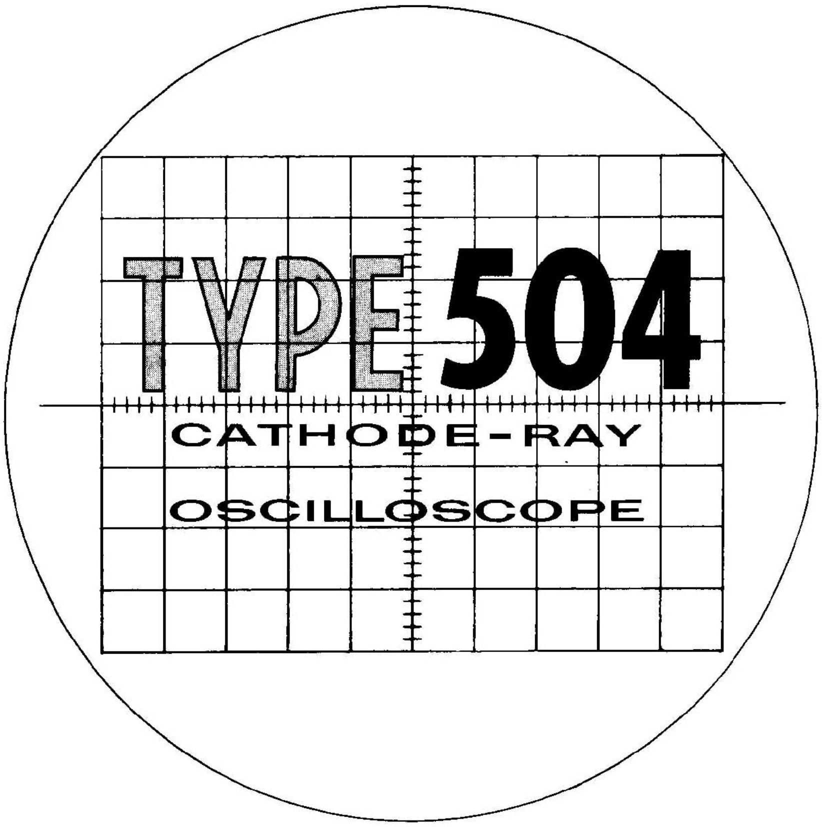
INSTRUCTION MANUAL



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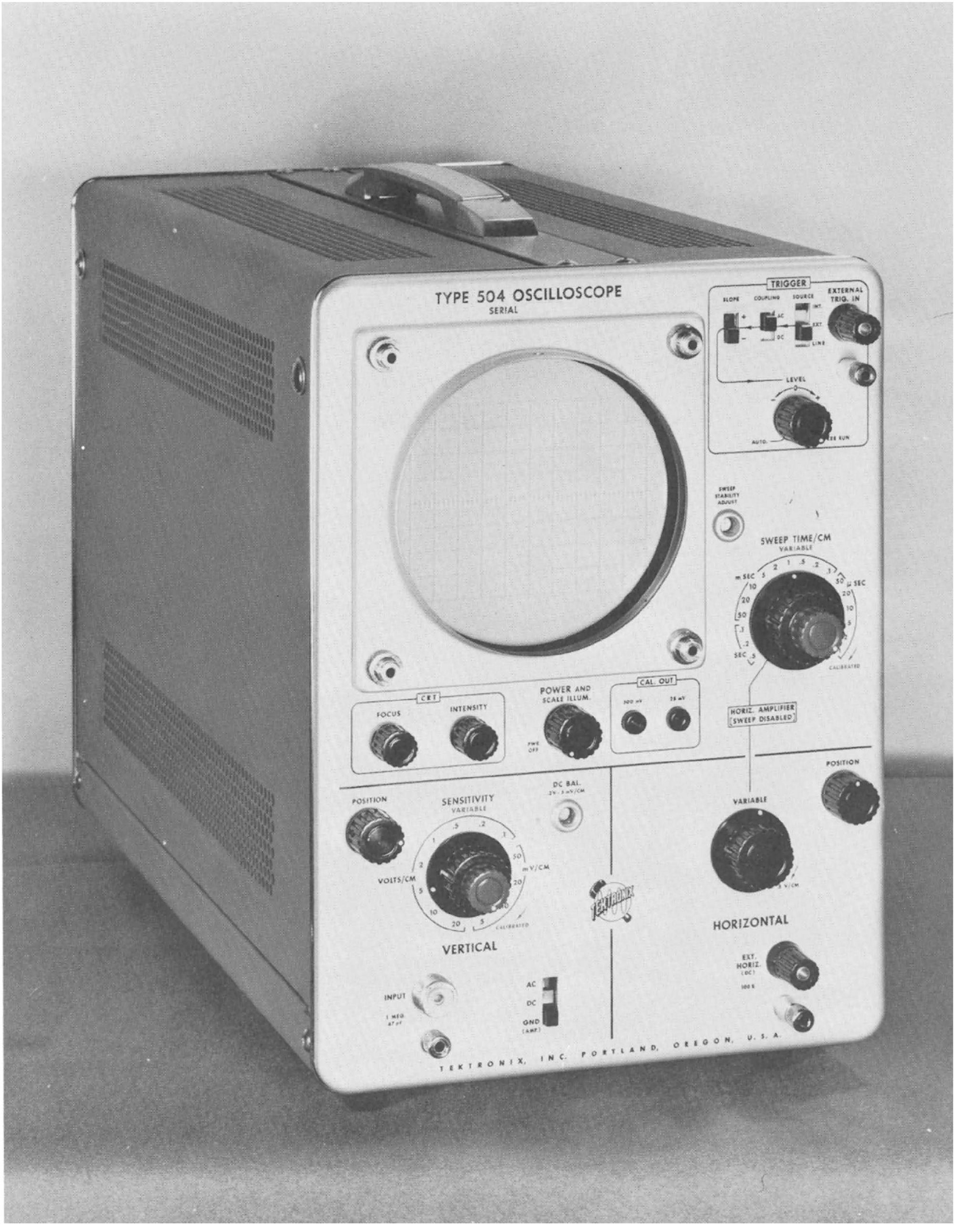
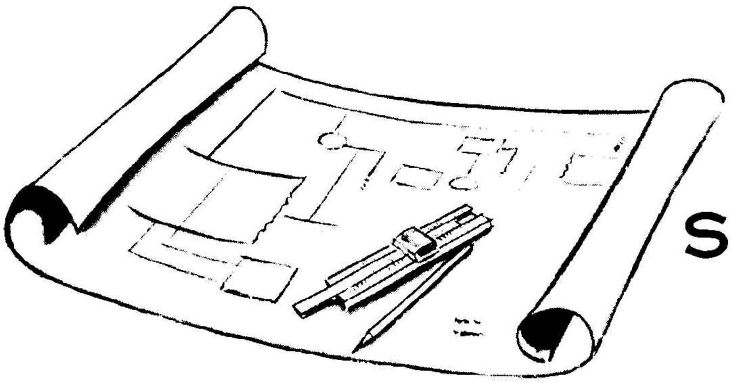

TYPE 504 OSCILLOSCOPE
SERIAL
TRIGGER
SLOPE
COUPLING
SOURCE
EXTERNAL TRIG. IN
LEVEL
SWEEP TIME/CM
VARIABLE
CRT
FOCUS
INTENSITY
POWER AND SCALE ILLUM.
CAL. OUT
HORIZ. AMPLIFIER [SWEEP DISABLED]
POSITION
SENSITIVITY
VARIABLE
DC BAL.
VOLTS/CM
VERTICAL
VARIABLE
HORIZONTAL
INPUT
AC
DC
GND
EXT. HORIZ.
TEKTRONIX, INC. PORTLAND, OREGON, U. S. A.



SECTION 1

SPECIFICATIONS

Introduction

The Tektronix Type 504 Oscilloscope is a low-frequency, high-sensitivity laboratory instrument providing accurate time and amplitude measurements in the range from dc to 450 kc. Its high reliability, stability, simple operation, and light weight make it adaptable as a general purpose laboratory instrument.

Vertical Deflection System

Input Impedance—1 megohm paralleled by 47 $\mu\mu$f.

Coupling—AC or DC.

Deflection Factors—Twelve calibrated deflection factors from 5 millivolts per centimeter to 20 volts per centimeter, accurate within 3%.

Bandpass—DC to 450 kc (vertical response down 3 db or less at 450 kc).

Triggering

Type—Automatic, or amplitude-level selection using preset stability.

Coupling—AC or DC.

Slope—Plus, from positive slope of triggering waveform, or minus, from negative slope of triggering waveform.

Source—Internal from vertical signal, external from triggering signal, or line from 60 cps.

Signal Requirements—Internal: signal producing 0.5 centimeter or more vertical deflection on crt screen.
External: 0.5 volt to 10 volts, peak. (Sweep will trigger on larger external signals, but LEVEL control operates over $\pm$10-volt range).

