TYPE 581

CATHODE-RAY OSCILLOSCOPES

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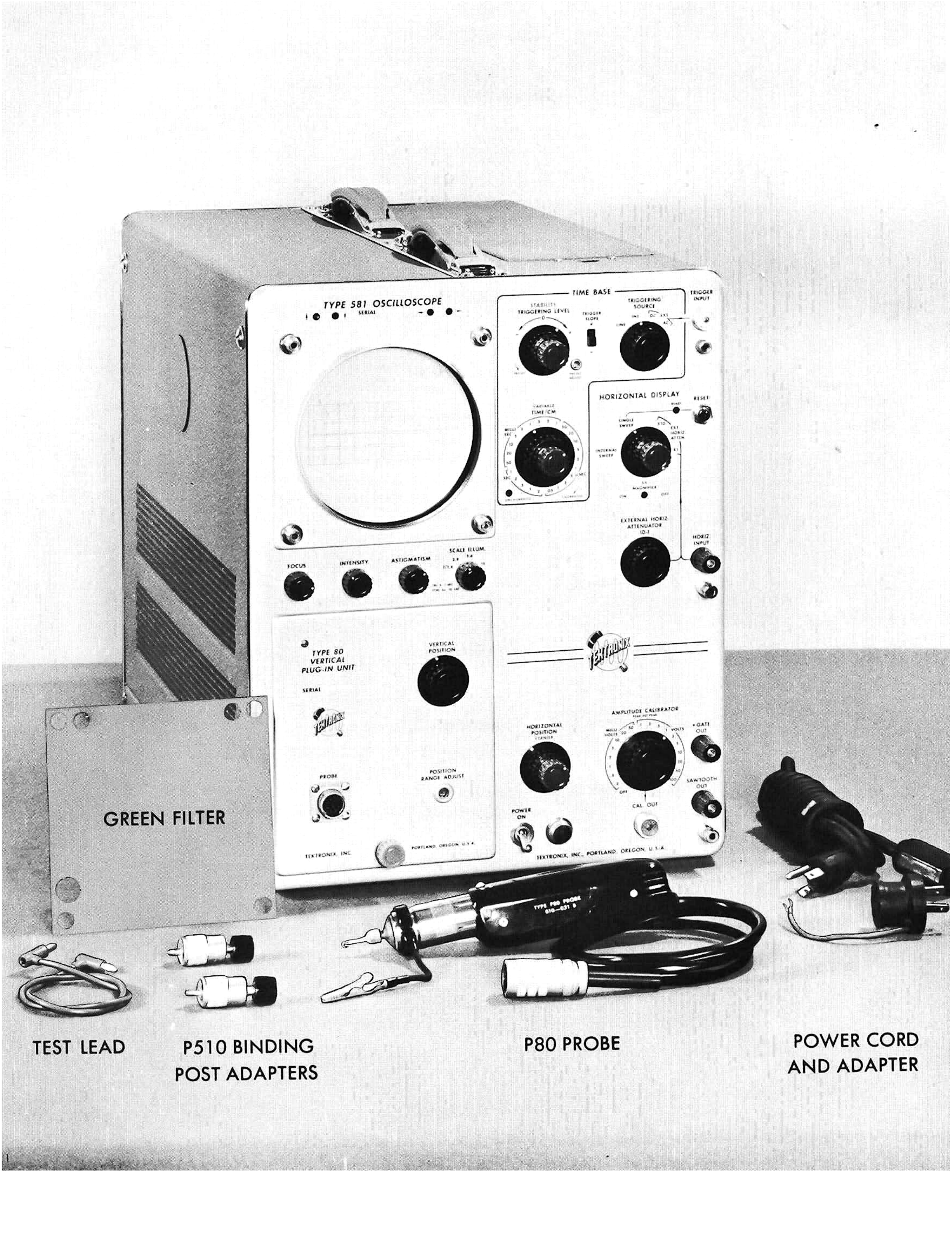
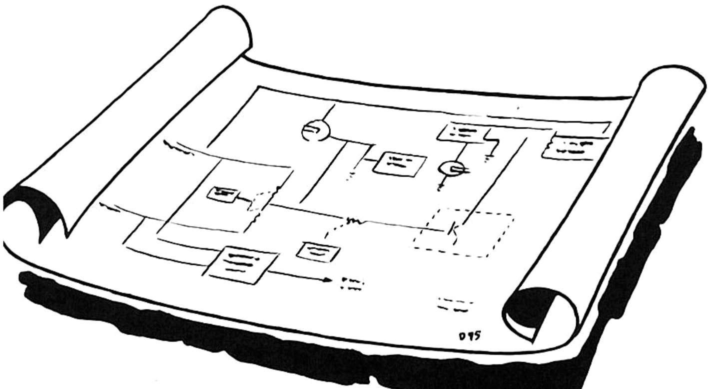

TYPE 581 OSCILLOSCOPE
TIME BASE
TRIGGERING LEVEL
TRIGGERING SOURCE
TRIGGER INPUT
HORIZONTAL DISPLAY
RESET
TIME/CM
EXTERNAL HORIZ. ATTENUATOR
HORIZ INPUT
FOCUS
INTENSITY
ASTIGMATISM
SCALE ILLUM.
TYPE 80 VERTICAL PLUG-IN UNIT
SERIAL
VERTICAL POSITION
PROBE
POSITION RANGE ADJUST
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.
TEKTRONIX
AMPLITUDE CALIBRATOR
HORIZONTAL POSITION
+GATE OUT
SAWTOOTH OUT
POWER ON
CAL. OUT
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.
GREEN FILTER
TYPE P80 PROBE
TEST LEAD
P510 BINDING POST ADAPTERS
P80 PROBE
POWER CORD AND ADAPTER

SECTION 1

SPECIFICATIONS



General Information

The Tektronix Type 581 Oscilloscope is a wide range, general purpose, laboratory, instrument which provides accurate measurements in the dc to 100 mc range. The instrument is made extremely versatile through the utilization of special purpose plug-in units. Any of the Tektronix Number Series Plug-In Units can be used with the oscilloscope to satisfy the requirements for many types of wide band applications. High calibrated sweep speeds allow you to take full advantage of the rise-time capabilities of the instrument.

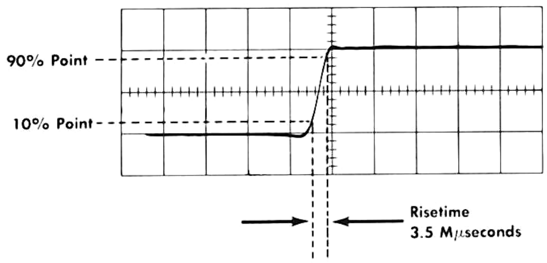


Fig. 1-1. Vertical risetime of the Type 581 Oscilloscope and Type 80 Plug-In combination.

Vertical Deflection System

Specifications for the vertical deflection system of the Type 581 Oscilloscope depend upon the plug-in unit and probe used with the instrument. The following specifications are given assuming that a Type 80 Plug-In Unit and a Type P80 probe are used.

Bandpass	DC to approximately 100 mc
Risetime	3.5 Millimicroseconds
Vertical Deflection Factor	0.1 volts per centimeter
Input Characteristics	100 Kilohms paralleled by approximately 10 μμf.

Triggering Modes

External, Internal, and Line. Triggering slope and level are adjustable.

Triggering Signal Requirements

Internal triggering—a signal large enough to produce 2 millimeters of vertical deflection.

External triggering—from 0.2 to 20 volts.

Sweep Speeds

0.05 microseconds to 2 seconds per centimeter in 24 accurately calibrated steps. An uncalibrated control permits sweep speeds to be varied continuously between 0.05 microseconds and approximately 5 seconds per centimeter. Calibrated sweep speeds are typically within 1% and in all cases within 3%, of the indicated sweep rate.

Magnifier

Provides a 5 times magnification of the center 2-centimeter portion of the oscilloscope display. Extends the fastest sweep speed to 0.01 microseconds per centimeter.

External Horizontal Input

Deflection factor—approximately 0.2 to 15 volts per centimeter, continuously variable.

Frequency response—from dc to 240 kc. Response down 3 db at 240 kc.

Horizontal input connector characteristics—1 megohm paralleled by approximately 47 μμf.

Cathode-Ray Tube

CRT type—T581P2

Phosphors—Type P2 phosphor normally supplied. P1, P7, and P11 phosphors optional. Other phosphors available on special order.

Unblanking—DC coupled.

Accelerating potential—10,000 volts.

Deflection system—electrostatic. Beam deflected vertically by 5 pairs of distributed deflection plates. Beam deflected horizontally by 1 pair of deflection plates.

