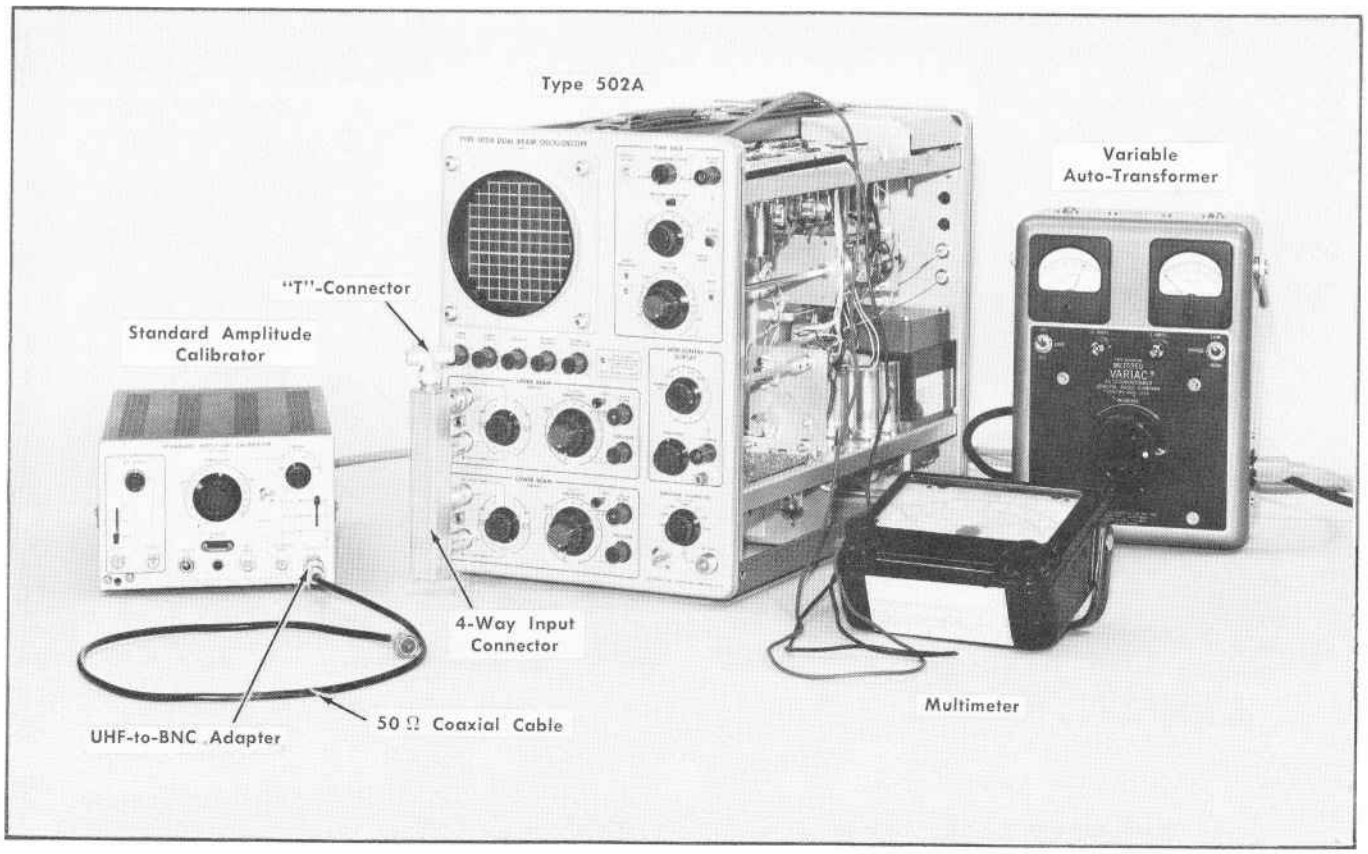


Fig. 6-34. Test equipment setup for trigger adjustments (steps 35 and 36).

TRIGGERING

35. Adjust STABILITY

a. Set up the equipment as shown in Fig. 6-34. The meter is connected between the center arm of the STABILITY ADJUST potentiometer and ground. Set the meter to the —150 volt range.

b. Preset the following controls:

SENSITIVITY (Both)	20 VOLTS PER CM
POSITION (All)	Centered
TRIGGERING LEVEL	AUTOMATIC
TIME/CM	50 μSEC

c. Rotate the STABILITY ADJUST control fully counterclockwise. (The trace will disappear.)

d. Turn the control slowly clockwise, noting the meter reading when the trace first appears.

e. Continue turning clockwise and note the reading when the trace brightens (free runs).

f. Set the STABILITY ADJUST halfway between the two meter readings.

36. Adjust Trigger Level Centering

a. Preset the following controls:

Type 502A

SENSITIVITY (Both)	1 VOLT PER CM
TIME/CM	.1 mSEC
TRIGGER SELECTOR	UPPER AC

Standard Amplitude Calibrator

MODE	Square wave
Amplitude	.2 Volts

b. Connect the meter between the center arm of the TRIGGERING LEVEL control and ground. Adjust this control for a reading of zero volts on the meter.

c. Connect the SAC to the 4-way input connector.

d. While switching the TRIGGER SELECTOR switch back and forth between + and —, adjust the Trig Level Cent Adjust R23 (see Fig. 6-35) so that the display is properly triggered, with the trace starting on a positive slope when the TRIGGER SELECTOR slide switch is set to + and on a negative slope when the slide switch is set to — (see Fig.

6-36). Be careful that the setting of the TRIGGERING LEVEL Control is not distrubed during this step.

e. Disconnect the meter from the Type 502A.

f. Set the TRIGGER SELECTOR switch to LOWER AC and check for proper triggering again.

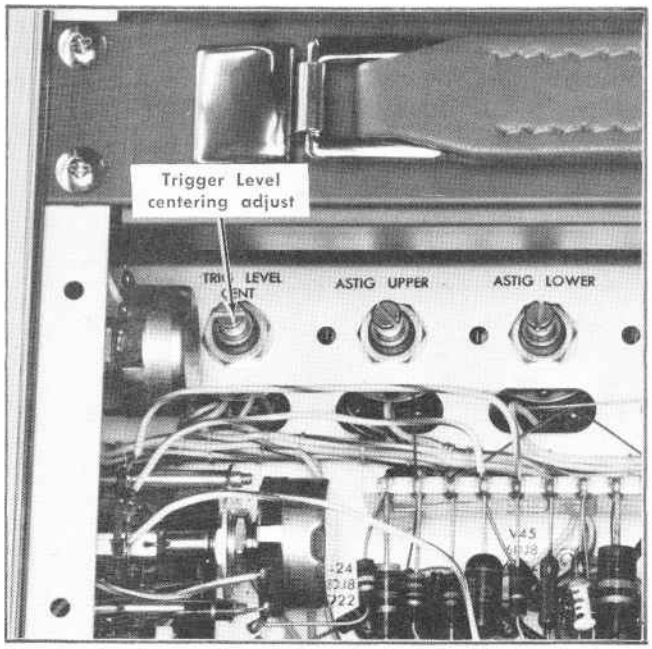


Fig. 6-35. Location of Trig Level Cent adjustment (step 36).

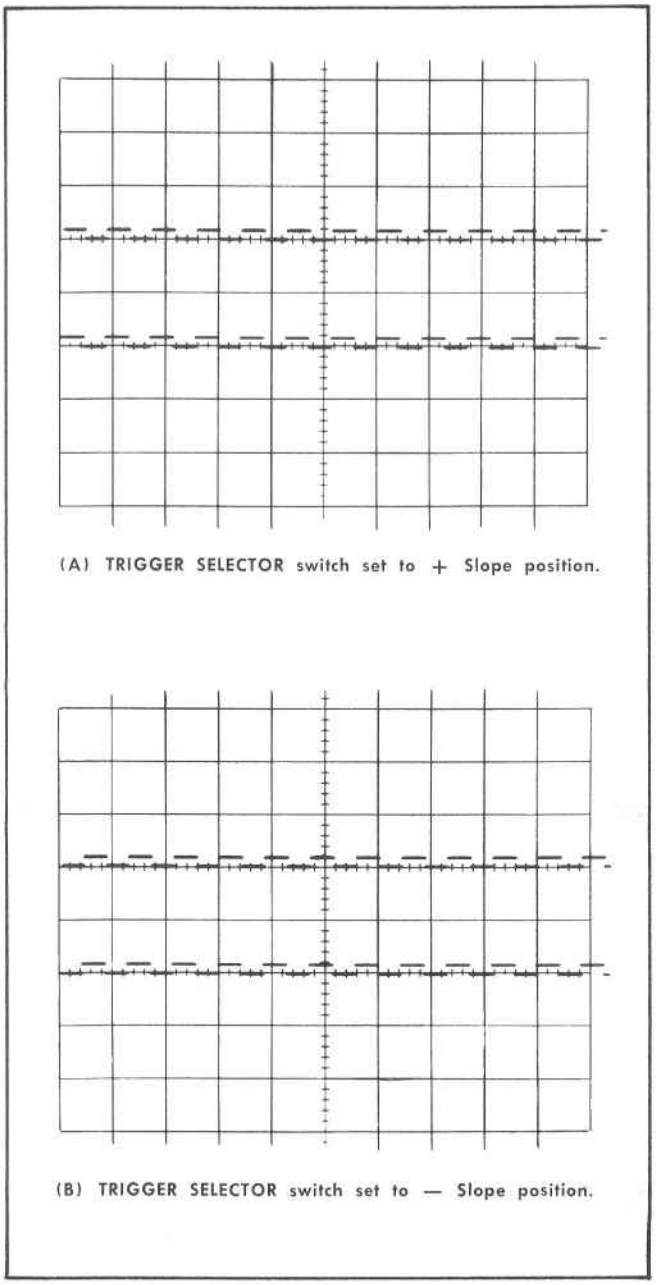
37. Check DC Triggering

a. Postion the traces to their respective upper and lower beam graticule center horizontal lines.

b. Set the TRIGGER SELECTOR switch to UPPER DC.

c. Check for proper triggering in both positions of the TRIGGER SELECTOR slide switch with adjustment of the TRIGGERING LEVEL control.

d. Set the TRIGGER SELECTOR switch to LOWER DC and repeat (c).



(A) TRIGGER SELECTOR switch set to + Slope position.

(B) TRIGGER SELECTOR switch set to — Slope position.

Fig. 6-36. Typical CRT displays showing effect of TRIGGER SELECTOR SLOPE switch (step 36d).

NOTES

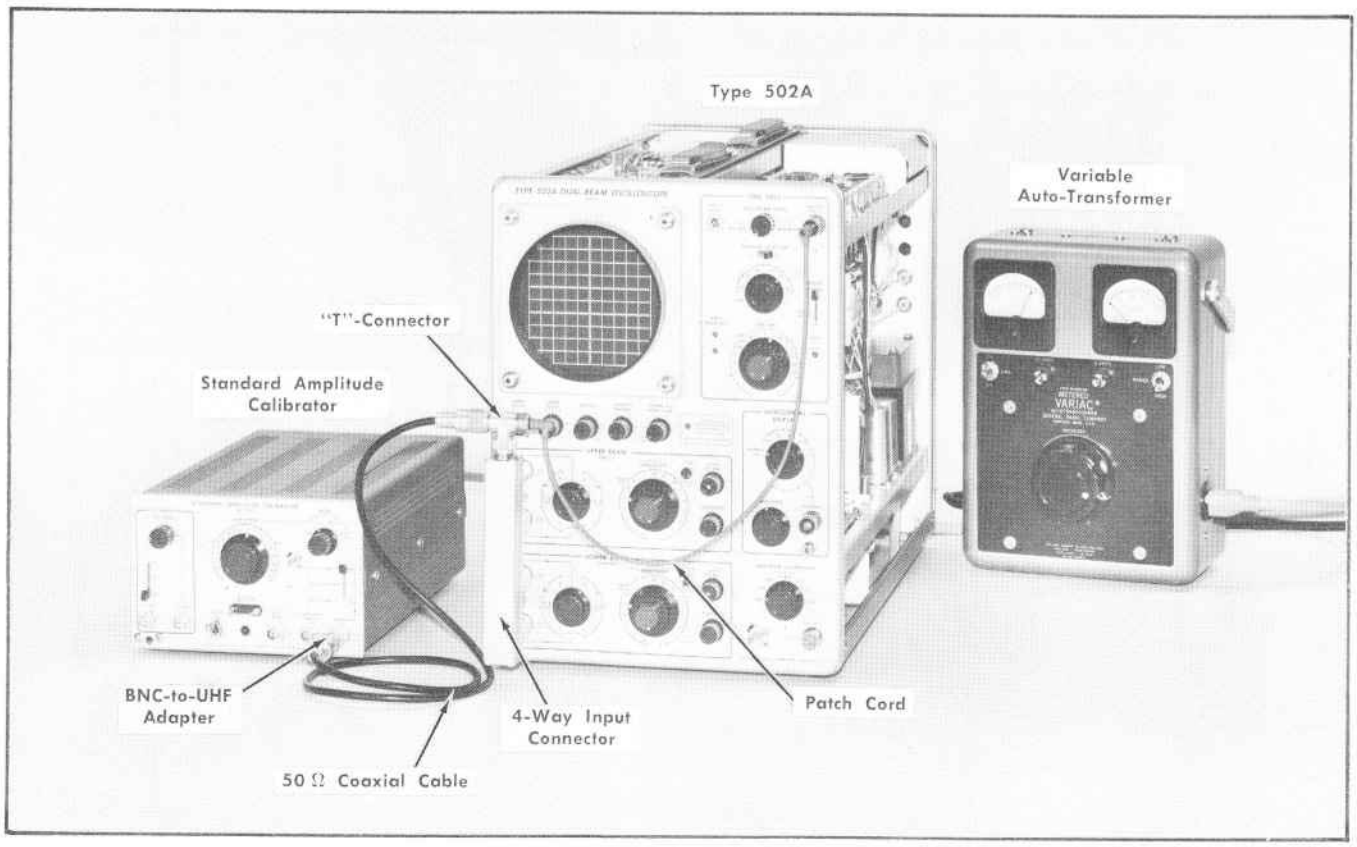


Fig. 6-37. Test equipment setup for checking external triggering (step 35).

38. Check External Triggering

a. Set up the equipment as shown in Fig. 6-37.

b. Set the TRIGGER SELECTOR switch to EXT AC.

c. Apply a .5 volt square wave and check that the sweep will trigger in both positions of the TRIGGER SELECTOR slope switch with adjustment of the TRIGGERING Level control.

d. Repeat the above check with the TRIGGER SELECTOR switch in the EXT DC position.

e. Remove the patch cord.

39. Check AUTOMATIC Triggering

a. Set the TRIGGERING LEVEL control to AUTOMATIC.

b. While switching the TRIGGER SELECTOR slide switch back and forth between + and —, check for stable displays in the EXT AC and EXT DC positions of the TRIGGER SELECTOR switch.

c. Set the SAC for a square-wave output of .2 volts.

d. Check for stable displays in all INT positions of the TRIGGER SELECTOR switch while switching back and forth between + and —.

e. Disconnect the SAC and the 4-way connector from the Type 502A.

40. Check LINE Triggering

a. Preset the following controls:

TRIGGER SELECTOR	+ LINE
TIME/CM	.5 mSEC
SENSITIVITY (Upper Beam)	10 VOLTS PER CM

b. Connect the 10× probe to the Upper Beam A INPUT and touch the probe tip to the AC power fuse holder.

c. Check for a triggered display starting on a positive slope.

d. Change the TRIGGER SELECTOR slide switch to + and check that the display starts on a negative slope.

e. Remove the 10× probe assembly.

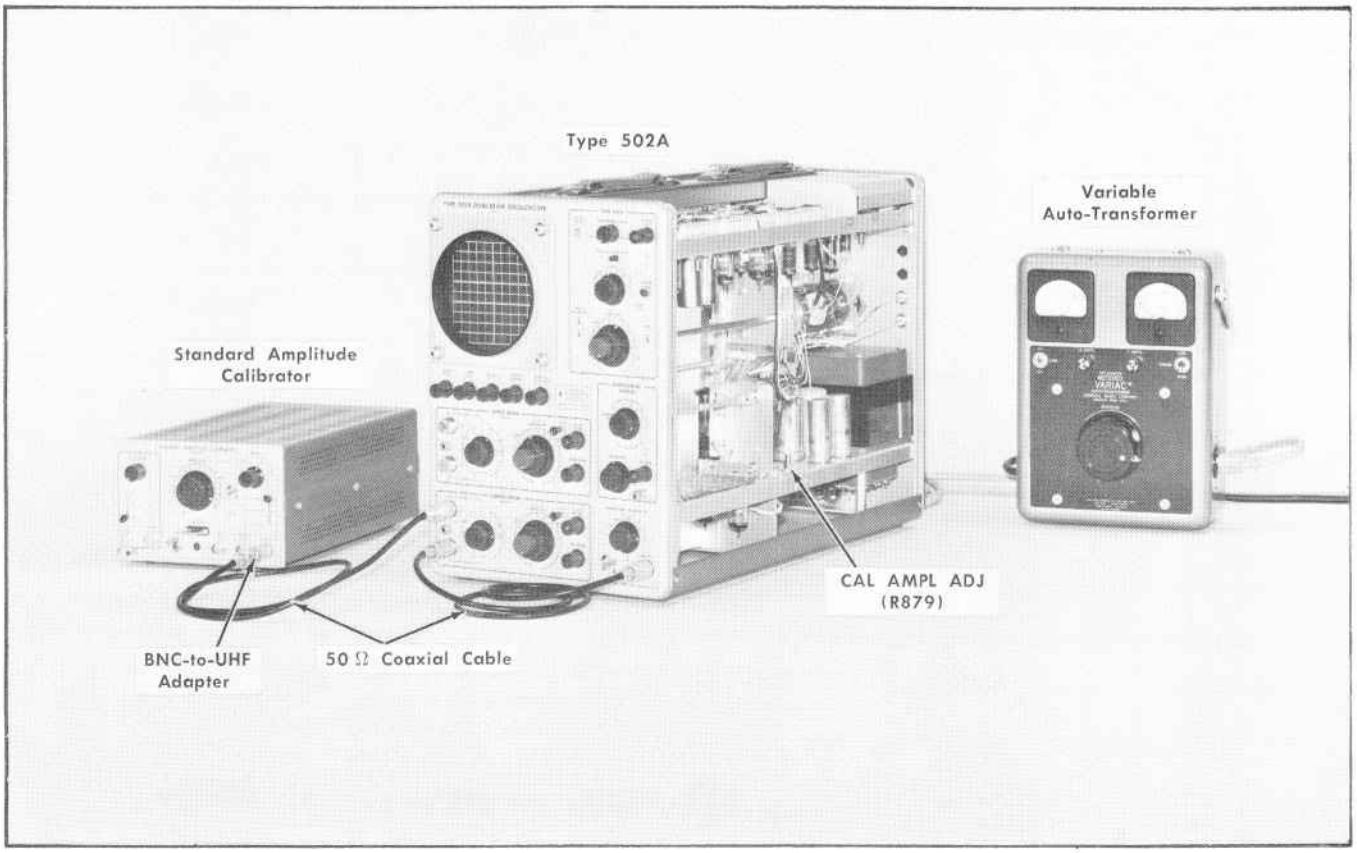


Fig. 6-38. Test equipment setup for Calibrator adjustment and checks (steps 41 through 44).

AMPLITUDE CALIBRATOR

Preset the following controls:

Type 502A	
INPUT SELECTOR (Lower Beam)	A AC
TRIGGERING LEVEL	AUTOMATIC
TRIGGER SELECTOR	+LOWER, AC
TIME/CM	5 ms
AMPLITUDE CALIBRATOR	50 V
SENSITIVITY	.5 VOLTS/CM

Standard Amplitude Calibrator (SAC)	
Mode	+DC
Source	Mixed
Amplitude	50 V

41. Adjust Calibrator Amplitude

a. Connect the equipment as shown in Fig. 6-38.

b. Remove V875 from its socket.

c. Adjust LOWER BEAM POSITION to observe a waveform similiar to that shown in Fig. 6-38A.

d. Adjust Cal Ampl, R879, to reduce the observed square wave to a straight line.

e. Check the remaining positions of the AMPLITUDE CALIBRATOR switch as shown in Table 6-12.

f. Disconnect the Standard Amplitude Caibrator signal from the Type 502A input.

g. Replace V875 in its socket.

TABLE 6-12

AMPLITUDE CALI-BRATOR	Standard Ampl Calibrator	Lower Beam Sensitivity	Maximum Display Amplitude
5 V	5 V	50 mV	3 cm
.5 V	.5 V	5 mV	3 cm
50 mV	50 mV	.5 mV	3 cm
5 mV	5 mV	.1 mV	1.5 cm[4]
.5 mV	.5 mV	.1 mV	1.5 mm

[4]Disregard any spikes on the waveform.

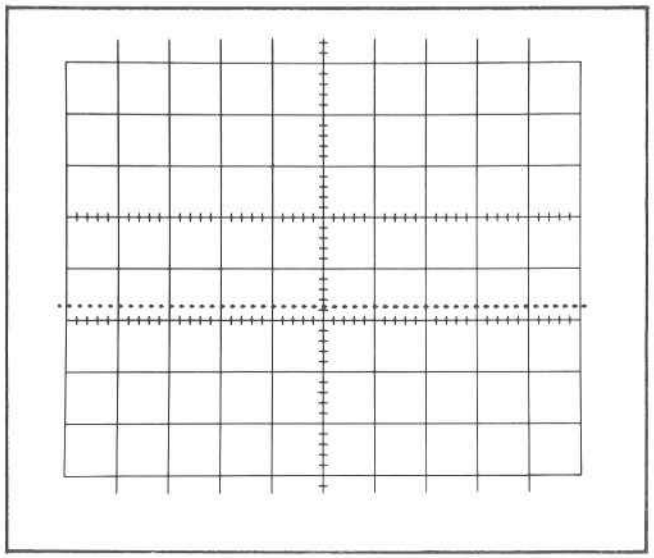


Fig. 6-39. Typical CRT display for intensity modulation check (step 45).

42. Check Calibrator Repetition Rate

a. Change the TIME/CM switch setting to .2 mSEC.

b. Set the AMPLITUDE CALIBRATOR and Lower Beam SENSITIVITY switch settings for a display 4 to 5 centimeters in amplitude.

c. Check for one cycle of display waveform per 5 centimeters ±1.5 centimeters.

43. Check Calibrator Symmetry

a. Set the TIME/CM switch to .1 mSEC.

b. Adjust the VARIABLE TIME/CM control to obtain 1 cycle over the 10 centimeters of horizontal sweep.

c. Check for 5 centimeters ±1.5 centimeters for each half-cycle.

Z-AXIS MODULATION

44. Check Intensity Modulation

a. Remove the grounding strap from the rear-panel CRT Cathode binding post.

b. Apply a 20 volt square-wave from the Standard Amplitude Calibrator to the binding post mentioned above.

c. The trace should appear as a broken line or row of dots (see Fig. 6-39). It may be necessary to turn the INTENSITY control slightly counterclockwise to obtain this display.

NEON INDICATORS

45. Check SWEEP MAGNIFIER Neon

a. Set the HORIZONTAL DISPLAY switch to each position.

b. Check that the SWEEP MAGNIFIER neon is illuminated in all magnified (×2 to ×20) positions and is not lit in the ×1 (NORMAL) and EXT VOLTS positions.

46. Check UNCALIBRATED (SWEEP) Neon

a. The UNCALIBRATED neon must light whenever the sweep rate exceeds 12 microseconds per centimeter. Check as indicated in Table 6-13:

TABLE 6-13

SWEEP MAGNIFIED Position	TIME/CM setting
×2	1 μSEC
×5	1 μSEC and 2 μSEC
×10	1 μSEC through 5 μSEC
×20	1 μSEC through 10 μSEC

47. Check HORIZ. DEF. PLATE SELECTOR Neon (This step does not apply to the Type RM502A.)

a. Set the HORIZ. DEF. PLATE SELECTOR switch to the UPPER BEAM AMP. position.

b. The neon next to the POWER AND SCALE ILLUM control should be lit.

c. Return the HORIZ. DEF. PLATE SELECTOR switch to the TIME BASE AMP position.

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
$^\circ$	degrees
$^\circ$C	degrees Celsius (degrees centigrade)
$^\circ$F	degrees Fahrenheit
$^\circ$K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geq$	equal to or greater than
$\leq$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

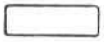
PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

SECTION 7

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description				S/N Range
		Bulbs				
B124	150-0027-00	Neon, NE-23	READY			20000-24379
B124	150-0030-00	Neon, NE-2V	READY			24380-up
B167	150-0027-00	Neon, NE-23				
B331M	150-0027-00	Neon, NE-23	ON			20000-24379
B331M	150-0030-00	Neon, NE-2V	ON			24380-up
B331N	150-0027-00	Neon, NE-23	UNCALIBRATED			20000-24379
B331N	150-0030-00	Neon, NE-2V	UNCALIBRATED			24380-up
B490	150-0027-00	Neon, NE-23				20000-24379
B490	150-0030-00	Neon, NE-2V				24380-25996X
B499	150-0030-00	Neon, NE-2V				X25997-up
B601	150-0001-00	Incandescent, #47	Graticule Light			
B602	150-0001-00	Incandescent, #47	Graticule Light			
		Capacitors				
Tolerance ±20% unless otherwise indicated.						
C10	283-0002-00	0.01 μF	Cer	500 V		
C11	283-0000-00	0.001 μF	Cer	500 V		
C13	283-0001-00	0.005 μF	Cer	500 V		
C24	283-0000-00	0.001 μF	Cer	500 V		
C31	285-0510-00	0.01 μF	MT	400 V		
C44	281-0510-00	22 pF	Cer	500 V		20000-24099
C44	281-0513-00	27 pF	Cer	500 V		24100-up
C131	281-0510-00	22 pF	Cer	500 V		20000-24099
C131	281-0513-00	27 pF	Cer	500 V		24100-up
C137	281-0503-00	8 pF	Cer	500 V	±0.5 pF	X21070-up
C141	281-0541-00	6.8 pF	Cer	500 V	10%	
C160A	281-0007-00	3-12 pF	Cer Var			
C160B	283-0534-00	82 pF	Mica	500 V	5%	
C160C	281-0010-00	4.5-25 pF	Cer Var			
C160D	*291-0008-00	0.001 μF			½%	20000-26679
C160E, C160F, C160G	*291-0007-00	0.01 μF, 0.1 μF, 1 μF	Timing Series		½%	20000-26679
C160D, C160E, C160F, C160G	*295-0095-00	0.001 μF, 0.01 μF, 0.1 μF, 1 μF	Timing Capacitor Assembly			26680-27039
C160D, C160E, C160F, C160G	*295-0095-01	0.001 μF, 0.01 μF, 0.1 μF, 1 μF	Timing Capacitor Assembly			27040-up
C167	283-0000-00	0.001 μF	Cer	500 V		
C180A	281-0528-00	82 pF	Cer	500 V	10%	

Capacitors *(Cont)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C180B	285-0501-00	0.001 μF	MT	600 V		
C180C	285-0510-00	0.01 μF	MT	400 V		
C180D	285-0526-00	0.1 μF	MT	400 V		
C181	281-0528-00	82 pF	Cer	500 V	10%	
C311	281-0010-00	4.5-25 pF	Cer	Var		
C312	281-0521-00	56 pF	Cer	500 V	10%	
C331E	281-0589-00	167 pF	Cer	500 V	5%	X27140-up
C331G	281-0546-00	330 pF	Cer	500 V	10%	X27140-up
C350	283-0001-00	0.005 μF	Cer	500 V		
C400[1], C401[1]	*295-0066-00	0.1 μF	PTM	600 V	matched within 1% of each other	
C402[1]	281-0544-00	5.6 pF	Cer	500 V	10%	X26300-up
C403A[1]	281-0103-00	1.8-13 pF	Air	Var		X25997-up
C403B[1]	281-0628-00	15 pF	Cer	600 V	5%	X25997-up
C403C[1]	281-0100-00	1.4-7.3 pF	Air	Var		X25997-up
C403D[1]	283-0604-00	304 pF	Mica	300 V	2%	X25997-up
C404[1]	281-0103-00	1.8-13 pF	Air	Var		X25997-up
C405A[1]	281-0103-00	1.8-13 pF	Air	Var		X25997-up
C405B[1]	281-0628-00	15 pF	Cer	600 V	5%	X25997-up
C405C[1]	281-0100-00	1.4-7.3 pF	Air	Var		X25997-up
C405D[1]	283-0604-00	304 pF	Mica	300 V	2%	X25997-up
C406[1]	281-0103-00	1.8-13 pF	Air	Var		X25997-up
C406A[1]	281-0012-00	7-45 pF	Cer	Var		
C406C[1]	281-0005-00	1.5-7 pF	Cer	Var		
C406G[1]	281-0012-00	7-45 pF	Cer	Var		
C406J[1]	281-0005-00	1.5-7 pF	Cer	Var		
C406L[1]	281-0546-00	330 pF	Cer	500 V	10%	
C407A[1]	281-0012-00	7-45 pF	Cer	Var		
C407C[1]	281-0005-00	1.5-7 pF	Cer	Var		
C407G[1]	281-0012-00	7-45 pF	Cer	Var		
C407J[1]	281-0005-00	1.5-7 pF	Cer	Var		
C407L[1]	281-0546-00	330 pF	Cer	500 V	10%	
C408[1]	281-0100-00	1.4-7.3 pF	Air	Var		X25997-up
C409B[1]	281-0506-00	12 pF	Cer	500 V	10%	
C409C[1]	281-0513-00	27 pF	Cer	500 V		
C409D[1]	281-0528-00	82 pF	Cer	500 V	10%	
C409E[1]	281-0524-00	150 pF	Cer	500 V		
C409F[1]	283-0513-00	220 pF	Mica	500 V	5%	
C409G[1]	283-0522-00	470 pF	Mica	500 V	10%	
C409H[1]	283-0524-00	750 pF	Mica	500 V	5%	
C409J[1]	283-0035-00	0.0015 μF	Cer	500 V		
C409K[1]	285-0510-00	0.01 μF	MT	400 V		
C409L[1]	285-0519-00	0.047 μF	MT	400 V		

[1]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

Capacitors *(Cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C410[2]	281-0010-00	4.5-25 pF	Cer	Var			20000-25996X
C415[2]	281-0081-00	1.8-13 pF	Air	Var			X25997-up
C420[2]	290-0114-00	47 μF	EMC		6 V		X25997-up
C428[2]	283-0003-00	0.01 μF	Cer		150 V		X25997-up
C429[2]	283-0057-00	0.1 μF	Cer		200 V	+80%—20%	X25997-up
C436[2]	283-0057-00	0.1 μF	Cer		200 V	+80%—20%	X25997-up
C438[2]	281-0081-00	1.8-13 pF	Air	Var			X25997-up
C440[2]	281-0010-00	4.5-25 pF	Cer	Var			20000-25996X
C456[2]	285-0543-00	0.0022 μF	MT		400 V		20000-25996X
C461[2]	283-0103-00	180 pF	Cer		500 V	5%	X25997-up
C469[2]	281-0027-00	0.7-3 pF	Tub.	Var			20000-25996X
C470[2]	281-0005-00	1.5-7 pF	Cer	Var			20000-25996X
C478[2]	281-0005-00	1.5-7 pF	Cer	Var			20000-25996
C478	281-0549-00	68 pF	Cer		500 V	10%	25997-up
C480[2]	281-0005-00	1.5-7 pF	Cer	Var			20000-25996X
C485[2]	281-0623-00	650 pF	Cer		500 V	5%	X25997-up
C487[2]	281-0078-00	1.4-7.3 pF	Air	Var			X25997-up
C491[2]	281-0534-00	3.3 pF	Cer		500 V	±0.25 pF	20000-25996X
C496[2]	281-0005-00	1.5-7 pF	Cer	Var			X25997-up
C515[2]	281-0572-00	6.8 pF	Cer		500 V	±0.5 pF	X25997-up
C561[2]	283-0103-00	180 pF	Cer		500 V	5%	X25997-up
C601	285-0612-00	1.5 μF	PMC		236 V		X20686-27559
C601	285-0612-01	1.5 μf	PMC		270 V		27560-up
C602A,B	Use 290-0085-00	80 μF x 10 μF	EMC		450 V		
C623	285-0510-00	0.01 μF	MT		400 V		
C633	285-0510-00	0.01 μF	MT		400 V		
C634	283-0000-00	0.001 μF	Cer		500 V		X25997-up
C635	Use 283-0057-00	0.1 μF	Cer		200 V	+80%—20%	
C642	Use 290-0084-00	4000 μF	EMC		15 V		
C644	290-0025-00	6.25 μF	EMT		300 V		
C645	290-0025-00	6.25 μF	EMT		300 V		
C652	Use 290-0013-00	2 x 40 μF	EMC		450 V		
C671	285-0510-00	0.01 μF	MT		400 V		
C685	290-0025-00	6.25 μF	EMT		300 V		
C686	290-0025-00	6.25 μF	EMT		300 V		
C722	Use 290-0013-00	2 x 40 μF	EMC		450 V		
C751	285-0511-00	0.01 μF	PTM		600 V		
C757A,B	Use 290-0010-00	2 x 20 μF	EMC		450 V		
C765A,B	Use 290-0010-00	2 x 20 μF	EMC		450 V		
C800	285-0501-00	0.001 μF	MT		600 V		
C805	285-0510-00	0.01 μF	MT		400 V		20000-27139
C805	285-0511-00	0.01 μF	PTM		600 V		27140-up
C807	283-0538-00	0.003 μF	Mica		500 V	10%	
C808	Use 283-0022-00	0.02 μF	Cer		1400 V		
C820	285-0519-00	0.047 μF	MT		400 V		
C822	283-0034-00	0.005 μF	Cer		4000 V		

[2]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

Capacitors (Cont)

Ckt. No.	Tektronix Part No.		Description			S/N Range
C824	Use 285-0510-00	0.01 μF	MT	400 V		
C828	283-0034-00	0.005 μF	Cer	4000 V		
C830	283-0034-00	0.005 μF	Cer	4000 V		
C833	283-0006-00	0.02 μF	Cer	500 V		
C836	283-0034-00	0.005 μF	Cer	4000 V		
C838	285-0526-00	0.1 μF	MT	400 V		
C839	283-0034-00	0.005 μF	Cer	4000 V		
C841	283-0001-00	0.005 μF	Cer	500 V		
C847	Use 283-0057-00	0.1 μF	Cer	200 V	+80%—20%	20000-27646X
C850	283-0034-00	0.005 μF	Cer	4000 V		
C851	283-0034-00	0.005 μF	Cer	4000 V		
C866	Use 283-0082-00	0.01 μF	Cer	4000 V	+80%—20%	
C867	Use 283-0082-00	0.01 μF	Cer	4000 V	+80%—20%	
C868	Use 283-0082-00	0.01 μF	Cer	4000 V	+80%—20%	
C869	Use 283-0082-00	0.01 μF	Cer	4000 V	+80%—20%	
C871	283-0518-00	330 pF	Mica	500 V	10%	
C876	283-0518-00	330 pF	Mica	500 V	10%	
C881	290-0164-00	1 μF	EMT	150 V		X27320-up

Diodes

D124	*152-0061-00	Silicon	Tek Spec	20000-22539
D124	*152-0107-00	Silicon	Replaceable by 1N647	22540-up
D126	*152-0061-00	Silicon	Tek Spec	20000-22539
D126	*152-0107-00	Silicon	Replaceable by 1N647	22540-up
D131	152-0008-00	Germanium		
D152	152-0246-00	Silicon	Low leakage 0.25 W, 40 V	X26160-up
D408[3]	*152-0185-00	Silicon	Replaceable by 1N3605	X25997-up
D409[3]	*152-0185-00	Silicon	Replaceable by 1N3605	X25997-up
D410[3]	*152-0165-00	Silicon	Selected from 1N3579	X25997-up
D471[3]	152-0243-00	Zener	1N965B 0.4 W, 15 V, 5%	X25997-up
D520[3]	*152-0165-00	Silicon	Selected from 1N3579	X25997-up
D642A	*152-0047-00	Silicon	Replaceable by 1N2862	20000-26159
D642A	152-0066-00	Silicon	1N3194	26160-up
D642B	*152-0047-00	Silicon	Replaceable by 1N2862	20000-26159
D642B	152-0066-00	Silicon	1N3194	26160-up
D644	*152-0185-00	Silicon	Replaceable by 1N3605	X25997-up

Fuses

F601	159-0017-00	4 A	3AG	Fast-Blo	117 V oper 60 cycle
	159-0026-00	3.2 A	3AG	Slo-Blo	117 V oper 50 cycle
	159-0021-00	2 A	3AG	Fast-Blo	234 V oper 60 cycle
	159-0003-00	1.6 A	3AG	Slo-Blo	234 V oper 50 cycle

[3]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

Inductors

Ckt. No.	Tektronix Part No.	Description	S/N Range
L408[4]	276-0507-00	Core, Ferramic Suppressor	X25997-up
L409[4]	276-0507-00	Core, Ferramic Suppressor	X25997-up
L437[4]	*120-0407-00	Torroid, 5 turns, single	X25997-up
L477	276-0557-00	Core, Toroid	X25997-up
L495[4]	276-0557-00	Core, Toroid	X25997-up
L577	276-0557-00	Core, Toroid	X25997-up
L595[4]	276-0557-00	Core, Toroid	X25997-up

Transistors

Q124	151-0093-00	Germanium	2N2043	
Q414[4]	151-0200-00	Silicon	2N3499	X25997-up
Q423[4]	151-0150-00	Silicon	2N3440	X25997-up
Q424[4]	*151-0188-01	Silicon	Replaceable by 2N3251	X25997-up
Q434[4]	*151-0188-01	Silicon	Replaceable by 2N3251	X25997-up
Q438[4]	151-0150-00	Silicon	2N3440	X25997-up
Q453A[4]	*151-0195-00	Silicon	Replaceable by MPS-6515	X25997-up
Q453B[4]	*151-0195-00	Silicon	Replaceable by MPS-6515	X25997-up
Q464A[4]	*151-0195-00	Silicon	Replaceable by MPS-6515	X25997-up
Q464B[4]	*151-0195-00	Silicon	Replaceable by MPS-6515	X25997-up
Q474[4]	151-0190-00	Silicon	2N3904	X25997-up
Q484[4]	151-0190-00	Silicon	2N3904	X25997-up
Q514[4]	151-0200-00	Silicon	2N3499	X25997-up
Q574[4]	151-0190-00	Silicon	2N3904	X25997-up
Q584[4]	151-0190-00	Silicon	2N3904	X25997-up
Q634	151-0004-00	Germanium	2N214	20000-25996
Q634	*151-0153-00	Silicon	Replaceable by 2N2923	25997-up
Q644	151-0004-00	Germanium	2N214	20000-25996
Q644	*151-0153-00	Silicon	Replaceable by 2N2923	25997-up
Q647	Use 151-0137-00	Germanium	2N2148	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R10	302-0105-00	1 MΩ	½ W	
R11	302-0474-00	470 kΩ	½ W	
R13	302-0224-00	220 kΩ	½ W	
R15	302-0105-00	1 MΩ	½ W	
R17[5]	311-0034-00	500 kΩ		Var
R18	302-0124-00	120 kΩ	½ W	
R21	302-0101-00	100 Ω	½ W	
R23	304-0473-00	47 kΩ	1 W	
R24	311-0005-00	500 Ω		Var
R26	302-0333-00	33 kΩ	½ W	

[4]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

[5]Furnished as a unit with SW17.

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R27	302-0101-00	100 Ω	½ W				
R29	301-0204-00	200 kΩ	½ W			5%	
R32	302-0275-00	2.7 MΩ	½ W				
R33	302-0101-00	100 Ω	½ W				
R36	306-0223-00	22 kΩ	2 W				
R39	309-0126-00	400 kΩ	½ W		Prec	1%	
R42	302-0101-00	100 Ω	½ W				
R44	309-0056-00	390 kΩ	½ W		Prec	1%	
R47	301-0302-00	3 kΩ	½ W			5%	
R48	302-0681-00	680 Ω	½ W				
R51	302-0392-00	3.9 kΩ	½ W				
R111	311-0032-00	250 kΩ		Var			
R114	302-0104-00	100 kΩ	½ W				
R116	Use 302-0394-00	390 kΩ	½ W				20000-27259
R116	302-0224-00	220 kΩ	½ W				27260-up
R121	316-0103-00	10 kΩ	¼ W				X21070-up
R122	301-0274-00	270 kΩ	½ W			5%	
R123	302-0183-00	18 kΩ	½ W				
R124	302-0683-00	68 kΩ	½ W				
R125	Use 302-0154-00	150 kΩ	½ W				
R126	302-0334-00	330 kΩ	½ W				
R127	302-0153-00	15 kΩ	½ W				
R128	302-0184-00	180 kΩ	½ W				
R131	302-0472-00	4.7 kΩ	½ W				
R134	301-0393-00	39 kΩ	½ W			5%	
R136	303-0224-00	220 kΩ	1 W			5%	
R137	302-0101-00	100 Ω	½ W				20000-21069
R137	302-0473-00	47 kΩ	½ W				21070-up
R141	309-0040-00	56.5 kΩ	½ W		Prec	1%	
R143	309-0176-00	43.4 kΩ	½ W		Prec	1%	
R144	324-0309-00	16.2 kΩ	1 W		Prec	1%	20000-22539
R144	324-0323-00	22.6 kΩ	1 W		Prec	1%	22540-up
R146	302-0101-00	100 Ω	½ W				
R147	302-0222-00	2.2 kΩ	½ W				
R148	302-0184-00	180 kΩ	½ W				
R152	316-0226-00	22 MΩ	¼ W				X26870-up
R160A	309-0014-00	1 MΩ	½ W		Prec	1%	
R160B	309-0023-00	2 MΩ	½ W		Prec	1%	
R160C	309-0087-00	5 MΩ	½ W		Prec	1%	
R160D	309-0095-00	10 MΩ	½ W		Prec	1%	
R160E	309-0095-00	10 MΩ	½ W		Prec	1%	
R160F	310-0061-00	15 MΩ	1 W		Prec	2%	
R160G	310-0061-00	15 MΩ	1 W		Prec	2%	
R160T	302-0822-00	8.2 kΩ	½ W				
R160V[6]	311-0108-00	20 kΩ		Var			
R161	302-0101-00	100 Ω	½ W				
R166	306-0154-00	150 kΩ	2 W				

[6]Furnished as a unit with SW160V.