Sweep

Type—Miller Integrator.

Rates—Eighteen calibrated sweep rates from 1 microsecond per centimeter to 0.5 second per centimeter.
Accuracy typically within 1% of the indicated sweep rate; in all cases within 3%.

External Horizontal Input

Sensitivity—0.5 volt per centimeter maximum.

Input Resistance—100 kilohms.

Amplitude Calibrator

Waveform—Square waves at approximately 350 cps.

Amplitude—25 millivolts and 500 millivolts, peak-to-peak.

Cathode-Ray Tube

Type T503P

Phosphor—Type P2 normally furnished; P1, P7, and P11 phosphors optional. Other phosphors available on special order.

Accelerating Potential—3000 volts.

Z-Axis Modulation—External terminal permits RC coupling to crt grid.

Graticule

Illumination—Variable edge lighting.

Display Area—Marked in 8 vertical and 10 horizontal 1-centimeter divisions, with 2-millimeter markings on the centerlines.

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, rms, 50-60 cycles. Will operate at line frequencies to 800 cps with higher line voltages (see Section 2).

Power Requirements—Approximately 110 watts.

Mechanical Specifications

Construction—Aluminum alloy chassis and cabinet.

Finish—Photo-etched anodized panel, blue vinyl-finish cabinet.

Dimensions—21 1/2" long, 9 3/4" wide, and 13 1/2" high.

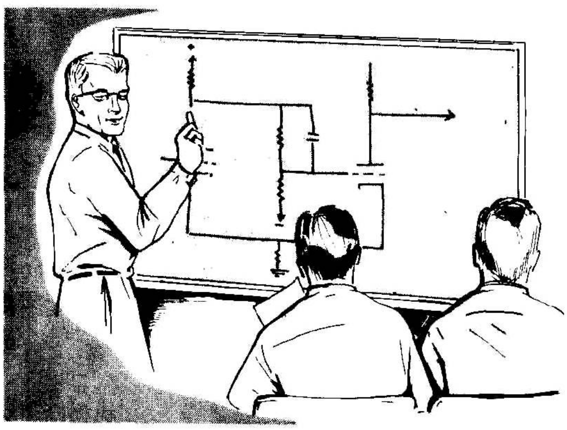
Weight—29 pounds.

Accessories

1 Binding Post Adaptor

1 Parts List and Schematic Diagrams Booklet

1 Instruction Manual



SECTION 4

CIRCUIT DESCRIPTION

A block diagram of the Type 504 Oscilloscope is shown in Fig. 4-1. In general, the operation of the instrument is as follows:

The signal to be displayed is amplified by the Vertical Amplifier and applied push-pull to the vertical deflection plates of the crt. A portion of the signal is "tapped off" in the Vertical Amplifier and applied to the Sweep Trigger as a triggering signal. Provisions are also made for applying an external signal or the ac line waveform, as desired, to the Sweep Trigger as a triggering signal. The Sweep Trigger generates a negative trigger pulse coincident with a selected point on each cycle of the triggering signal. The negative trigger pulse triggers the Sweep Generator which generates a positive-going sawtooth waveform. This sawtooth waveform is amplified by the Horizontal Amplifier and applied push-pull to the horizontal deflection plates to sweep the electron beam across the screen. If desired, the Sweep Generator can be disabled and an external signal applied directly through the Horizontal Amplifier to the horizontal deflection plates.