Usable viewing area—4 centimeters by 10 centimeters.

Graticule

Illumination—variable edge lighting.

Markings—marked in 4 vertical and 10 horizontal 1-centimeter divisions with 2-millimeter markings on the center-lines.

Amplitude Calibrator

Waveform—square-waves at approximately 1,000 cycles.

Output voltage—0.2 millivolts peak-to-peak to 100 volts peak-to-peak in 18 steps.

Accuracy—peak-to-peak amplitude of square-waves within 3% of indicated voltage.

Power Supplies

Electronically regulated for stable operation with widely varying line voltages and loads.

Line voltage requirements—105 to 125 volts, or 210 to 250 volts.

Power—approximately 670 watts with a Type 80 Plug-In Unit installed.

Line frequency—50 to 60 cycles.

Output Waveforms Available

Positive Gate—approximately 20 volts peak-to-peak with same duration as sweep.

Sawtooth—sweep sawtooth waveform, approximately 150 volts peak-to-peak.

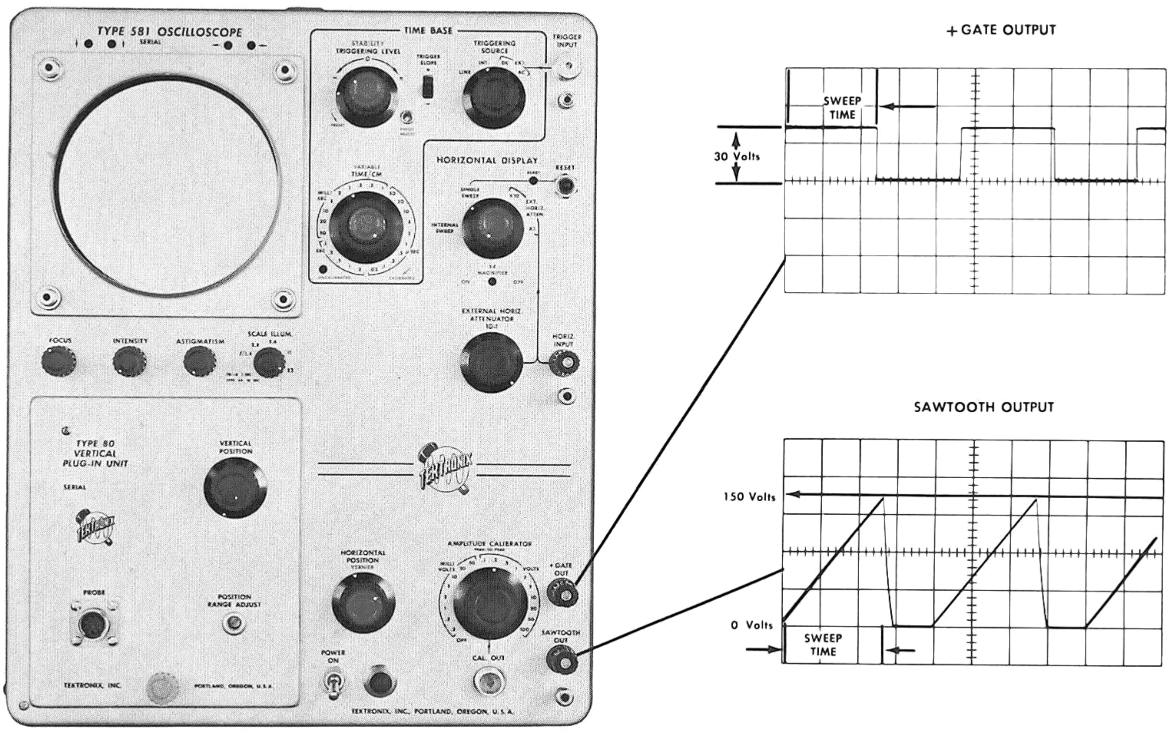


Fig. 1-2. Output waveforms available at the oscilloscope front panel.

EXPORT POWER TRANSFORMER

Transformer Primary

The instrument for which this manual was prepared is equipped with a special transformer The transformer has eight primary terminals making possible six different input connections The six primary connections are shown in Fig. 1.

POWER TRANSFORMER HAS TWO EXTRA WINDINGS PERMITTING NOMINAL PRIMARY VOLTAGES OF 110, 117, 124, 220, 234, OR 248 V, 50 OR 60∿ OPERATION.

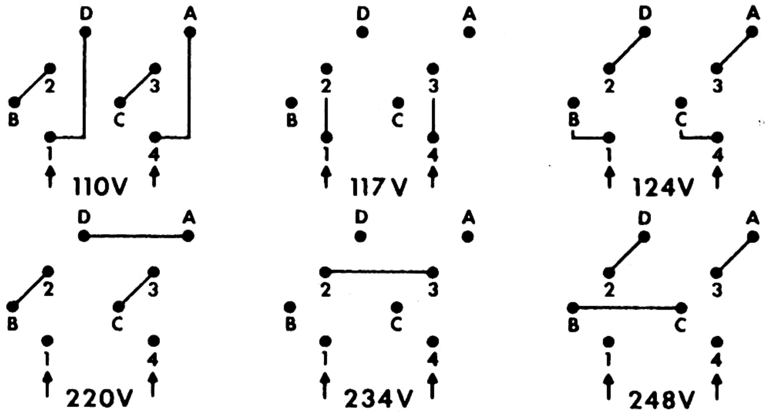


Fig.1. The power transformer has two extra windings permitting nominal primary voltages of 110, 117, 124, 220, 234, 248 volts, 50 or 60 cycle operation.

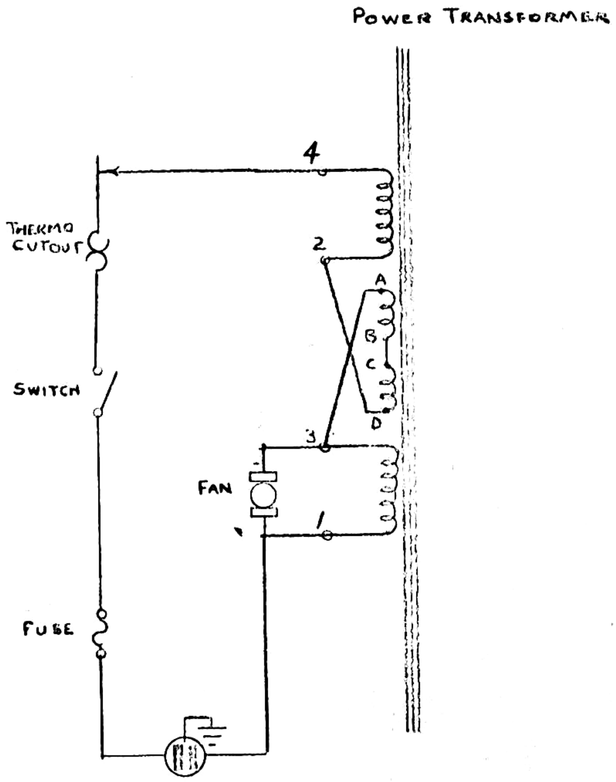
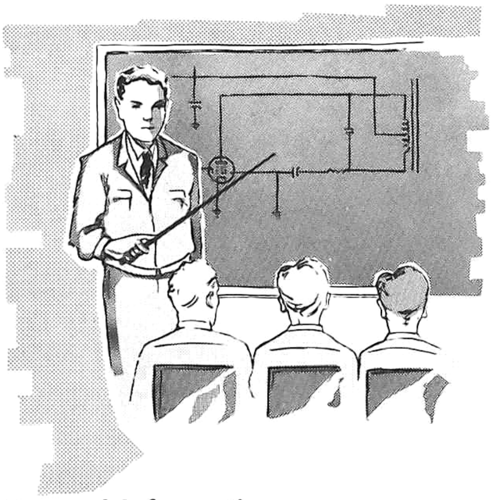


Fig. 2. When connecting the power transformer for operation with a supply voltage of 200 volts or more, be sure that the fan is connected between pins 1 and 3 of the primary. This is to insure that the fan is supplied with no more than 125 volts. Fig. 2 shows a typical high-voltage fan connection, using as an example the wiring for a 248 volt supply.



SECTION 4

THEORY OF OPERATION

General Information

This portion of the Operator's Manual presents a brief discussion of the Type 581 Oscilloscope's circuit operation. This discussion is keyed to various block diagrams inserted with the text and to detailed circuit diagrams contained in the asssociated Parts List and Schematics Booklet. Emphasis is placed on the interrelation of circuits rather than on detailed operation.