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R167	302-0155-00	1.5 MΩ	½ W			
R168	302-0473-00	47 kΩ	½ W			
R169	302-0101-00	100 Ω	½ W			
R174	306-0273-00	27 kΩ	2 W			
R176	311-0016-00	10 kΩ		Var		
R178	304-0183-00	18 kΩ	1 W			
R180A	302-0474-00	470 kΩ	½ W			
R180B	302-0475-00	4.7 MΩ	½ W			
R181	301-0825-00	8.2 MΩ	½ W			5%
R183	302-0101-00	100 Ω	½ W			
R185	302-0473-00	47 kΩ	½ W			
R186	301-0393-00	39 kΩ	½ W			5%
R311	309-0144-00	975 kΩ	½ W		Prec	1%
R312	309-0110-00	800 kΩ	½ W		Prec	1%
R314	309-0051-00	200 kΩ	½ W		Prec	1%
R315	302-0101-00	100 Ω	½ W			
R317	302-0104-00	100 kΩ	½ W			
R320	309-0014-00	1 MΩ	½ W		Prec	1%
R321	302-0101-00	100 Ω	½ W			
R324	301-0564-00	560 kΩ	½ W			5%
R331A	309-0090-00	50 kΩ	½ W		Prec	1%
R331C	309-0228-00	12.5 kΩ	½ W		Prec	1%
R331E	309-0229-00	5.55 kΩ	½ W		Prec	1%
R331G	309-0230-00	2.63 kΩ	½ W		Prec	1%
R331J	309-0231-00	16.69 kΩ	½ W		Prec	1%
R331M	302-0104-00	100 kΩ	½ W			
R331N	302-0104-00	100 kΩ	½ W			
R334	309-0234-00	154 kΩ	½ W		Prec	1%
R336	310-0065-00	56.5 kΩ	1 W		Prec	1%
R337	311-0045-00	15 kΩ		Var		
R338	310-0086-00	50 kΩ	1 W		Prec	1%
R341	311-0032-00	250 kΩ		Var		
R343	302-0474-00	470 kΩ	½ W			
R344	302-0392-00	3.9 kΩ	½ W			
R351	302-0101-00	100 Ω	½ W			
R354	301-0564-00	560 kΩ	½ W			5%
R356	309-0129-00	34 kΩ	½ W		Prec	1%
R357	311-0018-00	20 kΩ		Var		
R358	309-0129-00	34 kΩ	½ W		Prec	1%
R360	301-0304-00	300 kΩ	½ W			5%
R361	302-0101-00	100 Ω	½ W			
R364	308-0105-00	30 kΩ	8 W		WW	5%
R365	305-0823-00	82 kΩ	2 W			5%
R368	311-0011-00	5 kΩ		Var		
R370	301-0304-00	300 kΩ	½ W			5%

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R371	302-0101-00	100 Ω	½ W				
R374	308-0105-00	30 kΩ	8 W		WW	5%	
R376	305-0823-00	82 kΩ	2 W			5%	
R381	309-0052-00	220 kΩ	½ W		Prec	1%	
R383	301-0204-00	200 kΩ	½ W			5%	
R385	302-0223-00	22 kΩ	½ W				
R386	302-0223-00	22 kΩ	½ W				
R391	309-0052-00	220 kΩ	½ W		Prec	1%	
R393	301-0204-00	200 kΩ	½ W			5%	
R395	302-0223-00	22 kΩ	½ W				
R396	302-0223-00	22 kΩ	½ W				
R398	311-0416-00	2 x 50 kΩ		Var			
R403C[7]	323-0614-01	990 kΩ	½ W		Prec	½%	X25997-up
R403D[7]	321-0289-01	10 kΩ	⅛ W		Prec	½%	X25997-up
R403E[7]	311-0367-00	250 Ω		Var			X25997-up
R404[7]	323-0481-01	1 MΩ	½ W		Prec	½%	X25997-up
R405C[7]	323-0614-01	990 kΩ	½ W		Prec	½%	X25997-up
R405D[7]	321-1289-01	10.1 kΩ	⅛ W		Prec	½%	X25997-up
R406[7]	323-0481-01	1 MΩ	½ W		Prec	½%	X25997-up
R406C[7]	309-0111-00	900 kΩ	½ W		Prec	1%	
R406E[7]	309-0046-00	11 kΩ	½ W		Prec	1%	
R406J[7]	309-0013-00	990 kΩ	½ W		Prec	1%	
R406L[7]	309-0034-00	10.1 kΩ	½ W		Prec	1%	
R407C[7]	309-0111-00	900 kΩ	½ W		Prec	1%	
R407E[7]	309-0046-00	111 kΩ	½ W		Prec	1%	
R407J[7]	309-0013-00	990 kΩ	½ W		Prec	1%	
R407L[7]	309-0034-00	10.1 kΩ	½ W		Prec	1%	
R408A[7]	309-0243-00	193 kΩ	½ W		Prec	1%	20000-25996
R408A[7]	321-0713-01	30 Ω	⅛ W		Prec	½%	25997-up
R408B[7]	309-0090-00	50 kΩ	½ W		Prec	1%	20000-25996
R408B[7]	321-0704-00	60 Ω	⅛ W		Prec	½%	25997-up
R408C[7]	309-0231-00	16.69 kΩ	½ W		Prec	1%	20000-25996
R408C[7]	321-0714-01	120.3 Ω	⅛ W		Prec	½%	25997-up
R408D[7]	309-0229-00	5.55 kΩ	½ W		Prec	1%	20000-25996
R408D[7]	321-0715-01	301.5 Ω	⅛ W		Prec	½%	25997-up
R408E[7]	309-0230-00	2.63 kΩ	½ W		Prec	1%	20000-25996
R408E[7]	321-0716-01	606 Ω	⅛ W		Prec	½%	25997-up
R408F[7]	309-0241-00	1.28 kΩ	½ W		Prec	1%	20000-25996
R408F[7]	321-0717-01	1.224 kΩ	⅛ W		Prec	½%	25997-up
R408G[7]	309-0203-00	505.4 Ω	½ W		Prec	¼%	20000-25996
R408G[7]	321-0718-01	3.154 kΩ	⅛ W		Prec	½%	25997-up
R408H[7]	309-0178-00	250 Ω	½ W		Prec	1%	20000-25996
R408H[7]	321-0719-01	6.667 kΩ	⅛ W		Prec	½%	25997-up
R408J[7]	309-0240-00	125 Ω	½ W		Prec	1%	20000-25996
R408J[7]	321-0306-01	15 kΩ	⅛ W		Prec	½%	25997-up

[7]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R408K[8]	309-0128-00	50 Ω	½ W		Prec	1%	20000-25996
R408K[8]	321-0720-01	60 kΩ	⅛ W		Prec	½%	25997-up
R408L[8]	309-0177-00	25 Ω	½ W		Prec	1%	
R409B[8]	316-0123-00	12 kΩ	¼ W				
R409C[8]	315-0103-00	10 kΩ	¼ W			5%	
R409D[8]	316-0392-00	3.9 kΩ	¼ W				
R409E[8]	315-0272-00	2.7 kΩ	¼ W			5%	
R409F[8]	315-0222-00	2.2 kΩ	¼ W			5%	
R409G[8]	316-0152-00	1.5 kΩ	¼ W				
R409H[8]	315-0102-00	1 kΩ	¼ W			5%	
R409J[8]	315-0331-00	330 Ω	¼ W			5%	
R410[8]	*312-0583-00[9]	1 MΩ	½ W		Prec	1%	20000-25996
R410[8]	315-0101-00	100 Ω	¼ W			5%	25997-up
R411[8]	302-0102-00	1 kΩ	½ W				20000-25996X
R412[8]	308-0286-00	8.2 kΩ	3 W		WW	5%	X25997-up
R413[8]	301-0564-00	560 kΩ	½ W			5%	20000-25996
R413[8]	308-0414-00	16.2 kΩ	3 W		WW	1%	25997-up
R414[8]	309-0049-00	150 kΩ	½ W		Prec	1%	20000-25996
R414[8]	308-0414-00	16.2 kΩ	3 W		WW	1%	25997-up
R416[8]	315-0101-00	100 Ω	¼ W			5%	X25997-up
R417[8]	301-0273-00	27 kΩ	½ W			5%	20000-25996X
R418[8]	301-0472-00	4.7 kΩ	½ W			5%	20000-25996
R418[8]	308-0408-00	750 kΩ	½ W		WW	1%	25997-up
R419[8]	311-0614-00	30 kΩ		Var			X25997-up
R420[8]	311-0613-00	100 kΩ		Var			X25997-up
R421[8]	316-0106-00	10 MΩ	¼ W				X25997-up
R422[8]	316-0105-00[10]	1 MΩ	¼ W				X21070-25996X
R423[8]	301-0913-00	91 kΩ	½ W			5%	20000-25996
R423[8]	321-0340-00	34 kΩ	⅛ W		Prec	1%	25997-up
R424[8]	Use 311-0347-00	100 kΩ		Var			20000-25996X
R425[8]	301-0913-00	91 kΩ	½ W			5%	20000-25996
R425[8]	321-0332-00	28 kΩ	⅛ W		Prec	1%	25997-up
R426[8]	321-0313-00	17.8 kΩ	⅛ W		Prec	1%	X25997-up
R427[8]	309-0432-00	82.5 kΩ	½ W		Prec	1%	20000-25996
R427[8]	321-0382-00	93.1 kΩ	⅛ W		Prec	1%	25997-up
R428[8]	309-0432-00	82.5 kΩ	½ W		Prec	1%	20000-25996
R428[8]	321-0386-00	102 kΩ	⅛ W		Prec	1%	25997-up
R429[8]	311-0017-00	10 kΩ		Var			20000-25996
R429[8]	321-0337-00	31.6 kΩ	⅛ W		Prec	5%	25997-up
R433[8]	311-0243-00	50 kΩ		Var			20000-25996

[8]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

[9]Furnished as a unit with R440.

[10]Selected part, added if necessary.

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R433[11]	315-0333-00	33 kΩ	¼ W			5%	25997-up
R434[11]	301-0272-00	2.7 kΩ	½ W			5%	20000-25996X
R435[11]	311-0125-00	50 kΩ		Var			20000-25996X
R436[11]	323-0371-00	71.5 kΩ	½ W		Prec	1%	X25997-up
R437[11]	308-0364-00	9.65 kΩ	3 W		WW	1%	X25997-up
R440[11]	*312-0583-00[12]	1 MΩ	½ W		Prec	1%	20000-25996
R440[11]	321-0452-00	499 kΩ	⅛ W		Prec	1%	25997-up
R441[11]	302-0102-00	1 kΩ	½ W				20000-25996X
R442[11]	311-0618-00[13]	200 kΩ		Var			X25997-up
R443[11]	301-0564-00	560 kΩ	½ W			5%	20000-25996X
R444[11]	309-0049-00	150 kΩ	½ W		Prec	1%	20000-25996
R444[11]	301-0224-00	220 kΩ	½ W			5%	25997-up
R445[11]	311-0618-00[13]	100 kΩ		Var			X25997-up
R446[11]	301-0224-00	220 kΩ	½ W			5%	X25997-up
R447[11]	301-0273-00	27 kΩ	½ W			5%	20000-25996X
R448[11]	301-0472-00	4.7 kΩ	½ W			5%	20000-25996
R448[11]	303-0104-00	100 kΩ	1 W			5%	25997-up
R449[11]	303-0104-00	100 kΩ	1 W			5%	X25997-up
R450[11]	306-0473-00	47 kΩ	2 W				20000-25996X
R451[11]	302-0102-00	1 kΩ	½ W				20000-25996X
R452[11]	309-0414-00	5 MΩ	½ W		Prec	1%	20000-25996
R452[11]	321-0289-00	10 kΩ	⅛ W		Prec	1%	25997-up
R453[11]	306-0153-00	15 kΩ	2 W				20000-25996
R453[11]	315-0101-00	100 Ω	¼ W			5%	25997-up
R454[11]	301-0303-00	30 kΩ	½ W			5%	20000-25996X
R455[11]	311-0067-00	5 kΩ		Var			20000-25996X
R456[11]	311-0084-00	1 kΩ		Var			20000-25996
R456[11]	315-0124-00	120 kΩ	¼ W			5%	25997-up
R457[11]	301-0223-00	22 kΩ	½ W			5%	20000-25996
R457[11]	311-0552-00	1 MΩ		Var			25997-up
R458[11]	301-0223-00	22 kΩ	½ W			5%	20000-25996X
R460[11]	321-0222-00	2 kΩ	⅛ W		Prec	1%	X25997-up
R461[11]	302-0102-00	1 kΩ	½ W				20000-25996
R461[11]	315-0752-00	7.5 kΩ	¼ W			5%	25997-up
R462[11]	309-0414-00	5 MΩ	½ W		Prec	1%	20000-25996X
R463[11]	321-0126-00	200 Ω	⅛ W		Prec	1%	X25997-up
R464[11]	301-0303-00	30 kΩ	½ W			5%	20000-25996
R464[11]	323-0420-00	232 kΩ	½ W		Prec	1%	25997-up
R465[11]	Use 301-0565-00	5.6 MΩ	½ W			5%	

[11]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

[12]Furnished as a unit with R410.

[13]R442 and R445 furnished as a unit.

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R466[14]	311-0028-00	2 x 100 kΩ		Var		20000-25996
R466[14]	311-0617-00[15]	500 Ω		Var		25997-up
R467[14]	Use 301-0565-00	5.6 MΩ	½ W		5%	
R468[14]	302-0103-00	10 kΩ	½ W			20000-25996
R468[14]	315-0394-00	390 kΩ	¼ W		5%	25997-up
R469[14]	302-0103-00	10 kΩ	½ W			20000-25996
R469[14]	311-0225-00	2 x 100 kΩ		Var		25997-up
R470[14]	309-0195-00	90 kΩ	½ W	Prec	1%	20000-25996
R470[14]	305-0473-00	47 kΩ	2 W		5%	25997-up
R471[14]	302-0102-00	1kΩ	½ W			20000-25996
R471[14]	321-0232-00	2.55 kΩ	⅛ W	Prec	1%	25997-up
R472[14]	304-0223-00	22 kΩ	1 W			20000-25996X
R473[14]	302-0102-00	1 kΩ	½ W			20000-25996
R473[14]	322-0357-00	51.1 kΩ	¼ W	Prec	1%	25997-up
R474[14]	305-0273-00	27 kΩ	2 W		5%	20000-25996X
R475[14]	Use 306-0333-00	33 kΩ	2 W			20000-25996
R475[14]	311-0462-00	1 kΩ		Var		25997-up
R476[14]	306-0273-00	27 kΩ	2 W			20000-25996X
R478[14]	302-0472-00	4.7 kΩ	½ W			20000-25996
R478	311-0067-00	5 kΩ		Var		25997-up
R479[14]	302-0472-00	4.7 kΩ	½ W			20000-25996X
R480[14]	309-0195-00	90 kΩ	½ W	Prec	1%	20000-25996
R480[14]	305-0273-00	27 kΩ	2 W		5%	25997-26854
R480[14]	308-0321-00	24.4 kΩ	5 W	WW	1%	26855-up
R481[14]	302-0102-00	1 kΩ	½ W			20000-25996X
R482[14]	304-0223-00	22 kΩ	1 W			20000-25996X
R483[14]	302-0102-00	1 kΩ	½ W			20000-25996
R483[14]	321-0227-00	2.26 kΩ	⅛ W	Prec	1%	25997-up
R484[14]	305-0273-00	27 kΩ	2 W		5%	20000-25996
R484[14]	303-0243-00	24 kΩ	1 W		5%	25997-up
R485[14]	Use 306-0333-00	33 kΩ	2 W			20000-25996
R485[14]	315-0101-00	100 Ω	¼ W		5%	25997-up
R486[14]	306-0273-00	27 kΩ	2 W			20000-25996X
R487[14]	311-0399-00	7 kΩ		Var		20000-25996
R487[14]	309-0086-00	3.5 MΩ	½ W	Prec	1%	25997-up
R488[14]	311-0120-00	2.5 kΩ		Var		20000-25996X
R489[14]	311-0067-00	5 kΩ		Var		20000-25996
R489[14]	309-0021-00	1.84 MΩ	½ W	Prec	1%	25997-up
R490[14]	302-0683-00	68 kΩ	½ W			20000-25996
R490[14]	315-0224-00	220 kΩ	¼ W		5%	25997-up
R491[14]	309-0086-00	3.5 MΩ	½ W	Prec	1%	20000-25996

[14]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

[15]Furnished as a unit with SW466.

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R491[16]	311-0497-00	50 kΩ		Var			25997-up
R492[16]	309-0021-00	1.84 MΩ	½ W		Prec	1%	20000-25996X
R493[16]	303-0473-00	47 kΩ	1 W			5%	X25997-up
R494[16]	302-0224-00	220 kΩ	½ W				20000-25996
R494[16]	303-0473-00	47 kΩ	1 W			5%	25997-up
R495[16]	311-0125-00	50 kΩ		Var			20000-25996X
R496[16]	302-0472-00	4.7 kΩ	½ W				X25997-up
R497[16]	302-0472-00	4.7 kΩ	½ W				X25997-up
R499[16]	304-0473-00	47 kΩ	1 W				20000-25996
R499	302-0683-00	68 kΩ	½ W				25997-up
R510[16]	315-0101-00	100 Ω	¼ W			5%	X25997-up
R513[16]	308-0414-00	16.2 kΩ	3 W		WW	1%	X25997-up
R514[16]	308-0414-00	16.2 kΩ	3 W		WW	1%	X25997-up
R516[16]	315-0101-00	100 Ω	¼ W			5%	X25997-up
R518[16]	308-0408-00	750 Ω	½ W		WW	1%	X25997-up
R540[16]	321-0452-00	499 kΩ	⅛ W		Prec	1%	X25997-up
R552[16]	321-0289-00	10 kΩ	⅛ W		Prec	1%	X25997-up
R553[16]	315-0101-00	100 Ω	¼ W			5%	X25997-up
R556[16]	315-0124-00	120 kΩ	¼ W			5%	X25997-up
R560[16]	321-0222-00	2 kΩ	⅛ W		Prec	1%	X25997-up
R561[16]	315-0752-00	7.5 kΩ	¼ W			5%	X25997-up
R564[16]	323-0420-00	232 kΩ	½ W		Prec	1%	X25997-up
R568[16]	315-0394-00	390 kΩ	¼ W			5%	X25997-up
R571[16]	321-0232-00	2.55 kΩ	⅛ W		Prec	1%	X25997-up
R573[16]	322-0357-00	51.1 kΩ	¼ W		Prec	1%	X25997-up
R580[16]	305-0273-00	27 kΩ	2 W			5%	X25997-26854
R580[16]	308-0321-00	24.4 kΩ	5 W		WW	1%	26855-up
R584[16]	303-0243-00	24 kΩ	1 W			5%	X25997-up
R601[17]	311-0057-00	50 Ω		Var			
R602	302-0101-00	100 Ω	½ W				
R603	302-0101-00	100 Ω	½ W				
R604	308-0142-00	30 Ω	3 W		WW	5%	
R618	302-0102-00	1 kΩ	½ W				
R619	302-0105-00	1 MΩ	½ W				
R621	310-0054-00	68 kΩ	1 W		Prec	1%	
R622	311-0015-00	10 kΩ		Var			
R623	310-0086-00	50 kΩ	1 W		Prec	1%	
R630	302-0333-00	33 kΩ	½ W				
R631	302-0105-00	1 MΩ	½ W				
R632	302-0102-00	1 kΩ	½ W				
R633	302-0105-00	1 MΩ	½ W				
R635	302-0183-00	18 kΩ	½ W				
R636	302-0105-00	1 MΩ	½ W				
R637	308-0040-00	1.5 kΩ	25 W		WW	5%	20000-26909
R637	308-0102-00	1.25 kΩ	25 W		WW	5%	26910-up
R639	302-0333-00	33 kΩ	½ W				
R641	302-0223-00	22 kΩ	½ W				X25997-up

[16]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

[17]Furnished as a unit with SW601.

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R642	302-0104-00	100 kΩ	½ W			
R643	302-0104-00	100 kΩ	½ W			
R644	302-0101-00	100 Ω	½ W			
R645	302-0101-00	100 Ω	½ W			
R646	306-0150-00	15 Ω	2 W			20000-25996X
R647	306-0150-00	15 Ω	2 W			20000-25996X
R648	309-0030-00	1.8 kΩ	½ W	Prec	1%	
R649	310-0068-00	42.226 kΩ	1 W	Prec	1%	
R650	302-0470-00	47 Ω	½ W			
R651	302-0470-00	47 Ω	½ W			
R659	302-0102-00	1 kΩ	½ W			
R660	302-0473-00	47 kΩ	½ W			
R661	302-0473-00	47 kΩ	½ W			
R662	302-0185-00	1.8 MΩ	½ W			
R665	306-0273-00	27 kΩ	2 W			20000-26779
R665	306-0333-00	33 kΩ	2 W			27680-up
R666	302-0105-00	1 MΩ	½ W			
R668	302-0102-00	1 kΩ	½ W			
R669	302-0105-00	1 MΩ	½ W			
R671	310-0088-00	143 kΩ	1 W	Prec	1%	20000-26779
R671	323-0399-00	140 kΩ	½ W	Prec	1%	26780-up
R673	310-0055-00	220 kΩ	1 W	Prec	1%	20000-26779
R673	323-0418-00	221 kΩ	½ W	Prec	1%	26780-up
R685	302-0101-00	100 Ω	½ W			
R686	302-0101-00	100 Ω	½ W			
R722	302-0104-00	100 kΩ	½ W			
R739	302-0102-00	1 kΩ	½ W			
R740	302-0273-00	27 kΩ	½ W			
R741	302-0474-00	470 kΩ	½ W			
R742	304-0274-00	270 kΩ	1 W			
R745	304-0563-00	56 kΩ	1 W			20000-26779
R745	304-0473-00	47 kΩ	1 W			26780-up
R746	302-0225-00	2.2 MΩ	½ W			
R747	302-0102-00	1 kΩ	½ W			
R748	302-0102-00	1 kΩ	½ W			
R749	302-0225-00	2.2 MΩ	½ W			
R751	310-0094-00	400 kΩ	1 W	Prec	1%	20000-26779
R751	324-0443-00	402 kΩ	1 W	Prec	1%	26780-up
R753	309-0151-00	174 kΩ	½ W	Prec	1%	20000-26779
R753	323-0409-00	178 kΩ	½W	Prec	1%	26780-up
R756	302-0102-00	1 kΩ	½ W			
R757	308-0064-00	2.25 kΩ	20 W	WW	5%	
R765	302-0101-00	100 Ω	½ W			
R766	302-0101-00	100 Ω	½ W			
R800	306-0563-00	56 kΩ	2 W			
R805	302-0333-00	33 kΩ	½ W			
R806	302-0392-00	3.9 kΩ	½ W			
R808	306-0122-00	1.2 kΩ	2 W			
R809	302-0474-00	470 kΩ	½ W			
R820	302-0102-00	1 kΩ	½ W			
R824	316-0472-00	4.7 kΩ	¼ W			

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R825	306-0225-00	2.2 MΩ	2 W			
R826	311-0039-00	1 MΩ		Var		
R827	306-0275-00	2.7 MΩ	2 W			
R828	306-0335-00	3.3 MΩ	2 W			
R829	306-0335-00	3.3 MΩ	2 W			
R830	306-0395-00	3.9 MΩ	2 W			
R831	311-0254-00	5 MΩ		Var		
R832	311-0254-00	5 MΩ		Var		
R833	311-0026-00	100 kΩ		Var		
R834	316-0472-00	4.7 kΩ	1/4 W			
R836	306-0395-00	3.9 MΩ	2 W			
R837	302-0103-00	10 kΩ	1/2 W			
R838	302-0103-00	10 kΩ	1/2 W			
R839	302-0105-00	1 MΩ	1/2 W			
R840	311-0026-00	100 kΩ		Var		
R841	311-0026-00	100 kΩ		Var		
R842	311-0023-00	50 kΩ		Var		
R843	304-0273-00	27 kΩ	1 W			
R844	311-0026-00	100 kΩ		Var		
R845	304-0273-00	27 kΩ	1 W			
R846	302-0155-00	1.5 MΩ	1/2 W			20000-27646X
R847	302-0225-00	2.2 MΩ	1/2 W			20000-27646X
R852	306-0825-00	8.2 MΩ	2 W			
R853	306-0825-00	8.2 MΩ	2 W			
R854	306-0825-00	8.2 MΩ	2 W			
R858	306-0156-00	15 MΩ	2 W			
R859	306-0156-00	15 MΩ	2 W			
R860	311-0397-00	2 MΩ		Var		
R861	304-0105-00	1 MΩ	1 W			
R862	311-0397-00	2 MΩ		Var		
R863	302-0226-00	22 MΩ	1/2 W			
R864	302-0563-00	56 kΩ	1/2 W			
R865	302-0226-00	22 MΩ	1/2 W			
R866	302-0105-00	1 MΩ	1/2 W			
R868	302-0105-00	1 MΩ	1/2 W			
R870	302-0154-00	150 kΩ	1/2 W			
R871	302-0335-00	3.3 MΩ	1/2 W			
R872	302-0102-00	1 kΩ	1/2 W			
R873	302-0223-00	22 kΩ	1/2 W			X27320-up
R874	302-0683-00	68 kΩ	1/2 W			
R875	302-0225-00	2.2 MΩ	1/2 W			
R876	302-0102-00	1 kΩ	1/2 W			
R878	302-0473-00	47 kΩ	1/2 W			20000-27319
R878	301-0513-00	51 kΩ	1/2 W		5%	27320-up
R879	311-0016-00	10 kΩ		Var		
R880	304-0333-00	33 kΩ	1 W			20000-27319
R880	301-0393-00	39 kΩ	1/2 W		5%	27320-up
R881	306-0153-00	15 kΩ	2 W			X27320-up
R882	304-0682-00	6.8 kΩ	1 W			X27320-up
R883	302-0101-00	100 Ω	1/2 W			

Resistors (Cont)

Ckt. No.	Tektronix Part No.		Description			S/N Range
R884	Use 323-0731-01	204 Ω	½ W	Prec	½%	
R885	Use 323-1313-01	18 kΩ	½ W	Prec	½%	
R886	Use 323-1217-01	1.8 kΩ	½ W	Prec	½%	
R887	Use 323-0730-01	9 kΩ	½ W	Prec	½%	
R888	Use 323-0729-01	900 Ω	½ W	Prec	½%	
R889	Use 323-0728-01	90 Ω	½ W	Prec	½%	
R890	Use 323-0001-01	10 Ω	½ W	Prec	½%	
R899	*308-0090-00	0.25 Ω	1 W	WW		

Switches

	Unwired	Wired			
SW10	260-0233-00	*262-0177-00	Rotary	TRIGGER SELECTOR	
SW17[18]	260-0235-00	*262-0178-00	Rotary	TRIGGERING LEVEL	
SW20	260-0447-00		Slide	TRIGGER SELECTOR (Slope)	
SW126	260-0501-00		Lever	MODE	
SW160	260-0529-00	*262-0556-00	Rotary	TIME/CM	20000-26679
SW160	260-0529-00	*262-0556-01	Rotary	TIME/CM	26680-up
SW160V[19]	311-0108-00				
SW331	260-0236-00	*262-0172-00	Rotary	HORIZONTAL DISPLAY	
SW403	Use 260-0238-01	*262-0179-00	Rotary	INPUT SELECTOR (Upper)	
SW403	Use 260-0238-01	*262-0190-00	Rotary	INPUT SELECTOR (Lower)	
SW407[20]	260-0525-00	*262-0555-00	Rotary	SENSITIVITY	20000-25996
SW407[20]	260-0525-00	*262-0555-01	Rotary	SENSITIVITY	25997-up
SW466[20]	311-0617-00[21]				X25997-up
SW478[20]	260-0247-00		Push-Button	FINDER (Trace)	20000-25996X
SW496[20]	260-0247-00		Push-Button	FINDER (Trace)	X25997-up
SW489	260-0237-00	*262-0180-00	Rotary	HORIZ DEFL PLATE SELECTOR	20000-25996
SW489	260-0237-00	*262-0180-01	Rotary	HORIZ DEFL PLATE SELECTOR	25997-up
SW601[22]	311-0057-00			POWER OFF	
SW870	260-0234-00	*262-0176-00	Rotary	AMPLITUDE CALIBRATOR	20000-25996
SW870	260-0234-00	*262-0176-01	Rotary	AMPLITUDE CALIBRATOR	25997-up

Thermal Cut-Out

TK601	Use 260-0208-00	133°F ±5°F

[18]Furnished as a unit with R17.

[19]Furnished as a unit with R160V.

[20]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

[21]Furnished as a unit with R466.

[22]Furnished as a unit with R601.

Transformers

Ckt. No.	Tektronix Part No.	Description	S/N Range
T602	*120-0117-00	L.V. Power	
T801	*120-0150-00	H.V. Power	

Electron Tubes

V24	154-0187-00	6DJ8		
V45	154-0187-00	6DJ8		
V135	154-0078-00	6AN8		20000-24099
V135	154-0187-00	6DJ8		24100-up
V145	154-0078-00	6AN8		20000-26779
V145	154-0278-00	ECF-80/6BL8		26780-up
V152	Use *157-0104-01	6AL5	Selected	20000-26159
V152	154-0016-00	6AL5		26160-up
V161	154-0078-00	6AN8		20000-26779
V161	154-0278-00	ECF-80/6BL8		26780-up
V183	154-0187-00	6DJ8		
V324	154-0022-01	6AU6		20000-26029
V324	154-0022-00	6AU6		26030-up
V354	154-0022-01	6AU6		20000-26029
V354	154-0022-00	6AU6		26030-up
V364	154-0187-00	6DJ8		
V414[23] } V444 }	*157-0073-00	6AU6	Checked (1 pair)	20000-25996X
V414[23]	*157-0099-00[24]	8056	Checked	X25997-up
V454[23]	154-0022-01	6AU6		20000-25996X
V464[23]	154-0022-01	6AU6		20000-25996X
V474[23]	154-0039-02	12AT7		20000-25996X
V484[23]	154-0039-02	12AT7		20000-25996
V484[23]	154-0187-00	6DJ8		25997-up
V493[23]	154-0022-01	6AU6		20000-25996
V493[23]	154-0187-00	6DJ8		25997-up
V514[23]	157-0099-00[25]	8056	Checked	X25997-up
V602	154-0168-00	5AR4/GZ34		
V636	154-0078-00	6AN8		20000-26779
V636	154-0278-00	ECF-80/6BL8		26780-up
V637	154-0044-00	12B4		
V639	154-0052-00	5651		
V652	152-0119-00	6BW4		
V666	154-0078-00	6AN8		20000-26779
V666	154-0278-00	ECF-80/6BL8		26780-up
V677	154-0044-00	12B4		
V722	154-0168-00	5AR4/GZ34		
V746	154-0078-00	6AN8		20000-26779
V746	154-0278-00	ECF-80/6BL8		26780-up
V747	154-0044-00	12B4		
V757	154-0044-00	12B4		
V800	154-0302-00	6DT5		
V814	154-0041-00	12AU7		

[23]There are two parts of this description in your instrument, one in each of the Vertical Amplifiers.

[24]Furnished as a unit with V514.

[25]Furnished as a unit with V414.

Electron Tubes *(Cont)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
V822	154-0051-00	5642	
V832	154-0051-00	5642	
V859	*154-0246-00	T5021-2 CRT Standard Phosphor	
V862	154-0051-00	5642	
V873	154-0078-00	6AN8	20000-26779
V873	154-0278-00	ECF-80/6BL8	26780-up
V875	154-0022-01	6AU6	20000-26029
V875	154-0022-00	6AU6	26030-up

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

SECTION 8

MECHANICAL PARTS LIST

FIG. 1 FRONT

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-1	333-0748-00	20000	25996	1	PANEL, front
	333-0748-02	25997		1	PANEL, front
-2	337-0187-00			1	SHIELD, graticule light, 5 inch
-3	331-0047-00			1	GRATICULE, 10 CM vertical x 10 CM horizontal, 5 inch
-4	200-0382-00			1	COVER, graticule
	- - - - - -			-	cover includes:
-5	354-0116-00			1	RING, ornamental, 5 inch graticule
	- - - - - -			-	mounting hardware: (not included w/cover)
-6	210-0816-00			4	WASHER, rubber
-7	210-0424-00			4	NUT, knurled, graticule, 3/8-24 x 9/16 x 3/16 inch
-8	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-9	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-10	210-0494-00			1	NUT, hex., 3/8-32 x 1/2 x 11/16 inch
-11	210-0013-00			1	LOCKWASHER, internal 3/8 ID x 11/16 inch OD
-12	358-0010-00			1	BUSHING, 3/8-32 x 1/2 x 0.512 inch long
-13	387-0785-00			1	PLATE, subpanel, front
	- - - - - -			-	plate includes:
-14	354-0069-00			1	RING, ornamental, 1/8 inch diameter
-15	355-0043-00			4	STUD, graticule (replacement)
	- - - - - -			-	each stud includes:
	212-0507-00			1	SCREW, 10-32 x 3/8 inch, PHS
	210-0010-00			1	LOCKWASHER, internal, #10
-16	366-0148-00			1	KNOB, charcoal—TRIGGERING LEVEL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-17	262-0178-00			1	SWITCH, wired—TRIGGERING LEVEL
	- - - - - -			-	switch includes:
	260-0235-00			1	SWITCH, unwired
-18	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-19	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-20	210-0413-00			2	NUT, hex., 3/8-32 x 1/2 inch
-21	376-0014-00			1	COUPLING, steel wire
	- - - - - -			-	mounting hardware: (not included w/switch)
-22	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-23	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-24	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-25	129-0063-00			2	POST, binding, 5 way
	- - - - - -			-	mounting hardware for each: (not included w/post)
-26	358-0169-00			1	BUSHING, binding post
	210-0010-00	20000	21189X	1	LOCKWASHER, internal, #10
	210-0206-00	20000	21189X	1	LUG, solder, SE #10 long
	210-0445-00	20000	21189	2	NUT, hex., 10-32 x 3/8 inch
-27	220-0410-00	21190		1	NUT, keps, 10-32 x 3/8 inch

FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-28	366-0145-00			1	KNOB, charcoal—UPPER LOWER EXT AC-DC
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-29	262-0177-00			1	SWITCH, wired—UPPER LOWER EXT AC-DC
	- - - - - -			-	switch includes:
	260-0233-00			1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
-30	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-31	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-32	260-0447-00			1	SWITCH, unwired—TRIGGER SELECTOR
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0101-00			2	SCREW, 4-40 x 1/4 inch, 100° csk, FHS
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-33	366-0215-00	20000	23699	1	KNOB, charcoal—MODE
	366-0215-01	23700		1	KNOB, charcoal—MODE
-34	260-0501-00			1	SWITCH, unwired—MODE
	- - - - - -			-	mounting hardware: (not included w/switch)
-35	210-0004-00			2	LOCKWASHER, internal, #4
-36	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-37	352-0008-00	20000	24379	2	HOLDER, neon, single
	- - - - - -			-	mounting hardware for each: (not included w/holder)
-38	211-0031-00	20000	24379	1	SCREW, 4-40 x 1 inch, FHS
-39	210-0406-00	20000	24379	2	NUT, hex., 4-40 x 3/16 inch
	352-0067-00	24380		2	HOLDER, neon, single
	- - - - - -			-	mounting hardware for each: (not included w/holder)
	211-0109-00	24380		1	SCREW, 4-40 x 7/8 inch, FHS
	210-0406-00	24380		2	NUT, hex., 4-40 x 3/16 inch
-40	378-0541-00	X24380		4	FILTER, lens, clear
-41	352-0006-00	20000	24379	1	HOLDER, neon, double
	- - - - - -			-	mounting hardware: (not included w/holder)
-42	211-0031-00	20000	24379	1	SCREW, 4-40 x 1 inch, FHS
-43	210-0406-00	20000	24379	2	NUT, hex., 4-40 x 3/16 inch
	352-0064-00	24380		1	HOLDER, neon, double
	- - - - - -			-	mounting hardware: (not included w/holder)
	211-0109-00	24380		1	SCREW, 4-40 x 7/8 inch, FHS
	2100406-00	24380		2	NUT, hex., 4-40 x 3/16 inch
-44	366-0144-00			1	KNOB, charcoal—TIME/CM
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-45	366-0038-00			1	KNOB, red—VARIABLE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS

FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-46	358-0029-00			2	BUSHING, hex., 3/8-32 x 1/2 x 1/2 inch long
	- - - - - -			-	mounting hardware for each: (not included w/bushing)
-47	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-48	366-0145-00			1	KNOB, charcoal—HORIZONTAL DISPLAY
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-49	366-0145-00			1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-50	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-51	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
-52	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-52	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-54	366-0148-00	20000	25996	1	KNOB, charcoal—DC BAL
	- - - - - -			-	knob includes:
	213-0004-00	20000	25996	1	SCREW, set, 6-32 x 3/16 inch, HSS
	366-0254-00	25997		1	KNOB, charcoal—DC BAL
	- - - - - -			-	knob includes:
	213-0020-00	25997		1	SCREW, set, 6-32 x 1/8 inch, HSS
-55	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-56	210-0207-00	20000	25996X	1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
-57	210-0012-00	20000	25996	1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0013-00	25997		1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-58	210-0840-00	20000	25996X	1	WASHER, flat, 0.390 ID x 9/16 inch OD
-59	210-0413-00	20000	25996	1	NUT, hex., 3/8-32 x 1/2 inch
	210-0590-00	25997		1	NUT, hex., 3/8-32 x 7/16 inch
-60	200-0263-00	20000	25996X	2	COVER, dust, variable resistor
-61	366-0148-00	20000	25996	1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0004-00	20000	25996	1	SCREW, set, 6-32 x 3/16 inch, HSS
	366-0220-00	25997		1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0020-00	25997		1	SCREW, set, 6-32 x 1/8 inch, HSS
-62	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0207-00	X25997		1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
-63	210-0013-00	20000	25996	1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
	210-0012-00	25997		1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-64	210-0840-00	20000	25996X	1	WASHER, flat, 0.390 ID x 9/16 inch OD
-65	210-0413-00	20000	25996	1	NUT, hex., 3/8-32 x 1/2 inch
	210-0590-00	25997		1	NUT, hex., 3/8-32 x 7/16 inch

FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-66	129-0020-00			1		ASSEMBLY, binding post
	- - - - - -			-		assembly includes:
-67	200-0072-00			1		CAP, knurled
	355-0503-00			1		STEM, binding post
	- - - - - -			-		mounting hardware: (not included w/assembly)
-68	210-0206-00			1		LUG, solder, SE #10 long
	220-0410-00			1		NUT, keps, 10-32 x 3/8 inch
-69	366-0145-00			1		KNOB, charcoal—AMPLITUDE CALIBRATOR
	- - - - - -			-		knob includes:
	213-0004-00			1		SCREW, set, 6-32 x 3/16 inch, HSS
-70	262-0176-00	20000	25996	1		SWITCH, wired—AMPLITUDE CALIBRATOR
	262-0176-01	25997		1		SWITCH, wired—AMPLITUDE CALIBRATOR
	- - - - - -			-		switch includes:
	260-0234-00			1		SWITCH, unwired
	- - - - - -			-		mounting hardware: (not included w/switch)
-71	210-0013-00			1		LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-72	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch
-73	337-0237-00			1		SHIELD, switch
	- - - - - -			-		mounting hardware: (not included w/shield)
-74	210-0586-00			2		NUT, keps, 4-40 x 1/4 inch
-75	366-0148-00	20000	25996	1		KNOB, charcoal—DC BAL
	- - - - - -			-		knob includes:
	213-0004-00	20000	25996	1		SCREW, set, 6-32 x 3/16 inch, HSS
	366-0254-00	25997		1		KNOB, charcoal—DC BAL
	- - - - - -			-		knob includes:
	213-0020-00	25997		1		SCREW, set, 6-32 x 1/8 inch, HSS
-76	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-77	210-0207-00	20000	25996X	1		LUG, solder, 3/8 ID x 5/8 inch OD, SE
-78	210-0012-00	20000	25996	1		LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0013-00	25997		1		LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-79	210-0840-00	20000	25996X	1		WASHER, flat, 0.390 ID x 9/16 inch OD
-80	210-0413-00	20000	25996	1		NUT, hex., 3/8-32 x 1/2 inch
	210-0590-00	25997		1		NUT, hex., 3/8-32 x 7/16 inch

FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-81	366-0148-00	20000	25996	1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0004-00	20000	25996	1	SCREW, set, 6-32 x 3/16 inch, HSS
	366-0220-00	25997		1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0020-00	25997		1	SCREW, set, 6-32 x 1/8 inch, HSS
-82	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0207-00	X25997		1	LUG, solder, 3/8 ID x 5/8 inch, OD, SE
-83	210-0013-00	20000	25996	1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
	210-0012-00	25997		1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-84	210-0840-00	20000	25996X	1	WASHER, flat, 0.390 ID x 9/16 inch OD
-85	210-0413-00	20000	25996	1	NUT, hex., 3/8-32 x 1/2 inch
	210-0590-00	25997		1	NUT, hex., 3/8-32 x 7/16 inch
-86	384-0279-00	20000	21609	2	ROD, extension w/knob, 9 23/64 inches long
	384-0301-00	21610		2	ROD, extension w/knob, 9 29/64 inches long
-87	105-0050-00			2	STOP, shaft rotation
	- - - - - -			-	each stop includes:
	213-0048-00			1	SCREW, set, 4-40 x 1/8 inch, HSS
-88	366-0144-00			1	KNOB, charcoal—SENSITIVITY, lower beam
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-89	366-0038-00			1	KNOB, red—VARIABLE, lower beam
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-90	366-0144-00			1	KNOB, charcoal—SENSITIVITY, lower beam
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-91	366-0038-00			1	KNOB, red—VARIABLE, upper beam
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-92	366-0145-00			1	KNOB, charcoal—AC DC, lower beam
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-93	366-0145-00			1	KNOB, charcoal—AC DC, upper beam
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-94	129-0053-00			2	ASSEMBLY, binding post
	- - - - - -			-	each assembly includes:
-95	355-0507-00			1	STEM, binding post
-96	200-0103-00			1	CAP, knurled
	- - - - - -			-	mounting hardware for each: (not included w/assembly)
-97	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-98	210-0455-00			1	NUT, hex., 1/4-28 x 3/8 inch

FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-99	366-0225-00			1		KNOB, charcoal—UPPER FOCUS
	- - - - - -			-		knob includes:
	213-0020-00			1		SCREW, set, 6-32 x 1/8 inch, HSS
-100	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-101	210-0046-00			1		LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-102	210-0940-00			1		WASHER, flat, 1/4 ID x 3/8 inch OD
-103	210-0583-00			1		NUT, hex., 1/4-32 x 5/16 inch
-104	366-0225-00			1		KNOB, charcoal—LOWER FOCUS
	- - - - - -			-		knob includes:
	213-0020-00			1		SCREW, set, 6-32 x 1/8 inch, HSS
-105	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-106	210-0046-00			1		LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-107	210-0940-00			1		WASHER, flat, 1/4 ID x 3/8 inch OD
-108	210-0583-00			1		NUT, hex., 1/4-32 x 5/16 inch
-109	366-0225-00			1		KNOB, charcoal—INTENSITY
	- - - - - -			-		knob includes:
	213-0020-00			1		SCREW, set, 6-32 x 1/8 inch, HSS
-110	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-111	210-0046-00			1		LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-112	210-0940-00			1		WASHER, flat, 1/4 ID x 3/8 inch OD
-113	210-0583-00			1		NUT, hex., 1/4-32 x 5/16 inch
-114	366-0225-00			1		KNOB, charcoal—INTENSITY BALANCE
	- - - - - -			-		knob includes:
	213-0020-00			1		SCREW, set, 6-32 x 1/8 inch, HSS
-115	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-116	210-0046-00			1		LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-117	210-0940-00			1		WASHER, flat, 1/4 ID x 3/8 inch OD
-118	210-0583-00			1		NUT, hex., 1/4-32 x 5/16 inch

FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-119	366-0220-00			1		KNOB, charcoal—POWER and SCALE ILLUM
	- - - - - -			-		knob includes:
	213-0020-00			1		SCREW, set, 6-32 x 1/8 inch, HSS
-120	358-0178-00	20000	26699	1		BUSHING, panel, charcoal
	358-0216-00	26700		1		BUSHING, panel, gray
-121	131-0064-00			5		CONNECTOR, coaxial, 1 contact
	- - - - - -			-		mounting hardware: (not included w/connector)
-122	211-0025-00			2		SCREW, 4-40 x 3/8 inch, FHS
-123	406-0244-00			1		BRACKET, plastic
-124	210-0224-00			1		LUG, solder, #10 SE
-125	210-0812-00			2		WASHER, fiber, #10
-126	210-0586-00			2		NUT, keps, 4-40 x 1/4 inch
-127	337-0238-00	20000	21069	1		SHIELD, focus & intensity variable resistor
	337-0606-00	21070		1		SHIELD, focus & intensity variable resistor
	- - - - - -			-		mounting hardware: (not included w/shield)
-128	211-0541-00			2		SCREW, 6-32 x 1/4 inch, FHS
-129	179-0782-00	20000	25996X	1		CABLE HARNESS, position balance

FIG. 2 SWEEP & FOCUS & INTENSITY

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-1	441-0492-00	20000	26779	1	CHASSIS, sweep
	441-0492-02	26780		1	CHASSIS, sweep
	- - - - - -			-	mounting hardware: (not included w/chassis)
	210-0804-00			1	WASHER, flat, 0.170 ID x 3/8 inch OD
	212-0004-00			3	SCREW, 8-32 x 5/16 inch, PHS
	212-0040-00			4	SCREW, 8-32 x 3/8 inch, FHS
	210-0458-00			7	NUT, keps, 8-32 x 11/32 inch
-2	136-0008-00			3	SOCKET, tube, 7 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-3	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-4	136-0015-00			6	SOCKET, tube, 9 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-5	348-0005-00			4	GROMMET, rubber, 1/2 inch diameter
-6	348-0031-00	20000	25996X	1	GROMMET, plastic, 1/4 inch diameter
-7	385-0135-00			2	ROD, plastic, 5/16 x 15/16 inch
	- - - - - -			-	mounting hardware for each: (not included w/rod)
-8	213-0041-00			1	SCREW, thread cutting, 6-32 x 3/8 inch, THS
-9	136-0015-00			2	SOCKET, tube, 9 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0044-00	20000	25996X	2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-10	337-0005-00	X25997		1	SHIELD, tube, socket, 29/32 inch ID
-11	211-0033-00	X25997		2	SCREW, sems, 4-40 x 5/16 inch, PHS
-12	210-0004-00	X25997		2	LOCKWASHER, internal, #4
-13	210-0406-00	X25997		2	NUT, hex., 4-40 x 3/16 inch
-14	337-0008-00	X25997		2	SHIELD, tube, 1 1/32 ID x 1 15/16 inches high
-15	- - - - - -			9	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-16	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-17	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-18	136-0015-00			1	SOCKET, tube, 9 pin, w/ground lugs
	- - - - - -			-	mounting hardware: (not included w/socket)
	337-0005-00			1	SHIELD, socket, 29/32 inch ID
	211-0033-00			2	SCREW, sems, 4-40 x 5/16 inch, PHS
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch

FIG. 2 SWEEP & FOCUS & INTENSITY *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-19	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-20	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD
-21	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-22	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-23	385-0120-00			1	ROD, plastic, shield support
	- - - - - -			-	mounting hardware: (not included w/rod)
-24	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-25	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer)
-26	124-0045-00			1	STRIP, bakelite, 1/2 x 2 1/4 inches long
-27	346-0001-00			1	STRAP, 5/16 x 4 1/4 inches
-28	210-0004-00			2	LOCKWASHER, internal, #4
-29	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-30	337-0330-00			1	SHIELD, high voltage
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0541-00			2	SCREW, 6-32 x 1/4 inch, FHS
-31	211-0542-00			1	SCREW, 6-32 x 5/16 inch, THS
-32	441-0495-00			1	CHASSIS, focus & intensity
	- - - - - -			-	mounting hardware: (not included w/chassis)
	212-0040-00			3	SCREW, 8-32 x 3/8 inch, FHS
	210-0804-00			3	WASHER, flat, 0.170 ID x 3/8 inch OD
	210-0458-00			3	NUT, keps, 8-32 x 11/32 inch
-33	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-34	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-35	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD
-36	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-37	348-0003-00			1	GROMMET, rubber, 5/16 inch
-38	348-0002-00			2	GROMMET, rubber, 1/4 inch
-39	385-0120-00			1	ROD, plastic, shield support
	- - - - - -			-	mounting hardware: (not included w/rod)
-40	211-0538-00			1	SCREW, 6-32 x 5/16 inch, FHS
-41	337-0575-00			1	SHIELD, focus & intensity
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0541-00			2	SCREW, 6-32 x 1/4 inch, FHS
-42	211-0542-00			1	SCREW, 6-32 x 5/16 inch, THS
-43	348-0012-00			2	GROMMET, rubber, 5/8 inch

FIG. 3 LOW VOLTAGE POWER

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
3-1	441-0493-00	20000	26779	1	CHASSIS, low voltage power
	441-0493-02	26780		1	CHASSIS, low voltage power
	- - - - - -			-	mounting hardware: (not included w/chassis)
	212-0040-00			6	SCREW, 8-32 x 3/8 inch, FHS
	210-0458-00			6	NUT, keps, 8-32 x 11/32 inch
-2	348-0004-00			3	GROMMET, rubber, 3/8 inch
-3	337-0259-00	20000	25996	1	SHIELD, lower vertical amplifier
	337-0834-00	25997		1	SHIELD, lower vertical amplifier
	- - - - - -			-	mounting hardware: (not included w/shield)
-4	211-0507-00	20000	25996	2	SCREW, 6-32 x 5/16 inch, PHS
	211-0507-00	25997		1	SCREW, 6-32 x 5/16 inch, PHS
-5	348-0040-00			8	ASSEMBLY, shockmount
	- - - - - -			-	each assembly includes:
-6	348-0039-00			1	SHOCKMOUNT, assembly
-7	406-0399-00			1	BRACKET, shockmount
	- - - - - -			-	mounting hardware for each: (not included w/assembly)
	210-0006-00	20000	25996X	1	LOCKWASHER, internal, #6
-8	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-9	210-0457-00	X23900		2	NUT, keps, 6-32 x 5/16 inch
-10	343-0042-00			2	CLAMP, cable, plastic 5/16 inch (half)
	- - - - - -			-	mounting hardware for each: (not included w/clamp)
-11	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-12	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD
-13	210-0006-00			1	LOCKWASHER, internal, #6
-14	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-15	136-0015-00			9	SOCKET, tube, 9 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-16	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-17	136-0008-00			2	SOCKET, tube, 7 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-18	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-19	136-0011-00			2	SOCKET, tube, 8 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-20	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS

FIG. 3 LOW VOLTAGE POWER *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
3-21	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-22	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-23	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-24	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included w/resistor)
-25	212-0037-00			1	SCREW, 8-32 x 1 3/4 inches, FIL HS
-26	210-0008-00			1	LOCKWASHER, internal, #8
-27	210-0809-00			1	WASHER, centering, 25 watt
-28	210-0462-00			1	NUT, hex., 8-32 x 1/2 x 23/64 inch long
-29	212-0004-00			1	SCREW, 8-32 x 5/16 inch, PHS
-30	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included w/resistor)
-31	212-0037-00			1	SCREW, 8-32 x 1 3/4 inches, FIL HS
-32	210-0808-00			1	WASHER, centering, 20 watt
-33	210-0462-00			1	NUT, hex., 8-32 x 1/2 x 23/64 inch long
-34	212-0004-00			1	SCREW, 8-32 x 5/16 inch, PHS
-35	348-0002-00			2	GROMMET, rubber, 1/4 inch
-36	337-0256-00	20000	25996	1	SHIELD, upper vertical amplifier
	337-0835-00	25997		1	SHIELD, upper vertical amplifier
-37	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-38	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-39	210-0444-00			1	NUT, hex., 3/8-32 x 1/2 x 5/8 inch long
-40	337-0832-00	X25997		1	SHIELD, upper beam
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0008-00	X25997		1	SCREW, 4-40 x 1/4 inch, PHS
	210-0586-00	X25997		1	NUT, keps, 4-40 x 1/4 inch
-41	337-0831-00	X25997	27259	1	SHIELD, lower beam
	337-0831-01	27260		1	SHIELD, lower beam
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
	211-0008-00	X25997		1	SCREW, 4-40 x 1/4 inch, PHS
	210-0586-00	X25997		1	NUT, keps, 4-40 x 1/4 inch

FIG. 3 LOW VOLTAGE POWER *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
3-42	- - - - - -			1		TRANSISTOR
	- - - - - -			-		mounting hardware: (not included w/transistor)
-43	211-0510-00			2		SCREW, 6-32 x 3/8 inch, PHS
-44	210-0006-00			1		LOCKWASHER, internal, #6
-45	210-0202-00			1		LUG, solder, SE #6
-46	210-0407-00			2		NUT, hex., 6-32 x 1/4 inch
-47	136-0050-00			2		SOCKET, transistor, 4 pin
	- - - - - -			-		mounting hardware for each: (not included w/socket)
-48	213-0055-00			2		SCREW, thread forming, 2-32 x 3/16 inch, PHS
-49	348-0005-00			1		GROMMET, rubber, 1/2 inch
-50	- - - - - -			1		TRANSFORMER
	- - - - - -			-		transformer includes
-51	212-0546-00			4		SCREW, 10-32 x 4 1/2 inch, hex., HS
-52	210-0812-00			4		WASHER, fiber, #10
	- - - - - -			-		mounting hardware: (not included w/transformer)
-53	220-0410-00			3		NUT, keps, 10-32 x 3/8 inch
-54	- - - - - -			3		CAPACITOR
	- - - - - -			-		mounting hardware for each: (not included w/capacitor)
-55	211-0543-00			2		SCREW, 6-32 x 5/16 inch, RHS
-56	386-0254-00			1		PLATE, fiber, large
	210-0006-00			2		LOCKWASHER, internal, #6
	210-0407-00			2		NUT, hex., 6-32 x 1/4 inch
-57	200-0259-00			1		COVER, plastic, 1.365 ID x 3 9/16 inch long
-58	200-0258-00			1		COVER, plastic, 1.365 ID x 3 1/32 inch long
-59	200-0293-00			1		COVER, plastic, 1.365 ID x 2 9/16 inch long
-60	- - - - - -			1		CAPACITOR
	- - - - - -			-		mounting hardware: (not included w/capacitor)
-61	211-0534-00			2		SCREW, sems, 6-32 x 5/16 inch, PHS
-62	386-0255-00			1		PLATE, metal, large
	210-0006-00			2		LOCKWASHER, internal, #6
	210-0407-00			2		NUT, hex., 6-32 x 1/4 inch
-63	- - - - - -			2		CAPACITOR
	- - - - - -			-		mounting hardware for each: (not included w/capacitor)
-64	211-0534-00			2		SCREW, sems, 6-32 x 5/16 inch, PHS
-65	386-0253-00			1		PLATE, metal, small
	210-0006-00			2		LOCKWASHER, internal, #6
	210-0407-00			2		NUT, hex., 6-32 x 1/4 inch
-66	385-0141-00			1		ROD, hex., transformer support
	- - - - - -			-		mounting hardware: (not included w/rod)
	211-0522-00			1		SCREW, 6-32 x 5/8 inch, FHS

FIG. 4 VERTICAL AMPLIFIERS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty 1 2 3 4 5	Description
4-1	441-0494-00			2	CHASSIS, vertical amplifier (left & right)
	- - - - - -			-	mounting hardware for each: (not included w/chassis)
	210-0006-00			4	LOCKWASHER, internal, #6
	210-0407-00			4	NUT, hex., 6-32 x 1/4 inch
-2	406-0468-00			2	BRACKET, variable resistor
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
-3	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
-4	- - - - - -			6	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-5	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-6	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-7	136-0044-00			2	SOCKET, tube, 7 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-8	211-0033-00			2	SCREW, 4-40 x 5/16 inch, PHS
-9	210-0004-00			2	LOCKWASHER, internal, #4
-10	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-11	348-0002-00			2	GROMMET, rubber, 1/4 inch
-12	348-0003-00			4	GROMMET, rubber, 5/16 inch
-13	136-0015-00			4	SOCKET, tube, 9 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	211-0033-00			2	SCREW, 4-40 x 5/16 inch, PHS
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-14	136-0010-00			2	SOCKET, 9 pin, w/o ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-15	211-0033-00			2	SCREW, sems, 4-40 x 5/16 inch, PHS
	210-0201-00			1	LUG, solder, SE #4
-16	210-0004-00			1	LOCKWASHER, internal, #4
-17	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-18	136-0010-00			6	SOCKET, tube, 9 pin, w/o ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	211-0033-00			2	SCREW, sems, 4-40 x 5/16 inch, PHS
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch

FIG. 4 VERTICAL AMPLIFIERS *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
4-19	670-0446-00			2	ASSEMBLY, circuit board-VERTICAL AMPLIFIER (left & right)
	- - - - - -			-	each assembly includes:
	388-0724-00			1	BOARD, circuit
	- - - - - -			-	board includes:
-20	214-0506-00			25	PIN, connector, square
-21	136-0183-00			4	SOCKET, transistor, 3 pin
-22	136-0220-00			6	SOCKET, transistor, 3 pin
-23	136-0228-00			2	SOCKET, tube, 9 pin
-24	136-0235-00			2	SOCKET, transistor dual
-25	386-1084-00			2	SHIELD, circuit board
-26	136-0125-00			2	SOCKET, nuvistor, 5 pin
	- - - - - -			-	mounting hardware for each: (not included w/assembly)
-27	211-0116-00			4	SCREW, sems, 4-40 x 5/16 inch, PHB
-28	210-0586-00			4	NUT, keps, 4-40 x 1/4 inch
-29	407-0254-00			4	BRACKET, circuit board mounting
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-30	200-0658-00			2	COVER, plastic, transistor
-31	200-0687-00			4	COVER, plastic, transistor
-32	377-0103-00			4	INSERT, heat stabilizer
-33	200-0640-01			2	COVER, transistor
	- - - - - -			-	mounting hardware for each: (not included w/cover)
-34-	344-0121-00			1	CLAMP, transistor cover
-35	214-0713-00			2	INSULATOR, plastic
-36	124-0090-00			10	STRIP, ceramic, 3/4 inches h, w/9 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
-37	179-0395-00	20000	25996	1	CABLE HARNESS, vertical amplifier, right
	179-1074-00	25997		1	CABLE HARNESS, vertical amplifier, right
-38	179-0396-00	20000	25996	1	CABLE HARNESS, vertical amplifier, left
	179-1075-00	25997		1	CABLE HARNESS, vertical amplifier, left
-39	337-0007-00	20000	25996X	8	SHIELD, tube, w/spring

FIG. 5 SENSITIVITY SWITCHES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
5-1	262-0555-00	20000	25996	1		SWITCH, wired—SENSITIVITY (upper)
	- - - - - -			-		switch includes:
	260-0525-00			1		SWITCH, unwired
-2	- - - - - -			8		CAPACITOR, variable
	- - - - - -			-		mounting hardware for each: (not included w/capacitor)
	214-0153-00			1		FASTENER, plastic, snapin
-3	385-0111-00			2		ROD, plastic, 1/4 x 5/8 inch long
-4	406-0401-00			1		BRACKET, capacitor, front
-5	406-0402-00			1		BRACKET, capacitor, rear
	- - - - - -			-		mounting hardware: (not included w/switch)
-6	210-0865-00			1		WASHER, fiber, shouldered, 3/8 ID x 5/8 inch OD
	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch
-7	210-0803-00			4		WASHER, flat, 0.150 ID x 3/8 inch OD
-8	211-0104-00			2		SCREW, 5-40 x 3/8 inch, PHS
-9	406-0925-00			1		BRACKET, switch mounting (upper)
	- - - - - -			-		mounting hardware: (not included w/bracket)
	211-0507-00			2		SCREW, 6-32 x 5/16 inch, PHS
	210-0803-00			2		WASHER, flat, 0.150 ID x 3/8 inch OD
	210-0457-00			2		NUT, keps, 6-32 x 5/16 inch
-10	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-11	210-0865-00			2		WASHER, fiber, shouldered, 3/8 ID x 5/8 inch OD
-12	210-0413-00			2		NUT, hex., 3/8-32 x 1/2 inch
-13	260-0247-00			1		SWITCH, pushbutton—FINDER
	- - - - - -			-		mounting hardware: (not included w/switch)
-14	210-0046-00			1		LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-15	210-0595-00			1		NUT, hex., 1/4-32 x 1/2 inch long
-16	348-0004-00			1		GROMMET, rubber, 3/8 inch
-17	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
	210-0438-00			2		NUT, hex., 1-72 x 5/32 inch
-18	406-0635-00			1		BRACKET, plastic, variable resistor
-19	213-0088-00			2		SCREW, thread forming, 4-40 x 1/4 inch, PHS
-20	376-0014-00			2		COUPLING, steel wire
-21	384-0271-00			2		ROD, extension, 1/8 diameter x 9.751 inches long

FIG. 5 SENSITIVITY SWITCHES *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
5-22	262-0555-01	25997		1	SWITCH, wired—SENSITIVITY (upper)
	- - - - - -			-	switch includes:
	260-0790-00			1	SWITCH, unwired
	131-0371-00			4	CONNECTOR, single contact
-23	- - - - - -			6	CAPACITOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-24	214-0456-00			1	FASTENER, plastic, snapin
-25	385-0111-00			2	ROD, plastic, 1/4 x 5/8 inch long
-26	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0413-00			2	NUT, hex., 3/8-32 x 1/2 inch
-27	407-0255-02			1	BRACKET, front
-28	407-0255-03			1	BRACKET, rear
-29	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-30	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-31	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-32	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-33	376-0014-00			1	COUPLING, wire steel
-34	384-0365-00			1	ROD, extension, 1/8 diameter x 8.409 inches long
	- - - - - -			-	mounting hardware: (not included w/switch)
-35	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-36	210-0803-00			4	WASHER, flat, 0.150 ID x 3/8 inch OD
-37	211-0104-00			2	SCREW, 5-40 x 3/8 inch, PHS
-38	262-0555-00	20000	25996	1	SWITCH, wired—SENSITIVITY (lower)
	- - - - - -			-	switch includes:
	260-0525-00			1	SWITCH, unwired
-39	- - - - - -			8	CAPACITOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-40	214-0153-00			1	FASTENER, plastic, snapin

FIG. 5 SENSITIVITY SWITCHES *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
5-41	385-0111-00			2	ROD, plastic, 1/4 diameter x 5/8 inch long
-42	406-0401-00			1	BRACKET, capacitor, front
-43	406-0402-00			1	BRACKET, capacitor, rear
	- - - - - -			-	mounting hardware: (not included w/switch)
-44	210-0865-00			1	WASHER, fiber, shouldered, 3/8 ID x 5/8 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-45	210-0803-00			4	WASHER, flat, 0.150 ID x 3/8 inch OD
-46	211-0104-00			2	SCREW, 5-40 x 3/8 inch, PHS
-47	406-0927-00	200000	27259	1	BRACKET, switch mounting (lower)
	406-0927-02	27260		1	BRACKET, switch mounting (lower)
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
	210-0803-00			4	WASHER, flat, 0.150 ID x 3/8 inch OD
	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
	211-0522-00			2	SCREW, 6-32 x 5/8 inch, FHS
-48	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-49	210-0865-00			2	WASHER, fiber, shouldered, 3/8 ID x 5/8 inch OD
-50	210-0413-00			2	NUT, hex., 3/8-32 x 1/2 inch
-51	260-0247-00			1	SWITCH, pushbutton—FINDER
	- - - - - -			-	mounting hardware: (not included w/switch)
-52	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-53	210-0595-00			1	NUT, hex., 1/4-32 x 1/2 inch long
-54	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0438-00			2	NUT, hex., 1-72 x 5/32 inch
-55	406-0635-00			1	BRACKET, plastic, variable resistor
-56	213-0088-00			2	SCREW, thread forming, 4-40 x 1/4 inch, PHS
-57	348-0002-00			1	GROMMET, rubber, 1/4 inch
-58	348-0002-00	X23660	25996X	1	GROMMET, rubber, 1/4 inch
-59	262-0555-01	25997		1	SWITCH, wired—SENSITIVITY (lower)
	- - - - - -			-	switch includes:
	260-0790-00			1	SWITCH, unwired
	131-0371-00			4	CONNECTOR, single contact
-60	- - - - - -			6	CAPACITOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-61	214-0456-00			1	FASTENER, plastic, snapin
-62	385-0111-00			2	ROD, plastic, 1/4 x 5/8 inch long
-63	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-64	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-65	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-66	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

FIG. 5 SENSITIVITY SWITCHES *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
5-67	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
	210-0012-00			1		LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch
-68	407-0255-02			1		BRACKET, front
-69	407-0255-03			1		BRACKET, rear
-70	376-0014-00			1		COUPLING, wire steel
-71	384-0365-00			1		ROD, extension, 1/8 inch diameter x 8.409 inches long
	- - - - - -			-		mounting hardware: (not included w/switch)
-72	210-0013-00			1		LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch
-73	210-0803-00			4		WASHER, flat, 0.150 ID x 3/8 inch OD
-74	211-0104-00			2		SCREW, 5-40 x 3/8 inch, PHS

FIG. 6 TIME/CM, HORIZONTAL DISPLAY & INPUT SWITCHES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
6-1	262-0190-00			1		SWITCH, wired—INPUT SELECTOR (lower)
	- - - - - -			-		switch includes:
	260-0238-00	20000	23799	1		SWITCH, unwired
	260-0238-01	23800		1		SWITCH, unwired
-2	343-0006-00			2		CLAMP, cable, 1/2 inch plastic
	- - - - - -			-		mounting hardware for each: (not included w/clamp)
-3	211-0511-00			1		SCREW, 6-32 x 1/2 inch, PHS
-4	210-0803-00			2		WASHER, flat, 0.150 ID x 3/8 inch OD
-5	210-0006-00			1		LOCKWASHER, internal, #6
-6	210-0407-00			1		NUT, hex., 6-32 x 1/4 inch
-7	210-0202-00			1		LUG, solder, SE 6 w/2 wire holes
	- - - - - -			-		mounting hardware: (not included w/lug)
-8	211-0503-00			1		SCREW, 6-32 x 3/16 inch, PHS
-9	210-0407-00			1		NUT, hex., 6-32 x 1/4 inch
-10	348-0002-00			1		GROMMET, rubber, 1/4 inch
	- - - - - -			-		mounting hardware: (not included w/switch)
-11	210-0013-00			1		LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch
-12	386-0845-00			1		SHIELD, input selector switch
	- - - - - -			-		mounting hardware: (not included w/shield)
	210-0586-00			2		NUT, keps, 4-40 x 1/4 inch
-13	262-0179-00			1		SWITCH, wired—INPUT SELECTOR (upper)
	- - - - - -			-		switch includes:
	260-0238-00	20000	23799	1		SWITCH, unwired
	260-0238-01	23800		1		SWITCH, unwired
-14	343-0006-00			2		CLAMP, cable, 1/2 inch plastic
	- - - - - -			-		mounting hardware for each: (not included w/clamp)
-15	211-0511-00			1		SCREW, 6-32 x 1/2 inch, PHS
-16	210-0803-00			2		WASHER, flat, 0.150 ID x 3/8 inch OD
-17	210-0006-00			1		LOCKWASHER, internal, #6
-18	210-0407-00			1		NUT, hex., 6-32 x 1/4 inch
-19	210-0202-00			1		LUG, solder, SE 6 w/2 wire holes
	- - - - - -			-		mounting hardware: (not included w/lug)
-20	211-0503-00			1		SCREW, 6-32 x 3/16 inch, PHS
-21	210-0407-00			1		NUT, hex., 6-32 x 1/4 inch
-22	348-0002-00			1		GROMMET, rubber, 1/4 inch
	- - - - - -			-		mounting hardware: (not included w/switch)
-23	210-0013-00			1		LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch

FIG. 6 TIME/CM, HORIZONTAL DISPLAY & INPUT SWITCHES *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
6-24	386-0845-00			1		SHIELD, input selector switch
	- - - - - -			-		mounting hardware: (not included w/shield)
-25	210-0586-00			2		NUT, keps, 4-40 x 1/4 inch
-26	262-0172-00			1		SWITCH, wired—HORIZONTAL DISPLAY
	- - - - - -			-		switch includes:
	260-0236-00			1		SWITCH, unwired
	- - - - - -			-		mounting hardware: (not included w/switch)
-27	210-0012-00			1		LOCKWASHER, internal, 3/8 ID x 1/2 inch
-28	210-0840-00			1		WASHER, flat, 0.390 ID x 9/16 inch OD
-29	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch
-30	406-0372-00			1		BRACKET, horizontal display switch
	- - - - - -			-		mounting hardware: (not included w/bracket)
	211-0507-00			1		SCREW, 6-32 x 5/16 inch, PHS
-31	210-0006-00			1		LOCKWASHER, internal, #6
-32	210-0407-00			1		NUT, hex., 6-32 x 1/4 inch
-33	343-0002-00			1		CLAMP, cable, 3/16 inch plastic
	- - - - - -			-		mounting hardware: (not included w/clamp)
-34	211-0510-00			1		SCREW, 6-32 x 3/8 inch, PHS
-35	210-0863-00			1		WASHER, D type
-36	210-0006-00			1		LOCKWASHER, internal, #6
-37	210-0407-00			1		NUT, hex., 6-32 x 1/4 inch
-38	210-0202-00			1		LUG, solder, SE 6 w/2 wire holes
	- - - - - -			-		mounting hardware: (not included w/lug)
-39	211-0503-00			1		SCREW, 6-32 x 3/16 inch, PHS
-40	210-0407-00			1		NUT, hex., 6-32 x 1/4 inch
-41	348-0002-00			1		GROMMET, rubber, 1/4 inch
-42	124-0088-00	20000	25996	1		STRIP, ceramic, 3/4 inch h x 4 notches
	124-0149-00	25997		1		STRIP, ceramic, 7/16 inch h x 7 notches
	- - - - - -			-		each strip includes:
-43	355-0046-00			2		STUD, plastic
	- - - - - -			-		mounting hardware for each: (not included w/strip)
-44	361-0009-00			2		SPACER, plastic, 0.406 inch long
-45	384-0545-00			1		ROD, spacing, 1/4 x 9 1/4 inches long
	- - - - - -			-		mounting hardware: (not included w/rod)
-46	376-0007-00			1		COUPLING, 1 inch long
	- - - - - -			-		coupling includes:
	213-0005-00			2		SCREW, set, 8-32 x 1/8 inch, HSS

FIG. 6 TIME/CM, HORIZONTAL DISPLAY & INPUT SWITCHES *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
6-47	262-0556-00	20000	26679	1	SWITCH, wired—TIME/CM
	262-0556-01	26680		1	SWITCH, wired—TIME/CM
	- - - - - -			-	switch includes:
	260-0529-00			1	SWITCH, unwired
-48	406-0361-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
-49	210-0006-00			1	LOCKWASHER, internal, #6
-50	210-0202-00			1	LUG, solder, SE 6 w/2 wire holes
-51	210-0449-00			2	NUT, hex., 5-40 x 1/4 inch
-52	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-53	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-54	210-0413-00			2	NUT, hex., 3/8-32 x 1/2 inch
-55	376-0014-00			1	COUPLING, wire steel
-56	384-0277-00			1	ROD, extension, 1/8 diameter x 18 31/64 inches long
-57	406-0361-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-58	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0510-00			4	SCREW, 6-32 x 3/8 inch, PHS
	210-0803-00			4	WASHER, flat, 0.150 ID x 3/8 inch OD
	210-0407-00			4	NUT, hex., 6-32 x 1/4 inch
-59	- - - - - -			1	CAPACITOR
	- - - - - -			-	capacitor includes:
	407-0277-00	X26680		1	BRACKET, mounting
	124-0187-00	X26680		1	STRIP, ceramic, 7/16 inch h, w/5 notches
	- - - - - -			-	strip includes:
	355-0046-00			2	STUD, plastic
	124-0187-01	X26680		1	STRIP, ceramic, 7/16 inch h, w/5 notches and silver band
	- - - - - -			-	strip includes:
	355-0046-00			2	STUD, plastic
	361-0007-00	X26680		4	SPACER, plastic, 0.188 inch long
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-60	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
-61	210-0006-00	20000	26679X	2	LOCKWASHER, internal, #6
-62	210-0407-00	20000	26679	4	NUT, hex., 6-32 x 1/4 inch
	210-0457-00	26680		2	NUT, keps, 6-32 x 5/16 inch
-63	406-0926-00			1	BRACKET, variable resistor
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0507-00			2	SCREW, 6-32 5/16 inch, PHS
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch

FIG. 6 TIME/CM, HORIZONTAL DISPLAY & INPUT SWITCHES *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
6-64	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-65	210-0012-00			1		LOCKWASHER, internal, $\frac{3}{8}$ ID x $\frac{1}{2}$ inch OD
-66	210-0840-00			1		WASHER, flat, 0.390 ID x $\frac{5}{16}$ inch OD
-67	210-0413-00			1		NUT, hex., $\frac{3}{8}$-32 x $\frac{1}{2}$ inch
-68	384-0547-00			1		ROD, spacing, $\frac{1}{4}$ diameter x 13 $\frac{13}{64}$ inches
	- - - - - -			-		mounting hardware: (not included w/rod)
-69	376-0007-00			1		COUPLING, 1 inch long
	- - - - - -			-		coupling includes:
	213-0005-00			2		SCREW, set, 8-32 x $\frac{1}{8}$ inch, HSS

FIG. 7 HORIZONTAL DEFLECTION SWITCH & BULKHEAD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
7-1	386-0837-00			1	PLATE, bulkhead
	- - - - - -			-	mounting hardware: (not included w/plate)
	212-0023-00			6	SCREW, 8-32 x 3/8 inch, PHS
	210-0804-00			3	WASHER, flat, 0.170 ID x 3/8 inch OD
	210-0458-00			6	NUT, keps, 8-32 x 11/32 inch
-2	214-0210-00			1	ASSEMBLY, solder spool
	- - - - - -			-	assembly includes:
	214-0209-00			1	SPOOL, w/o solder
	- - - - - -			-	mounting hardware: (not included w/assembly)
	361-0007-00			1	SPACER, plastic, 0.188 inch long
-3	343-0004-00			1	CLAMP, cable, 5/16 inch plastic
	- - - - - -			-	mounting hardware: (not included w/clamp)
-4	210-0803-00			1	WASHER, flat, 0.150 ID x 3/16 inch OD
-5	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-6	- - - - - -			1	SWITCH, thermal cutout
	- - - - - -			-	mounting hardware: (not included w/switch)
-7	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
-8	210-0006-00			2	LOCKWASHER, internal, #6
-9	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-10	- - - - - -	X20686		1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-11	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
-12	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-13	406-0888-00			1	BRACKET, capacitor
-14	262-0180-00	20000	25996	1	SWITCH, wired—HORIZ DEF PLATE SELECTOR
	262-0180-01	25997		1	SWITCH, wired—HORIZ DEF PLATE SELECTOR
	- - - - - -			-	switch includes:
	260-0237-00			1	SWITCH, unwired
-15	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-16	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-17	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-18	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-19	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-20	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

FIG. 7 HORIZONTAL DEFLECTION SWITCH & BULKHEAD *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
7-21	- - - - - -	X25997		1	CAPACITOR, variable
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-22	211-0017-00	X25997		2	SCREW, 4-40 x 3/4 inch, RHS
-23	166-0026-00	X25997		2	TUBE, spacer, 0.125 ID x 3/16 OD x 3/8 inch long
-24	210-0801-00	X25997		2	WASHER, flat, 5S x 9/32 inch OD
-25	210-0586-00	X25997		2	NUT, keps, 4-40 x 1/4 inch
-26	348-0056-00	X25997		1	GROMMET, plastic, 0.354 ID x 0.406 inch OD
-27	348-0002-00			3	GROMMET, rubber, 1/4 inch
-28	406-0359-00	20000	25996	1	BRACKET, switch
	406-0359-02	25997		1	BRACKET, switch
-29	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-30	175-0586-00			1	WIRE, CRT lead, striped brown
	- - - - - -			-	wire includes:
	131-0049-00			1	CONNECTOR, CRT pin
	175-0587-00			1	WIRE, CRT lead, striped red
	- - - - - -			-	wire includes:
	131-0049-00			1	CONNECTOR, CRT pin
	175-0591-00			1	WIRE, CRT lead, striped green
	- - - - - -			-	wire includes:
	131-0049-00			1	CONNECTOR, CRT pin
	175-0593-00			1	WIRE, CRT lead, striped blue
	- - - - - -			-	wire includes:
	131-0049-00			1	CONNECTOR, CRT pin
-31	386-0784-00			1	PLATE, 1 3/8 x 1 1/4 inches
	- - - - - -			-	mounting hardware: (not included w/plate)
-32	210-0004-00			2	LOCKWASHER, internal, #4
-33	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-34	211-0504-00			1	SCREW, 6-32 x 1/4 inch, PHS
-35	385-0080-00			1	ROD, hex., 1/4 x 7/16 inch
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0507-00			4	SCREW, 6-32 x 5/16 inch, PHS
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-36	366-0068-00			1	KNOB, black—HORIZ DEF PLATE SELECTOR
-37	343-0004-00			1	CLAMP, cable, 5/16 inch plastic
	- - - - - -			-	mounting hardware: (not included w/clamp)
-38	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
-39	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD
-40	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-41	385-0136-00			1	ROD, plastic
	- - - - - -			-	mounting hardware: (not included w/rod)
	213-0041-00			1	SCREW, thread cutting, 6-32 x 3/8 inch, THS
-42	385-0137-00			1	ROD, plastic
	- - - - - -			-	mounting hardware: (not included w/rod)
	213-0041-00			1	SCREW, thread cutting, 6-32 x 3/8 inch, THS

FIG. 8 CRT SHIELD & SUPPORT BRACKET

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty 1 2 3 4 5	Description
8-1	337-0196-00			1	SHIELD, cathode ray tube
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0559-00			5	SCREW, 6-32 x 3/8 inch, FHS
-2	211-0534-00			1	SCREW, sems, 6-32 x 5/16 inch, PHS
-3	166-0033-00			1	TUBE, spacer, 0.180 ID x 1/4 inch OD
-4	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
-5	210-0457-00			7	NUT, keps, 6-32 x 5/16 inch
-6	136-0035-00			2	SOCKET, graticule light
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-7	211-0534-00			1	SCREW, sems, 6-32 x 3/16 inch, PHS
-8	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD
-9	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-10	124-0068-00			1	STRIP, felt, 1/8 x 1 x 5 3/4 inches
-11	175-0585-00			1	WIRE, CRT lead, striped brown
	- - - - - -			-	wire includes:
	131-0049-00			1	CONNECTOR, CRT pin
	175-0593-00			1	WIRE, CRT lead, striped blue
	- - - - - -			-	wire includes:
	131-0049-00			1	CONNECTOR, CRT pin
-12	406-0537-00			1	BRACKET, CRT support
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
-13	348-0003-00			1	GROMMET, rubber, 5/16 inch
-14	432-0022-00			1	BASE, CRT rotator
	- - - - - -			-	mounting hardware: (not included w/base)
-15	211-0561-00			2	SCREW, 6-32 x 3/8 inch, hex., soc FH cap
-16	210-0503-00			1	NUT, CRT rotator securing
-17	354-0178-00			1	RING, CRT securing
-18	354-0103-00			1	RING, CRT clamping
	- - - - - -			-	ring includes:
-19	210-0502-00			1	NUT, round, 3/8 x 10-32 inch
	- - - - - -			-	mounting hardware: (not included w/ring)
-20	211-0560-00			1	SCREW, 6-32 x 1 inch, RHS
-21	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-22	355-0049-00			1	STUD, CRT rotator 10-32 x 3 1/4 inches
-23	366-0032-00			1	KNOB, red—CRT ROTATOR
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-24	136-0019-00			1	SOCKET, CRT, 14 pin
-25	406-0239-00			3	BRACKET, bronze, 3/4 x 2 1/4 x 5/8 inches
-26	344-0047-00	20000	22448	5	CLIP, deflection, plastic
	344-0111-00	22449		5	CLIP, deflection, plastic
-27	- - - - - -	20000	26009	2	SCREW, 4-36 x 3/4 inch, RHS
	211-0017-00	26010		2	SCREW, 4-40 x 3/4 inch, RHS
	- - - - - -	20000	26009	2	NUT, hex., 4-36 x 1/4 inch
	210-0586-00	26010		2	NUT, keps, 4-40 x 1/4 inch

FIG. 9 CABINET & RAILS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
9-1	381-0204-00			1	BAR, 20 7/16 inches long
	- - - - - -			-	bar includes:
-2	367-0011-00			2	HANDLE, 5 1/2 inches, blue fabric
-3	343-0073-00			2	CLAMP, cover plate
	- - - - - -			-	mounting hardware: (not included w/bar)
-4	212-0039-00			4	SCREW, 8-32 x 3/8 inch, THS
	381-0073-00			2	BAR, retaining, 3/16 x 1/2 x 1 3/4 inches
-5	122-0065-00			2	ANGLE, frame, bottom 20 7/16 inches
	- - - - - -			-	mounting hardware for each: (not included w/angle)
-6	212-0039-00			4	SCREW, 8-32 x 3/8 inch, THS
	210-0458-00			4	NUT, keps, 8-32 x 11/32 inch
-7	122-0061-00			1	ANGLE, frame, top left, 20 7/16 inches long
	- - - - - -			-	mounting hardware: (not included w/angle)
	211-0559-00			4	SCREW, 6-32 x 3/8 inch, FHS
	210-0457-00			4	NUT, keps, 6-32 x 3/16 inch
-8	387-0057-00	20000	27259	1	PLATE, cabinet (bottom)
	387-0057-04	27260		1	PLATE, cabinet (bottom)
	- - - - - -			-	plate includes:
-9	214-0057-00			4	ASSEMBLY, cabinet latch
	- - - - - -			-	each assembly includes:
-10	210-0480-00			1	NUT, plastic, w/insert
-11	213-0033-00			1	SCREW, 8-32 x 1/2 inch
-12	210-0847-00			1	WASHER, flat, plastic, 0.164 ID x 0.500 inch OD
-13	105-0007-00			1	STOP, steel
-14	387-0056-00			1	PLATE, cabinet side (right)
	- - - - - -			-	plate includes:
	214-0057-00			2	ASSEMBLY, cabinet latch
-15	387-0055-00			1	PLATE, cabinet side (left)
	- - - - - -			-	plate includes:
	214-0057-00			2	ASSEMBLY, cabinet latch