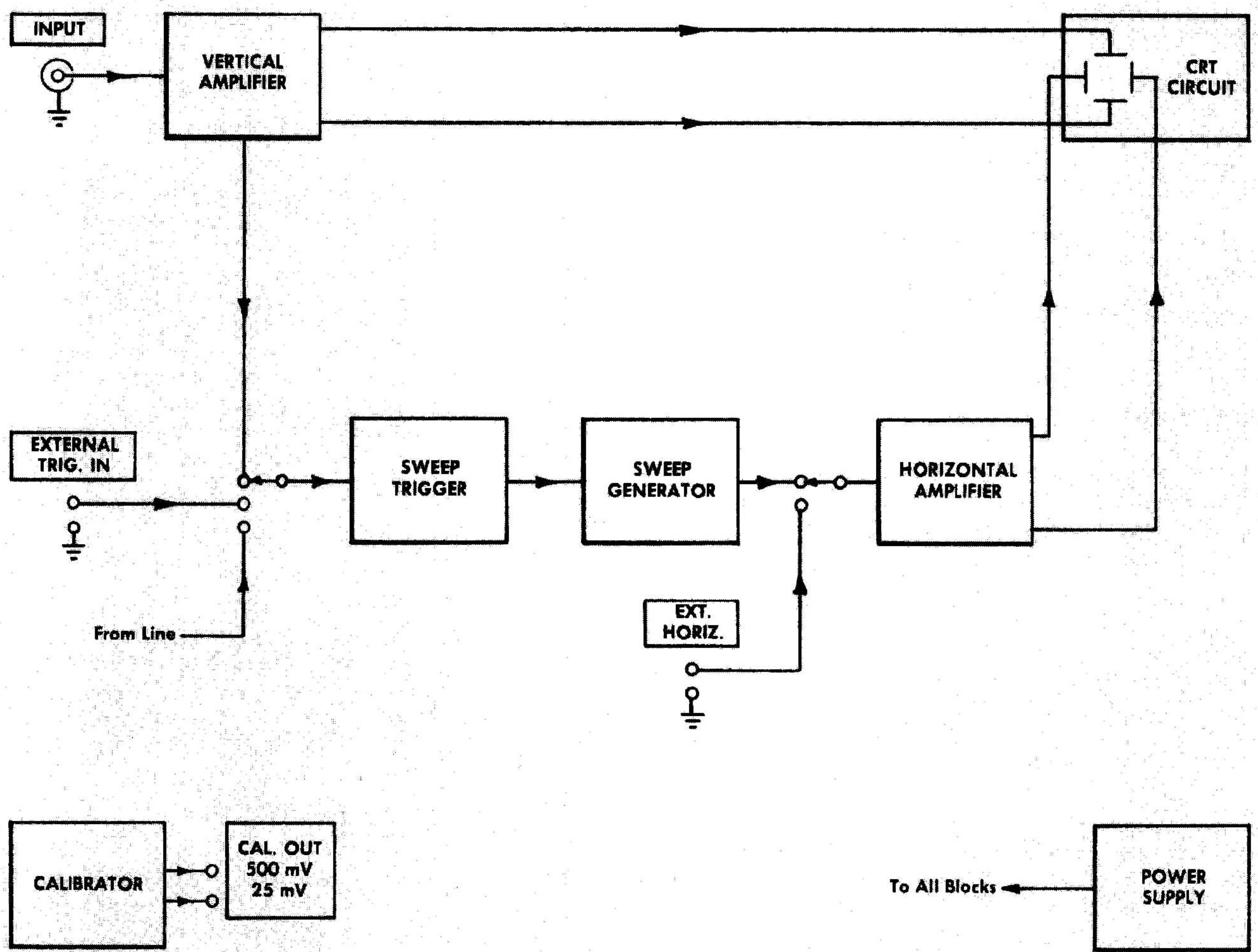


Fig. 4-1. Type 504 simplified block diagram.

The Calibrator generates amplitude-calibrated square waves of 25 millivolts and 500 millivolts amplitude primarily for use in calibrating the gain of the Vertical Amplifier. The Power Supply supplies the regulated voltages and currents necessary for proper operation.

The remainder of this section discusses the operation of each of the circuits of the Type 504 Oscilloscope in detail. During these discussions, you should refer to the circuit diagrams contained in the Parts List and Schematic Diagrams booklet which accompanies this manual.

VERTICAL AMPLIFIER

General Description

The Vertical Amplifier consists basically of a two-stage Input Amplifier and a single-stage Output Amplifier. The maximum overall gain of the Vertical Amplifier is on the order of 4400, which provides the required 22 volts per centimeter of vertical deflection at the crt for each 5 millivolts of signal at the input (with the SENSITIVITY control in the 5 mV/CM position).

The first stage of the Input Amplifier is a cathode-coupled paraphase amplifier which converts the single-ended input to push-pull output. The second stage is o pair of transistors operated push-pull. The output from the Input Amplifier drives the Output Amplifier, which, in turn drives the crt vertical deflection plates. Step changes in Vertical Amplifier sensitivity are accomplished by changes in input attenuation and negative feedback in the Input Amplifier. Vernier sensitivity control is accomplished by degeneration in the cathode circuit of the Output Amplifier.

Input Circuit

The Input Switch, SW410, permits the input to the Vertical Amplifier to be either ac or dc coupled, or to be grounded. The lower bandpass limit of the input circuit when ac coupled is about 7.5 cps.