Instrument Operation

The simplified block diagram of Figure 4-1 illustrates the interrelation of the various circuits composing the Type 581 Oscilloscope. The input signal to the oscilloscope is connected through the probe to the input connector of the plug-in unit. The output signal from the plug-in unit is then applied to the vertical amplifier of the oscilloscope. The output of the vertical amplifier is used to drive the vertical deflection plates of the crt.

A trigger pickoff circuit in the vertical amplifier applies a sample of the input waveform to the trigger circuit. This waveform sample can then be used to trigger a sweep by the time base unit. In addition, an external waveform or a line frequency waveform can also be used to trigger the sweep.

Signals of widely varying shapes and amplitudes are applied to the trigger circuit. The trigger circuit in turn produces nearly constant amplitude output pulses which are used to start the horizontal sweep at the proper instant of time. This insures a stable display of the input waveform.

The output pulses from the trigger circuit are applied to the time base generator to initiate an output sweep sawtooth waveform. The selected sawtooth waveform is then amplified by the horizontal amplifier and applied to the horizontal deflection plates of the cathode-ray tube.

When an external sweep waveform is used, the waveform is connected through the HORIZ. INPUT connector to the external horizontal amplifier. The output signal of the external horizontal amplifier is then amplified by the horizontal amplifier and applied to the horizontal deflection plates to produce the desired horizontal deflection.

The amplitude calibrator produces a square wave output waveform which can be used to check the calibration of the vertical deflection system. The calibration voltage is also used in compensating the attenuators used with the probe.

There are six regulated low voltage power supplies used in the Type 581 Oscilloscopes. These power supplies provide the operating voltages for all circuits except the cathode-ray tube. Operating voltages for the crt are provided by a separate high voltage power supply contained in the crt circuit. In addition to the high voltage power supply, the crt circuit contains the controls and circuitry which affect the crt display.

Vertical Deflection System

Input signals to the oscilloscope are applied through the Type P80 probe to the plug-in unit. The output of the plug-in unit is then applied to the delay-line driver stage of the oscilloscope vertical amplifier through the interconnecting plug. The plug-in unit adds positioning voltages to the input waveform and permits the trace to be positioned vertically on the oscilloscope screen.

The delay line driver stage of the vertical amplifier is a balanced distributed amplifier consisting of seven push-pull triode sections. Use of the distributed amplifier permits amplification of frequencies up to 100 mc; dc coupling allows amplification of frequencies down to dc. All triode sections are neutralized to prevent spurious oscillations. Gain of the vertical amplifier is set in the delay driver stage by means of the VERT. GAIN ADJ. control.

The push-pull output of the delay line driver stage is applied through the a balanced delay line to the output distributed amplifier stage. The delay line is a specially braided line which delays application of the vertical signal to the deflection plates until the crt has been unblanked and the horizontal sweep started. This delay allows the leading edge of fast rising pulses to be displayed. The delay line does not require adjustment because of the nature of its construction.

The output distributed amplifier consists of five triode sections and is driven by the signal from the delay line. This stage is similar to the delay line driver stage with all triodes neutralized to prevent oscillations. The output of the distributed amplifier is applied to a push-pull power output stage which supplies the necessary power to drive the vertical deflection plates of the cathode-ray tube.

Five pairs of distributed vertical deflection plates are used in the cathode-ray tube. This arrangement of distributed plates permits the necessary crt sensitivity while at the same time reducing objectionable effects of capacitance between the plates. The deflection plate lines are constructed so that

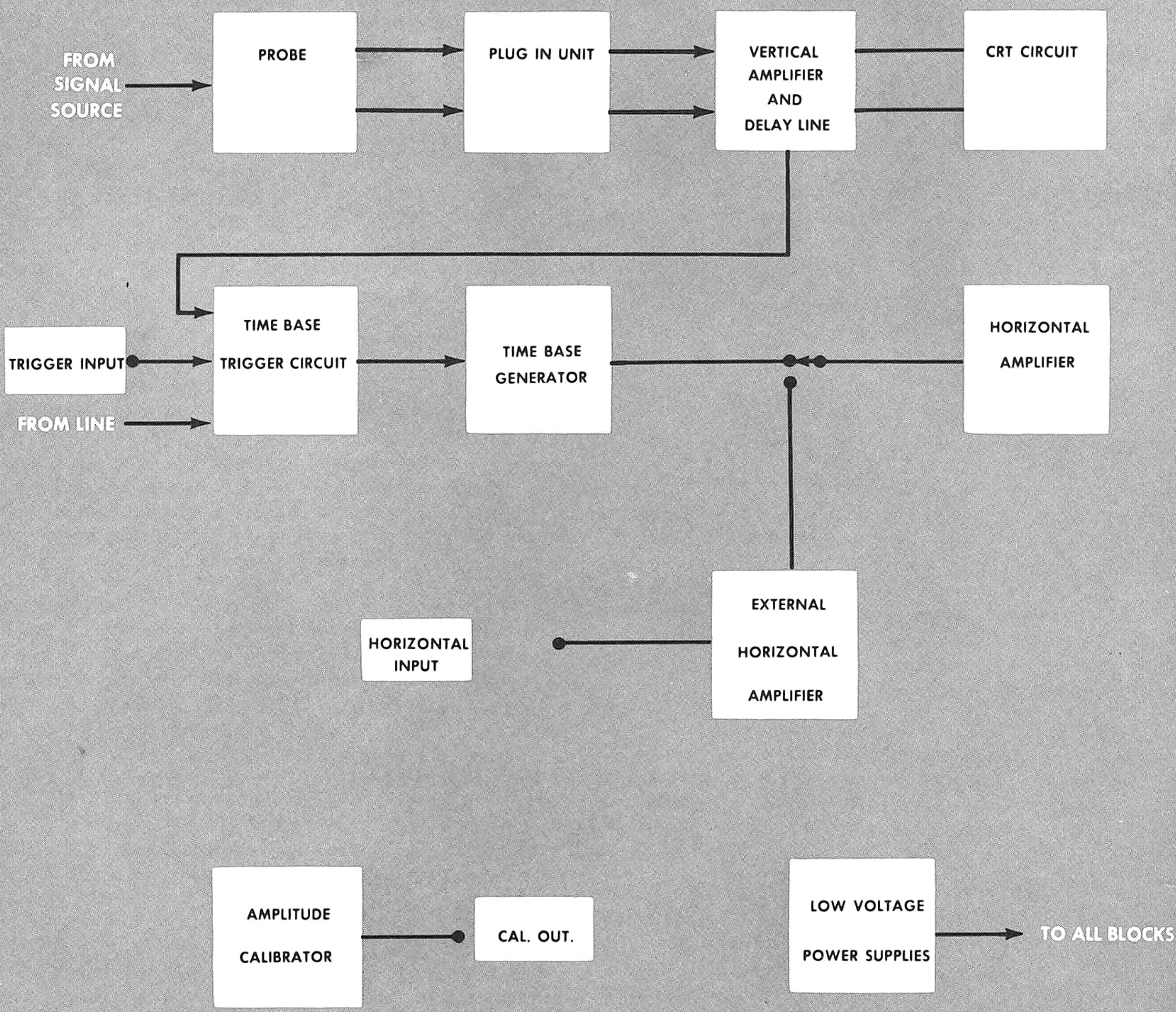


Fig. 4-1. Type 581 Oscilloscope functional block diagram.