FIG. 10 FAN MOTOR & REAR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
10-1	635-0411-00	20000	20685	1	ASSEMBLY, fan motor
	635-0427-00	20686	26589	1	ASSEMBLY, fan motor
	635-0430-00	26590	26959	1	ASSEMBLY, fan motor
	635-0427-00	26960		1	ASSEMBLY, fan motor
	- - - - - -			-	assembly includes:
-2	147-0020-00	20000	20685	1	MOTOR, fan
	147-0022-00	20686		1	MOTOR, fan
	- - - - - -			-	mounting hardware: (not included w/motor)
-3	212-0022-00	X20686		2	SCREW, 8-32 x 1 1/2 inches
-4	166-0084-00	20000	20685	2	TUBE, spacer
	166-0006-00	20686		2	TUBE, spacer
-5	210-0008-00			2	LOCKWASHER, internal, #8
-6	210-0409-00			2	NUT, hex., 8-32 x 5/16 inch
-7	426-0046-00			1	MOUNT, fan motor
-8	348-0008-00			3	SHOCKMOUNT, rubber, 1/2 x 1/2 inch
	- - - - - -			-	mounting hardware for each: (not included w/shockmount)
-9	210-0008-00			1	LOCKWASHER, internal, #8
-10	210-0409-00			1	NUT, hex., 8-32 x 5/16 inch
-11	369-0001-00	20000	20685	1	FAN, blade
	369-0015-00	20686		1	FAN, blade
-12	354-0051-00			1	RING, fan, w/mounting ears
	- - - - - -			-	mounting hardware: (not included w/ring)
-13	210-0008-00			3	LOCKWASHER, internal, #8
-14	210-0409-00			3	NUT, hex., 8-32 x 5/16 inch
	- - - - - -			-	mounting hardware: (not included w/assembly)
-15	213-0104-00			6	SCREW, thread forming, 6-32 x 3/8 inch, THS
-16	387-0787-00	20000	25996	1	PLATE, sub panel, rear
	387-0787-02	25997		1	PLATE, sub panel, rear
	- - - - - -			-	each plate includes:
-17	354-0069-00			1	RING, ornamental
-18	387-0786-00	20000	25996	1	PLATE, rear overlay
	387-0786-02	25997		1	PLATE, rear overlay
	- - - - - -			-	mounting hardware: (not included w/plate)
-19	213-0104-00			4	SCREW, thread forming, 6-32 x 3/8 inch, THS
-20	131-0102-00	20000	25996	1	CONNECTOR, 3 wire motor base
	131-0150-00	25997	27319	1	CONNECTOR, 3 wire motor base
	131-0150-01	27320		1	CONNECTOR, 3 wire motor base
	- - - - - -			-	connector includes:
-21	129-0041-00	20000	27319	1	POST, ground
	129-0041-01	27320		1	POST, ground
-22	200-0185-00	20000	27319	1	COVER
	200-0185-01	27320		1	COVER
-23	210-0003-00	20000	27319X	2	LOCKWASHER, external, #4
	210-0551-00	20000	27319X	2	NUT, hex., 4-40 x 1/4 inch
	211-0132-00	X27320		1	SCREW, 4-40 x 1/2 inch, PHS
-24	211-0015-00	20000	27319	1	SCREW, 4-40 x 1/2 inch RHS
	213-0088-00	27320		1	SCREW, thread forming, 4-40 x 1/4 inch PHS
-25	214-0078-00			2	PIN, connecting
-26	377-0041-00	20000	27319	1	INSERT, black
	377-0051-00	27320		1	INSERT, black
-27	386-0933-00	20000	25996	1	PLATE, mounting
-28	205-0014-00	25997		1	SHELL, motor base mounting
	- - - - - -			-	mounting hardware: (not included w/connector)
-29	211-0537-00	20000	25996	2	SCREW, 6-32 x 3/8 inch, THS
-30	210-0457-00	20000	25996	2	NUT, keps, 6-32 x 5/16 inch
	213-0104-00	25997		2	SCREW, thread forming, 6-32 x 3/8 inch, THS

FIG. 10 FAN MOTOR & REAR *(Cont)*

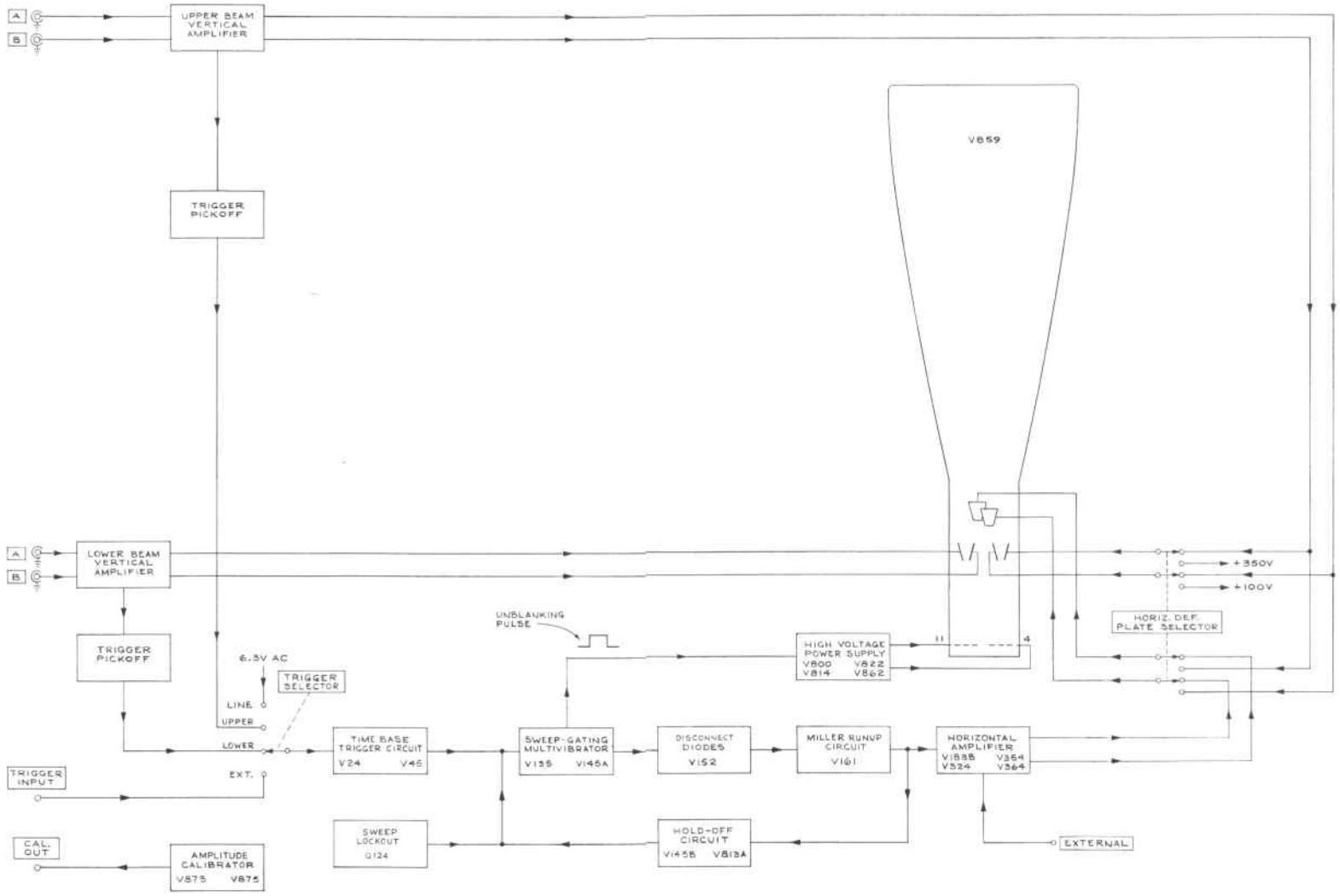
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty 1 2 3 4 5	Description
10-31	352-0002-00			1	ASSEMBLY, fuse
	- - - - - -			-	assembly includes:
-32	200-0582-00			1	CAP, fuse
-33	352-0010-00			1	HOLDER, fuse
-34	210-0873-00			1	WASHER, rubber
-35	- - - - - -			1	NUT, hex., fuse holder
-36	134-0067-00			2	PLUG, plastic, "D" hole
-37	134-0067-00	20000	25996	2	PLUG, plastic, "D" hole
	131-0081-00	25997		2	CONNECTOR, coaxial, 1 contact, UHF
-38	334-0649-00			1	TAG, voltage rating
	- - - - - -			-	mounting hardware: (not included w/tag)
-39	213-0088-00			2	SCREW, thread forming, #4 x 1/4 inch, PHS
-40	129-0063-00			1	POST, binding, 5 way
	- - - - - -			-	mounting hardware: (not included w/post)
-41	358-0169-00			1	BUSHING, binding post, charcoal
	210-0206-00	20000	21189X	1	LUG, solder, SE #10 long
	210-0010-00	20000	21189X	1	LOCKWASHER, internal, #10
	210-0445-00	20000	21189	2	NUT, hex., 10-32 x 3/8 inch
-42	220-0410-00	21190		1	NUT, keps, 10-32 x 3/8 inch
-43	129-0063-00			1	POST, binding, 5 way
	- - - - - -			-	mounting hardware: (not included w/post)
	210-0010-00	20000	21189X	1	LOCKWASHER, internal, #10
	210-0445-00	20000	21189	1	NUT, hex., 10-38 x 3/8 inch
-44	220-0410-00	21190		1	NUT, keps, 10-32 x 3/8 inch
-45	386-0427-00			1	PLATE, grounding, open end
-46	378-0763-00			1	FILTER, screen, 6 1/2 x 6 1/2 x 3/16 inches
-47	378-0022-00			1	FILTER, air, foam
-48	380-0017-00			1	HOUSING, air filter
	- - - - - -			-	mounting hardware: (not included w/housing)
-49	212-0031-00			2	SCREW, 8-32 x 1 1/4 inches
-50	210-0458-00			2	NUT, keps, 8-32 x 11/32 inch
-51	210-0402-00			2	NUT, hex., cap, 8-32 x 5/16 inch
-52	387-0017-00			1	PLATE, air deflection

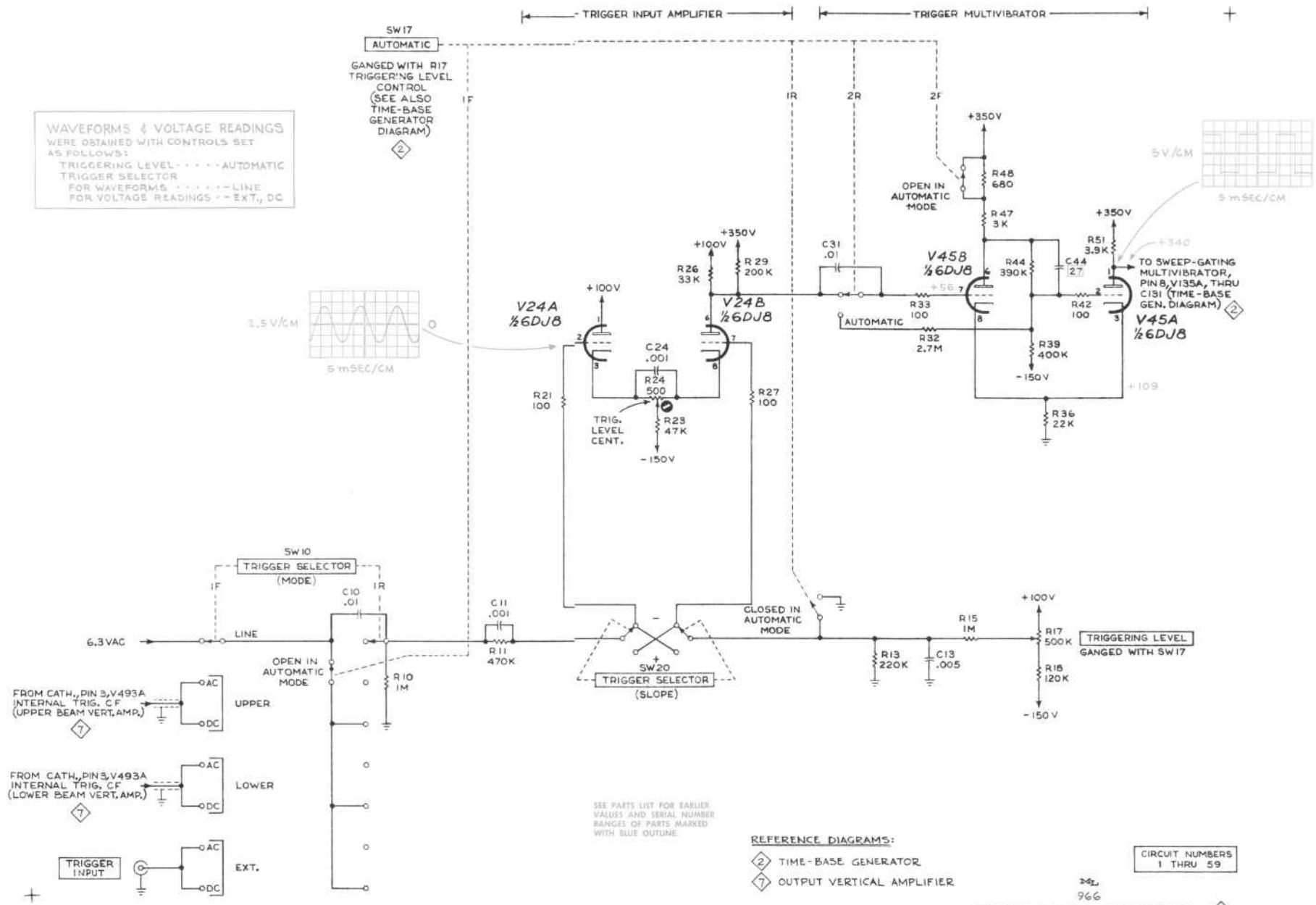
FIG. 11 CABLE HARNESS & CERAMIC STRIP DETAIL

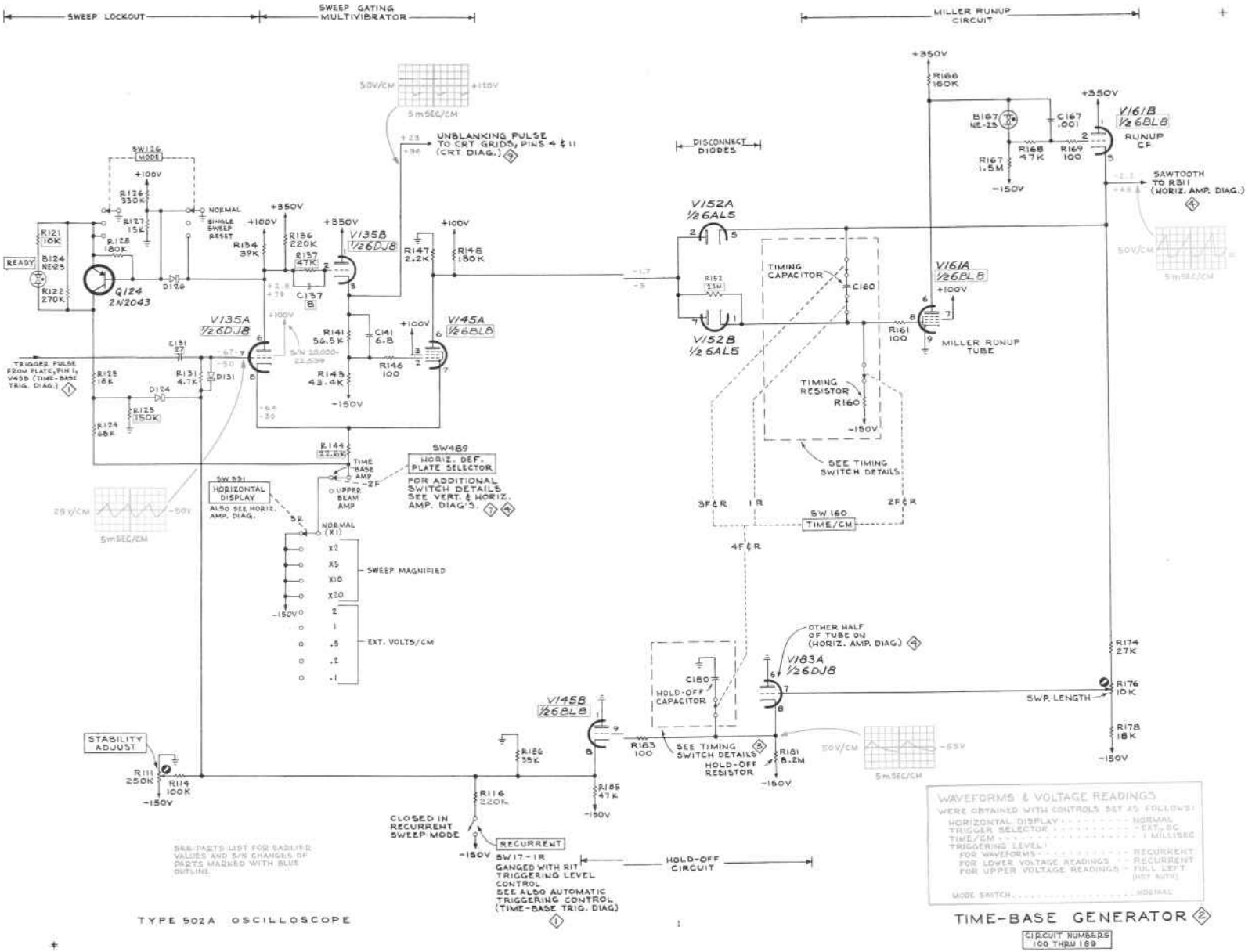
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
11-1	124-0100-00	20000	25996	2	STRIP, ceramic, 3/4 inch h w/1 notch
	124-0086-00	25997		2	STRIP, ceramic, 3/4 inch h w/2 notches
	- - - - - -			-	each strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0007-00			1	SPACER, plastic, 0.188 inch long
-2	124-0089-00			1	STRIP, ceramic, 3/4 inch h w/7 notches
	- - - - - -			-	strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -				mounting hardware: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
-3	124-0087-00			1	STRIP, ceramic, 3/4 inch h w/3 notches
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware: (not included w/strip)
	361-0009-00			1	SPACER, plastic, 0.406 inch long
-4	124-0091-00			8	STRIP, ceramic, 3/4 inch h w/11 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
-5	124-0106-00			2	STRIP, ceramic, 7/16 inch h w/11 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0007-00			2	SPACER, plastic, 0.188 inch long
-6	179-0263-00	20000	25996	1	CABLE HARNESS, calibrator switch
	179-0263-01	25997	27319	1	CABLE HARNESS, power #2
	179-0263-02	27320		1	CABLE HARNESS, power #2
-7	179-0779-00	20000	25996	1	CABLE HARNESS, main power
	179-0779-01	25997	26779	1	CABLE HARNESS, main power
	179-0779-02	26780		1	CABLE HARNESS, main power
-8	179-0396-00	20000	25996	1	CABLE HARNESS, upper vertical amplifier
	179-1075-00	25997		1	CABLE HARNESS, upper vertical amplifier
	- - - - - -			-	cable harness includes:
	131-0371-00	X25997		15	CONNECTOR, single contact
-9	179-0395-00	20000	25996	1	CABLE HARNESS, lower vertical amplifier
	179-1074-00	25997		1	CABLE HARNESS, lower vertical amplifier
	- - - - - -			-	cable harness includes:
	131-0371-00	X25997		15	CONNECTOR, single contact
-10	179-0262-00			1	CABLE HARNESS, trigger
-11	124-0091-00			11	STRIP, ceramic, 3/4 inch h w/11 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long

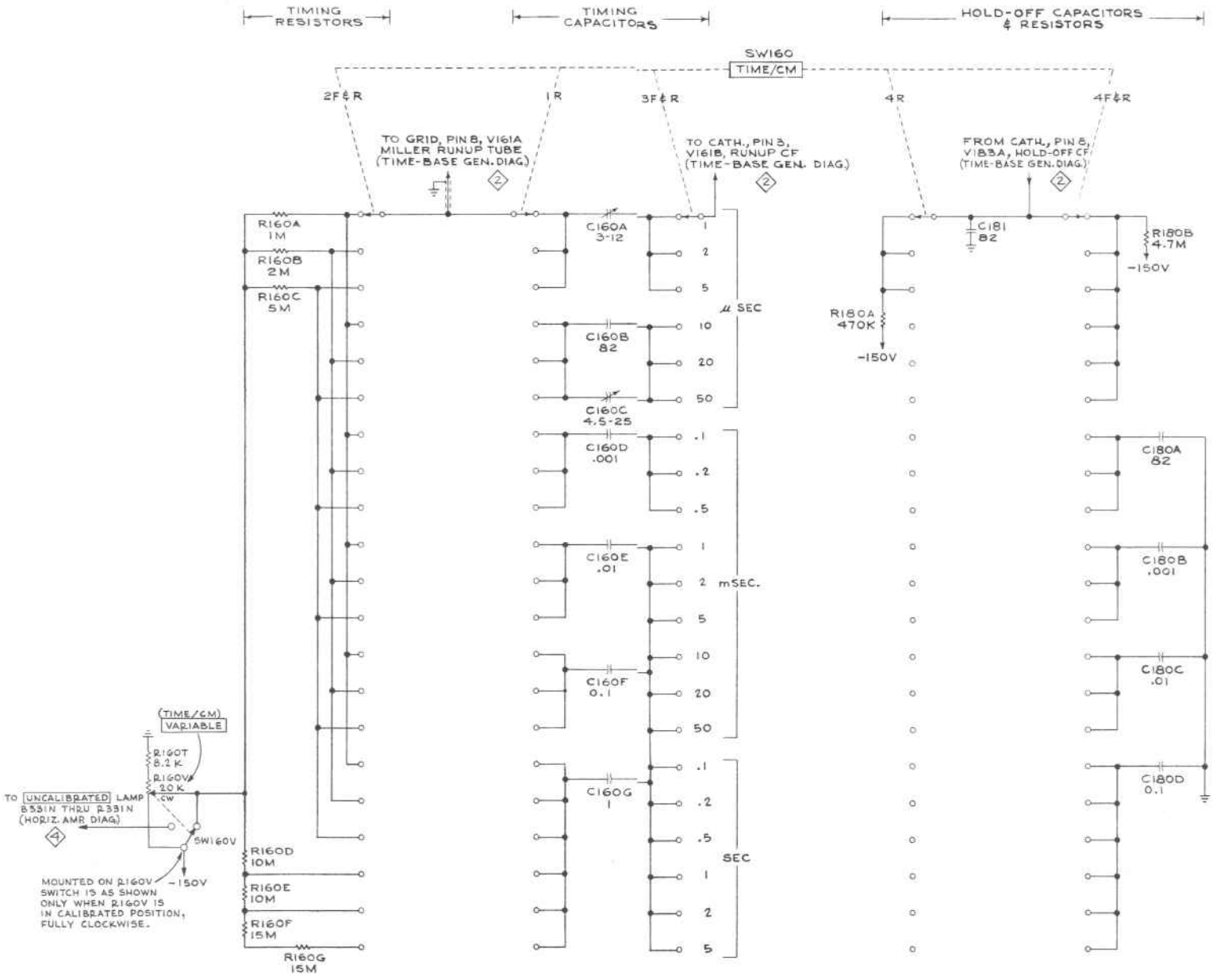
FIG. 11 CABLE HARNESS & CERAMIC STRIP DETAIL *(Cont)*

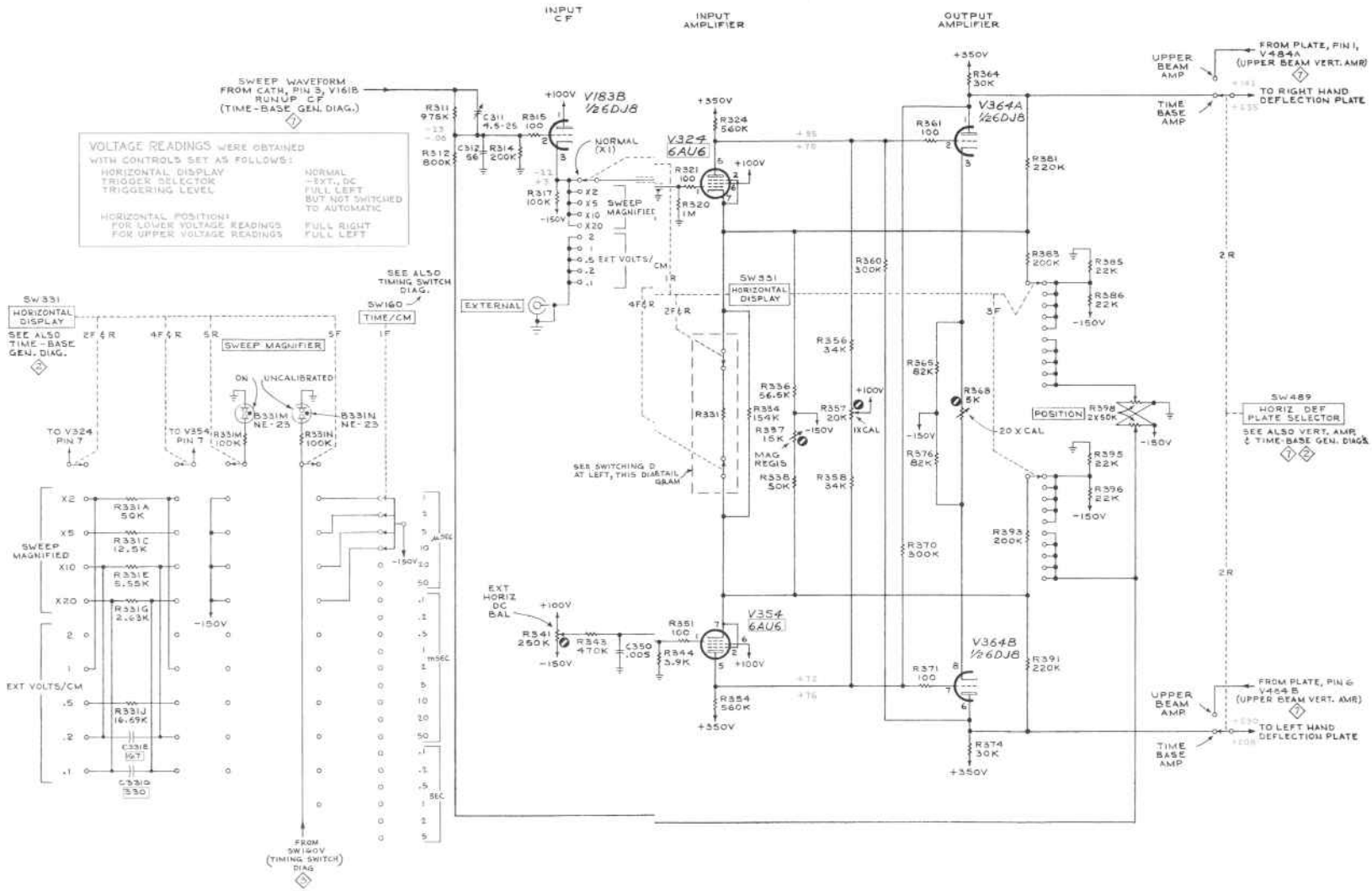
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
11-12	124-0088-00			2		STRIP, ceramic, 3/4 inch x 4 notches
	- - - - - -			-		each strip includes:
	355-0046-00			2		STUD, plastic
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	361-0009-00			2		SPACER, plastic
-13	124-0089-00			2		STRIP, ceramic, 3/4 inch h w/7 notches
	- - - - - -			-		each strip includes:
	355-0046-00			2		STUD, plastic
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	361-0009-00			2		SPACER, plastic, 0.406 inch long
-14	124-0100-00			1		STRIP, ceramic, 3/4 inch h w/1 notch
	- - - - - -			-		strip includes:
	355-0046-00			1		STUD, plastic
	- - - - - -			-		mounting hardware: (not included w/strip)
	361-0007-00			1		SPACER, plastic, 0.188 inch long
-15	179-0778-00			1		CABLE HARNESS, sweep
-16	124-0086-00			1		STRIP, ceramic, 3/4 inch h w/2 notches
	- - - - - -			-		strip includes:
	355-0046-00			1		STUD, plastic
	- - - - - -			-		mounting hardware: (not included w/strip)
	361-0007-00			1		SPACER, plastic, 0.188 inch long
-17	179-0279-00	20000	20685	1		CABLE HARNESS, 110 volt
	179-0696-00	20686		1		CABLE HARNESS, 110 volt
-18	124-0090-00			6		STRIP, ceramic, 3/4 inch h w/9 notches
	- - - - - -			-		each strip includes:
	355-0046-00			2		STUD, plastic
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	361-0009-00			2		SPACER, plastic, 0.406 inch long
-19	179-0780-00			1		CABLE HARNESS, focus & intensity
-20	124-0087-00	20000	25996X	1		STRIP, ceramic, 3/4 inch h w/3 notches
	- - - - - -			-		strip includes:
	355-0046-00			1		STUD, plastic
	- - - - - -			-		mounting hardware: (not included w/strip)
	361-0009-00			1		SPACER, plastic, 0.406 inch long


A
B
UPPER BEAM VERTICAL AMPLIFIER
TRIGGER PICKOFF
V859
A
B
LOWER BEAM VERTICAL AMPLIFIER
TRIGGER PICKOFF
+350V
+100V
UNBLANKING PULSE
HORIZ. DEF. PLATE SELECTOR
HIGH VOLTAGE POWER SUPPLY
V800 V822
V814 V862
11
4
6.3V AC
TRIGGER SELECTOR
LINE
UPPER
LOWER
EXT.
TRIGGER INPUT
TIME BASE TRIGGER CIRCUIT
V24 V45
SWEEP-GATING MULTIVIBRATOR
V135 V145A
DISCONNECT DIODES
V152
MILLER RUNUP CIRCUIT
V161
HORIZONTAL AMPLIFIER
V183B V354
V324 V364
SWEEP LOCKOUT
Q124
HOLD-OFF CIRCUIT
V145B V813A
EXTERNAL
CAL. OUT
AMPLITUDE CALIBRATOR
V873 V875


TRIGGER INPUT AMPLIFIER
TRIGGER MULTIVIBRATOR
SW17
AUTOMATIC
GANGED WITH R17 TRIGGERING LEVEL CONTROL (SEE ALSO TIME-BASE GENERATOR DIAGRAM)
2
1F
1R
2R
2F
WAVEFORMS & VOLTAGE READINGS
WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
TRIGGERING LEVEL - - - - - AUTOMATIC
TRIGGER SELECTOR
FOR WAVEFORMS - - - - - - LINE
FOR VOLTAGE READINGS - - EXT., DC
+350V
R48 680
OPEN IN AUTOMATIC MODE
R47 3K
5 V/CM
5 mSEC/CM
+350V
R51 3.9K
+340
+350V
+100V
R26 33K
R29 200K
C31 .01
V45B 1/6DJ8
R44 390K
C44 27
TO SWEEP-GATING MULTIVIBRATOR, PIN 8, V135A, THRU C131 (TIME-BASE GEN. DIAGRAM) 2
2.5 V/CM
5 mSEC/CM
+100V
V24A 1/6DJ8
V24B 1/6DJ8
+56
R33 100
AUTOMATIC
R32 2.7M
R39 400K
-150V
V45A 1/6DJ8
+109
C24 .001
R24 500
R21 100
R27 100
TRIG. LEVEL CENT.
R23 47K
-150V
R36 22K
SW10
TRIGGER SELECTOR
(MODE)
1F
1R
C10 .01
C11 .001
CLOSED IN AUTOMATIC MODE
R15 1M
+100V
6.3 VAC
LINE
R11 470K
SW20
TRIGGER SELECTOR
(SLOPE)
R13 220K
C13 .005
R17 500K
TRIGGERING LEVEL
GANGED WITH SW17
OPEN IN AUTOMATIC MODE
R10 1M
R18 120K
-150 V
FROM CATH., PIN 3, V493A INTERNAL TRIG. CF (UPPER BEAM VERT. AMP.)
7
AC
DC
UPPER
FROM CATH., PIN 3, V493A INTERNAL TRIG. CF (LOWER BEAM VERT. AMP.)
7
AC
DC
LOWER
TRIGGER INPUT
AC
DC
EXT.
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
REFERENCE DIAGRAMS:
2 TIME-BASE GENERATOR
7 OUTPUT VERTICAL AMPLIFIER
CIRCUIT NUMBERS 1 THRU 59
966
TIME-BASE TRIGGER 1
TYPE 502A OSCILLOSCOPE
F


SWEEP LOCKOUT
SWEEP GATING MULTIVIBRATOR
MILLER RUNUP CIRCUIT
DISCONNECT DIODES
UNBLANKING PULSE TO CRT GRIDS, PINS 4 & 11 (CRT DIAG.)
SAWTOOTH TO R811 (HORIZ. AMP. DIAG.)
TRIGGER PULSE FROM PLATE, PIN 1, V45B (TIME-BASE TRIG. DIAG.)
SW126 MODE
NORMAL
SINGLE SWEEP RESET
READY
Q124 2N2043
V135A 1/2 6DJ8
V135B 1/2 6DJ8
V145A 1/2 6BL8
V145B 1/2 6BL8
V152A 1/2 6AL5
V152B 1/2 6AL5
V161A 1/2 6BL8
V161B 1/2 6BL8
V183A 1/2 6DJ8
TIMING CAPACITOR
TIMING RESISTOR
MILLER RUNUP TUBE
SEE TIMING SWITCH DETAILS
SW 160 TIME/CM
SW489 HORIZ. DEF. PLATE SELECTOR
FOR ADDITIONAL SWITCH DETAILS SEE VERT. & HORIZ. AMP. DIAG'S.
SW 331 HORIZONTAL DISPLAY
ALSO SEE HORIZ. AMP. DIAG.
TIME BASE AMP
UPPER BEAM AMP
SWEEP MAGNIFIED
EXT. VOLTS/CM
OTHER HALF OF TUBE ON (HORIZ. AMP. DIAG.)
HOLD-OFF CAPACITOR
HOLD-OFF RESISTOR
SWP. LENGTH
STABILITY ADJUST
CLOSED IN RECURRENT SWEEP MODE
RECURRENT
SW 17-1R GANGED WITH R17 TRIGGERING LEVEL CONTROL SEE ALSO AUTOMATIC TRIGGERING CONTROL (TIME-BASE TRIG. DIAG.)
HOLD-OFF CIRCUIT
SEE PARTS LIST FOR RADIUS VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE
WAVEFORMS & VOLTAGE READINGS
WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
HORIZONTAL DISPLAY ..... NORMAL
TRIGGER SELECTOR ..... +EXT., DC
TIME/CM ..... 1 MILLISEC
TRIGGERING LEVEL:
FOR WAVEFORMS ..... RECURRENT
FOR LOWER VOLTAGE READINGS ..... RECURRENT
FOR UPPER VOLTAGE READINGS ..... FULL LEFT (NOT AUTO)
MODE SWITCH ..... NORMAL
TYPE 502A OSCILLOSCOPE
TIME-BASE GENERATOR 2
CIRCUIT NUMBERS 100 THRU 189
TIME-BASE GENERATOR 2


TIMING RESISTORS
TIMING CAPACITORS
HOLD-OFF CAPACITORS & RESISTORS
SW160
TIME/CM
2F&R
1R
3F&R
4R
4F&R
TO GRID, PIN 8, V161A MILLER RUNUP TUBE (TIME-BASE GEN. DIAG.) 2
TO CATH., PIN 3, V161B, RUNUP CF (TIME-BASE GEN. DIAG.) 2
FROM CATH., PIN 8, V183A, HOLD-OFF CF (TIME-BASE GEN. DIAG.) 2
R160A 1M
R160B 2M
R160C 5M
R160D 10M
R160E 10M
R160F 15M
R160G 15M
C160A 3-12
C160B 82
C160C 4.5-25
C160D .001
C160E .01
C160F 0.1
C160G 1
1
2
5
10
20
50
μ SEC
.1
.2
.5
1
2
5
10
20
50
mSEC.
.1
.2
.5
1
2
5
SEC
C181 82
R180A 470K
-150V
R180B 4.7M
-150V
C180A 82
C180B .001
C180C .01
C180D 0.1
(TIME/CM) VARIABLE
R160T 8.2 K
R160V 20 K
CW
TO UNCALIBRATED LAMP B331N THRU R331N (HORIZ. AMP. DIAG.) 4
SW160V
-150V
MOUNTED ON R160V SWITCH IS AS SHOWN ONLY WHEN R160V IS IN CALIBRATED POSITION, FULLY CLOCKWISE.

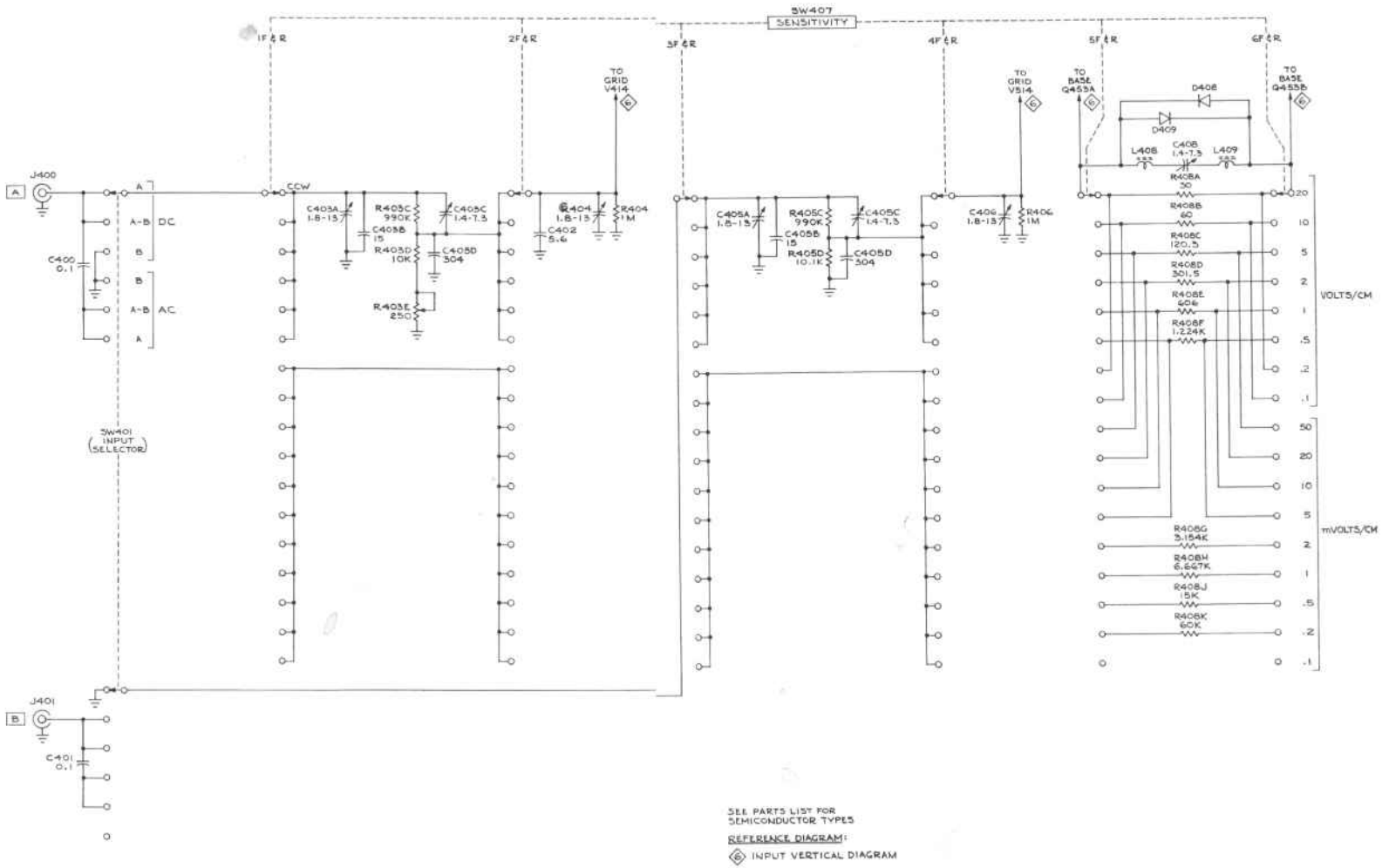


TYPE 502A OSCILLOSCOPE

HORIZONTAL AMPLIFIER 4

CIRCUIT NUMBERS 300 THRU 399

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.