The signal at the input connector is applied either "straight through" or through either of two attenuators to the grid circuit of V434B. One of the attenuators attenuates the signal by a factor of 10, the other attenuates it by a factor of 100. These attenuators, combined with changes in resistance in the cathode circuit of the first stage of the Input Amplifier, provide the means of varying the effective sensitivity of the Vertical Amplifier, in steps, between 5 millivolts and 20 volts per centimeter of deflection.

The attenuators are both resistance and capacitance dividers which provide constant attenuation of the signal throughout the frequency range of the instrument. In addition to providing the proper degree of attenuation, the resistance and capacitance values of the attenuators are chosen or adjusted to provide a constant 1-megohm input resistance and 47-$\mu\mu$f input capacitance regardless of the setting of the SENSITIVITY control.

Input Amplifier

The gain of the Input Amplifier is varied (in steps) by changing the value of R408 in the cathode circuit of the first stage. This varies the amount of negative feedback applied to the first stage from the output of the second. This feedback is applied through R457 and R467 to the parallel network of R419 and L419 in series and R408. As the value of R408 is increased, the amount of the negative feedback voltage is increased, limiting the gain of the amplifier.

The DC BAL. control in the grid circuit of V434A provides the means of setting the potential of the cathode of V434A equal to the potential of the cathode of V434B when there is no input signal, so that there is no current through R408. This provides vertical stability of the no-signal trace as the value of R408 is changed by the SENSITIVITY control.

The second stage of the Input Amplifier is provided with a positive feedback path from the collector of each side to the base of the other. The amount of positive feedback is adjusted to varying the value of R460, which varies the gain of the stage. The overall negative feedback through the first stage of the amplifier prevents the second stage from oscillating. The effect of R460 is most pronouced in the 5 mV/CM position of the SENSITIVITY control since there is the least amount of overall negative feedback in this position.

Output Amplifier

The gain of the Output Amplifier is adjusted by means of the .2 V GAIN ADJ., R478, and the VARIABLE control, R488. Vertical positioning of the crt beam is accomplished by means of the cross-coupled dual POSITION potentiometer, R470. Adjustment of this control varies the current through the Output Amplifier tubes, thereby changing the average dc voltage at each of the plates inversely to the other. At the same time, through feedback in the Input Amplifier, the control also produces a small push-pull change in voltage at the grids of the Output Amplifier to maintain the cathodes at the same potential as the current is changed.

Trigger Pickoff

Part of the output from one side of the Output Amplifier is applied through a divider network to the SOURCE switch, SW5, in the Sweep Trigger. Thus, when the SOURCE switch is in the INT. position, a part of the displayed signal is applied to the Sweep Trigger to start the horizontal sweep.

SWEEP TRIGGER

The Sweep Trigger consists basically of the Trigger Input Amplifier, V24, and the Trigger Multivibrator, V45. The Trigger Input Amplifier amplifies (and, when desired, inverts) the incoming triggering signal and applies it to the input grid of the Trigger Multivibrator. The Trigger Multivibrator is a Schmitt circuit which is switched from one state to the other by the signal at its input. Its square-wave output is differentiated to form negative and positive spikes. The negative spikes are applied to the Sweep Generator to start the sweep. The positive spikes are bypassed to the +250-volt supply through diode D44.

Trigger Input Amplifier

The input to the Trigger Input Amplifier, V24, may be selected from any of three sources by means of the SOURCE switch, SW5. When the SOURCE switch is in the INT. position, the signal is obtained from the Trigger Pickoff circuit in the Vertical Amplifier. When the SOURCE switch is in the EXT. position, the signal may be obtained from an external source through the TRIGGER INPUT connector on the front panel. When the SOURCE switch is in the LINE position, the signal is obtained from one of the 6.3-volt secondary windings of the line transformer.

As will be seen later, the negative spike at the output of the Sweep Trigger occurs only when there is a negative-going signal at the input to the Trigger Multivibrator (output of the Trigger Input Amplifier). However, it is desired to be able to start the sweep during either a positive-going or negative-going portion of the incoming triggering signal as seen at the input to the Trigger Input Amplifier. To accomplish this, the SLOPE switch SW20 provides the means for inverting or not inverting, as desired, the triggering signal in the Trigger Input Amplifier.

When the SLOPE switch is in the — position, the incoming triggering signal is applied to the grid of V24A, and V24 is a cathode-coupled amplifier. Its output is in phase with its input. Thus, the negative-going portion of the signal at the input to the Trigger Multivibrator corresponds to the negative-going portion of the incoming triggering signal. So, the negative spike at the output of the Sweep Trigger will occur during a time when the triggering signal is moving in a negative direction.