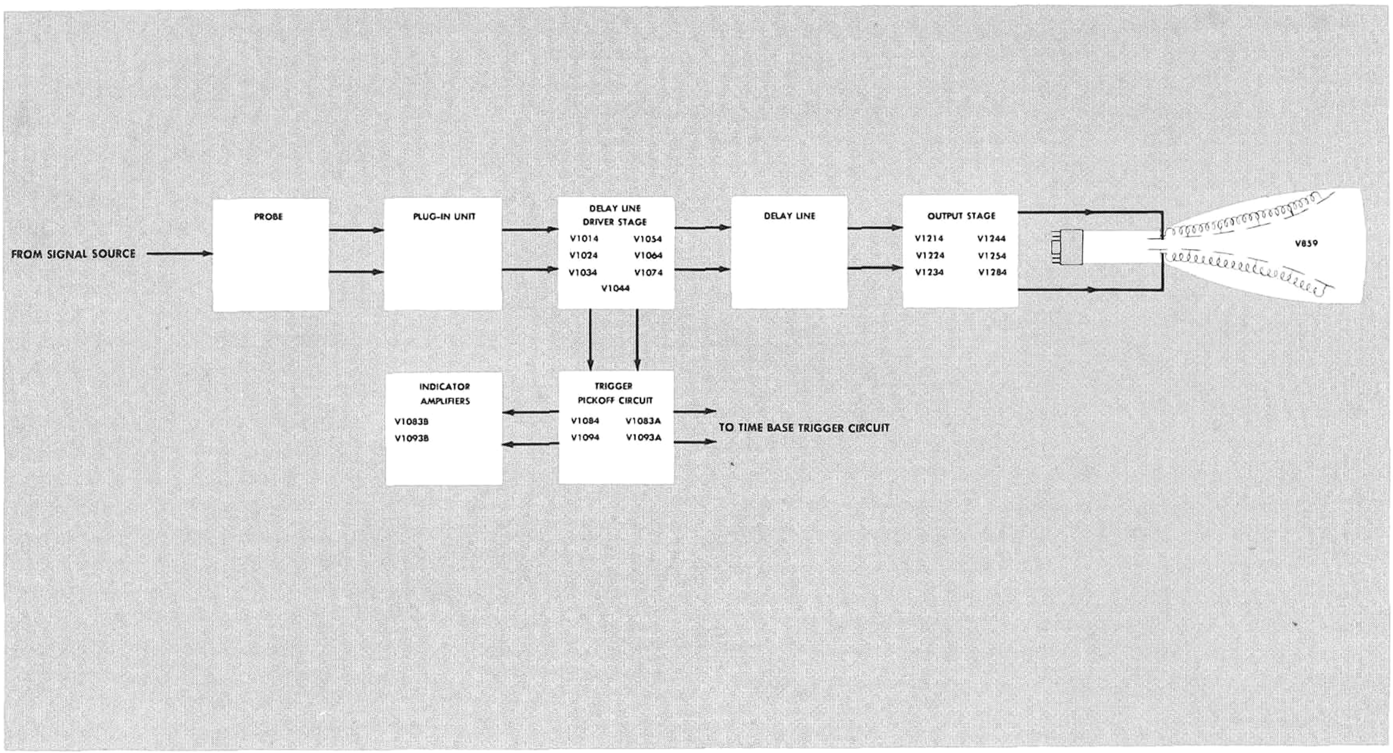


Fig. 4-2. Vertical deflection system block diagram.

the velocity of the deflection waveform through the line is the same as the velocity of the electrons passing through the plates.

A push pull signal from the delay line driver stage of the vertical amplifier is applied to the trigger pickoff circuit. This circuit consists of a difference amplifier and two cathode followers. The signal from the vertical amplifier is applied to the difference amplifier. The two outputs of the difference amplifier are then applied through the cathode followers to the trigger circuit. In addition, an output from each cathode follower is also applied to another difference amplifier. This difference amplifier controls operation of the vertical beam position indicator lights.

Triggering Circuit

Triggering signals from the line, TRIGGER INPUT connector, and trigger pickoff circuit of the vertical amplifier are connected to the input of the triggering circuit. The triggering signal selected by the TRIGGERING SOURCE switch is then connected to the control grids of the trigger circuit input amplifier stage.

The trigger input amplifier is a difference amplifier stage which is used to control operation of the trigger multivibrator. The TRIGGERING LEVEL control establishes the operating point of the trigger input amplifier by determining

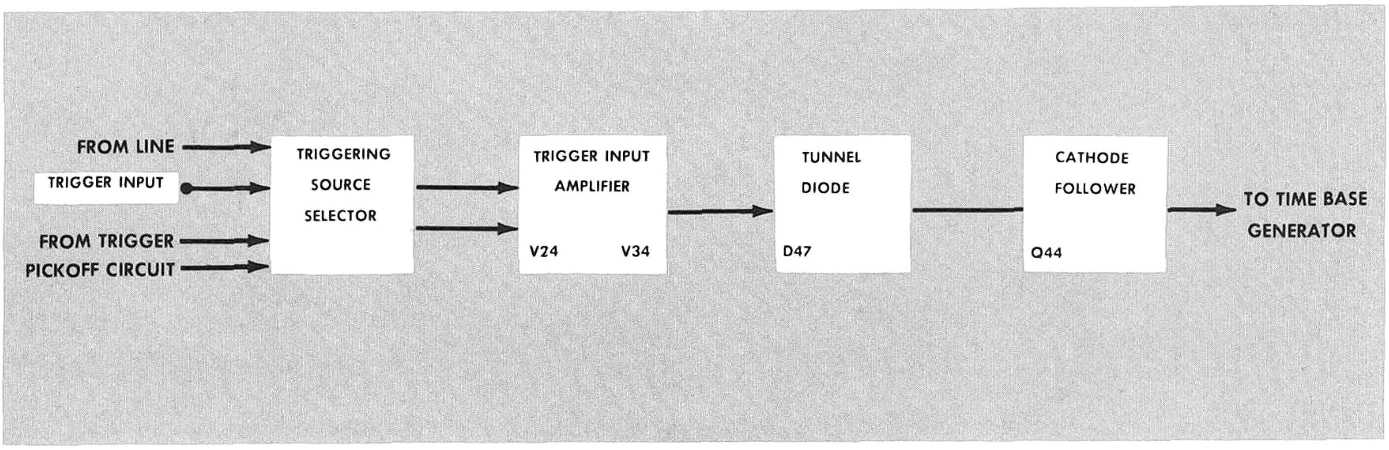


Fig. 4-3. Trigger Circuit block diagram.

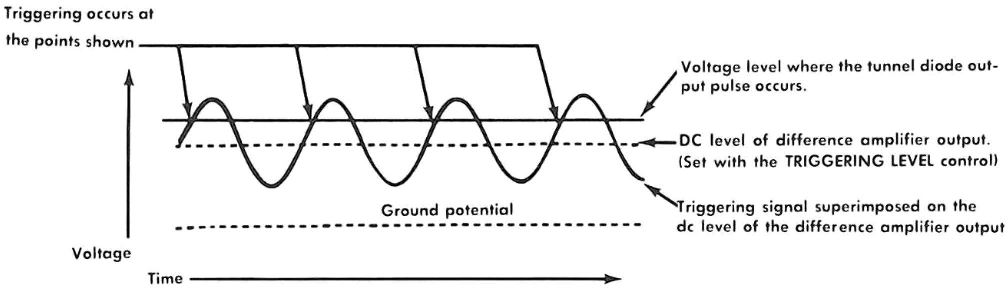


Fig. 4-4. Operation of the trigger circuit. As the triggering signal voltage exceeds the switching voltage the resulting pulse initiates a sweep.

controlling the operating point of the difference amplifier with the TRIGGERING LEVEL control it is possible to determine at which voltage level of the triggering waveform, triggering occurs.

The amplified triggering pulses from the difference amplifier are applied to a tunnel diode. The tunnel diode switches when the output from the difference amplifier reaches a certain level. When the tunnel diode switches, an output pulse is applied to a single transistor amplfier stage. A toroid transformer in the collector circuit of the transistor couples the pulse to the Sweep-Gating Multivibrator in the Time-Base Generator. This pulse is relatively constant in amplitude regardless of the amplitude of the original signal. After application of the pulse to the sweep circuit, the tunnel diode returns to its original level to await the next triggering signal.

Time Base Generator

Output pulses from the trigger multivibrator of the triggering circuit. are applied to the sweep gating multivibrator through a differentiating network. The sweep gating multivibrator is a Schmitt Trigger Circuit which acts as an electronic switch for the sweep circuit. When the triggering pulse is applied, the sweep gating multivibrator switches, thereby cutting off the disconnect diodes and allowing the Miller Run Up Circuit to operate. One output of the sweep gating multivibrator is connected through the unblanking cathode follower to the crt to unblank the tube. Another output is connected through the +gate output cathode follower to the +GATE OUT connector on the front panel.