SEE PARTS LIST FOR SEMICONDUCTOR TYPES

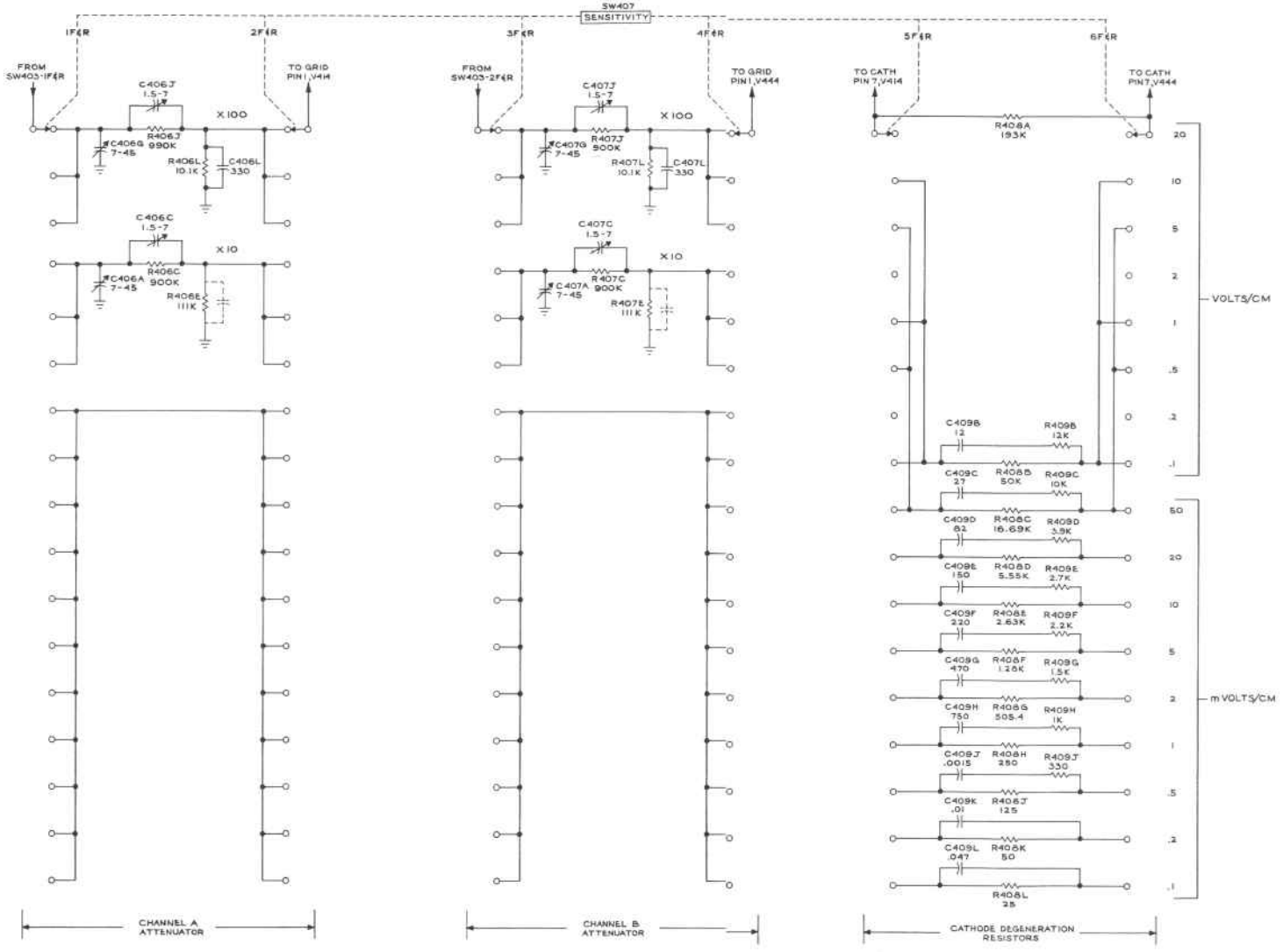
REFERENCE DIAGRAM:

⑥ INPUT VERTICAL DIAGRAM

MR4
966

S/N 25997-UP

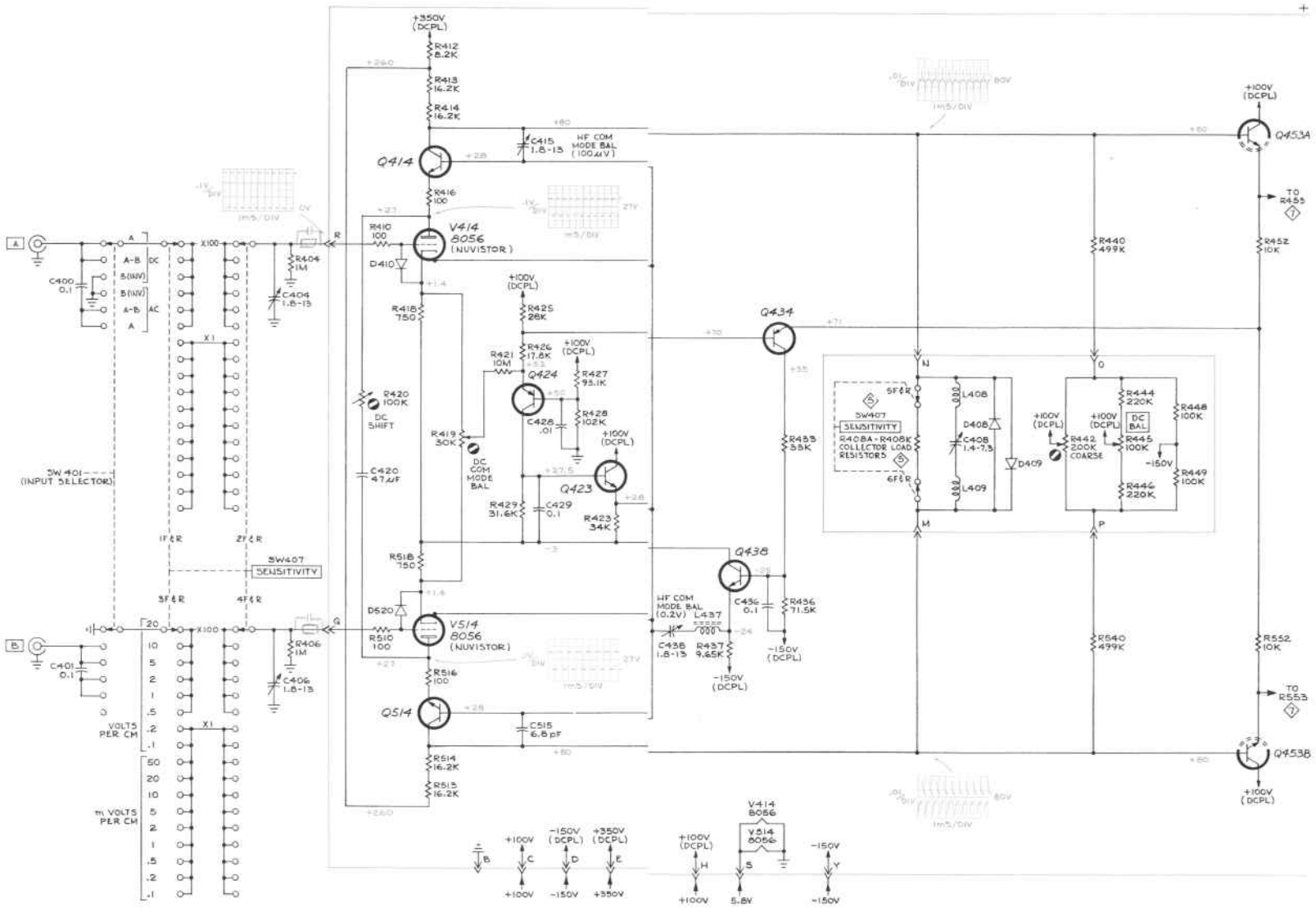
VERTICAL ATTENUATOR SWITCH ⑤



TYPE 502A OSCILLOSCOPE

S/N 101 – S/N 25996 CMD 966

VERTICAL ATTENUATOR SWITCH (5)



TYPE 502A OSCILLOSCOPE

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS:

5 VERTICAL ATTENUATOR SWITCH

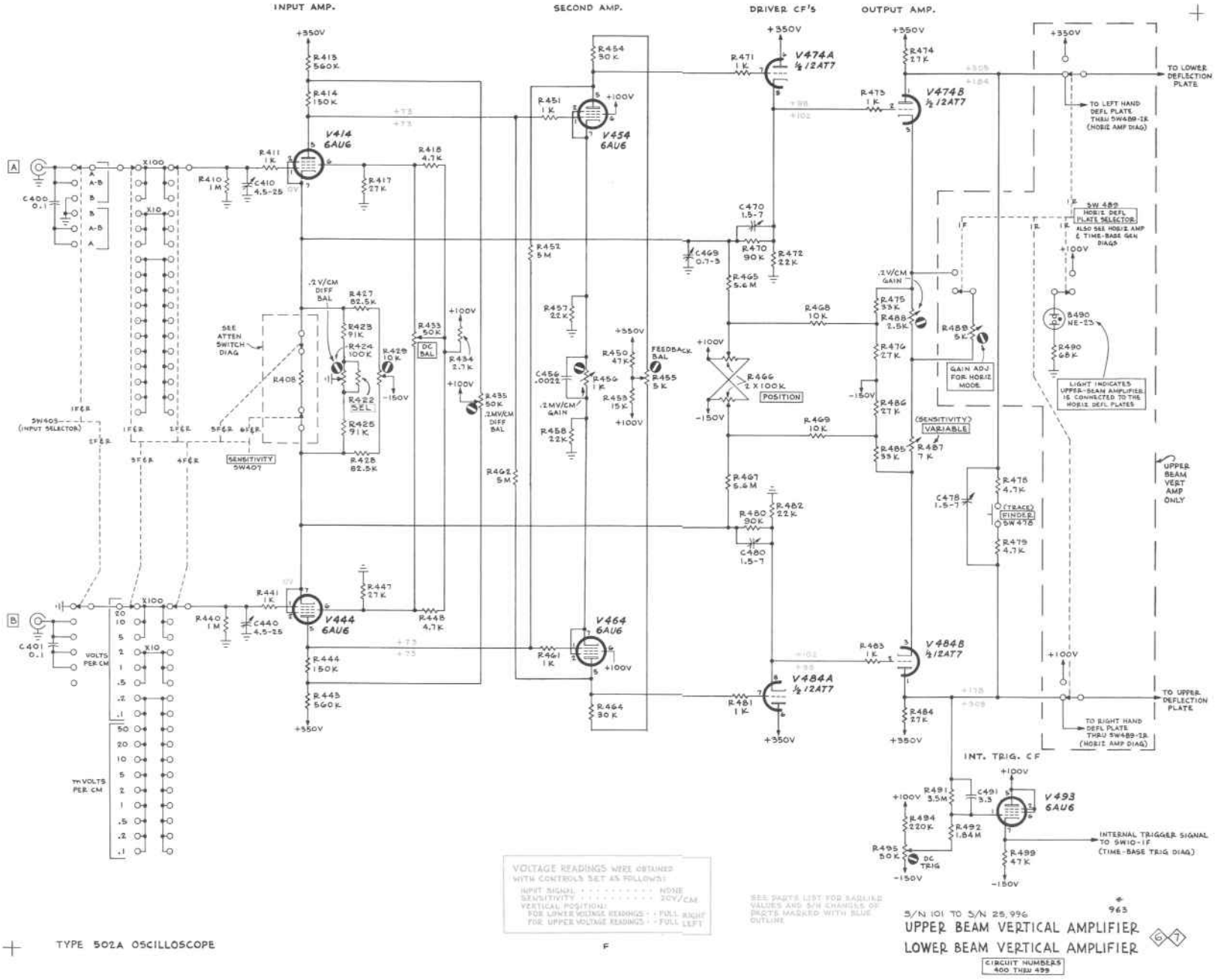
7 OUTPUT VERTICAL AMPLIFIER

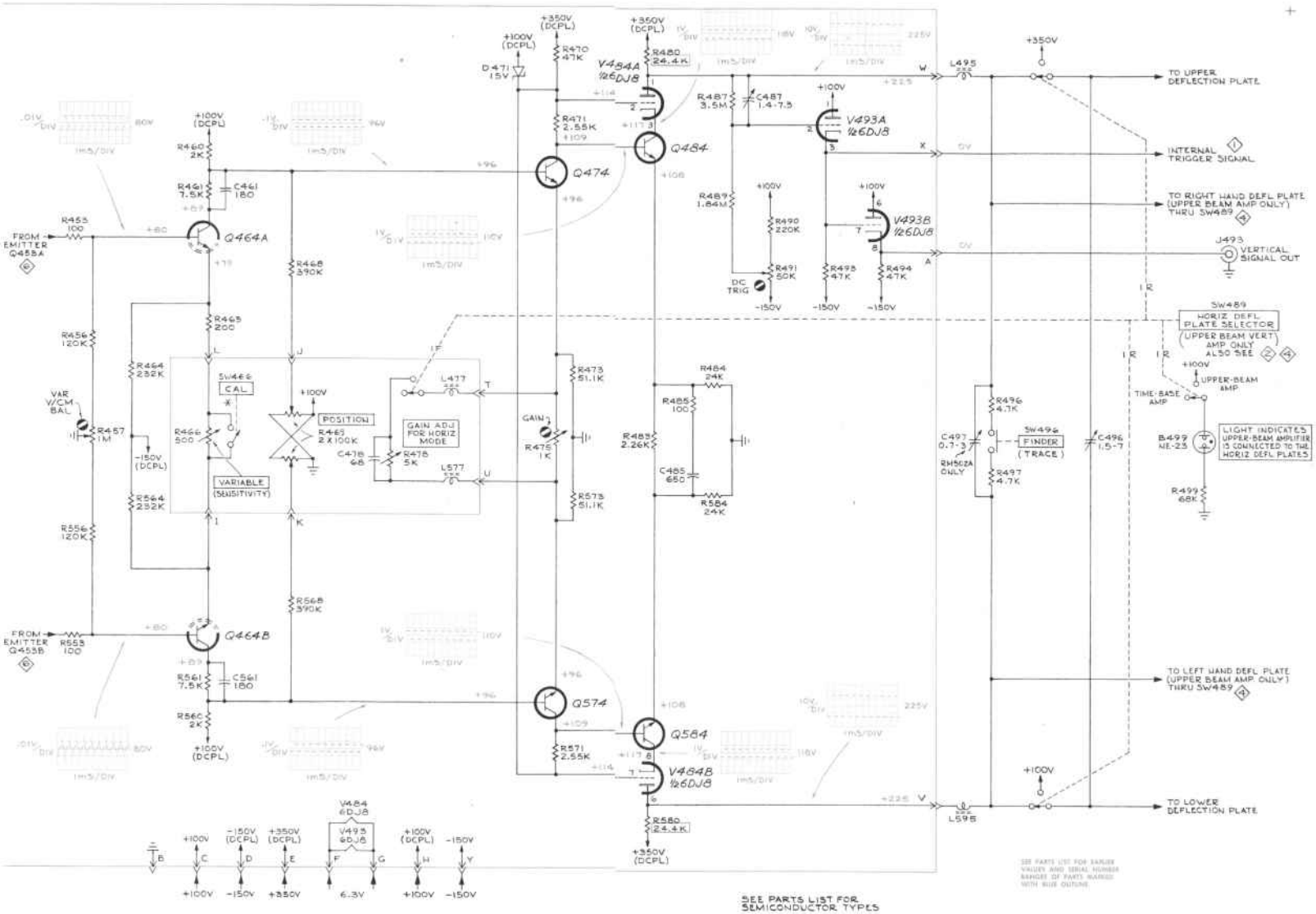
S/N 25997-UP

INPUT VERTICAL AMPLIFIER 6

CIRCUIT NUMBERS 400-455 510-552

MRH 4-67


INPUT AMP.
SECOND AMP.
DRIVER CF'S
OUTPUT AMP.
+350V
V414 6AU6
V444 6AU6
V454 6AU6
V464 6AU6
V474A ½12AT7
V474B ½12AT7
V484A ½12AT7
V484B ½12AT7
V493 6AU6
TO LOWER DEFLECTION PLATE
TO LEFT HAND DEFL PLATE THRU SW489-1R (HORIZ AMP DIAG)
TO UPPER DEFLECTION PLATE
TO RIGHT HAND DEFL PLATE THRU SW489-1R (HORIZ AMP DIAG)
SW 489 HORIZ DEFL PLATE SELECTOR ALSO SEE HORIZ AMP & TIME-BASE GEN DIAGS
LIGHT INDICATES UPPER-BEAM AMPLIFIER IS CONNECTED TO THE HORIZ DEFL PLATES
GAIN ADJ FOR HORIZ MODE
POSITION
SENSITIVITY VARIABLE
SENSITIVITY SW407
SEE ATTEN SWITCH DIAG
SW405 (INPUT SELECTOR)
.2V/CM DIFF BAL
.2MV/CM GAIN
.2MV/CM DIFF BAL
DC BAL
FEEDBACK BAL
VOLTS PER CM
mV VOLTS PER CM
INT. TRIG. CF
INTERNAL TRIGGER SIGNAL TO SW10-1F (TIME-BASE TRIG DIAG)
UPPER BEAM VERT AMP ONLY
(TRACE) FINDER SW478
VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
INPUT SIGNAL . . . . . NONE
SENSITIVITY 20V/CM
VERTICAL POSITION:
FOR LOWER VOLTAGE READINGS - - FULL RIGHT
FOR UPPER VOLTAGE READINGS - - FULL LEFT
SEE PARTS LIST FOR RADIUS VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE
TYPE 502A OSCILLOSCOPE
F
S/N 101 TO S/N 25,996
963
UPPER BEAM VERTICAL AMPLIFIER
LOWER BEAM VERTICAL AMPLIFIER
CIRCUIT NUMBERS 400 THRU 499
UPR & LWR BEAM VERT AMP
6
7



* SW466, GANGED WITH R466, IS CLOSED ONLY WHEN R466 IS FULL CW

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS:

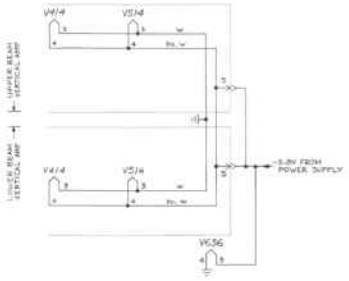
1. TIME-BASE TRIGGER
2. TIME-BASE GENERATOR
4. HORIZONTAL AMPLIFIER
6. INPUT VERTICAL AMPLIFIER

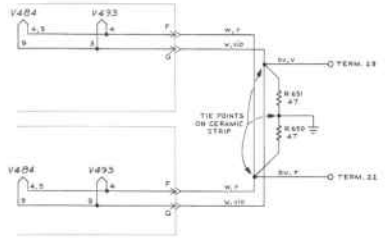
S/N 25997 - UP

OUTPUT VERTICAL AMPLIFIER 7

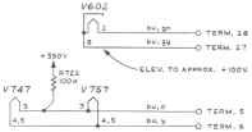
CIRCUIT NUMBERS 455-499 555-595

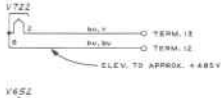
MRH 267

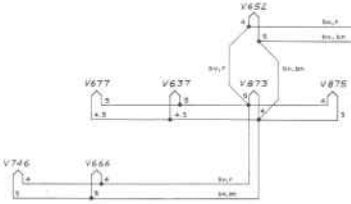




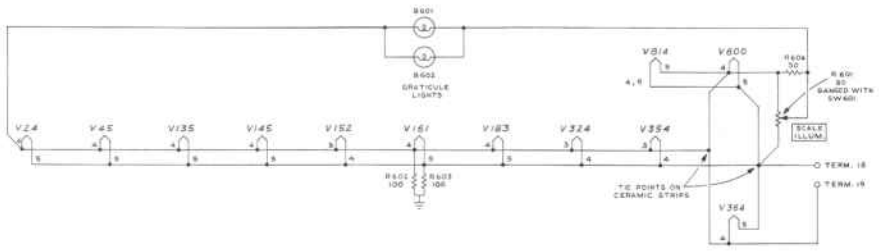
UPPER BEAM & LOWER BEAM VERTICAL CHASSIS







POWER SUPPLY CHASSIS

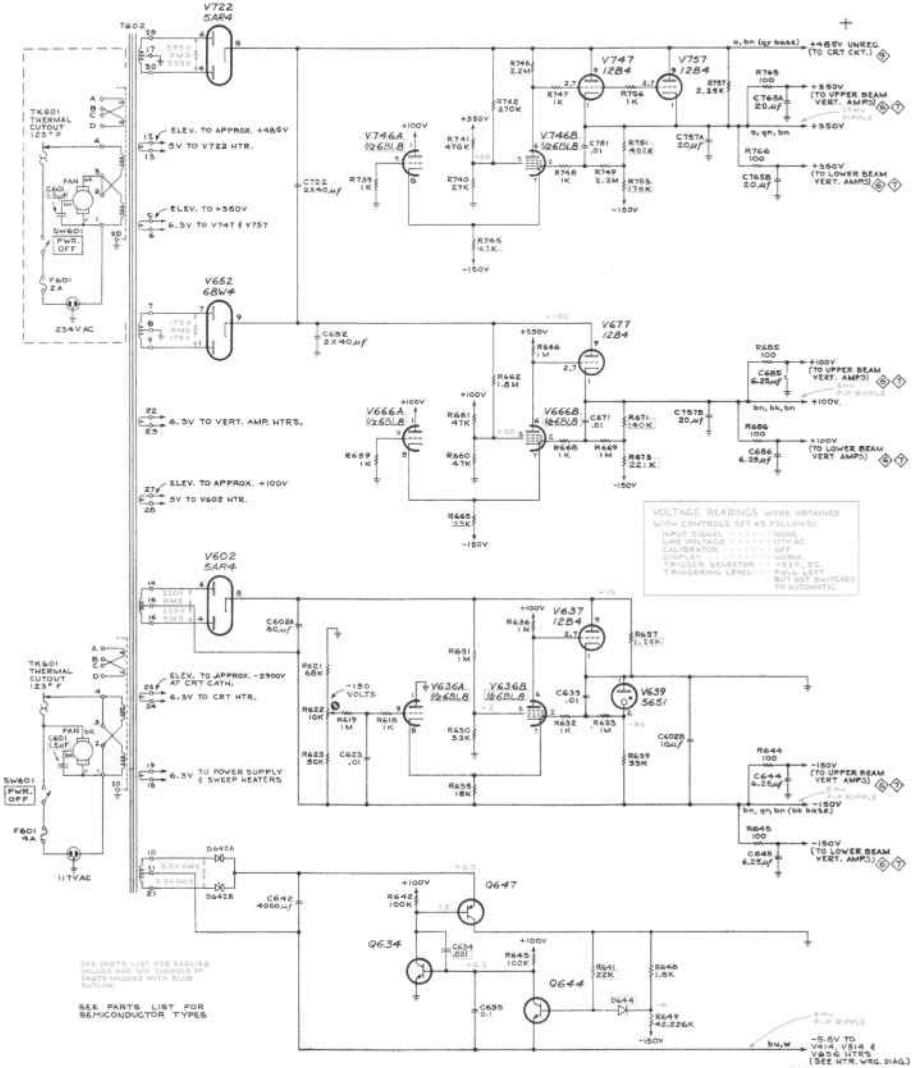


SWEEP CHASSIS

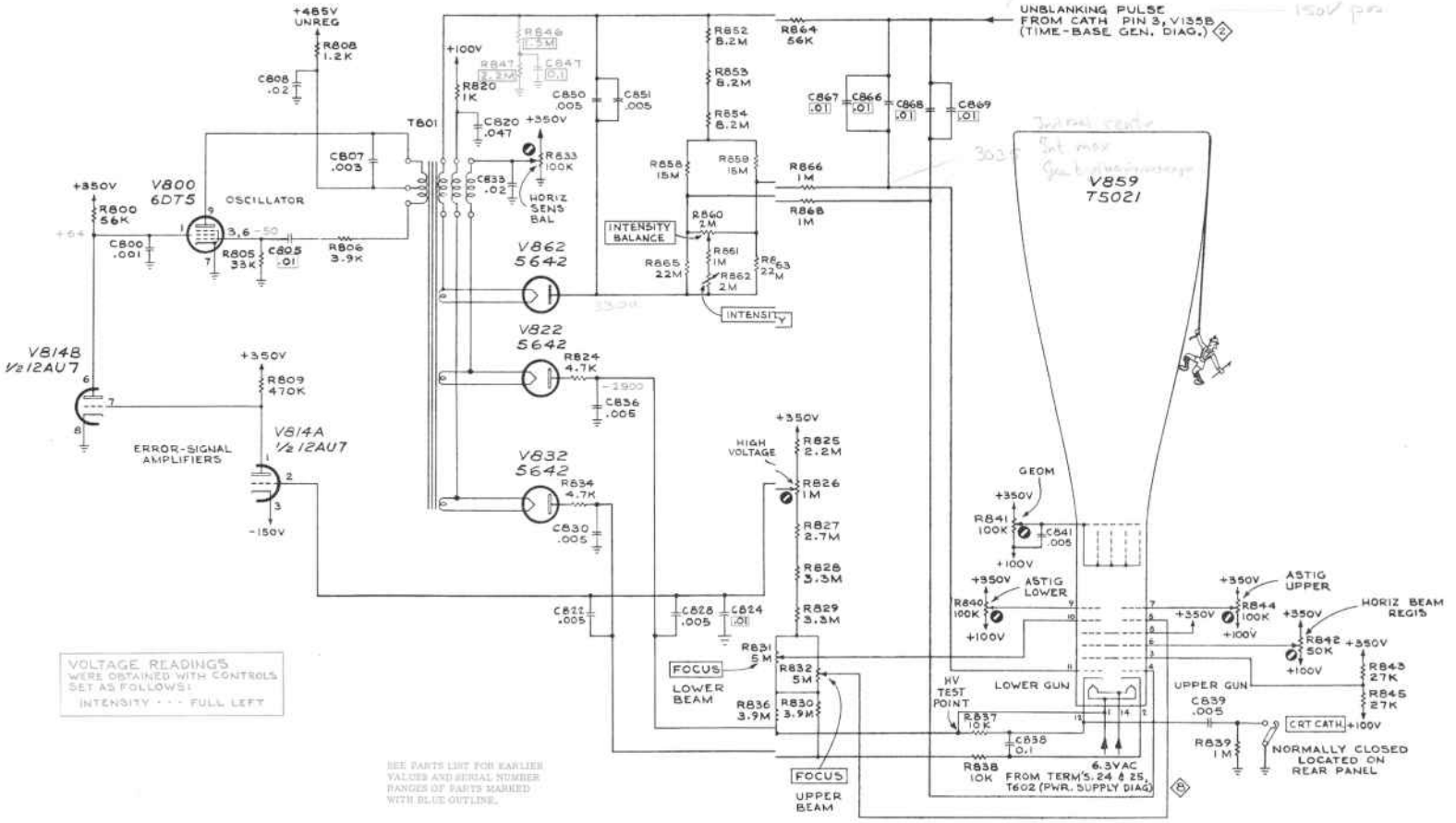
TYPE 502A OSCILLOSCOPE

DON

HEATER WIRING DIAGRAM



POWER SUPPLY ⟨8⟩



TYPE 502A OSCILLOSCOPE

CIRCUIT NUMBERS 800 THRU 869

CRT CIRCUIT ⑨

1067
JDB

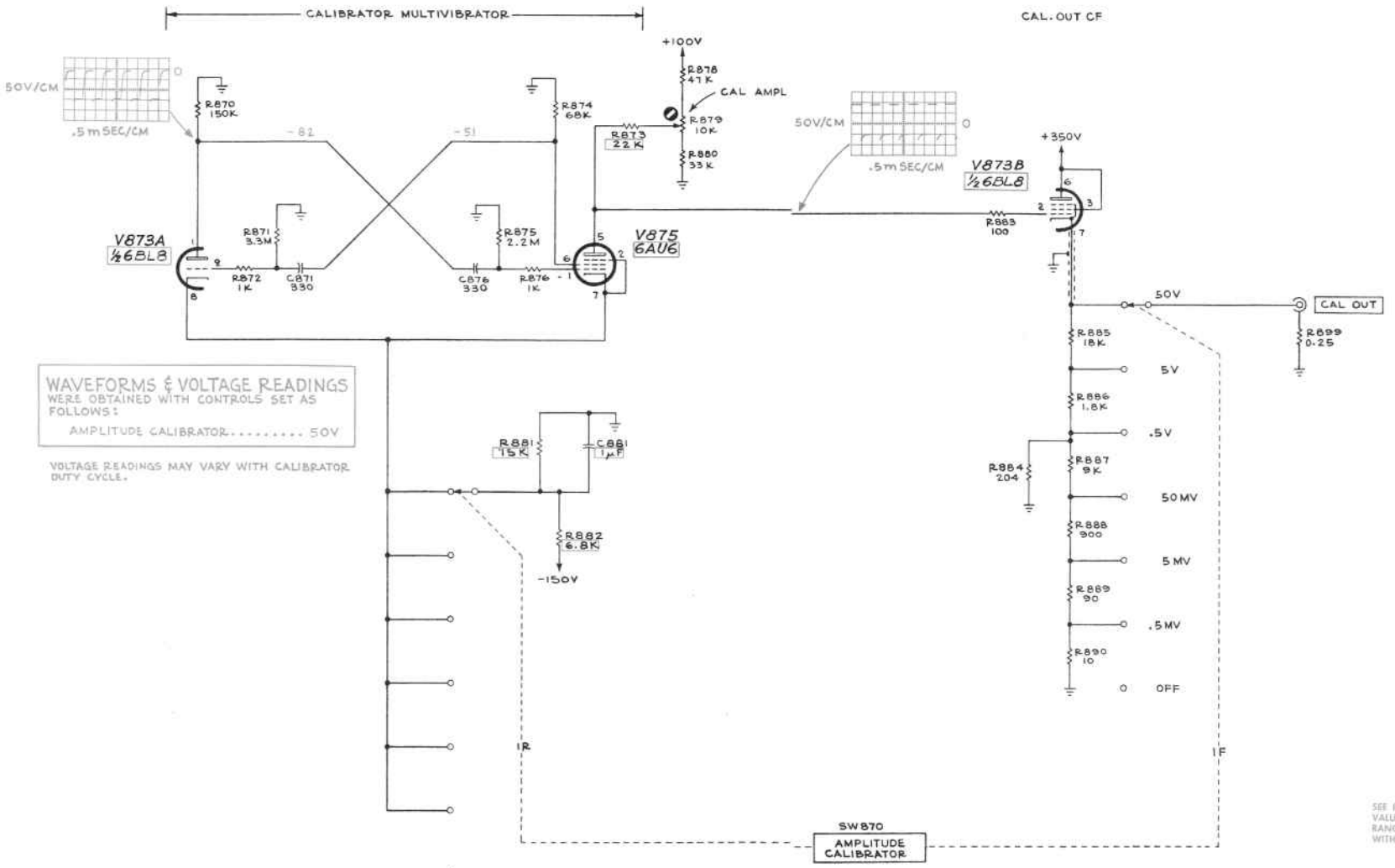

CALIBRATOR MULTIVIBRATOR
CAL. OUT CF
50V/CM
.5 m SEC/CM
R870 150K
R874 68K
+100V
R878 47K
CAL AMPL
R879 10K
R880 33K
R873 22K
50V/CM
.5m SEC/CM
+350V
V873B ½6BL8
R883 100
V873A ½6BL8
R871 3.3M
R875 2.2M
V875 6AU6
R872 1K
C871 330
C876 330
R876 1K
50V
CAL OUT
R899 0.25
R885 18K
5V
R886 1.8K
.5V
R884 204
R887 9K
50 MV
R888 900
5 MV
R889 90
.5 MV
R890 10
OFF
R881 15K
C881 1 µF
R882 6.8K
-150V
1R
1F
SW870
AMPLITUDE CALIBRATOR
WAVEFORMS & VOLTAGE READINGS
WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
AMPLITUDE CALIBRATOR..... 50V
VOLTAGE READINGS MAY VARY WITH CALIBRATOR DUTY CYCLE.
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

FIG. 1 FRONT

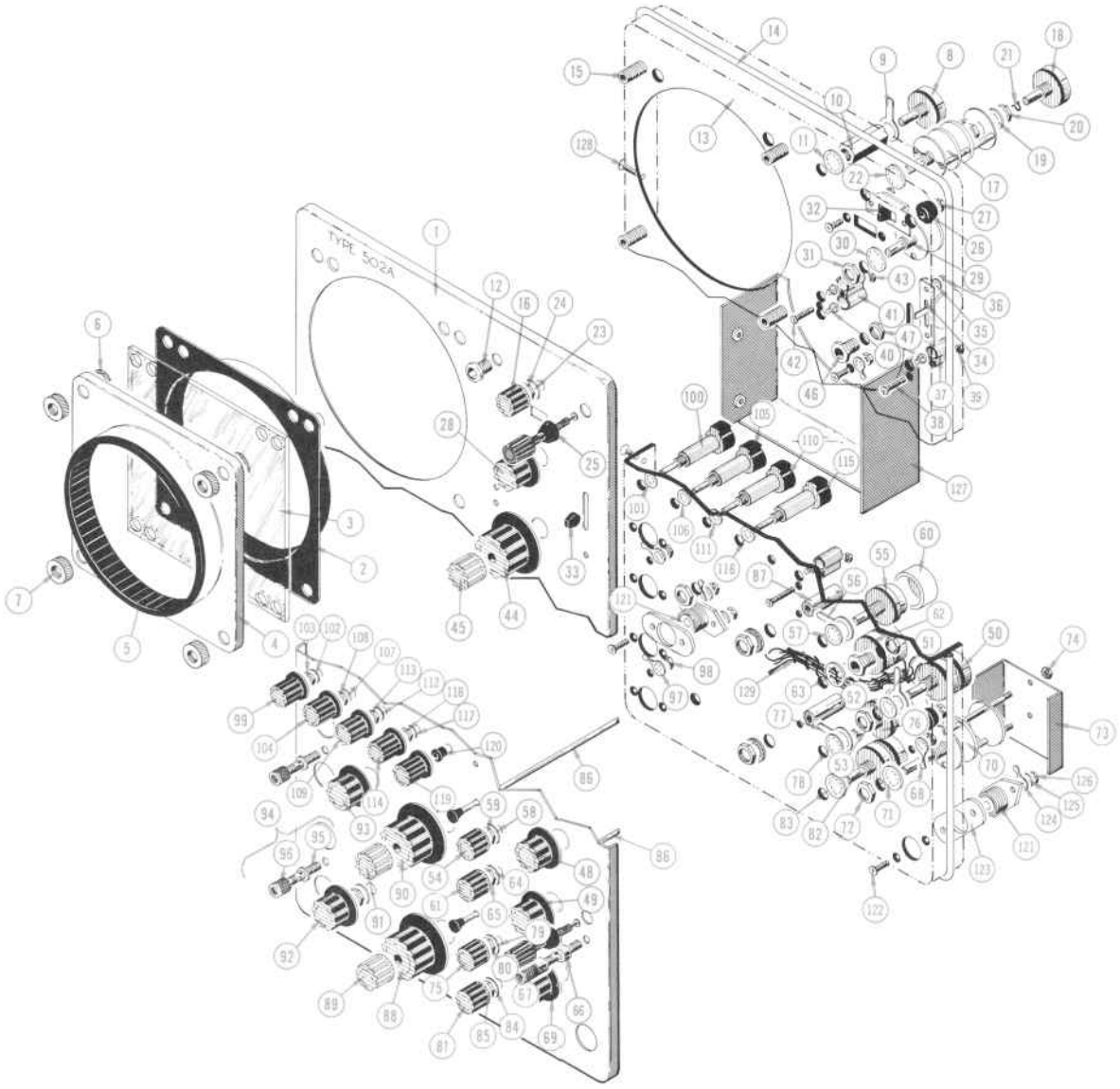


FIG. 2 SWEEP & FOCUS & INTENSITY

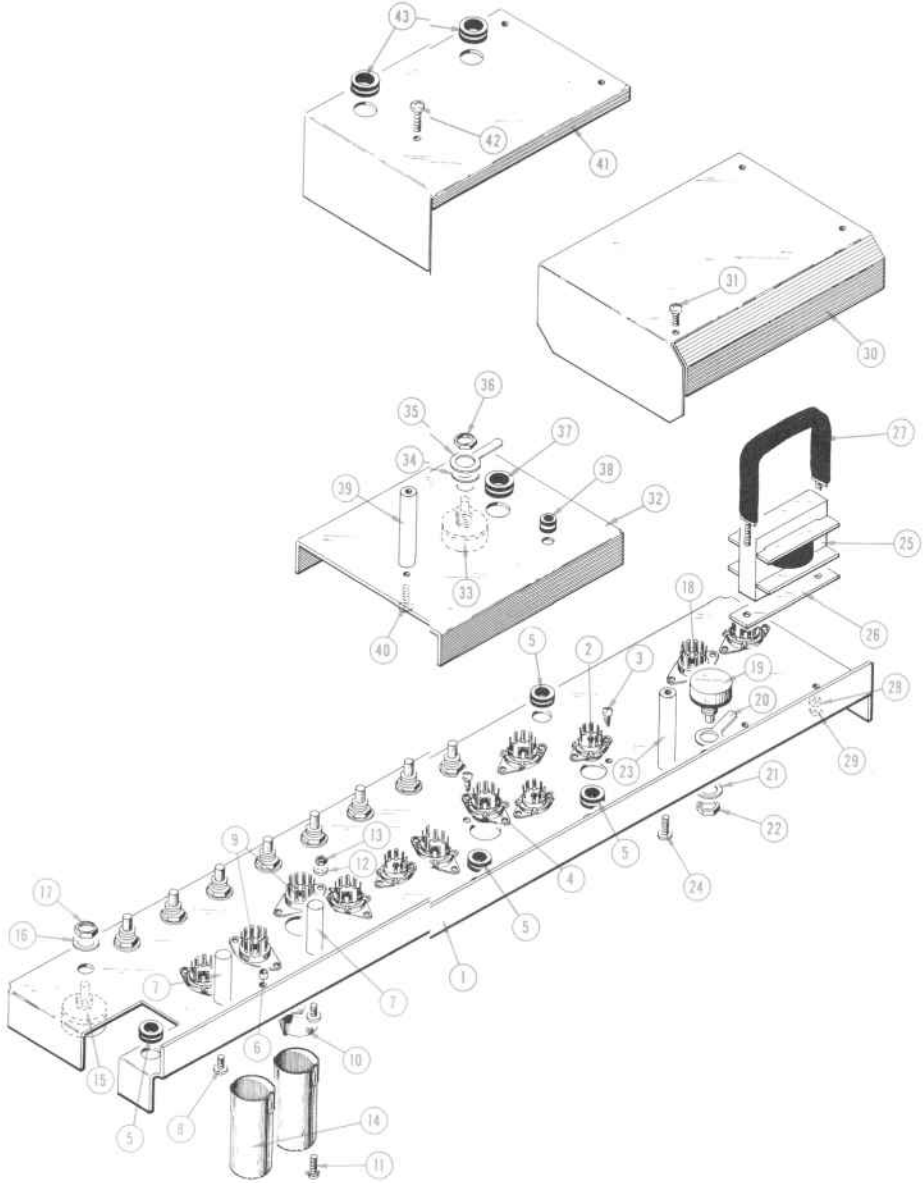
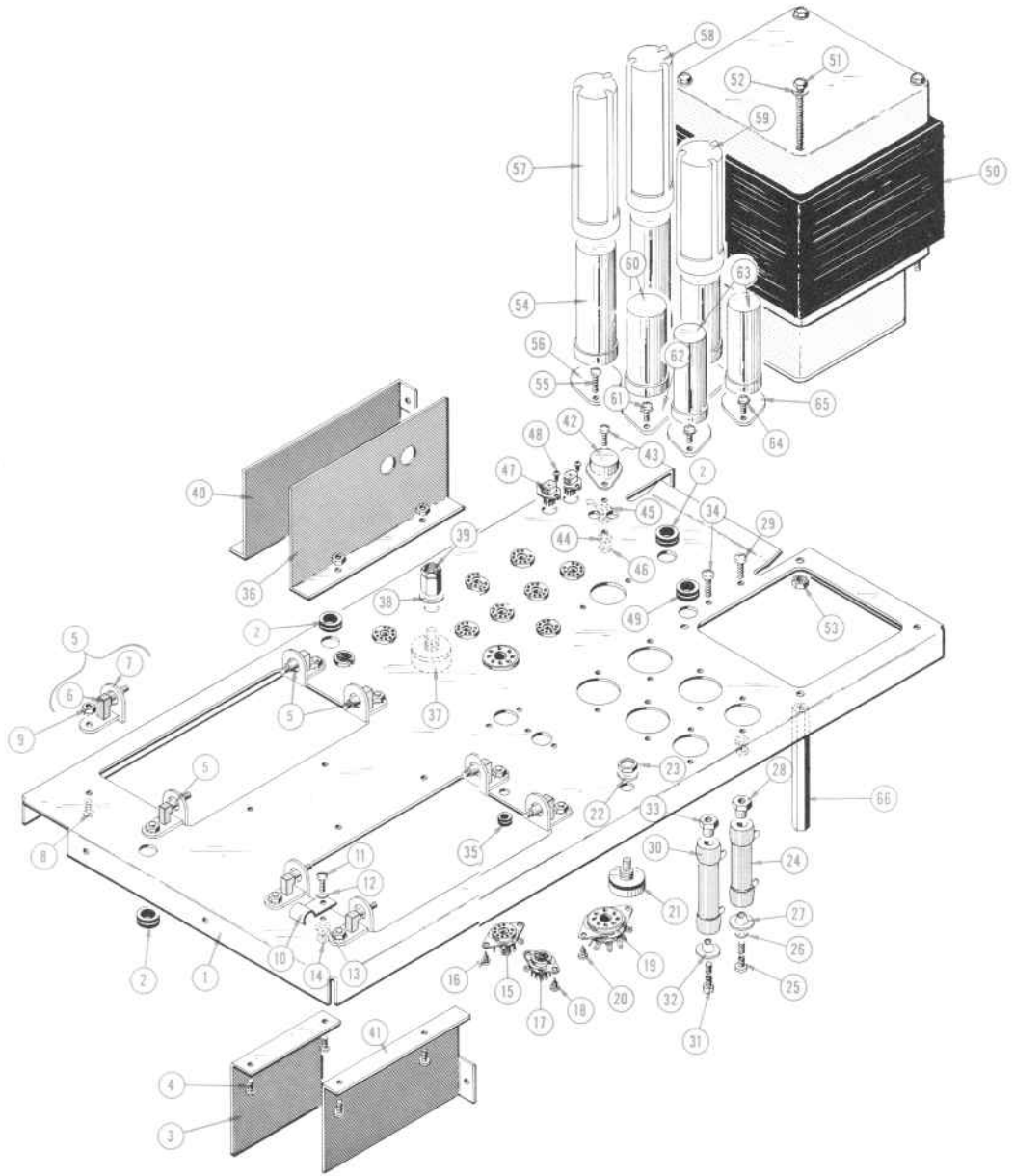