When the SLOPE switch is in the + position, the incoming triggering signal is applied to the grid of V24B, and V24B acts as a plate-loaded amplifier. Its output is opposite in polarity to its input. Thus, the negative-going portion of the signal at the input to the Trigger Multivibrator corresponds to the positive-going portion of the incoming triggering signal. So, the negative spike at the output of the Sweep Trigger will occur during a time when the triggering signal is moving in a positive direction.

The LEVEL control, R17, varies the average dc level of the plate of V24B from about +70 volts to +130 volts. This is true whether SW20 is in the + position or — position. The minimum level of +70 volts represents the point where V24B is taken into saturation by a sufficiently positive setting of R17 when SW20 is in the — position, or by a sufficiently negative setting of R17 when SW20 is in the + position. The maximum level of +130 volts represents the point where V24B is taken into cutoff by a sufficiently negative setting of R17 when SW20 is in the — position, or by a sufficiently positive setting of R17 when SW20 is in the + position. As will be seen later, the voltage at the plate of V24B must pass through the approximate center of this range (about +100 volts) in order to cause the Trigger Multivibrator to change states.

For small triggering signals, R17 is set such that the average dc level of the plate of V24B is close to the center of its range. Then a small triggering signal, as amplified by V24, is sufficient to carry the plate voltage through the +100-volt point. When a large triggering signal is applied and it is desired to trigger on an extreme positive or negative point of it, R17 is set such that V24B is well into saturation, or cutoff, depending on whether triggering is desired on a negative or positive point on the signal and on a negative or positive slope. In this case, the triggering signal must be large enough to overcome the saturation or cutoff of V24B and produce an additional 30 volts of swing at the plate of V24B in order to cause the Trigger Multivibrator to change states.

It should be noted that the voltages given in the foregoing discussion are typical nominals only and will vary somewhat from instrument to instrument and with time.

Trigger Multivibrator

The Trigger Multivibrator, V45, is a typical two-state Schmitt circuit. When the voltage at its input grid (grid of V45A) is above a certain critical level (neglecting hysteresis for the moment), the Trigger Multivibrator is in one state, with V45A conducting and V45B cut off. When the Trigger Multivibrator is in this state, the voltage at its output (plate of V45B) is +250 volts. When the voltage at the input grid is below the critical level (still neglecting hysteresis), the Trigger Multivibrator is in the other state, with V45A cut off and V45B conducting. When the Trigger Multivibrator is in this second state, the voltage at its output is about +230 volts. The transition from one state to the other occurs very rapidly regardless of how slowly the voltage at the input grid passes the critical level. Thus the output of the Trigger Multivibrator is a 20-volt square wave. The negative-going portion of the square wave occurs when the voltage at the input passes the critical level while moving in a negative direction; the positive-going portion of the square wave occurs when the voltage at the input passes the critical level while moving in a positive direction. As mentioned before, only the negative-going portion of the square wave is of significance timewise. By means of the SLOPE switch and the LEVEL control, this point can be made to coincide with virtually any point on the incoming triggering signal.

Actually, the input voltage level at which the Trigger Multivibrator changes states on a negative-going signal is slightly lower than the input voltage level at which it changes states on a positive-going signal. The difference between the two input voltage levels at which the two changes in state occur is the hysteresis of the circuit. To maintain stable triggering, the incoming triggering signal must be large enough that, when it is amplified by the Trigger Input Amplifier, it will have sufficient amplitude to overcome the hysteresis of the Trigger Multivibrator.

It will be seen in the discussion of the Sweep Generator that not every negative trigger pulse from the Sweep Trigger initiates a sweep. During sweep time, the negative trigger pulses have no effect on the Sweep Generator. It is only after a sweep has been completed and all circuits have returned to their quiescent state that the Sweep Generator will be re-triggered by the Sweep Trigger.

Automatic Triggering Mode

When the LEVEL control is turned fully counterclockwise, the AUTO. switch, SW17, is activated and converts the Trigger Multivibrator from a bistable configuration to an astable (free-running) configuration. This is accomplished by coupling the grid circuit of V45B to the grid circuit of V45A via R40. The time constant thus formed is such that, in the absence of a triggering signal, the Trigger Multivibrator free-runs at about 50 cps. However, since the triggering signals from the Trigger Input Amplifier are still coupled to the Trigger Multivibrator through C31, any triggering signal over 50 cps in frequency will produce synchronized operation of the Trigger Multivibrator at the triggering signal frequency. In the absence of any such triggering signal, the sweep continues to be triggered at a 50-cps rate. This provides a base line from which to make dc voltage measurements and also provides an indication that the instrument is adjusted to display any signal that might be applied to the INPUT connector.