The disconnect diodes clamp the sweep circuit output voltage at a fixed level between sweeps. This prevents hori-

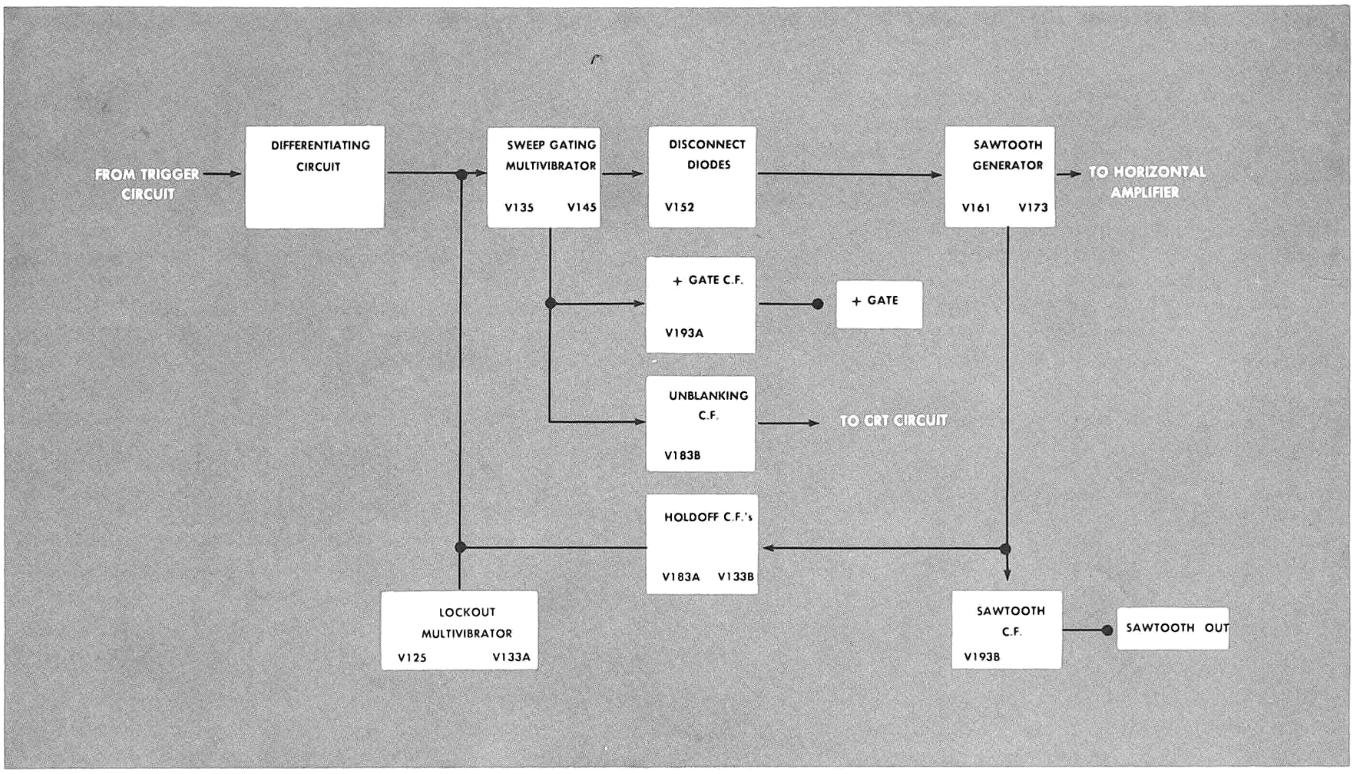


Fig. 4-5. Time Base Generator block Diagram.

zontal jitter at the start of the sweep. When the disconnect diodes are cut off, their clamping action stops and the Miller Run Up Circuit operates.

The Miller Run Up Circuit is a modified Miller Integrator circuit which provides an extremely linear output sawtooth waveform. The sawtooth waveform is built up on a timing capacitor which forms an integral part of the circuit. The rate that the charge builds up on the timing capacitor determines the sweep time per centimeter. The rate of charge is in turn dependent on the time constant of the timing capacitor and timing resistor. The sweep timing is set with the TIME/CM control by varying this time constant. All sweep ranges are accurately calibrated by means of variable timing capacitors and resistors.

The output sawtooth from the Miller Run Up Circuit is applied through the sweep cathode follower to the horizontal amplifier. Feedback from the sweep cathode follower is applied to the timing capacitor to eliminate unlinearity in the charging of the capacitor. This feedback insures a linear sawtooth waveform. The sawtooth waveform from the sweep cathode follower is also connected through the sawtooth output cathode follower to the SAWTOOTH OUT connector on the front panel.

The sawtooth waveform from the sweep cathode follower is applied through the holdoff cathode followers to reset the sweep gating multivibrator at the end of each sweep. The holdoff cathode followers then insure that the sweep gating multivibrator is not switched again until the Miller Run Up Circuit has reset and become stabilized.

The dc level at the input of the sweep gating multivibrator is controlled by the lockout multivibrator and STABILITY control. In normal sweep operation, one half of the lockout multivibrator is disabled while the other half operates as a cathode follower for the STABILITY control. The voltage at the input of the sweep gating multivibrator is then controlled through the cathode follower by the STABILITY control. The STABILITY control can be set to allow normal triggering or to cause free running operation of the sweep gating multivibrator.

When the Type 581 is used to provide a single sweep presentation, both sections of the lockout multivibrator operate and the multivibrator acts as an electronic switch to control operation of the sweep gating multivibrator. One condition of the lockout multivibrator disables the sweep gating multivibrator to prevent any horizontal sweeps. This condition exists until the RESET switch is depressed. When the lockout multivibrator switches, operation of the sweep gating multivibrator returns to normal to allow one horizontal sweep. Depending on the setting of the STABILITY control, this sweep may occur immediately or be delayed until a triggering pulse is applied from the triggering circuit to the sweep gating multivibrator.

When the sweep occurs, an output from the holdoff cathode follower is applied to reset the lockout multivibrator. The sweep gating multivibrator is again disabled by the Lockout multivibrator until the RESET button is again depressed.

Horizontal Amplifier

The input to the horizontal amplifier is selected from waveforms applied from the Time Base Generator and the external horizontal amplifier. The selected input waveform is split in phase and amplified to drive the horizontal deflection plates of the crt. The amplifier is designed for optimum operation with a sawtooth input waveform.

A feedback network from the output of the amplifier to the first amplifier stage is used to reduce the gain of the amplifier to the amount used with a normal sweep presentation. The gain of the amplifier is controlled by adjustment of the feedback network. When the sweep magnifier is used, a portion of the degenerative feedback network is eliminated to increase the gain of the amplifier by a factor of 5. This provides the magnified sweep presentation.

The external horizontal amplifier is a cathode coupled circuit which provides the necessary gain to drive the horizontal amplifier from external signals. An input attenuator and a gain control provide horizontal deflection factors between approximately 0.2 and 15 volts per centimeter.

CRT Circuit

Cathode ray tube operating voltages are obtained from a separate high voltage power supply circuit. Outputs from an oscillator circuit are taken from the secondary windings of the high voltage transformer. The primary winding of

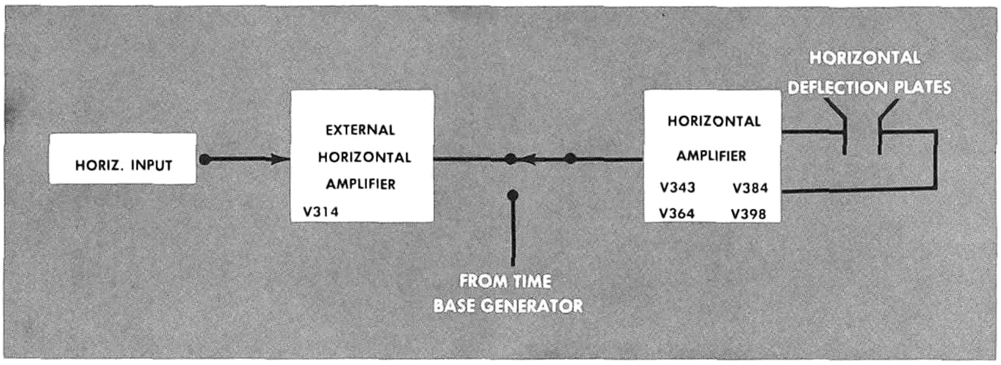


Fig. 4-6. Horizontal-Deflection System block diagram.

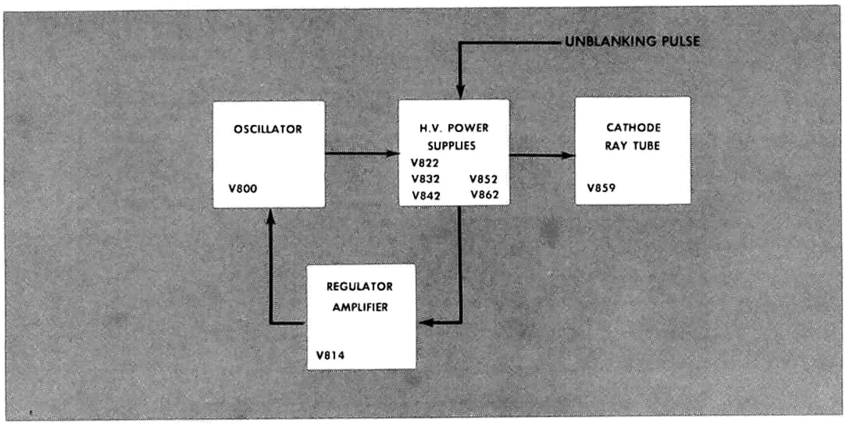


Fig. 4-7. CRT Circuit block diagram.

the high voltage transformer forms a part of the oscillator circuit. The transformer steps up the oscillator output voltage to the required level. The voltage is then rectified and filtered and applied to the crt circuitry. Control grid and cathode operating voltages are obtained from conventional rectifier circuits. A voltage tripler circuit supplies the anode voltage.