FIG. 3 LOW VOLTAGE POWER



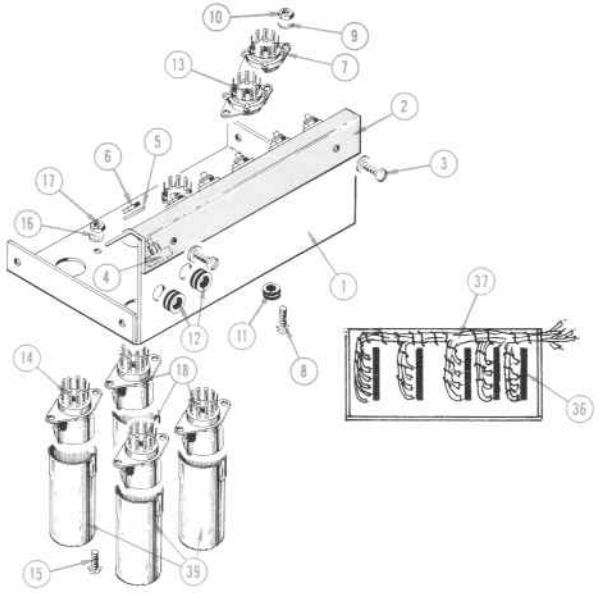
TYPE 502A OSCILLOSCOPE

FIG. 3

FIG. 4 VERTICAL AMPLIFIERS

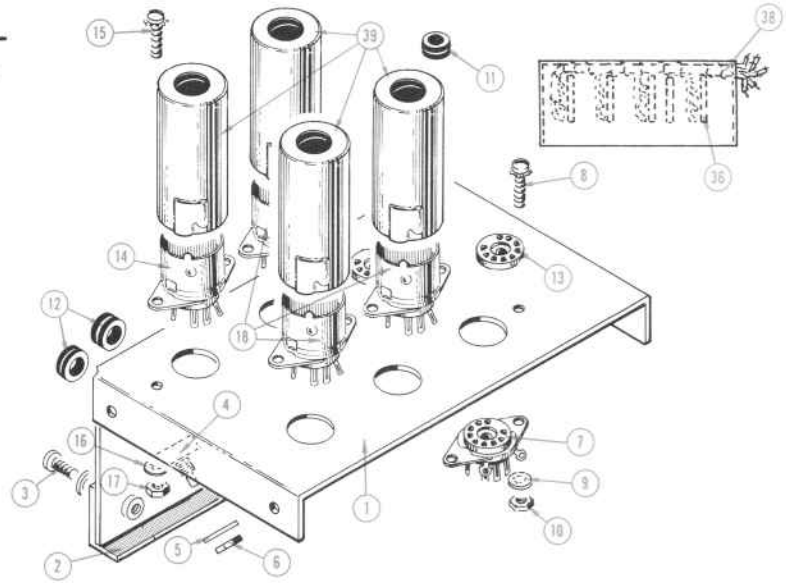
S/N
20000-25996

RIGHT

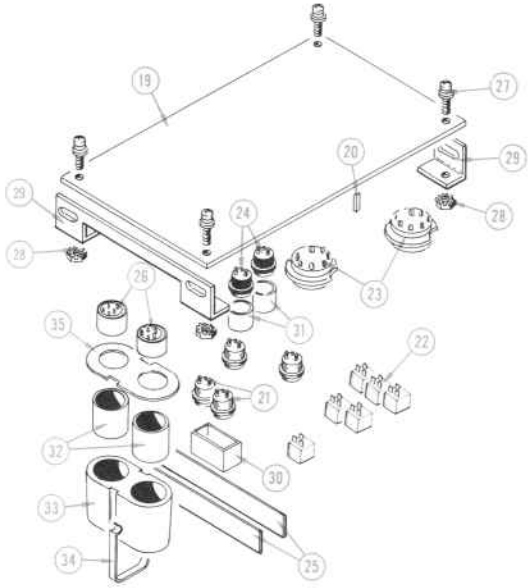


S/N
20000-
25996

LEFT



S/N
25997-UP



S/N
25997-UP

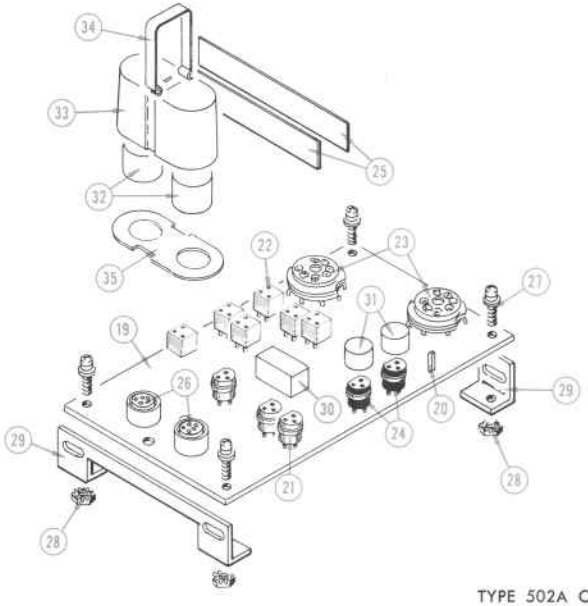
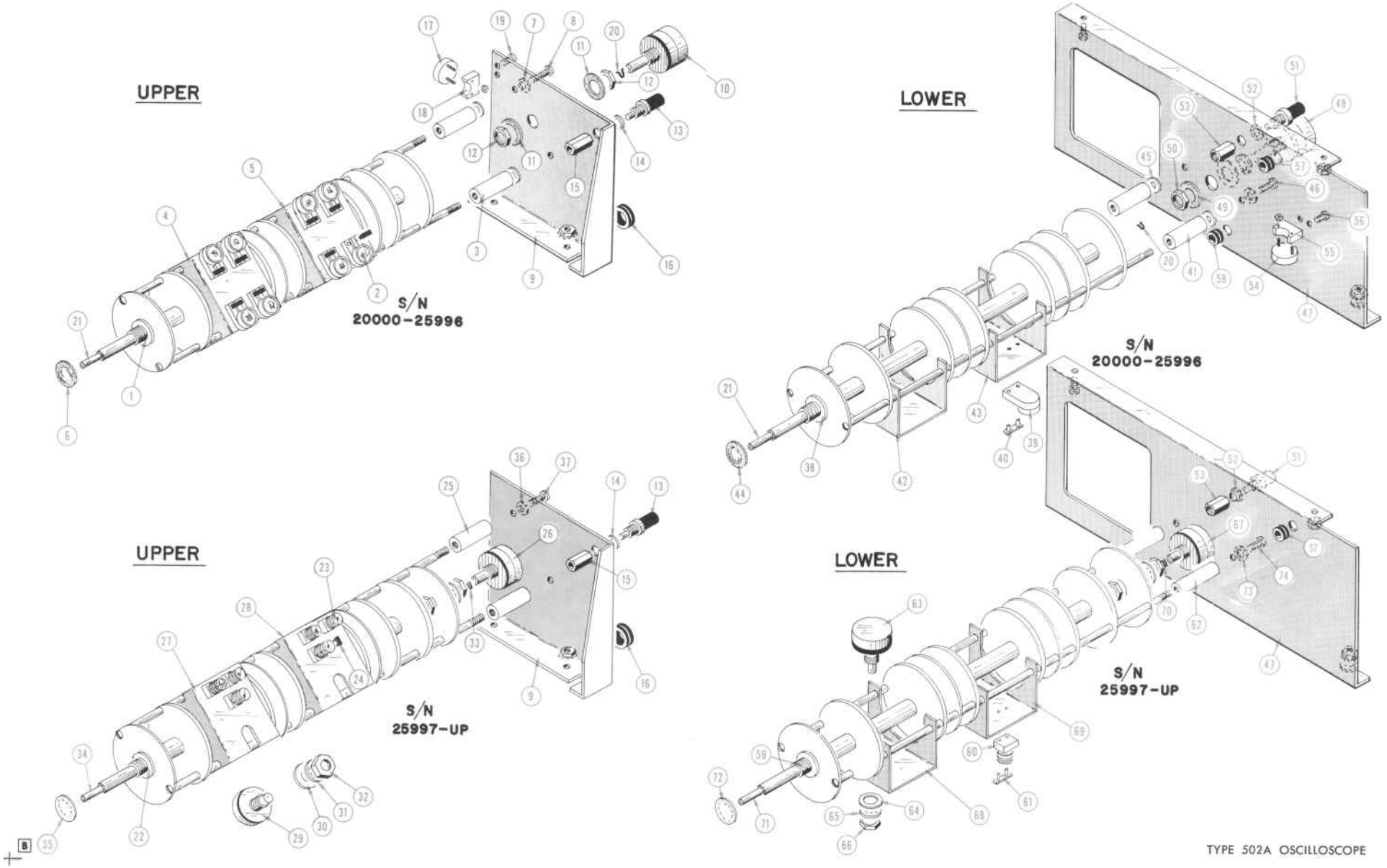


FIG. 5 SENSITIVITY SWITCHES



TYPE 502A OSCILLOSCOPE

FIG. 5

FIG. 6 TIME/CM, HORIZONTAL DEFLECTION DISPLAY & INPUT SWITCHES

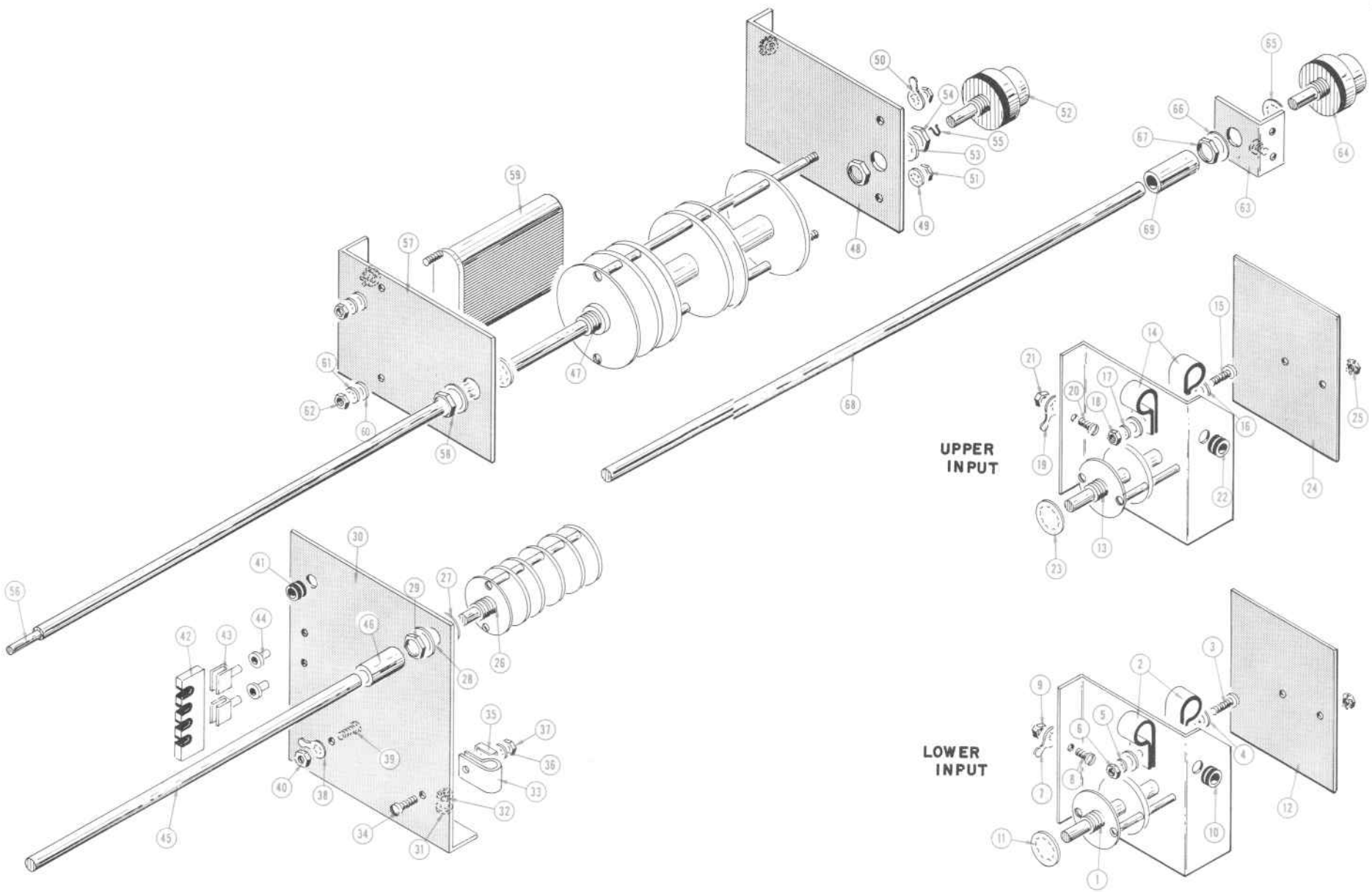


FIG. 7 HORIZONTAL DEFLECTION SWITCH & BULKHEAD

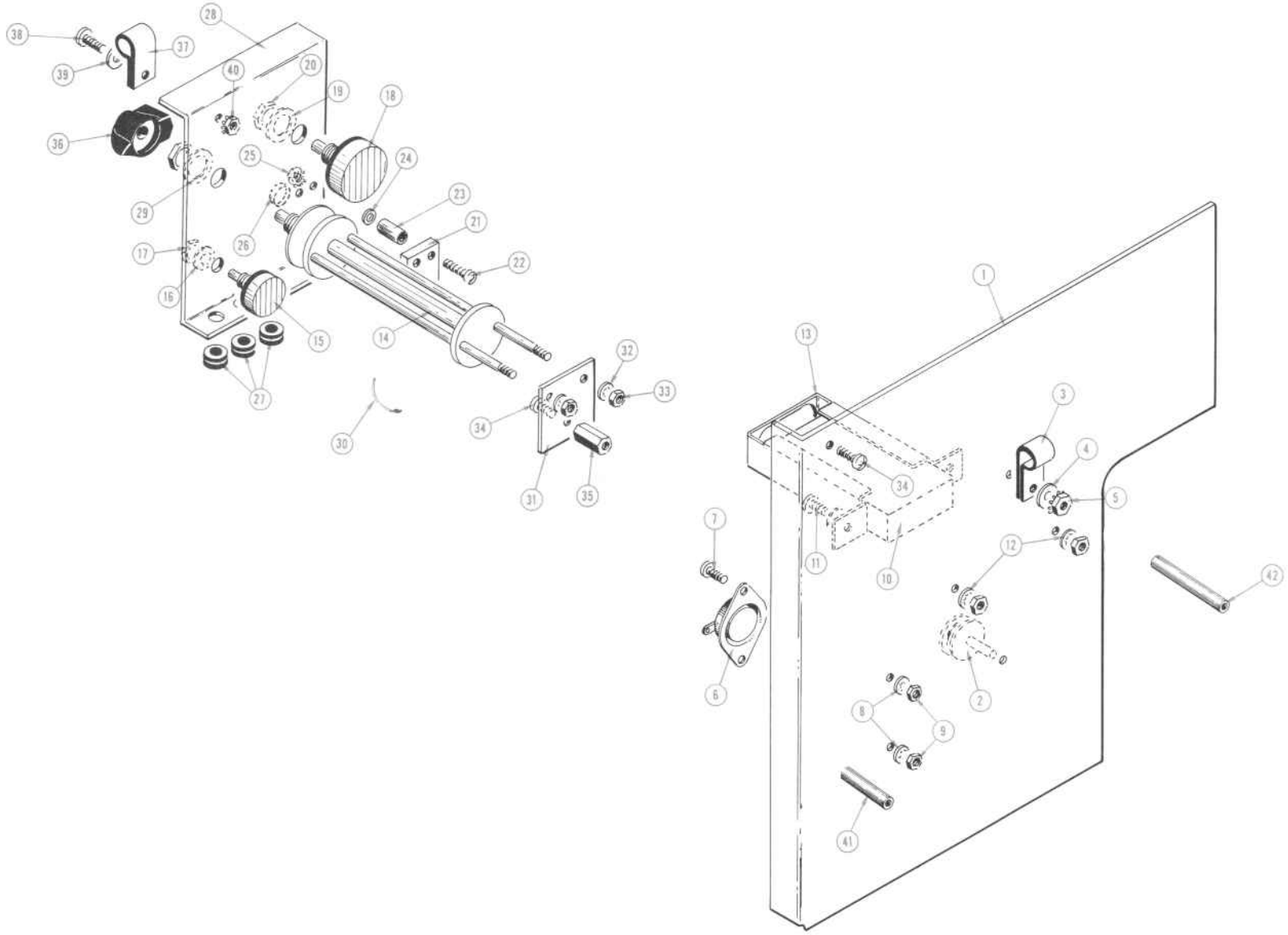


FIG. 8 CRT SHIELD & SUPPORT BRACKET

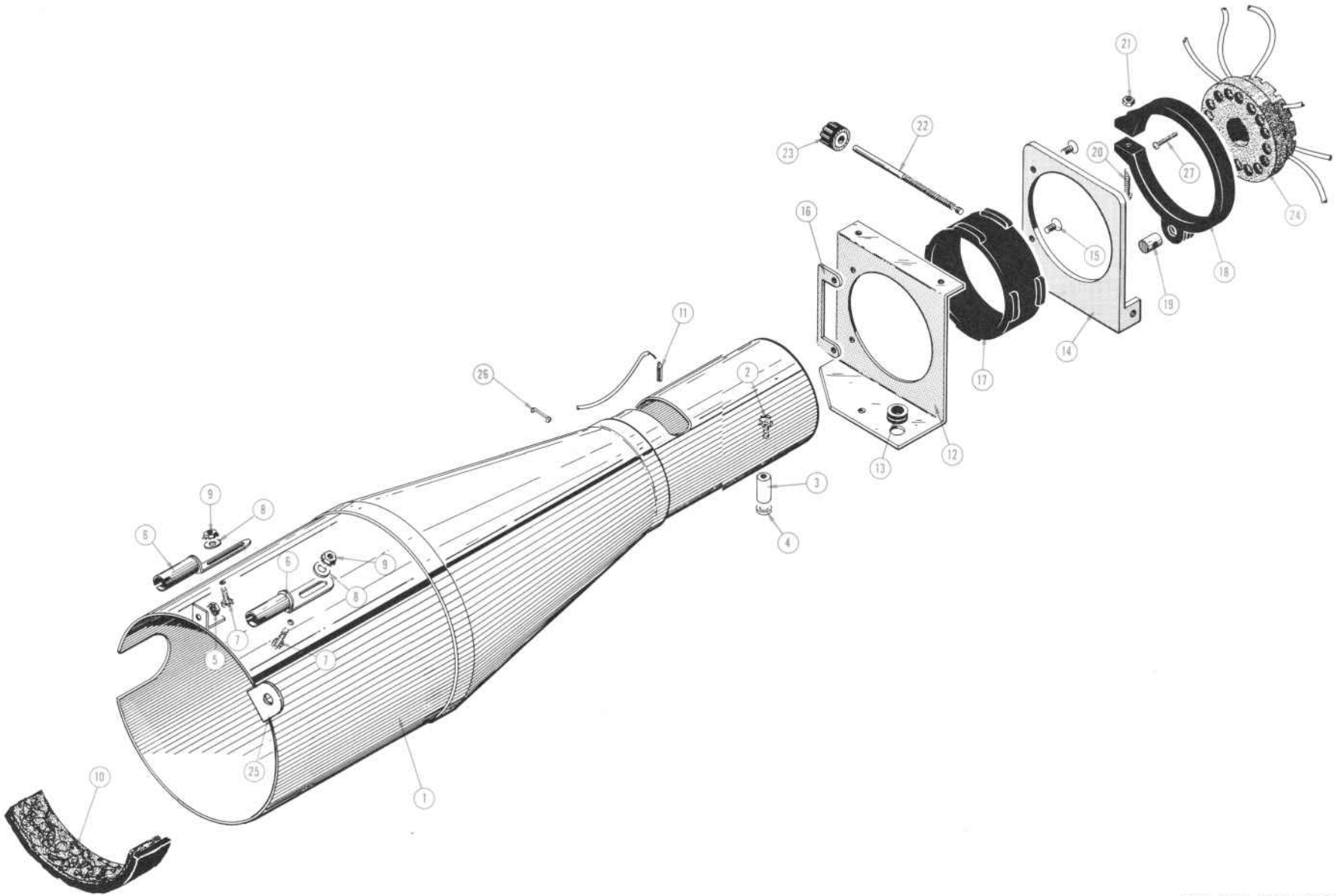


FIG. 9 CABINET & RAILS

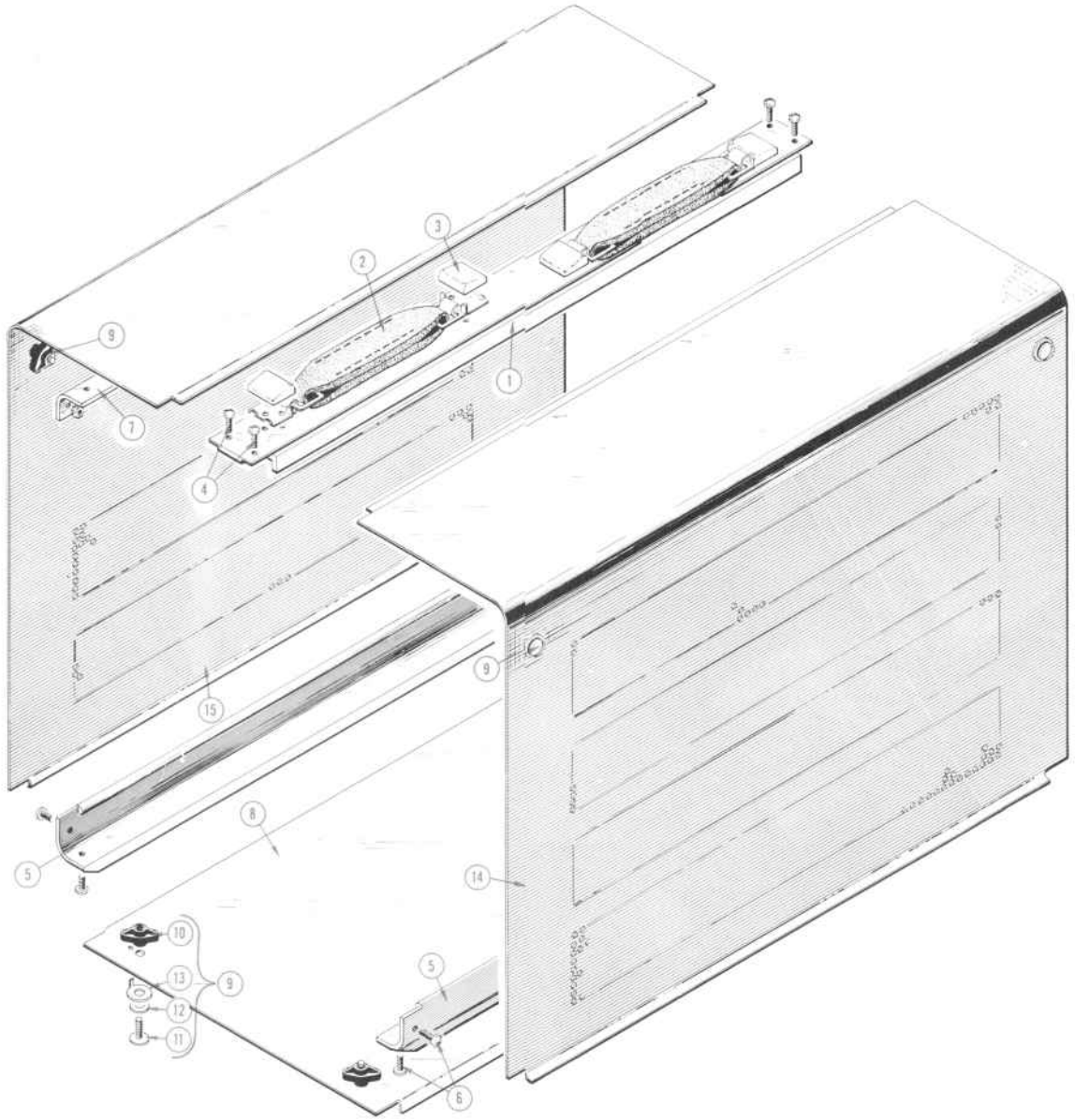


FIG. 10 FAN MOTOR & REAR

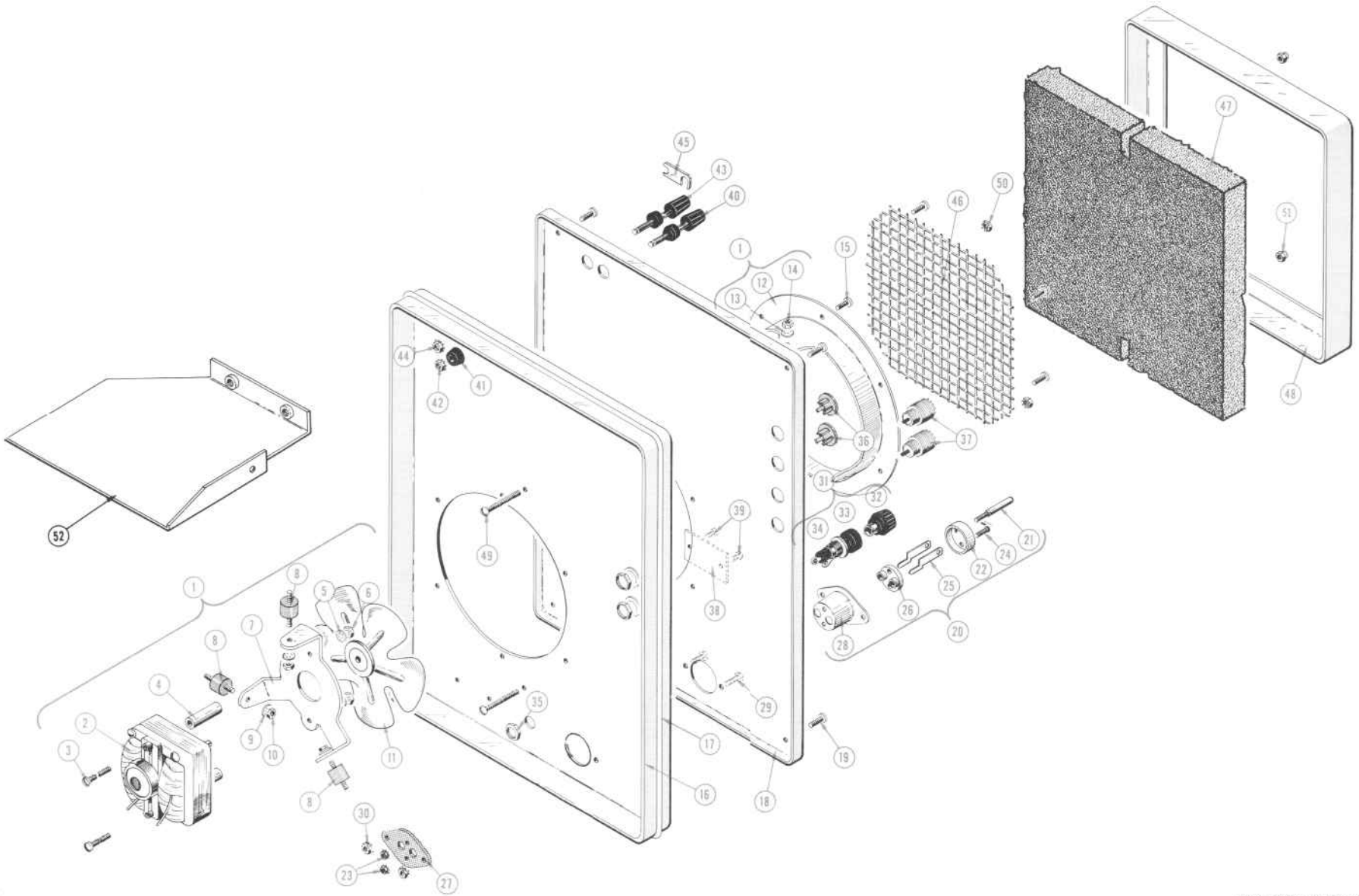
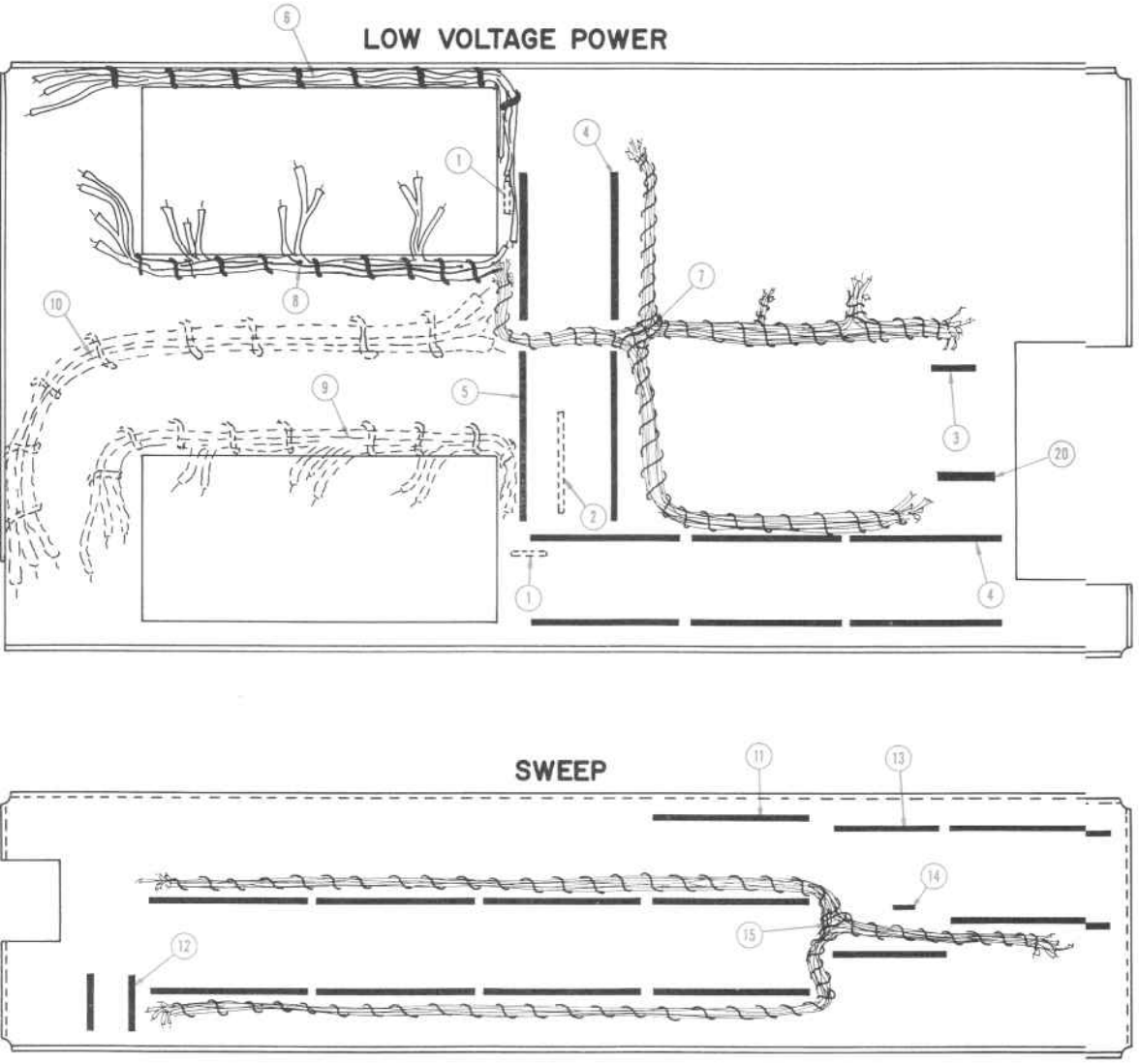
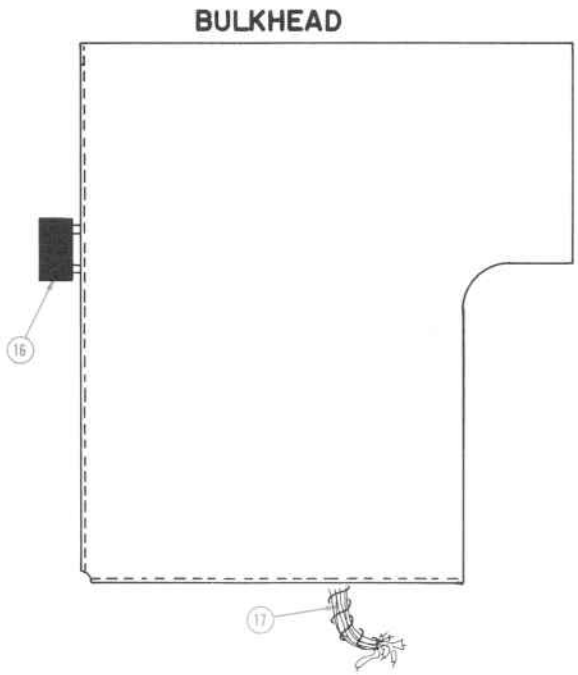


FIG. 11 CABLE HARNESS & CERAMIC STRIP DETAIL





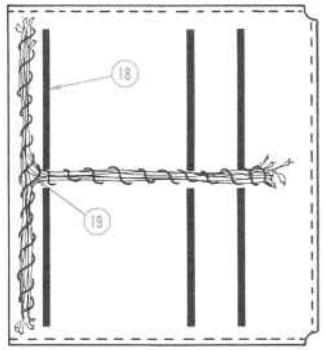


FIG. 11

FIG. 12 STANDARD ACCESSORIES

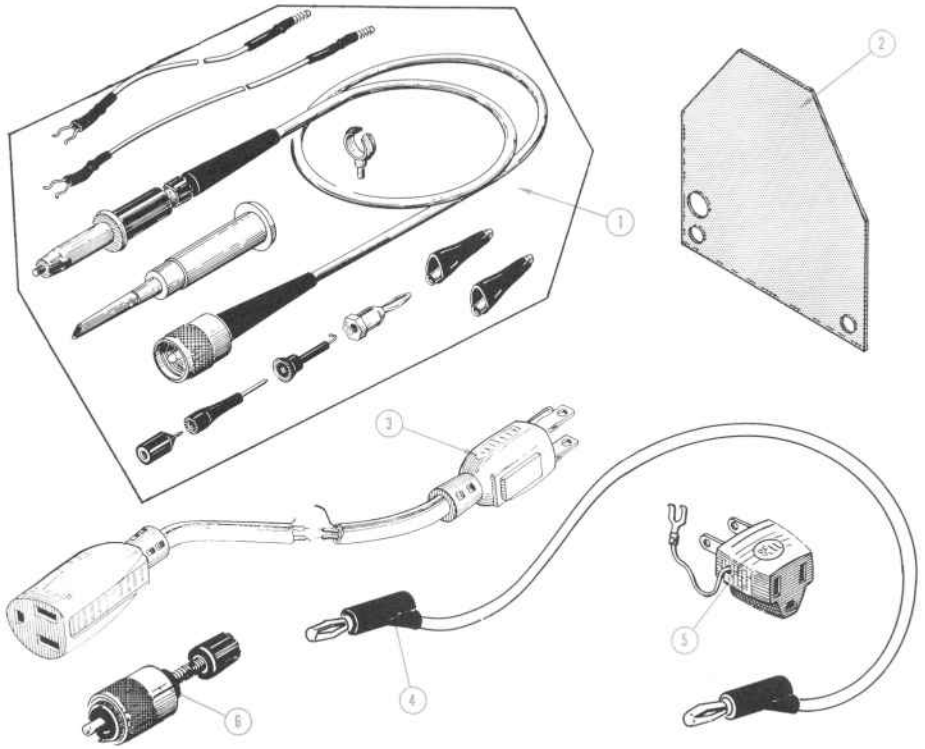


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
12-1	010-0125-00			2		PROBE, P6006, 10 meg, 10 x 42 inches, UHF
-2	378-0539-00	20000	241129	1		FILTER, light, polarized
	378-0567-00	24130		1		FILTER, light, smokey gray
-3	161-0010-00	20000	27139	1		CORD, power, 16 ga. 8 ft., 3 wire
	161-0010-03	27140		1		CORD, power, 16 ga. 8 ft., 3 wire
-4	012-0031-00			1		CORD, patch-banana plug both ends 18 inches
-5	103-0013-00			1		ADAPTER, power cord, 3 to 2 wire
-6	013-0004-00			2		ADAPTER, binding post, UHF
	070-0382-02			2		MANUAL, instruction (not shown)

SECTION 10
RACKMOUNTING

General

This section of the manual contains rackmounting instructions, a mechanical parts list, and dimensional drawing for the Type RM502A. Essentially, the Type RM502A is identical to the Type 502A, except for the mechanical changes required to adapt it for rackmounting.

Mounting Methods

This instrument has been designed to fit most 19-inch wide racks whose dimensions conform to EIA specifications. This instrument is intended to be fastened in place to the front rails of the rack by means of the four screws supplied with the instrument (see Fig. 10-1).

To perform many routing maintenance functions it is not necessary to completely remove the instrument from the rack. Only the four front-panel holding screws need be removed. The instrument can then be pulled out of the rack like a drawer to its fully extended position (see Fig. 10-2), and then tilted up or down and locked in one of several positions—horizontal, or 45°, 90°, and 105° above or below horizontal.

Some means of support (for example, make extensions for the rear mounting brackets) is needed to support the rear ends of the slideout tracks if the tracks are going to be installed in a rack whose inside dimensions between front and rear rails are not the proper distance (14 1/4" to 24 11/16"). Earlier (SN 20,000-23,289) slideout tracks had a shorter rear mounting bracket for which the proper inside dimension between the front and rear rails should be 18 1/4" to 20 3/4".

Instrument Dimensions

The last pullout page in this section shows dimensional drawings of the instrument exclusive of power cord and probes.

Rack Dimensions

Width—A standard 19" rack may be used. The dimension or opening between the front rails of the rack must be at least 17 5/8" for a rack in which the front lip of the stationary section is mounted **behind the front rail** as shown in Fig. 10-5b; at least 17 3/4" if the lip is mounted in **front of the front rail** as shown in Fig. 10-5a. These dimensions allow room on each side of the instrument for the slideout tracks to operate so the instrument can move freely in and out of the rack.

Depth—For circulation of cooling air, allow 4" behind the rear of the instrument and any rear enclosure on the rack. The space allowed can be reduced slightly so long as the instrument receives at least 250 cu ft/min of air not exceeding 50° C in temperature.

Rackmounting in a Cabinet Type Rack

General Information

The slideout tracks for the instrument consist of two assemblies, one each for the right and left sides. Each assembly consists of three sections as illustrated in Fig. 10-3. The stationary section attaches to the front and rear rails of a rack with inside dimensions as shown in Fig. 10-2, the chassis section is attached to the instrument, and the intermediate section fits between the other two sections to allow the instrument to fully extend out of the rack.

The small hardware components included with the slideout track assemblies are shown in Fig. 10-4. The hardware shown in Fig. 10-4 is used to mount the slideout tracks to the rack rails having this compatibility; rail holes tapped for #10-32 machine screws or with any larger hole, tapped or untapped; rail holes located on EIA/REMA/Western Electric or Universal spacing. Because of this compatibility, there will be some small parts left over.

Stationary and Intermediate Sections Installation

The stationary and intermediate sections for both sides of the cabinet rack are shipped as a matched set and should not be separated. The matched sets for both sides are marked 351-0085-00 (351-0006-00, SN 20,000-23,289) on the package. Use the following procedure to mount both sets. See Fig. 10-5 for installation details.

1. If the instrument is to be mounted directly above or below another instrument in the cabinet rack, select the appropriate holes in the front rack rails for the stationary sections using Fig. 5c as a guide.

2. If the rack rail holes are tapped for #10-32 machine screws, mount the left stationary section with hardware provided as shown in Fig. 10-5a. Using Fig. 10-5a as a guide, mount the right stationary section in the same manner.

3. If the rack rail holes are not tapped to accept #10-32 machine screws, mount the left stationary section with hardware provided as shown in Fig. 10-5b. Using Fig. 10-5b as a guide, mount the right stationary section in the same manner.

Adjustments

To adjust the slideout tracks for smooth operation, proceed as follows:

1. Insert the instrument into the rack as shown in Fig. 10-6.

2. Adjust the slideout tracks for proper spacing as shown in Fig. 10-7.

3. If the instrument does not slide smoothly after the spacing adjustments, the detent bar assembly of the chassis sections may not be parallel to the bottom of the instrument, and/or the eccentric pivot screws may not be set evenly so the slides are not parallel to each other. Adjust as shown in Fig. 10-8.

NOTE

If the eccentric pivot screw does not turn freely when adjusting it, the slit in the detent plate is fitting too tightly around the 1/4" diameter roll pin. This condition can be corrected as follows: Remove the nut, lockwasher, and flat washer from the eccentric pivot screw. Remove the outer slide, pivot screw, and dial plate. Using a round file, slightly enlarge the slot in the dial plate where the roll pin fits. Then remount the parts.

Maintenance

The slideout tracks require no lubrication. The special gray finish on the sliding parts is a permanent lubrication.

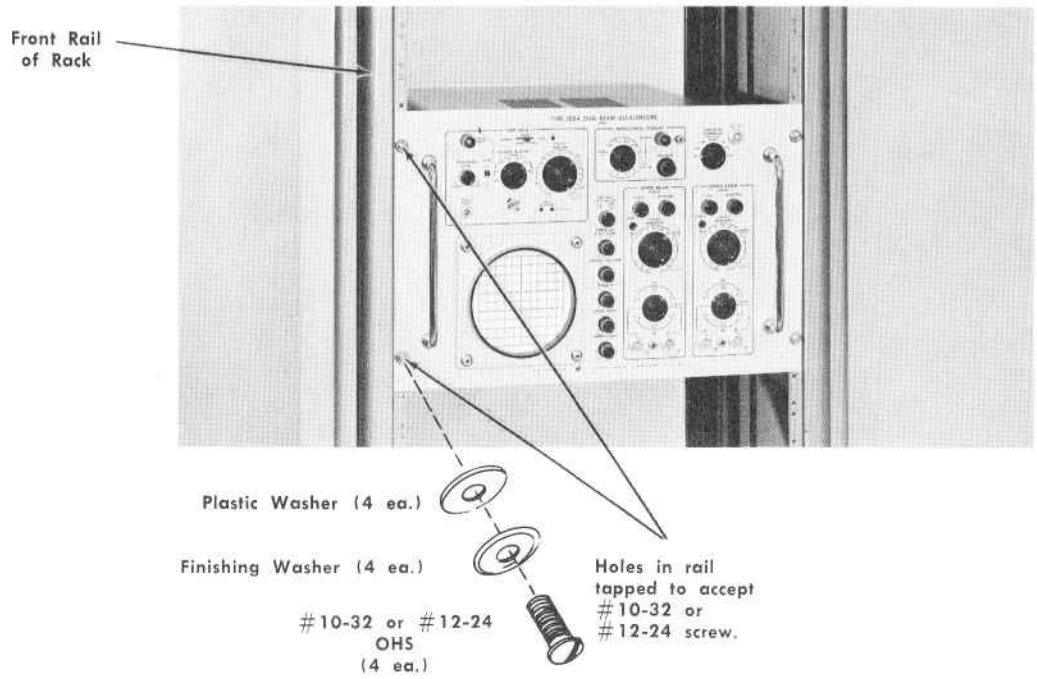


Fig. 10-1. Instrument installed in cabinet-type rack.