SWEEP GENERATOR

The Sweep Generator, upon receipt of a negative trigger pulse from the Sweep Trigger, produces a linearly rising (sawtooth) voltage which is applied through the Horizontal Amplfier to the crt horizontal deflection plates. This causes the electron beam to move from left to right across the crt screen and form the sweep. The amplitude of the sawtooth voltage is about 100 volts. Its rate of rise is controlled by the values of the Timing Capacitor and Timing Resistor switched into the circuit by the SWEEP TIME/CM control on the front panel.

The Sweep Generator consists basically of three main circuits; the Sweep-Gating Multivibrator, the Miller Runup Circuit, and the Hold-Off Circuit. The Sweep-Gating Multivibrator consists of V135A, V135B, V145A and associated circuitry. The essential components of the Miller Runup Circuit are: the Miller Tube, V160A; the Runup Cathode Follower, V160B; the Disconnect Diodes, V152A and V152B; the Timing Capacitor, C160; and the Timing Resistor, R160. The Hold-Off Circuit consists of the Hold-Off Diode, V152C; the Hold-Off Cathode Follower, V145B; the Hold-Off Resistor, R181; and the Hold-Off Capacitance, C181 and C160 (the Hold-off Circuit makes use of some of the same timing capacitors as the Miller Runup Circuit).

Sweep Generation

In the quiescent state—that is, when no sweep is being generated—V135A is conducting and V145A is cut off. The plate of V145A is at about —2.5 volts with respect to ground. The Disconnect Diodes are conducting and hold both sides of the Timing Capacitor at about —2.5 volts. With its cathode grounded and its grid at —2.5 volts, V160A is conducting heavily and its plate is at about +30 volts.

A negative trigger pulse, arriving at the grid of V135A from the Sweep Trigger, causes the Sweep-Gating Multivibrator to switch rapidly to its other state. That is, V135A cuts off and V145A conducts. As V145A conducts, the increased current through the common cathode resistor, R144, raises the cathode voltage of the two tubes. This holds V135A in cutoff after the negative trigger pulse has passed. Since V135A is now in cutoff, further trigger pulses arriving at its grid will have no effect on the circuit until after the sweep has been completed and the grid has been returned to its quiescent level by the Hold-Off Circuit. Thus the sweep is actually triggered at a submultiple of the triggering signal, provided the sweep time is significantly greater than the period of the triggering signal.

As V145A conducts, its plate voltage goes down, cutting off the Disconnect Diodes. When the Disconnect Diodes cut off, the plates of the Timing Capacitor are no longer held at —2.5 volts, and the Timing Capacitor starts to charge toward the instantaneous potential difference between the —100-volt supply and the potential on the cathode of V160B. However, as the lower plate of the Timing Capacitor starts to move in a negative direction, it takes the grid of V160A with it. This produces a positive swing at the plate of V160A which is coupled, through B167 and V160B, to the upper plate of the Timing Capacitor. This positive swing on the upper plate tends to prevent the lower plate from swinging negatively. It also increases the voltage to which the Timing Capacitor is trying to charge. The effect is to "straighten out" the charging curve by increasing the charging voltage with each increment of charge on the capacitor. Since the gain of V160A is about 200, the potential on the upper plate moves about 100 volts with respect to ground while the potential on the lower plate moves about one-half volt. The result is an extremely linear sawtooth at the cathode of V160B, which is applied through the Horizontal Amplifier to the horizontal deflection plates of the crt.

Sweep Length

The length of the sweep—that is, the distance the spot moves across the screen—is determined by the setting of the SWP. LENGTH adjustment, R176. As the sweep voltage rises at the cathode of V160B, there is proportionate rise in voltage at the wiper arm of the SWP. LENGTH adjustment. This increases the voltage at the plate, and therefore the cathode, of V152C and at the grid and cathode of V145B. As the voltage at the cathode of V145B rises, the voltage at the grid of V135A also rises. When the voltage at the grid of V135A rises to the point where V135A comes out of cutoff, the Sweep-Gating Multivibrator reverts rapidly to its original state, with V135A conducting and V145A cut off. The voltage at the plate of V145A rises, carrying with it the voltage at the plates of the Disconnect Diodes.