A sample of the power supply output voltage is fed back through the regulator amplifier to the high voltage oscillator. This voltage controls the oscillator output and compensates for any changes in the output voltages of the high voltage power supplies.

Additional crt circuitry controls intensity, geometry, astigmatism, and focus of the crt display. Unblanking pulses from the two sweep circuits are applied to the crt control grid during sweep time to unblank the tube. The blanked tube eliminates any visible sweep retrace.

Low Voltage Power Supplies

The low voltage power supplies produce all operating voltages for the oscilloscope with the exception of parts of the crt circuit. These power supplies produce regulated voltages of —150, +100, +225, +350, and +500 volts and an unregulated output of +340 volts. In addition a separate transistorized power supply provides regulated filament voltages for the probe, plug-in unit, and the Time Base Miller Runup tube.

Each of the power supplies operates in a similar manner. A sensing circuit compares a sample of the output voltage against a fixed reference voltage. Any error in the output voltage produces an error signal which is amplified and applied to the series regulator tubes, causing the series regulators to compensate for the error and return the voltage to normal.

Reference voltage for the —150 volt supply is obtained from a gas filled voltage regulator tube. Reference voltages for the other regulated power supplies except the filament supply are obtained from the output of the —150 volt supply. Consequently, operation of the regulated power supplies is dependent on operation of the —150 volt supply. The output voltages of all the regulated power supplies are adjusted by adjusting the output of the —150 volt supply.

Calibrator

The calibrator multivibrator, free running at approximately a 1000 cycle rate, produces the amplitude calibrator square waves. The square waves are applied through the calibrator output cathode follower and a precision attenuator to the CAL. OUT connector on the front panel. Accuracy of the calibrator output is insured by adjusting the multivibrator output voltage.

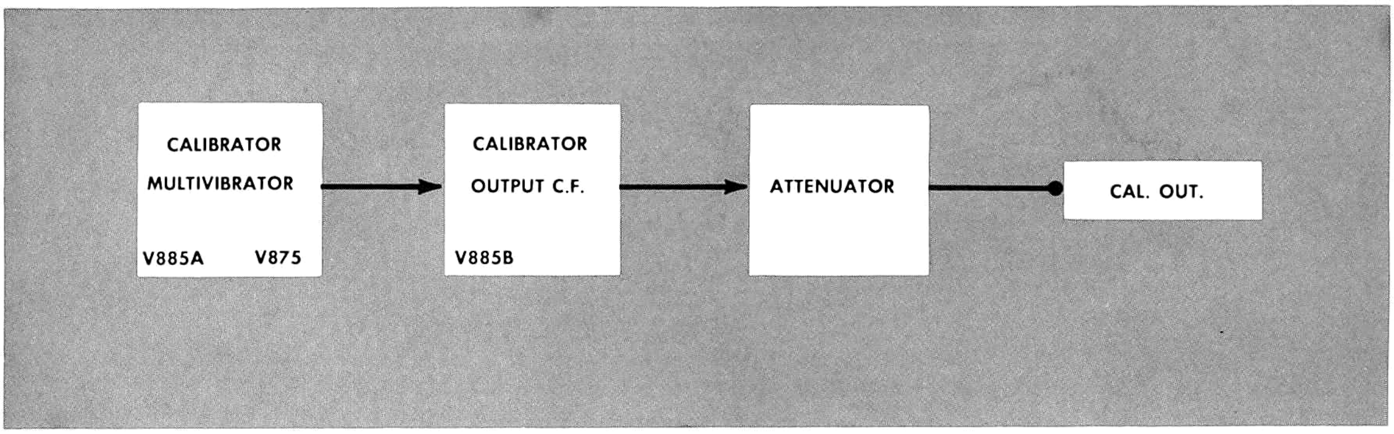
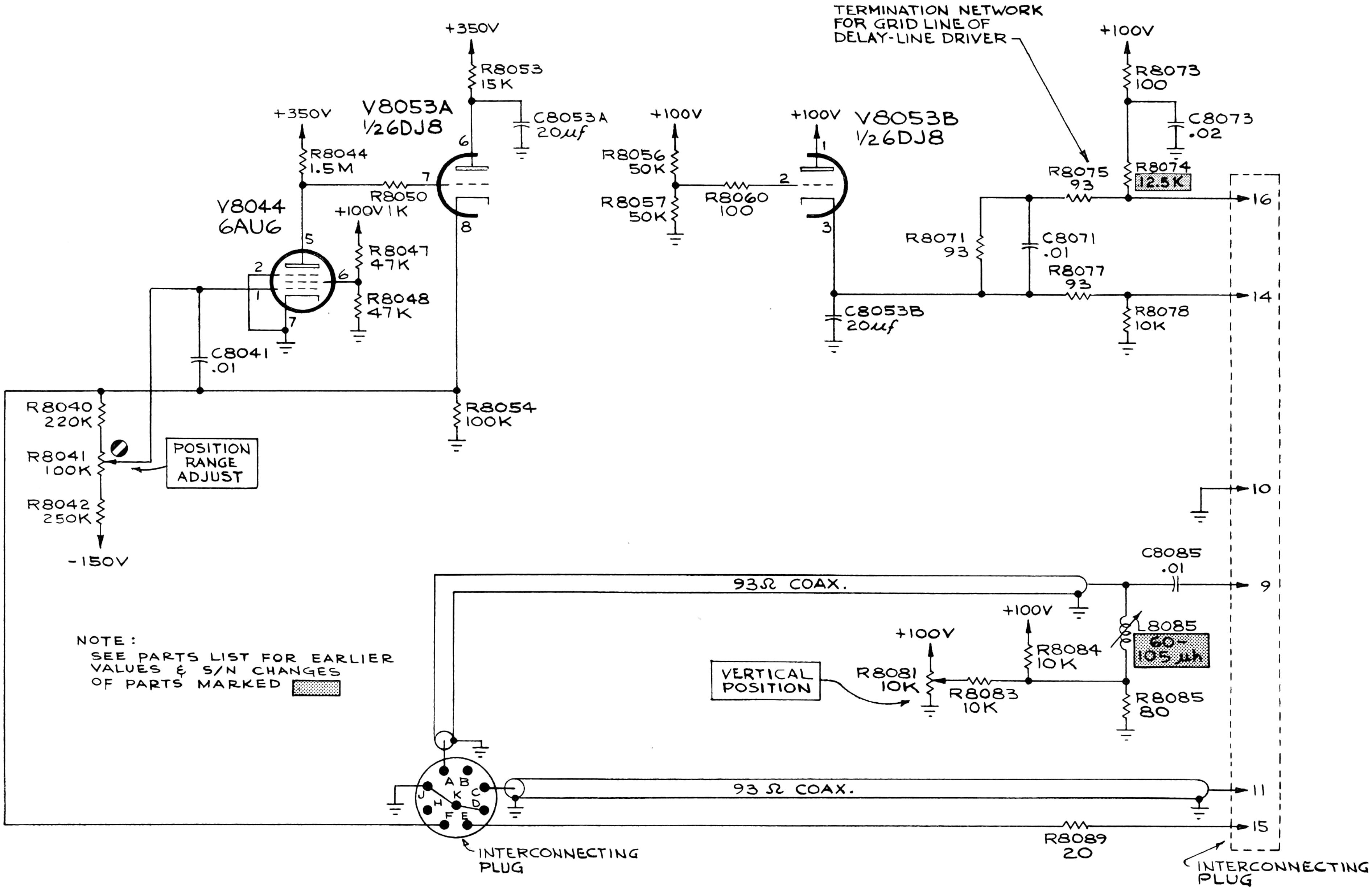


Fig. 4-8. Amplitude Calibrator block diagram.