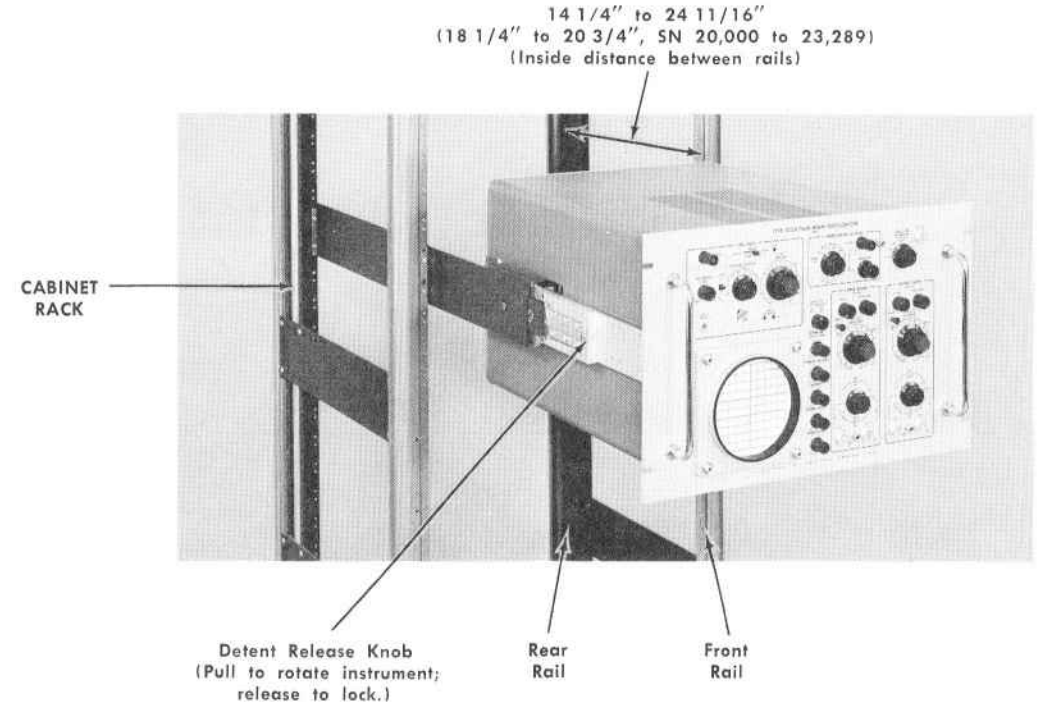
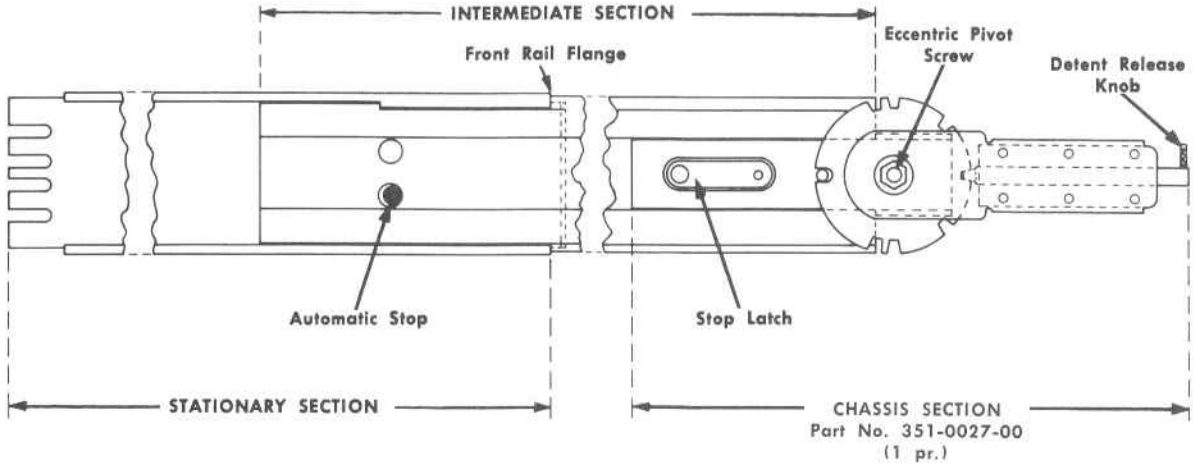


Fig. 10-2. Instrument supported by slideout tracks mounted between front and rear cabinet rack rails.



*Matched stationary and intermediate sections for both sides—Part No. 351-0085-00 (351-0006-00, SN 20,000 to 23,289).

Fig. 10-3. Illustration showing the slideout track assembly for the right side.

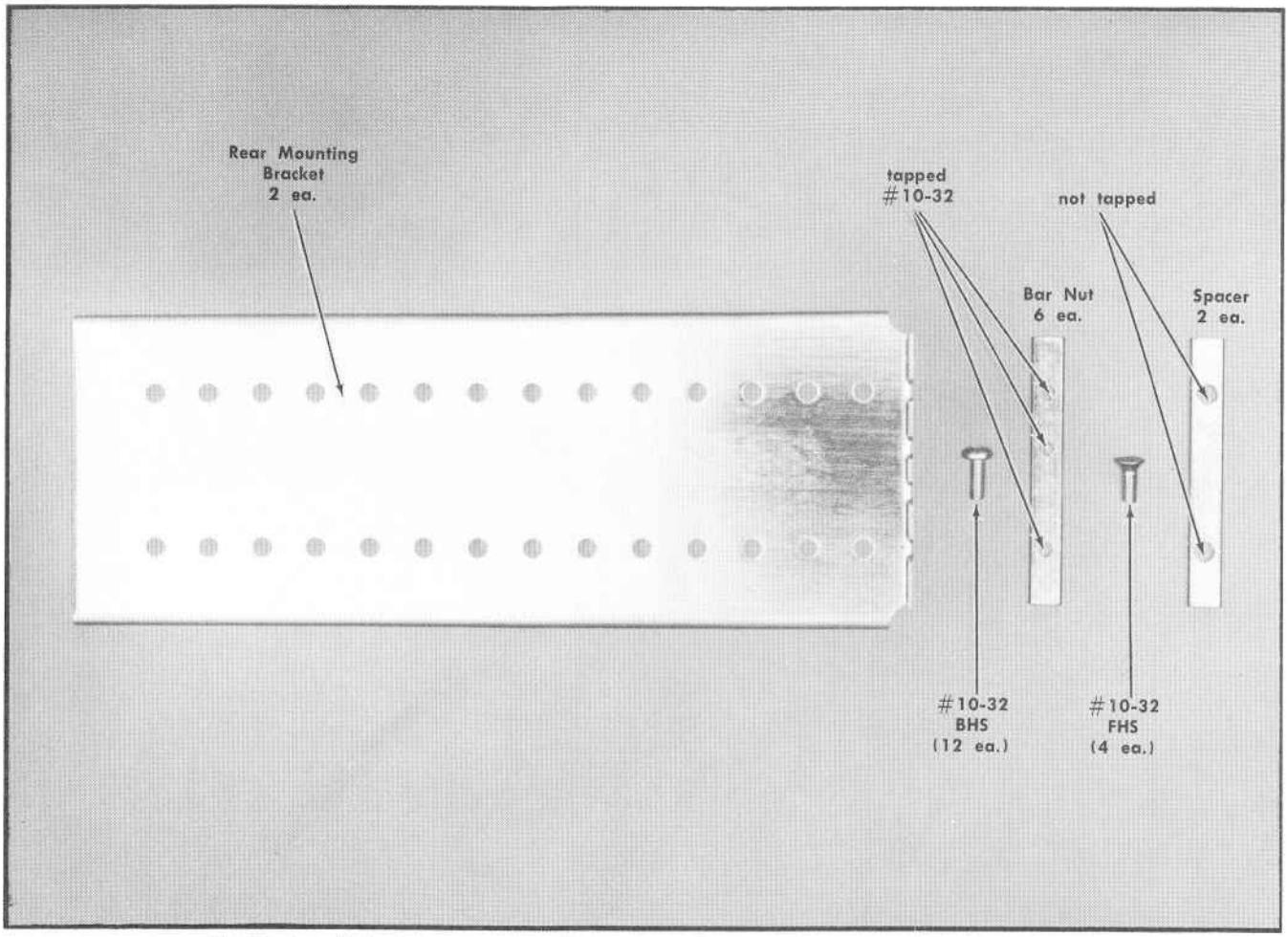
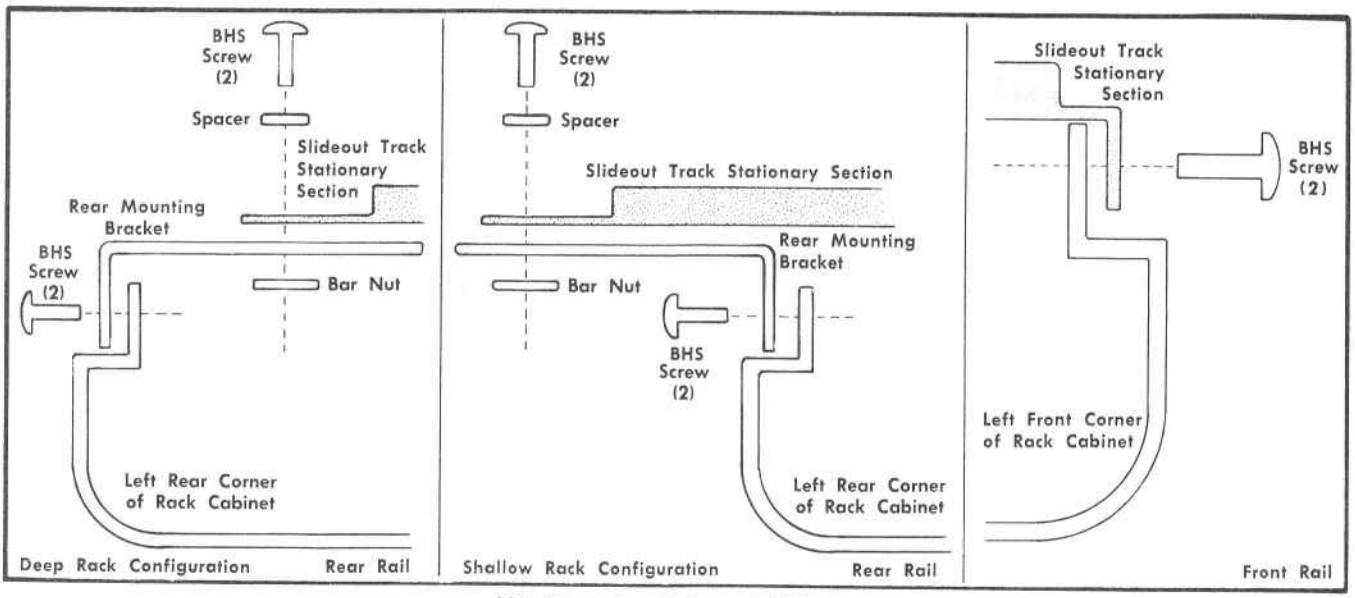
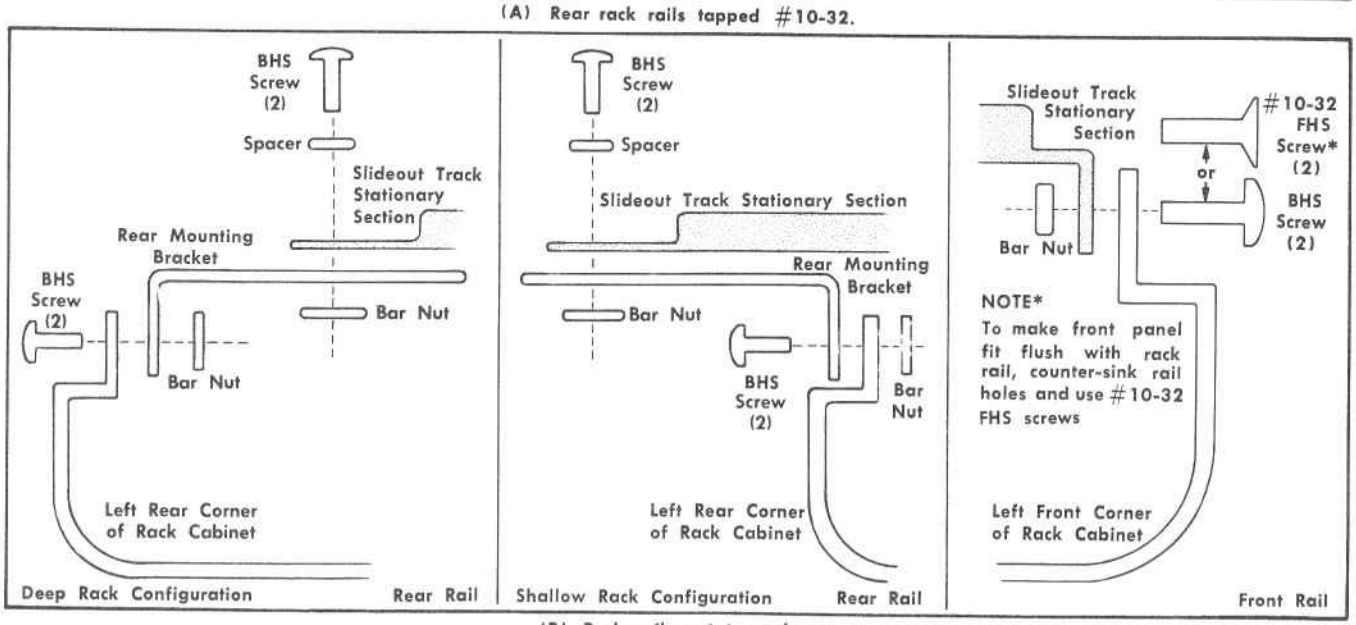


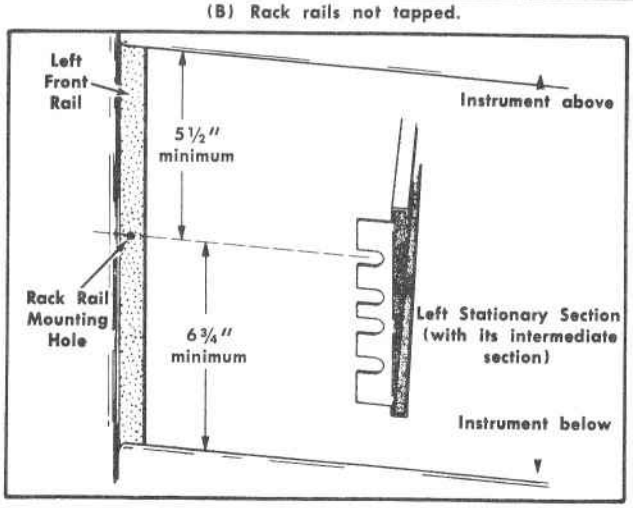
Fig. 10-4 Small hardware components for mounting the stationary sections of the rack rails.



(A) Rear rack rails tapped #10-32.



(B) Rack rails not tapped.

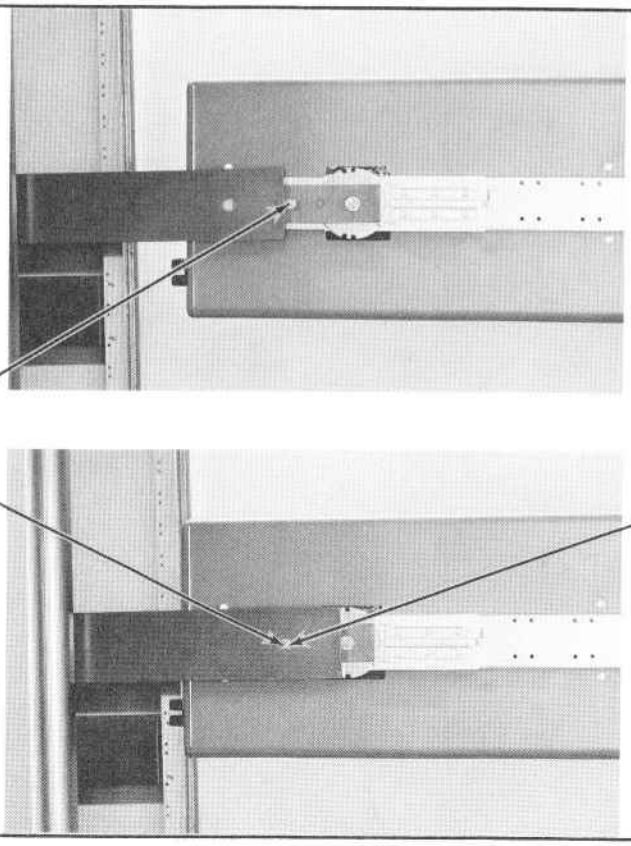


(C) Locating vertical mounting position.

Fig. 10-5. Mounting the left stationary section with its matched intermediate section (not shown) to rack rails.

TO INSTALL

1. Pull the slideout track intermediate sections out to the fully extended position.
2. Insert the instrument chassis sections into the intermediate section.
3. Press stop latches and push instrument toward rack until the latches snap into their holes.
4. Again press stop latches and push instrument into rack.
5. Secure the instrument in place with the four front-panel screws.



TO REMOVE

1. Remove the four front-panel screws from the instrument.
2. Pull instrument outward until the stop latches snap into the holes.
3. Press stop latches and remove the instrument.

Fig. 10-6. Installing and removing the instrument.

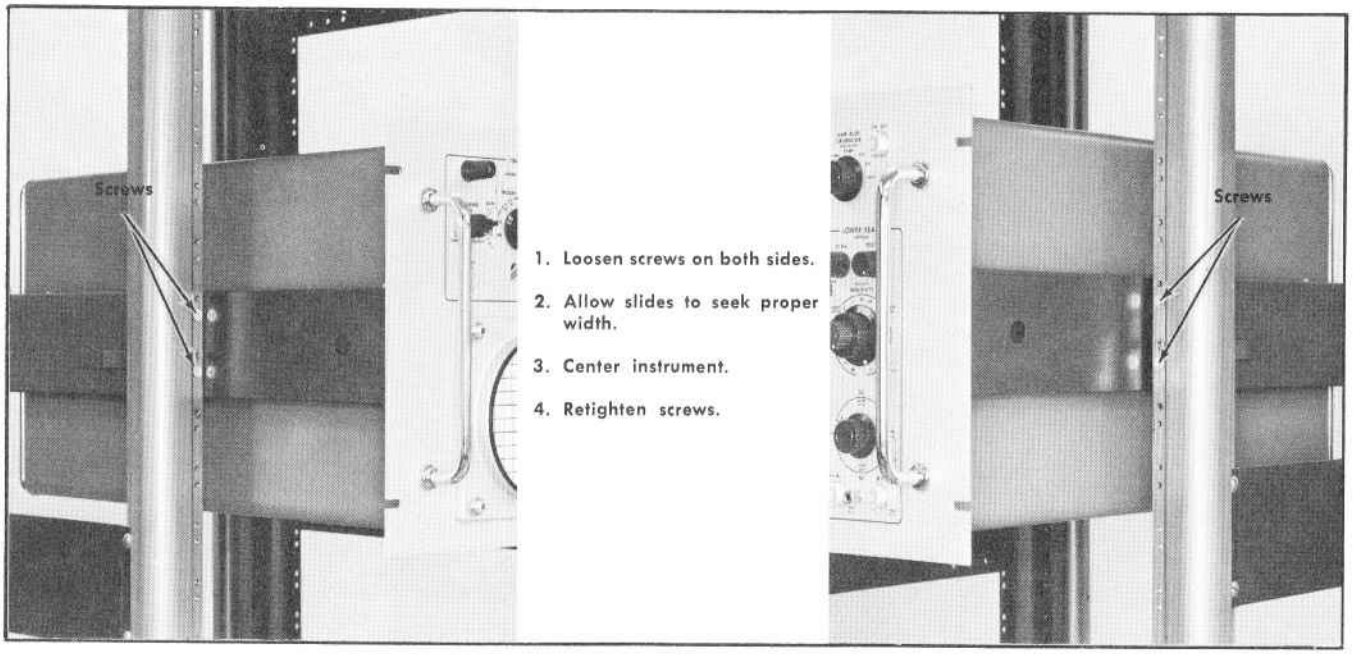
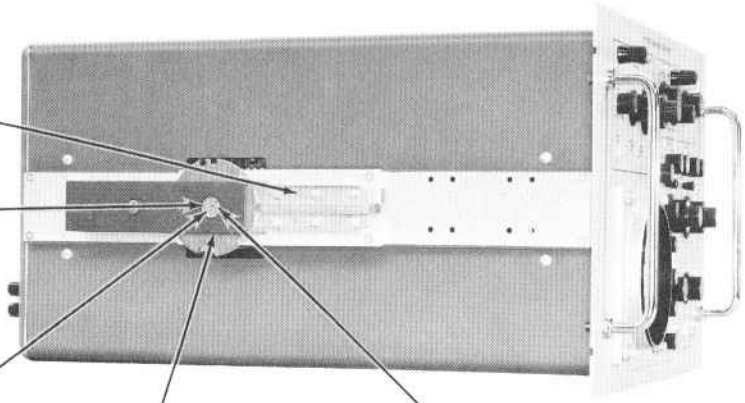


Fig. 10-7. Adjusting the slideout tracks for smooth sliding action.



1. Check detent bar assembly for parallel alignment with bottom of instrument. If assembly is not parallel, correct the misalignment.

2. Loosen nut on eccentric pivot screw. (Located inside instrument. One turn is usually enough.)

3. Turn eccentric pivot screw

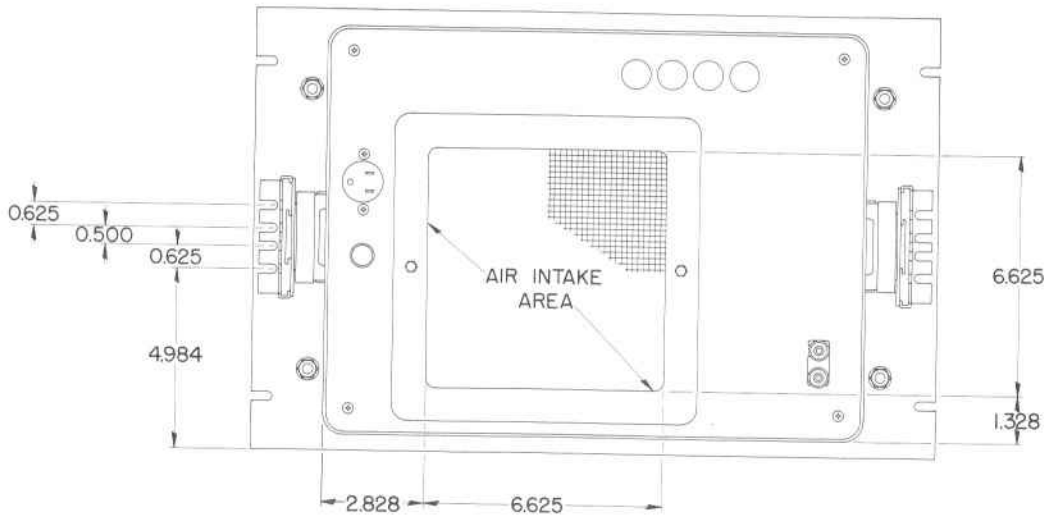
4. to make edge of slide parallel with bottom of instrument.*

5. Hold eccentric pivot screw and retighten nut. Repeat these 5 steps for the other side of the instrument.

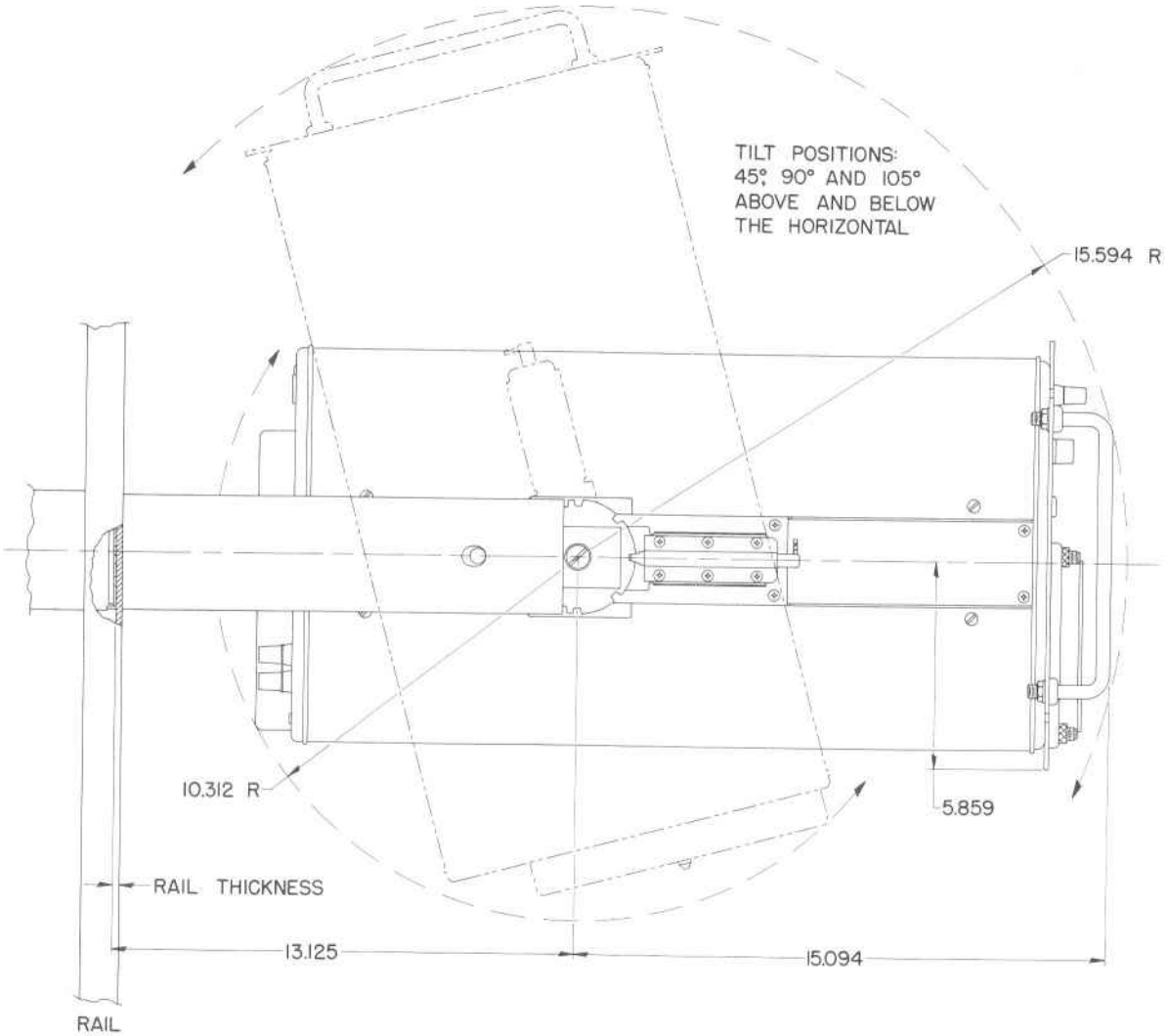
*Exception—The eccentric pivot screws may be adjusted to shift the front of the instrument up or down to maintain parallel alignment between left and right slides, to center the instrument front panel in the space between upper and lower instrument in the rack, and/or to allow the rear side of the front panel to fit parallel to the front rack rails when the instrument is all the way in the rack.

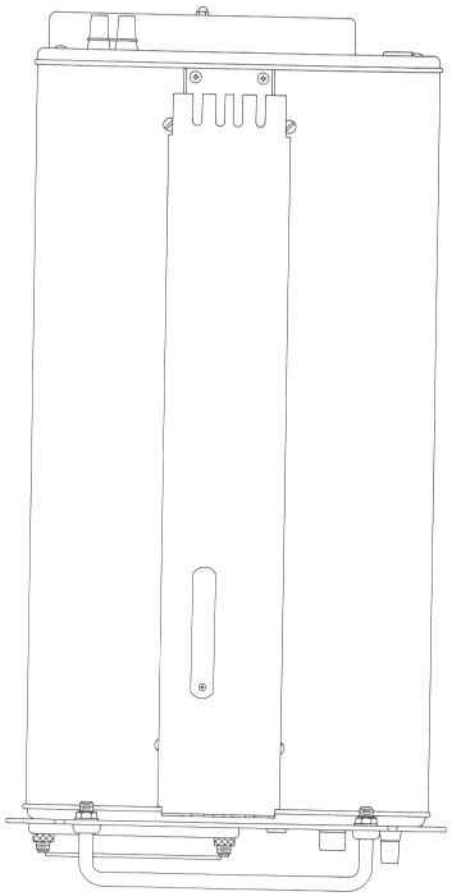
6. Reinstall the bottom cover and insert the plug-in units into their compartments.

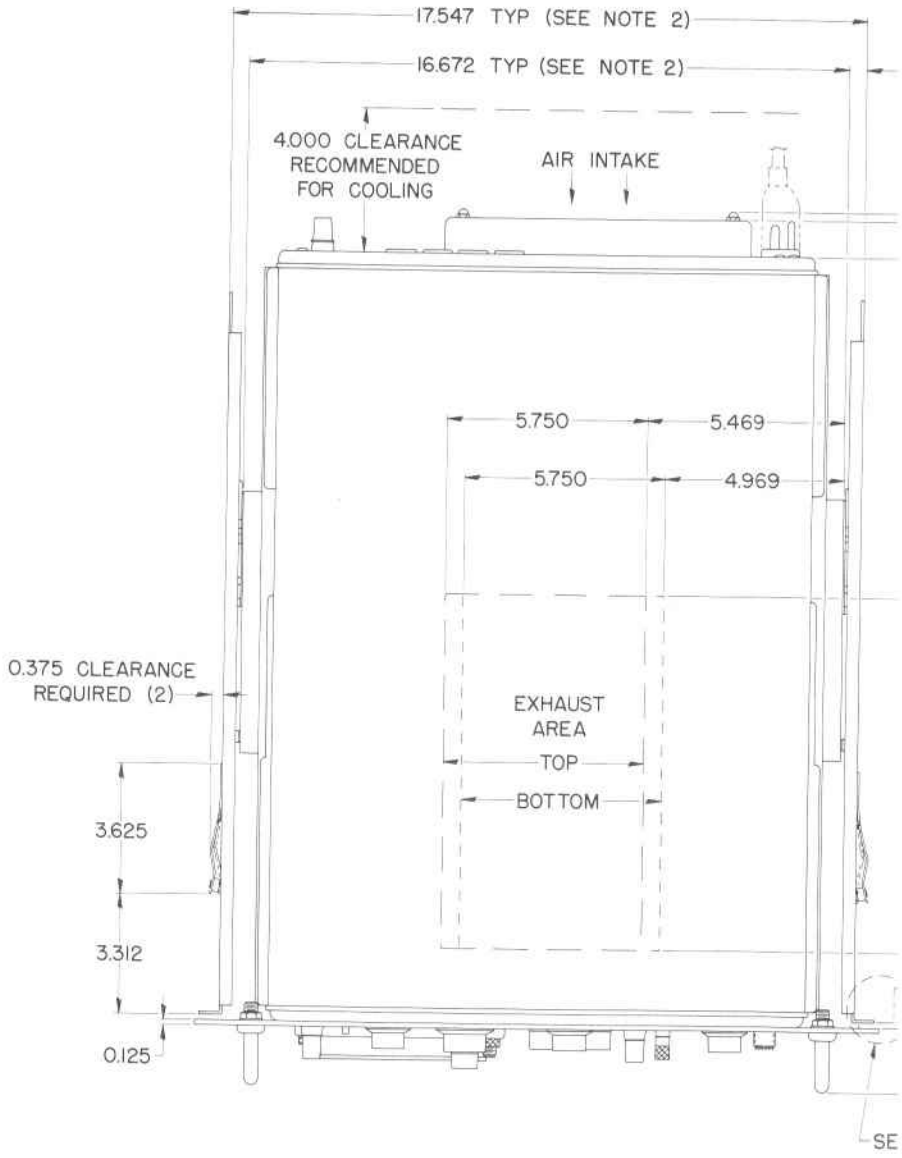
Fig. 10-8. Adjusting the chassis sections.

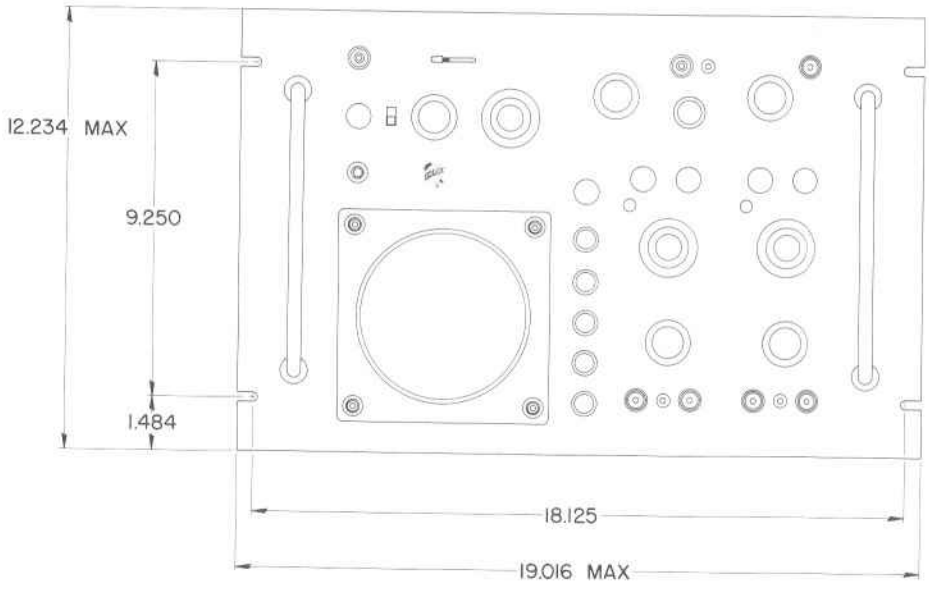

0.625
0.500
0.625
4.984
AIR INTAKE
AREA
6.625
1.328
2.828
6.625

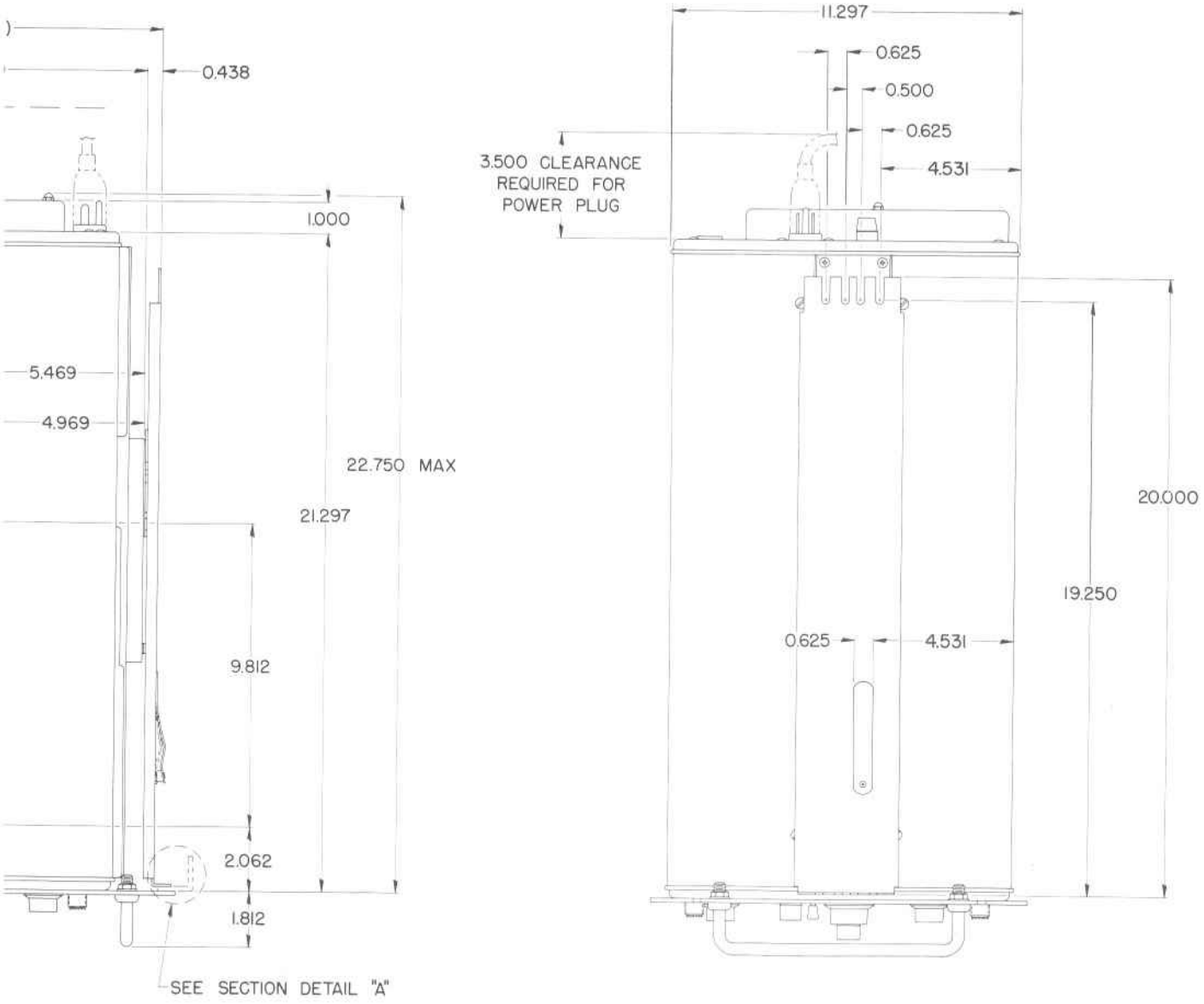
REAR VIEW

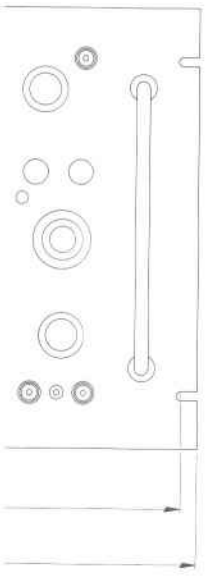

TILT POSITIONS:
45°, 90° AND 105°
ABOVE AND BELOW
THE HORIZONTAL
15.594 R
10.312 R
5.859
RAIL THICKNESS
13.125
15.094
RAIL

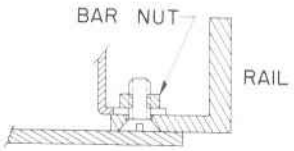



17.547 TYP (SEE NOTE 2)
16.672 TYP (SEE NOTE 2)
4.000 CLEARANCE
RECOMMENDED
FOR COOLING
AIR INTAKE
5.750
5.469
5.750
4.969
0.375 CLEARANCE
REQUIRED (2)
EXHAUST
AREA
TOP
BOTTOM
3.625
3.312
0.125
SE


12.234 MAX
9.250
1.484
18.125
19.016 MAX







SECTION DETAIL "A"

RECOMMENDED MOUNTING

NOTES:
1. ALL DIMENSIONS ARE REFERENCE DIMENSIONS EXCEPT AS NOTED
2. SUBJECT TO APPROXIMATELY ±0.047 DEVIATION

TYPE RM502A

A

DIMENSIONAL DRAWING

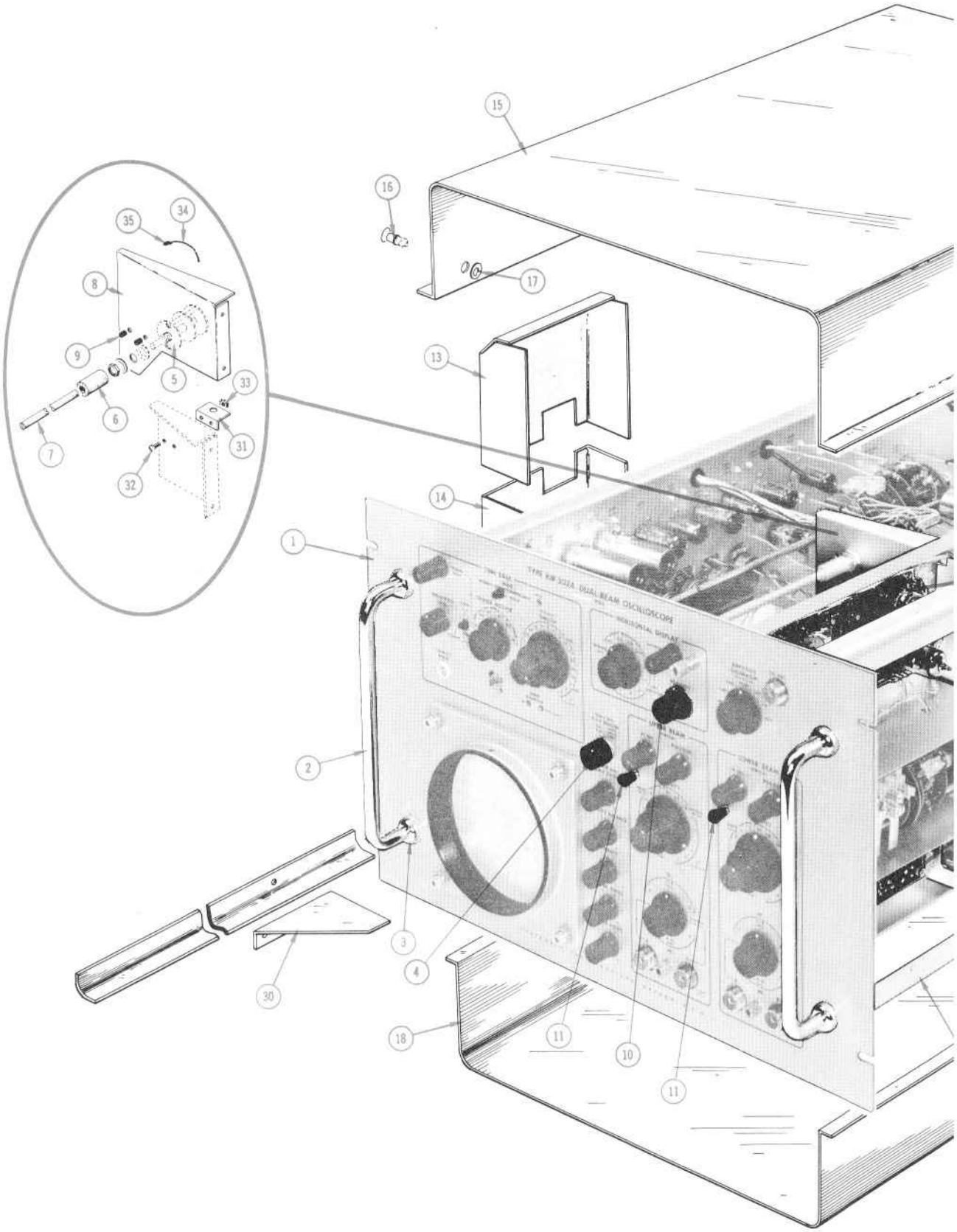
FIG. 10-9 RM502A MECHANICAL PARTS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
					1 2 3 4 5
-1	333-0877-00			1	PANEL, front
	- - - - - -			-	mounting hardware: (not included w/panel)
	212-0040-00			1	SCREW, 8-32 x 3/8 inch, 100° csk, FHS
	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch
-2	367-0003-00			2	HANDLE
	- - - - - -			-	mounting hardware for each: (not included w/handle)
-3	432-0004-00			2	BASE, 3/4 OD x 1/4 inch long
	210-0807-00			2	WASHER, flat, 5/16 ID x 5/8 inch OD
	210-0524-00			2	NUT, 5/16-24 x 1/2 x 3/16 inch thick
-4	366-0148-00			1	KNOB, charcoal—HORIZ DEFL PLATE SELECTOR
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-5	260-0644-00			1	SWITCH, unwired—HORIZ DEFL PLATE SELECTOR
-6	376-0007-00			1	COUPLER, 1 inch long
	- - - - - -			-	coupler includes:
	213-0005-00			2	SCREW, set, 8-32 x 1/8 inch, HSS
-7	384-0545-00			1	ROD, extension, 1/4 x 9 1/4 inches long
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
	358-0029-00			1	BUSHING, hex., 3/8-32 x 1/2 inch long
-8	407-0087-00			1	BRACKET, horizontal display switch
-9	348-0031-00			5	GROMMET, plastic, 1/4 inch diameter
-10	366-0173-00			1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-11	384-0207-00	20000	25999	2	ROD, extension, w/knob—FINDER
	384-0271-00	26000		2	ROD, extension, w/knob—FINDER
-12	122-0124-00			2	ANGLE, corner rail
	- - - - - -			-	mounting hardware for each: (not included w/angle)
	211-0559-00			4	SCREW, 6-32 x 3/8 inch, 100° csk, FHS
	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
-13	337-0709-00			1	SHIELD, high voltage
-14	337-0710-00			1	SHIELD, high voltage
-15	386-0113-00			1	PLATE, cabinet top
	- - - - - -			-	plate includes:
-16	214-0390-00			4	FASTENER, stud
-17	214-0389-00			4	RETAINER, split ring fastener
-18	386-0114-00			1	PLATE, cabinet bottom
	- - - - - -			-	plate includes:
	214-0390-00			4	FASTENER, stud
	214-0389-00			4	RETAINER, split ring fastener