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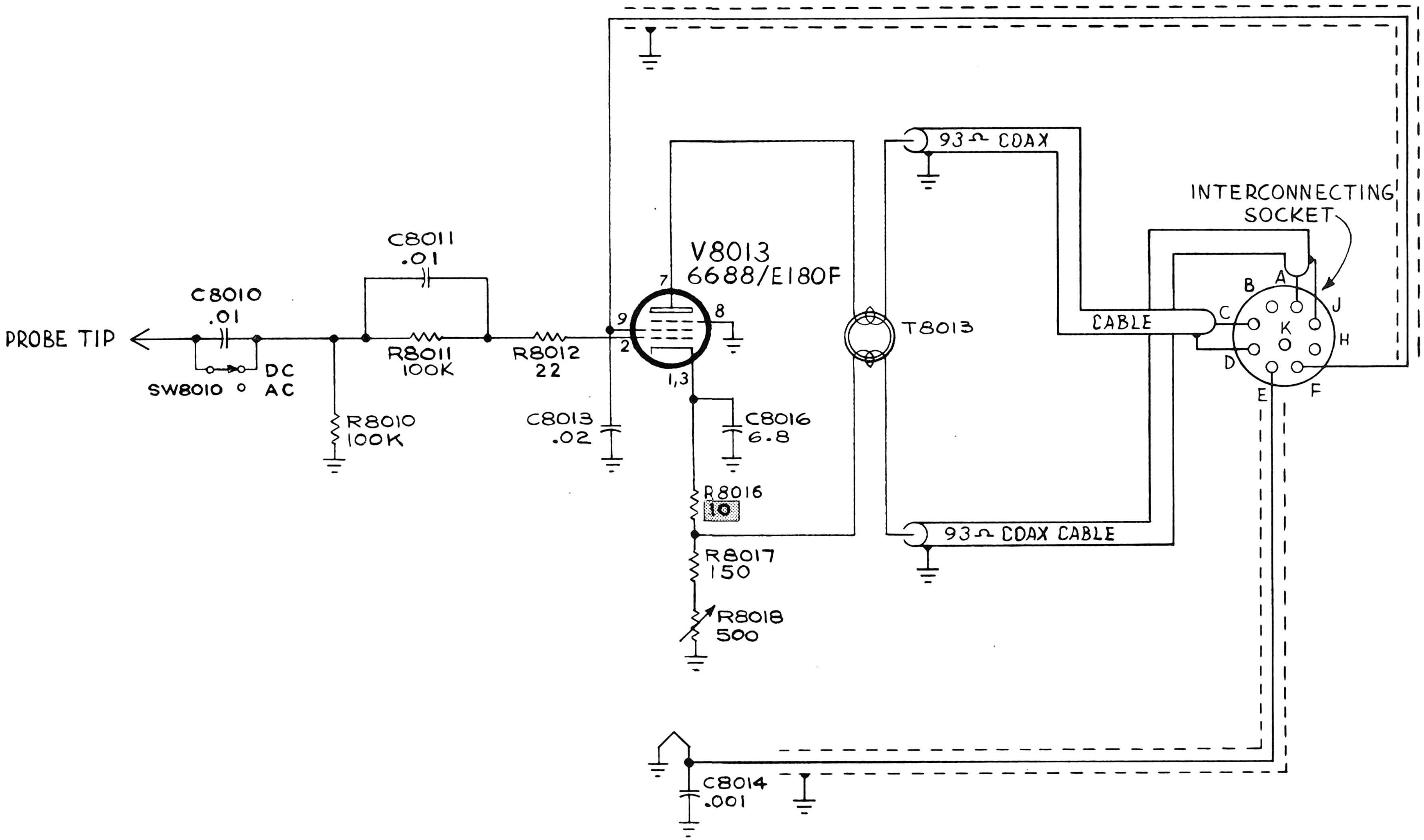
C

TYPE 80 PLUG-IN UNIT



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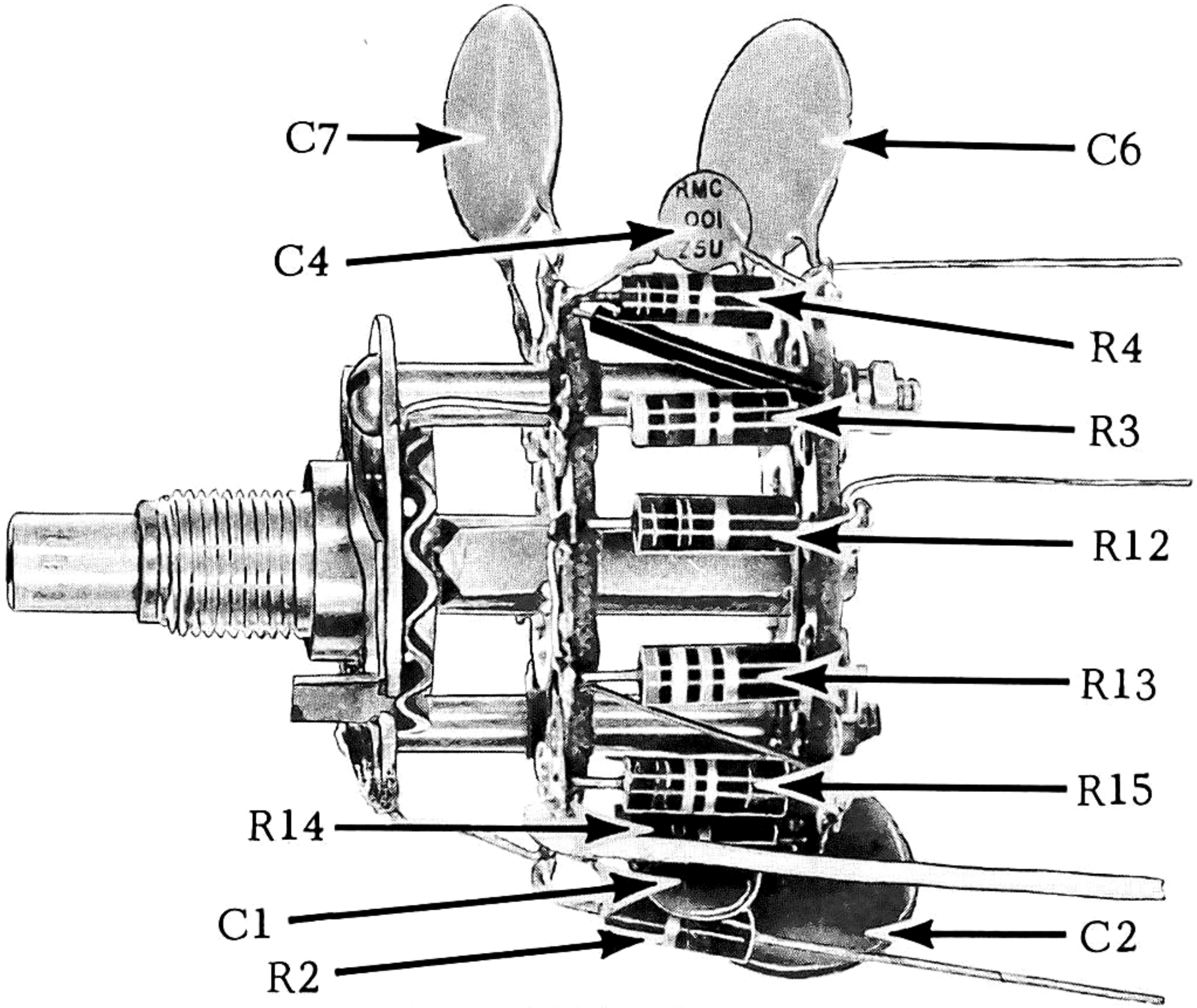
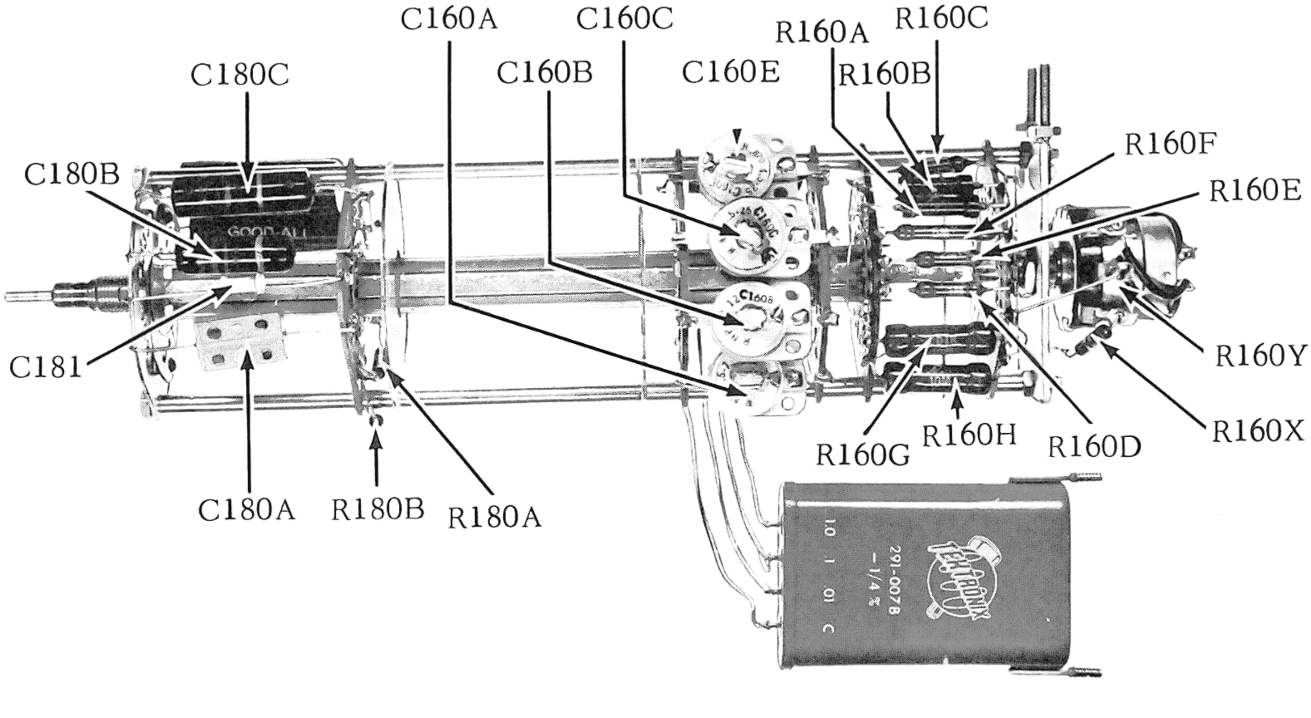
TYPE 80 PROBE



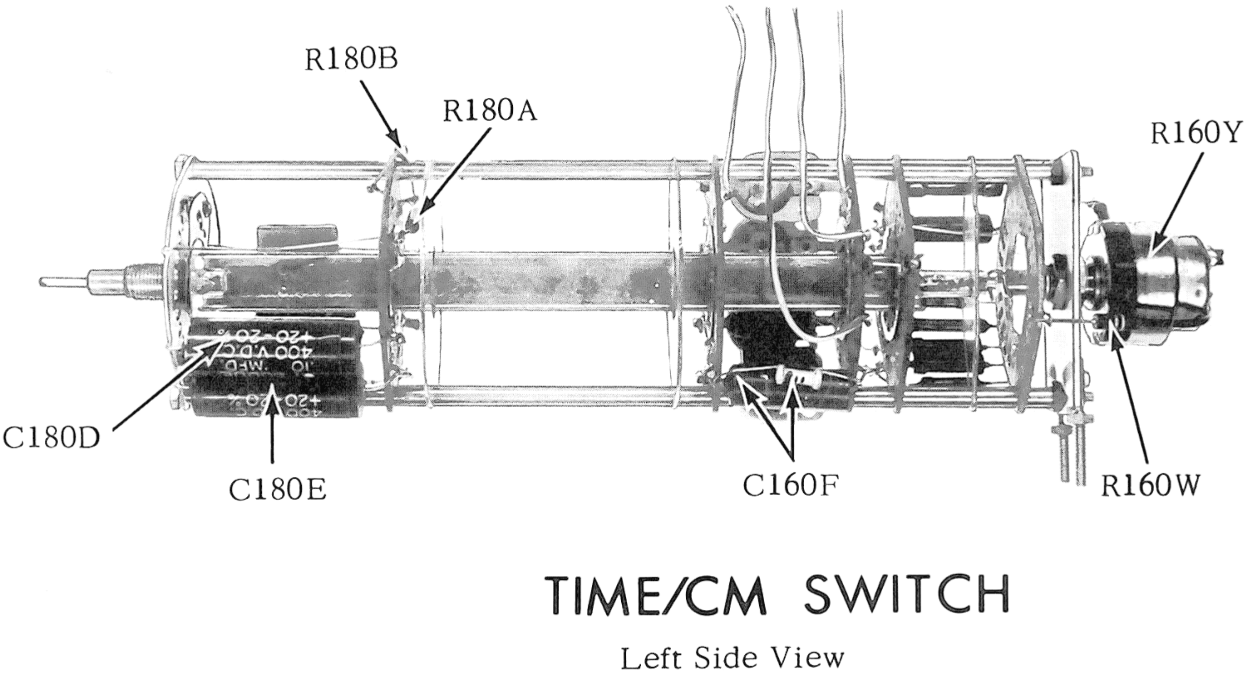
TRIGGERING SOURCE SWITCH

Top View



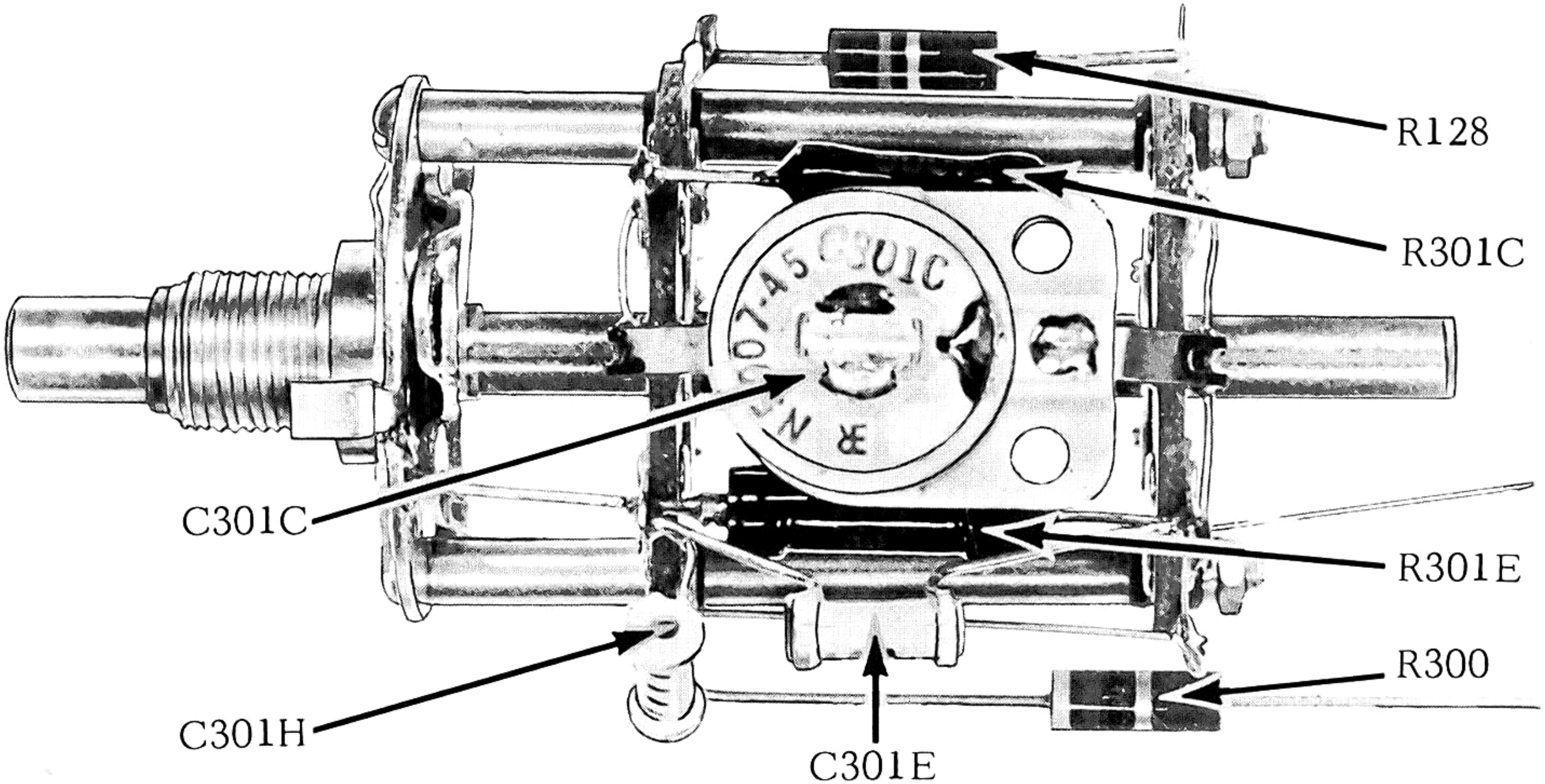
TIME/CM SWITCH

Right Side View



TIME/CM SWITCH

Left Side View



HORIZONTAL DISPLAY SWITCH

Right Side View

A