FIG. 10-9 RM502A MECHANICAL PARTS *(cont)*

Fig & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
-19	407-0084-00			4	BRACKET, dust cover
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
-20	211-0511-00			2	SCREW, 6-32 x 1/2 inch, PHS
-21	381-0241-00	20000	25999	2	BAR, chassis track support
	381-0241-01	26000		2	BAR, chassis track support
	- - - - - -			-	mounting hardware for each: (not included w/bar)
-22	212-0011-00			4	SCREW, 8-32 x 3/4 inch, 100° csk, FHS
	210-0458-00			4	NUT, keps, 8-32 x 11/32 inch
-23	407-0085-00			2	BRACKET, chassis track
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
-24	212-0011-00			6	SCREW, 8-32 x 3/4 inch, 100° csk, FHS
-25	351-0027-00			1 pr	SLIDE, chassis track
-26	407-0116-00			4	BRACKET, shockmount, right
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
-27	407-0083-00			4	BRACKET, shockmount, left
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
-28	407-0086-00			1	BRACKET, lower beam sensitivity switch
-29	385-0185-00			1	ROD, hex., transformer support
-30	407-0082-00			1	BRACKET, horizontal beam register
-31	406-0576-00			1	BRACKET, variable resistor
	- - - - - -			-	mounting hardware: (not included w/bracket)
-32	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
-33	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-34	175-0582-00			2	WIRE, CRT lead, striped brown
	175-0583-00			1	WIRE, CRT lead, striped red
	175-0584-00			1	WIRE, CRT lead, striped green
	175-0596-00			2	WIRE, CRT lead, striped blue
	- - - - - -			-	each wire includes:
-35	131-0049-00			1	CONNECTOR, CRT cable

FIG. 10-9 RM502A MECHANIC



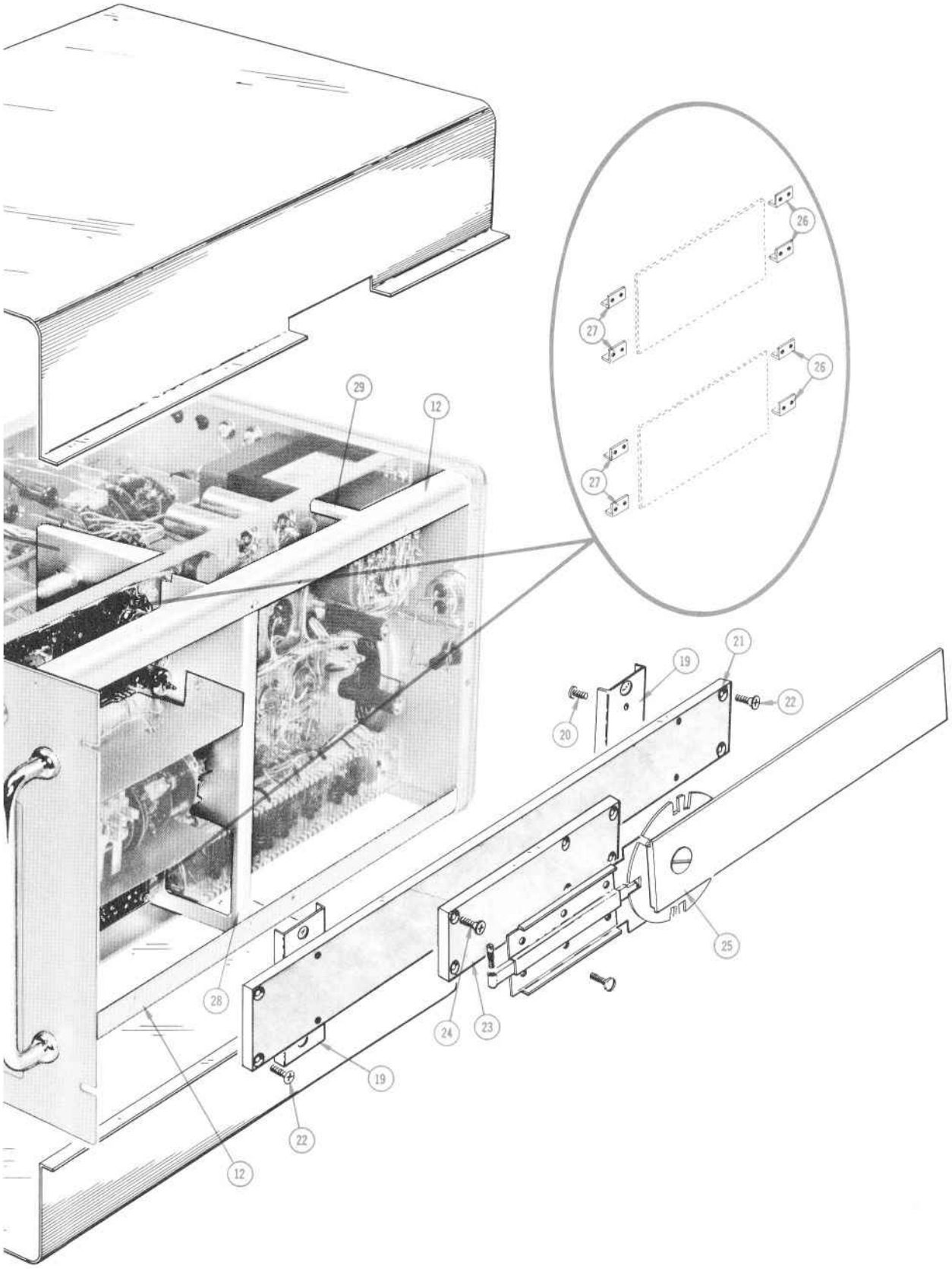

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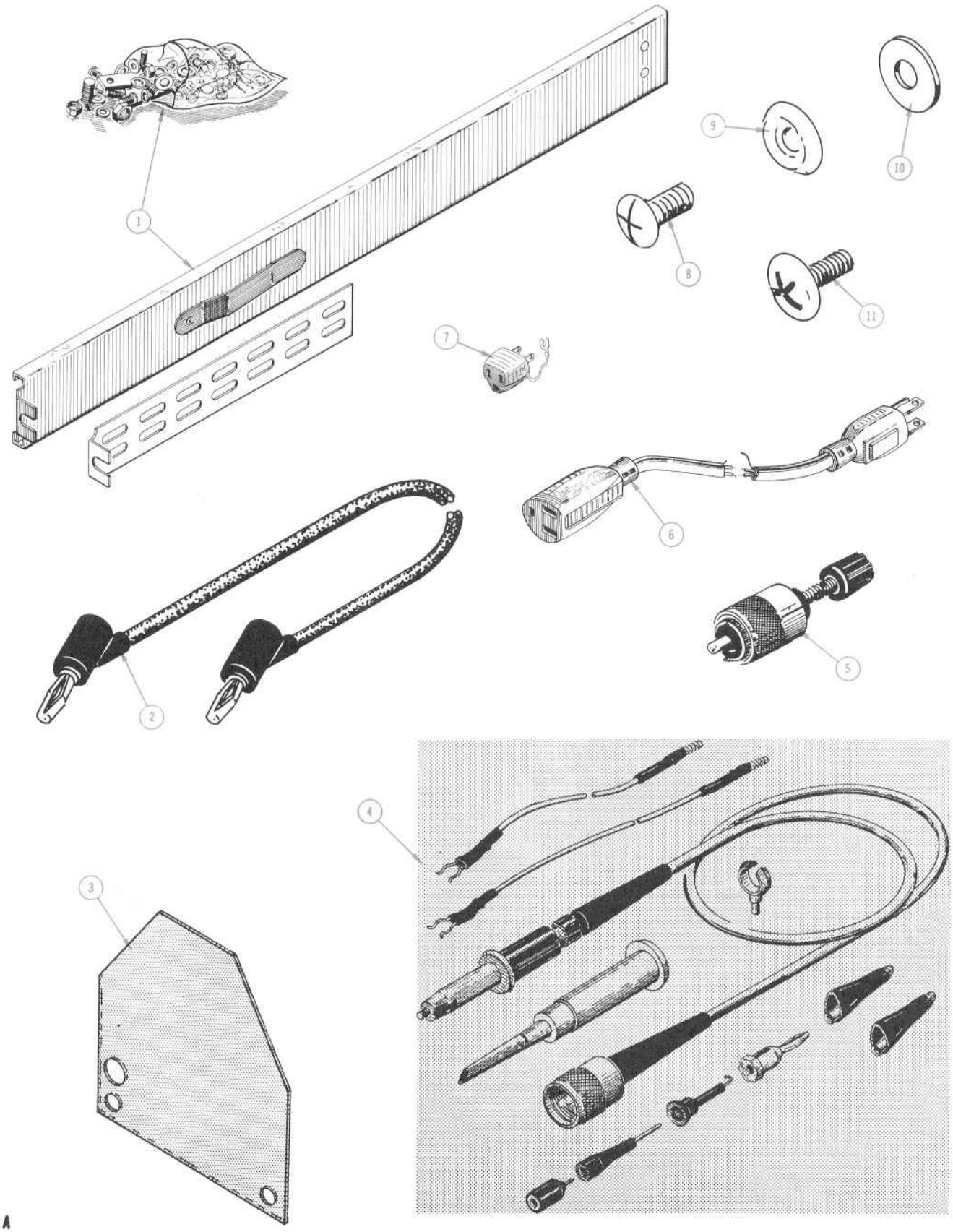
FIG. 10-10 RM502A STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
-1	351-0006-00	20000	23289	1 pr		TRACK, slide, stationary & inter-section, w/mounting hardware
	351-0085-00	23290		1 pr		TRACK, slide, stationary & inter-section, w/mounting hardware
-2	012-0031-00			1		CORD, patch-banana plug both ends, 18 inches
-3	378-0539-00	20000	24129	1		FILTER, light, polarized
	378-0567-00	24130		1		FILTER, light, smoke gray
-4	010-0125-00			2		PROBE PACKAGE, P6006, 10X, 3.5 feet, UHF
-5	013-0004-00			2		ADAPTER, binding post, UHF
-6	161-0010-00			1		CORD, power, 3 wire, 8 foot
-7	103-0013-00			1		ADAPTER, power cord, 3 to 2 wire
-8	212-0512-00			4		SCREW, 10-32 x 1/2 inch, OHS
-9	210-0833-00			4		WASHER, finishing, #10
-10	210-0917-00			4		WASHER, plastic, 0.191 ID x 5/8 inch OD
-11	212-0561-00			4		SCREW, 12-24 x 1/2 inch, OHS
	070-0382-02			2		MANUAL, instruction (not shown)

Ⓐ

FIG. 10-10 RM502A STANDARD ACCESSORIES



MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

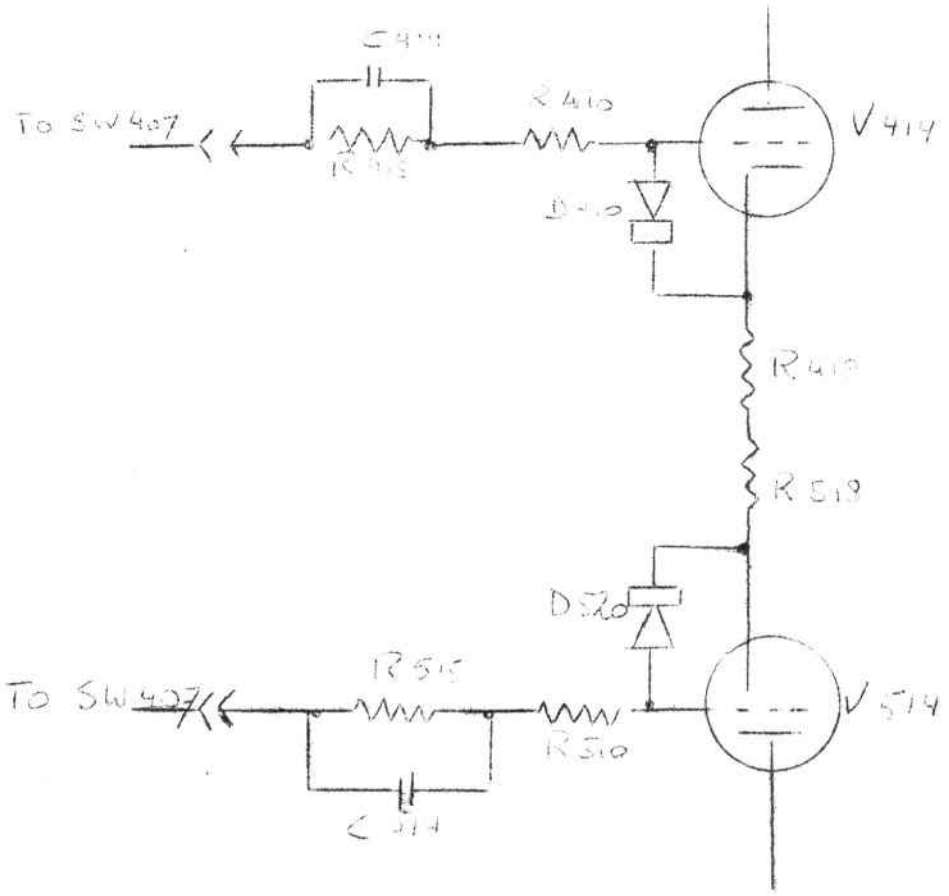
Type 502A Tent S/N 702-094

Parts List Correction

Add:

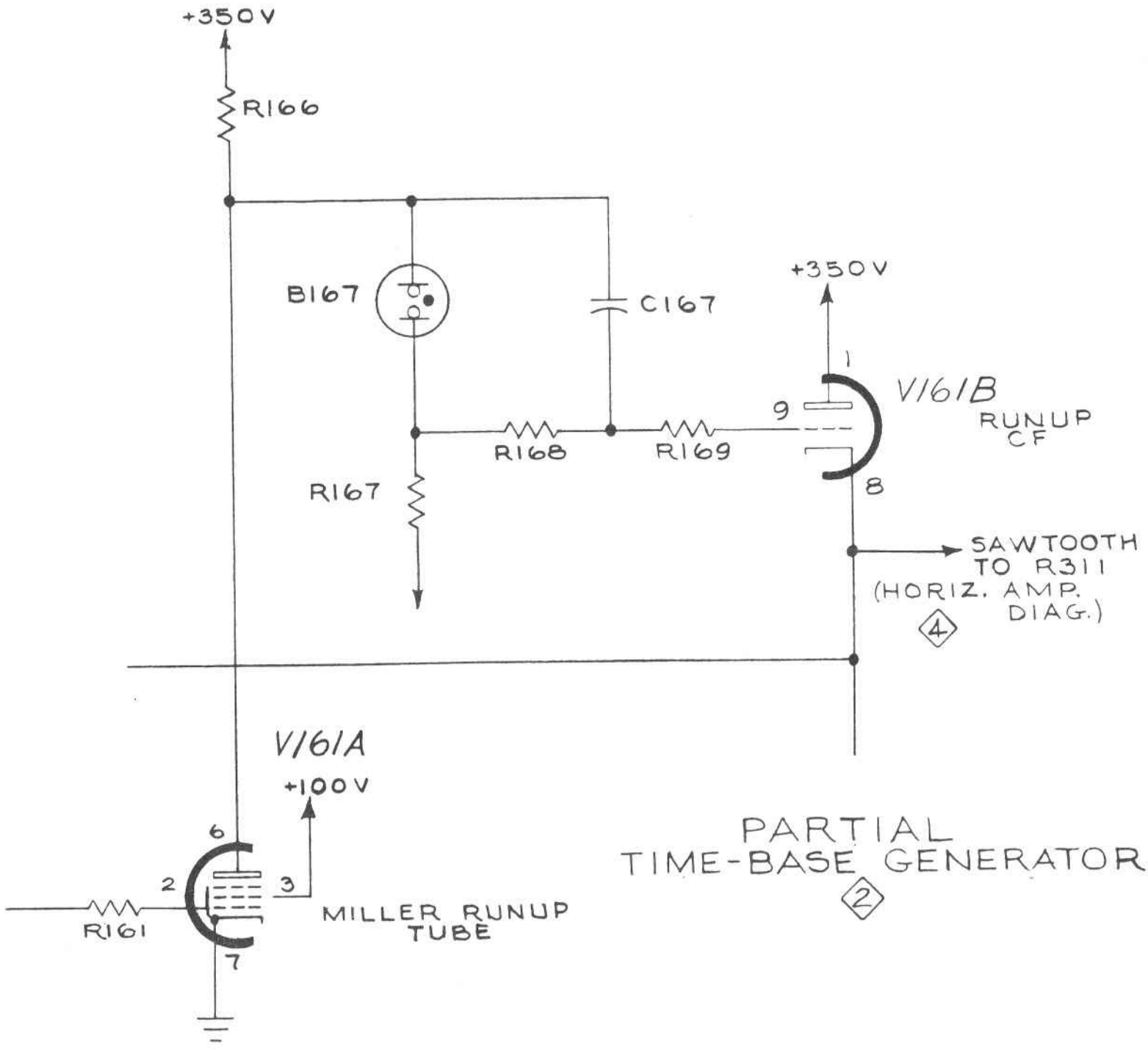
C414-C514	285-0598-00	.01μF	100V	
R414-R514	315-0154-00	150k	1/4W	5%

Schematic Correction



M13371/926/1267

SCHEMATIC CORRECTION



TYPE 502A/RM502A TENT SN 27780

PARTS LIST CORRECTION

CHANGE TO:

TK601	260-0336-00	150°F

M12,921/1067

TYPE 502A/RM502A TENT SN 27780

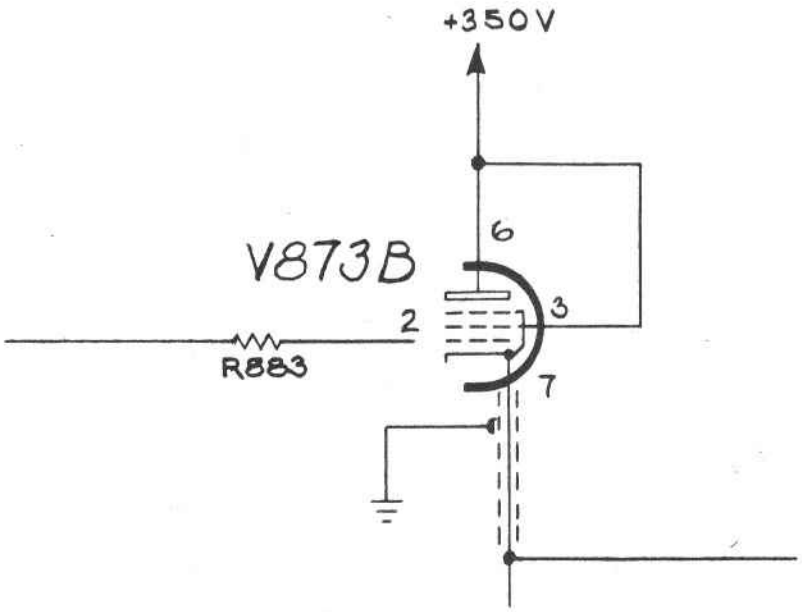
PARTS LIST CORRECTION

CHANGE TO:

R121	316-0183-00	18 k	1/4 W	10%
R123	301-0123-00	12 k	1/2 W	10%
R128	302-0274-00	270 k	1/2 W	10%

M12,691/1067

SCHEMATIC CORRECTION



PARTIAL

CALIBRATOR 10

TYPE 502A/RM502A TENT SN 27647

PARTS LIST CORRECTION

REMOVE:

C847	283-0057-00	0.1 µF	Cer	200 V	+80%-20%
R846	302-0155-00	1.5 MΩ	1/2 W		
R847	302-0225-00	2.2 MΩ	1/2 W		

M12,334/967

TYPE 502A TENT SN 27570

PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

C601	285-0612-01	1.5 µF	270 V

M11,606/867

TYPE 502A/RM502A TENT SN 27320

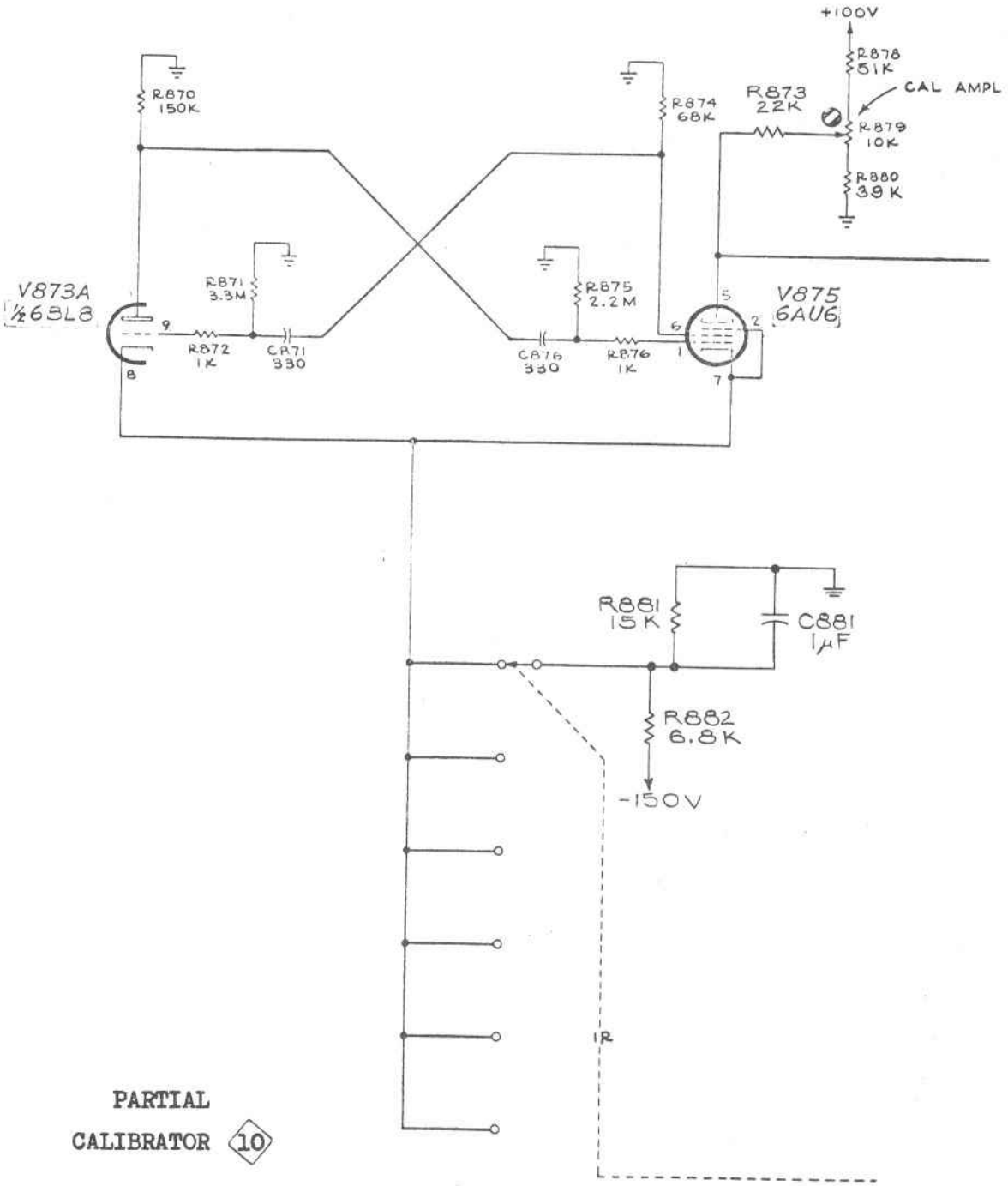
PARTS LIST & SCHEMATIC CORRECTION

CHANGE TO:

R878	301-0513-00	51 k	½ w	5%
R880	301-0393-00	39 k	½ w	5%

ADD:

C881	290-0164-00	1 µF		150 V DC
R873	302-0223-00	22 k	½ w	10%
R881	306-0153-00	15 k	2 w	10%
R882	304-0682-00	6.8 k	1 w	10%



M12,344/667

TYPE 502A/RM502A TENT SN 27260

PARTS LIST & SCHEMATIC CORRECTION

CHANGE TO:

R116	302-0224-00	220 k	1/2 W	10 %

M12,192/567

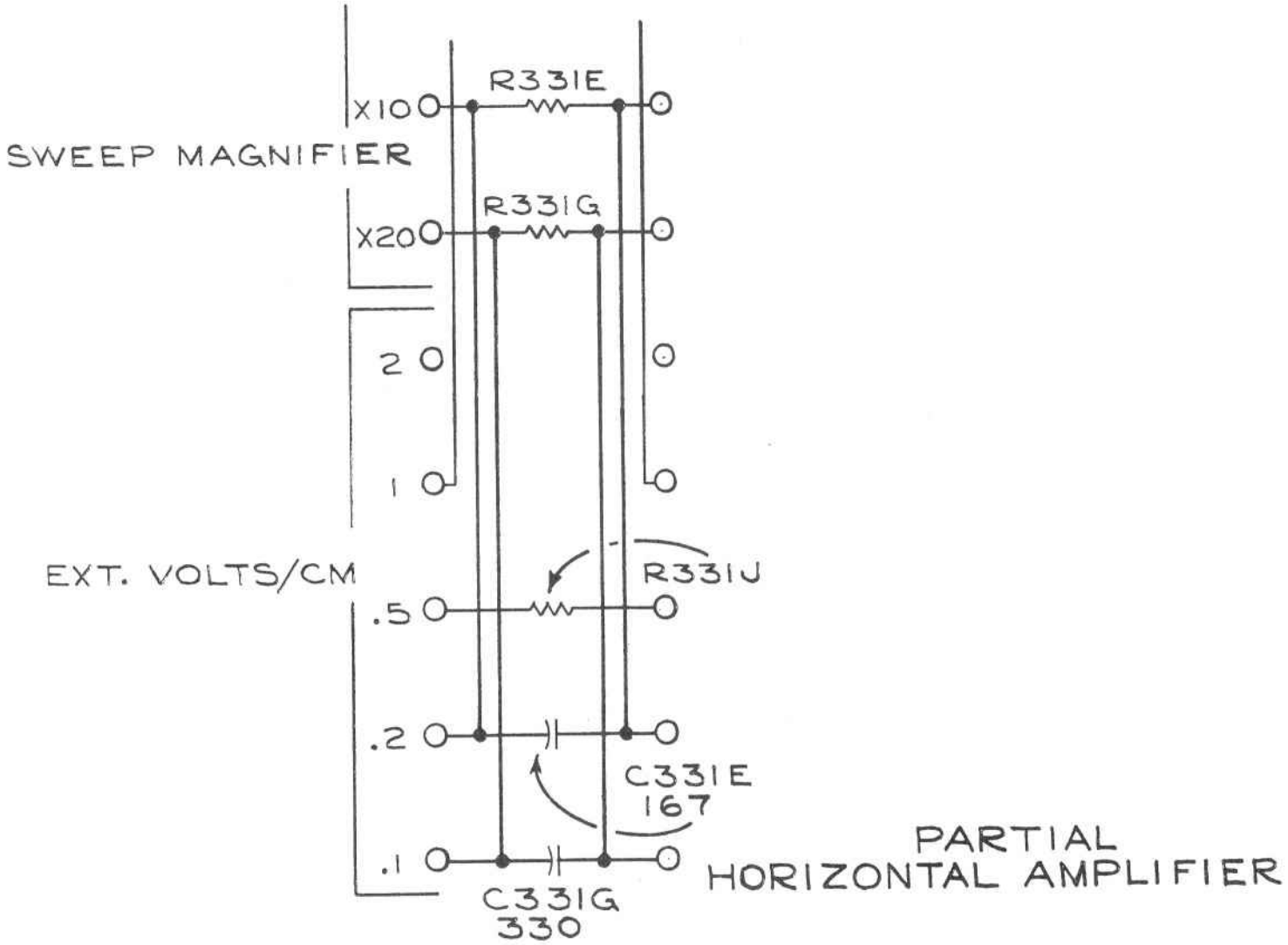
TYPE 502A/RM502A TENT SN 27140

PARTS LIST CORRECTION

ADD:

C331E	281-0589-00	167 pF	500 V	10 %
C331G	281-0546-00	330 pF	500 V	10 %

SCHEMATIC CORRECTION

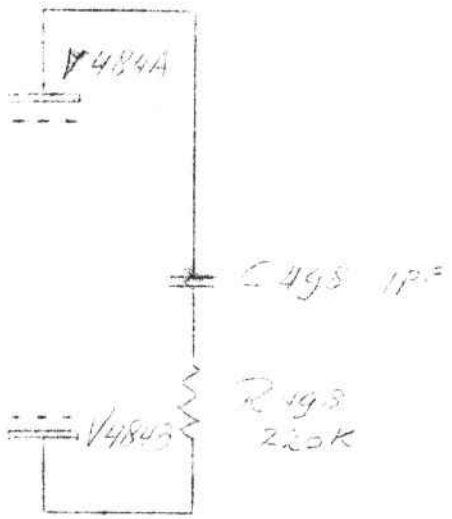


M12,126/467

Type 502A Tent S/N 701821

Add :

C498	281-0538-00	1pF	Cer.	
C499	281-0043-00	0,7-3pF	Var.	
R498	301-0224-00	220K	$\frac{1}{2}$W	5%



H743/0467

TYPE 502A/RM502A TENT SN 27140

PARTS LIST CORRECTION

CHANGE TO:

C805	285-0511-00	.01 µF	600 V

M12,163/367

TYPE 502A/RM502A TENT SN 27040

PARTS LIST CORRECTION

CHANGE TO:

C160 D, E, F, G	295-0095-01	Timing Capacitor Assembly

TEXT CORRECTION

Section 6 Calibration

Page 6-31, 6-32

DELETE:

Photo of test equipment setup, Fig. 6-38.

ADD:

New photo of test equipment setup (Fig. 6-38). Use the same cutline.

DELETE:

Under AMPLITUDE CALIBRATOR, delete the preset control instructions and Step 41. Adjust Calibrator Amplitude.

ADD:

502A	
INPUT SELECTOR (Lower Beam)	A, AC
TRIGGERING LEVEL	AUTOMATIC
TRIGGER SELECTOR	+ LOWER, AC
TIME/CM	5 ms
AMPLITUDE CALIBRATOR	50 V
SENSITIVITY	.5 VOLTS/CM
Standard Amplitude Calibrator	
Mode	+ DC
Source	Mixed
Amplitude	50 V

41. Adjust Calibrator Amplitude

a. Connect the equipment as shown in Fig. 6-38.

b. Remove V875 from its socket.

c. Adjust LOWER BEAM POSITION to observe a waveform similar to that shown in Fig. 6-38A.

d. Adjust Cal Ampl, R879, to reduce the observed square wave to a straight line.

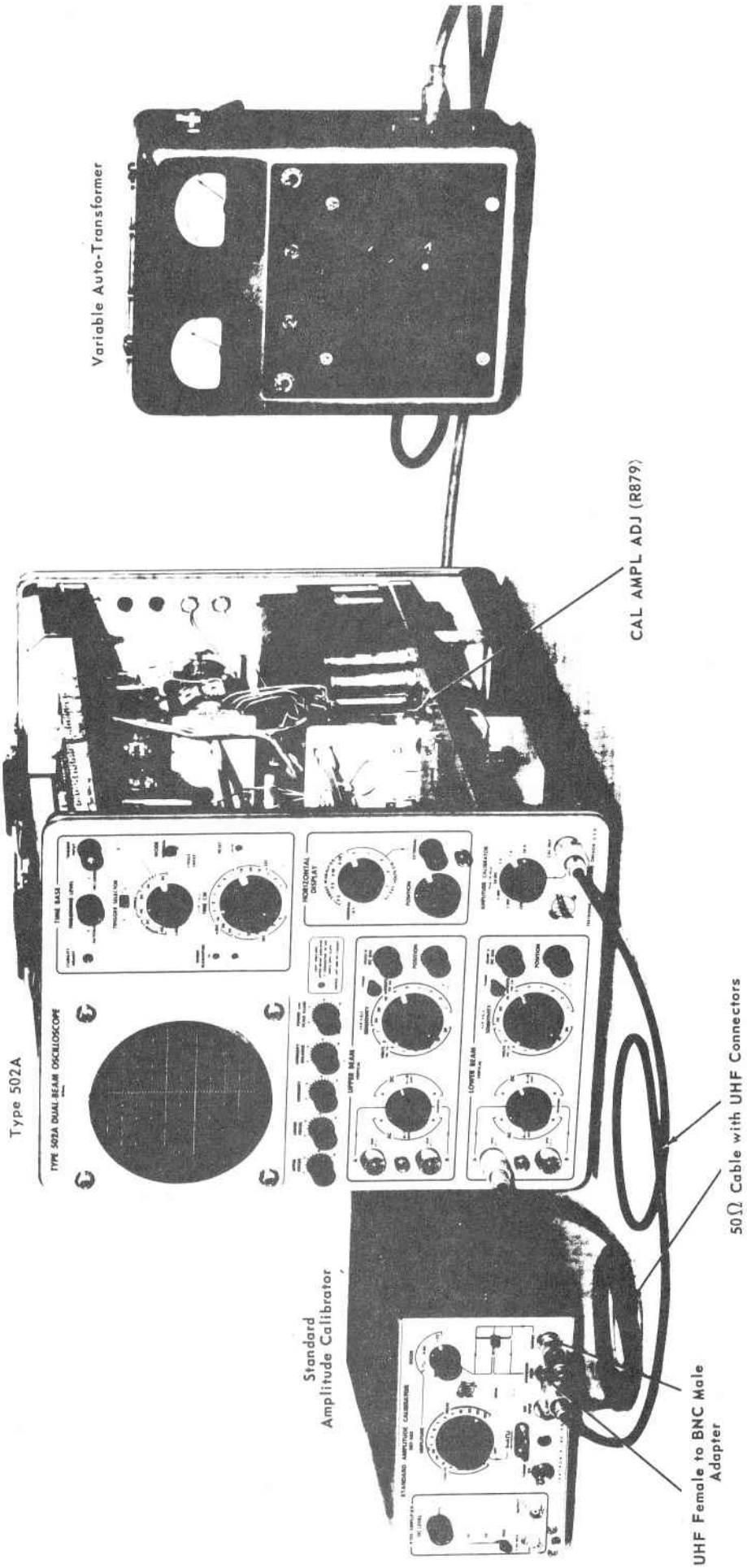

Variable Auto-Transformer
CAL AMPL ADJ (R879)
Type 502A
TYPE 502A DUAL-BEAM OSCILLOSCOPE
Standard
Amplitude Calibrator
50Ω Cable with UHF Connectors
UHF Female to BNC Male
Adapter

Fig. 6-38

e. Check the remaining positions of the AMPLITUDE CALIBRATOR switch as shown in Table 6-12.

TABLE 6-12

AMPLITUDE CALIBRATOR	Standard Ampl Calibrator	Lower Beam Sensitivity	Maximum Display Amplitude
5 V	5 V	50 mV	3 cm
.5 V	.5 V	5 mV	3 cm
50 mV	50 mV	.5 mV	3 cm
5 mV	5 mV	.1 mV	1.5 cm*
.5 mV	.5 mV	.1 mV	1.5 mm

*Disregard any spikes on the waveform.

f. Disconnect the Standard Amplitude Calibrator signal from the Type 502A input.

g. Replace V875 in its socket.

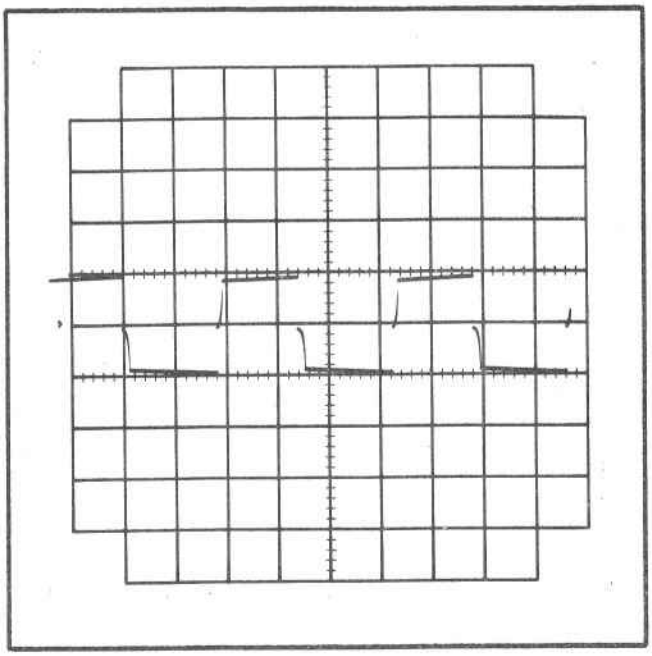


Fig. 6-38A. Typical waveform for Step 41c.

TYPE 502A TENT SN 26160

PARTS LIST CORRECTION

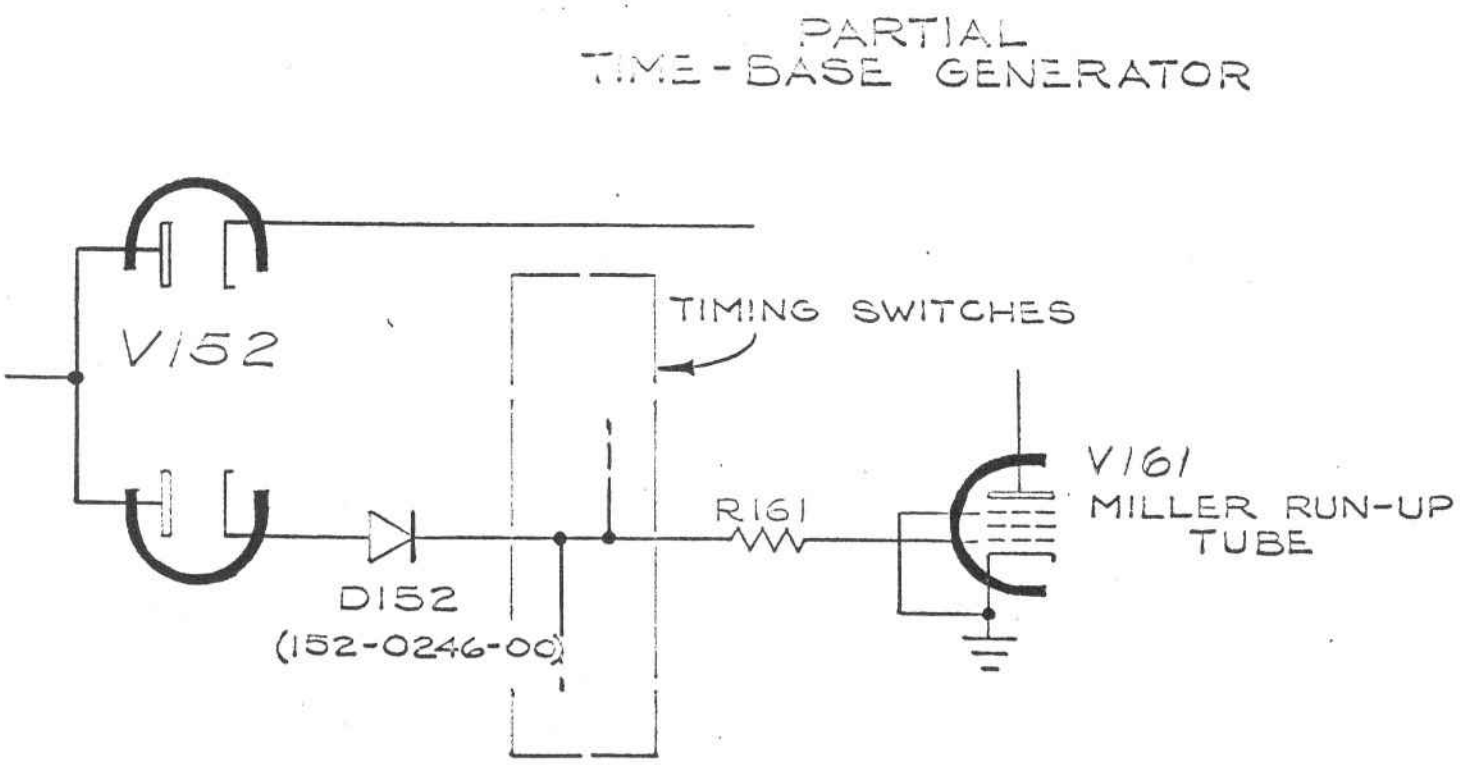
ADD:

D152	152-0246-00	Silicon

CHANGE TO:

V152	154-0016-00	6AL5, Raw

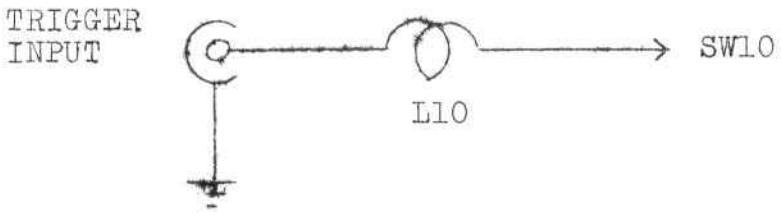
SCHEMATIC CORRECTION



Type 502A Tent S/N 701031

Parts List Correction

Add.			
L10	276-0507-00	6mH	Ferramic



MH439/1065

Type 502A Tent S/N 700811

Parts List Correction

Add:

C144	283-002	10.000pF	500V

C144 is added in the Timebase Generator between the lower end of R144 and ground.

MHV/0665

Type 502A Tent S/N 700274

Parts List Correction

Change to:

Q634	151-0040-00	Transistor 2N1302
Q644	151-0040-00	Transistor 2N1302

MH14/1064