V152B starts conducting, and forms a discharge path for the Timing Capacitor, through R147, the —100-volt power supply, and the cathode resistance of V160B. This brings the grid of V160A quickly back up to its quiescent level. The rise in voltage at the grid causes the tube to conduct more, so the plate voltage drops, carrying with it the grid and cathode of V160B. When the voltage at the cathode of V160B returns to about —2.5 volts, V152A conducts, clamping the voltage at this point. The circuit has now returned to its quiescent level and is ready for the next trigger.

Hold-Off

The Hold-Off Circuit prevents the Sweep Generator from being triggered until after the Miller Runup Circuit has stabilized in the quiescent condition following the previous sweep. It does this by holding the grid of V135A positive enough to keep V135A in conduction.

During sweep time, the rising voltage at the cathode of V152C charges up the Hold-Off Capacitance, C160 and

C181. Then, at the end of the sweep, the voltage at the plate of V152C drops suddenly and the cathode tries to follow it. The cathode however, is held up by the charge on the Hold-Off Capacitance which must discharge exponentially through the 4.7-M Hold-Off Resistor, R181. This, then, holds the grid and cathode of V145B and the grid of V135A high enough to hold V135A in conduction for a length of time determined by the time constant of the Hold-Off Capacitance and the Hold-Off Resistor. The amount of hold-off time required is determined, in general, by the sweep rate. For this reason, the SWEEP TIME/CM control changes the amount of capacitance in the Hold-Off Circuit simultaneously with that of the Timing Circuit.

Sweep Stability

The SWEEP STABILITY ADJUST, R111, regulates the quiescent dc level of the grid of V135A. This potentiometer (a front panel adjustment) is adjusted so that after the decay of the hold-off voltage the grid of V135A is just high enough (with the FREE RUN switch open) to hold V135A in conduction. In this case, a sweep can be produced only when a negative trigger pulse from the Sweep Trigger drives V135A into cutoff. Turning the LEVEL control fully clockwise closes the FREE RUN switch and shorts out R111. This places a more negative voltage on the grid of V135A such that V135A cuts off upon decay of the hold-off voltage and the next sweep is initiated immediatey (no trigger pulse is necessary). The result is a free-running sweep whose period is the total of the sweep time plus the hold-off time at any given setting of the SWEEP TIME/CM control. (This is compared to a fixed repetition rate of about 50 cps when the LEVEL control is turned fully counterclockwise to the AUTO. position to make the Trigger Multivibrator in the Sweep Trigger free run.)

Unblanking

The positive rectangular pulse appearing at the cathode of V135B during sweep time is applied as an unblanking pulse to the crt. Action of this pulse is discussed under the description of the Crt Circuit later in this section. It should be noted that, when the SWEEP TIME/CM control is in the HORIZ. AMPLIFIER position, the Sweep-Gating Multivibrator is disabled, and there is no current flowing through V135A or V145A. Therefore, the cathode of V135B is held at a potential of about +205 volts and the crt is continuously unblanked.

HORIZONTAL AMPLIFIER

The Horizontal Amplifier is a cathode-coupled paraphase amplifier which converts a single-ended input to a push-pull output and applies it to the horizontal deflection plates of the crt. When the SWEEP TIME/CM control is in any position but the HORIZ. AMPLIFIER position, the sawtooth waveform from the Sweep Generator is applied through a divider network to the grid of V374. When the SWEEP TIME/CM control is in the HORIZ. AMPLIFIER position, the grid of V374 is connected through the HORIZONTAL VARIABLE control, R310, to the EXT. HORIZ. connector on the front panel. This provides a means of applying an external signal to the horizontal deflection plates.

The Horizontal Amplifier has a nominal sensitivity of 0.5 volt per centimeter of deflection with the HORIZONTAL VARIABLE control set fully clockwise. The gain can be adjusted by means of the SWP. CAL. adjustment, R379.

Horizontal positioning is accomplished by varying the dc level of the grid of V384 by means of the HORIZONTAL POSITION control, R361. This varies the average dc level of the two plates of the amplifier inversely to one another.

CRT CIRCUIT

The crt in the Type 504 Oscilloscope makes use of an extra set of deflection plates for unblanking during sweep time. One of these plates has a fixed potential of about +225 volts on it; the other is tied to the cathode of V135B in the Sweep Generator. Quiescently, this latter plate is held at a relatively low potential, in the vicinity of +80 volts. Therefore, the electron beam in the crt is deflected forward and absorbed by the +225-volt plate; none of it reaches the screen. During sweep time, however, the unblanking pulse from V135B raises the potential of the second plate from +80 volts to about +205 volts which permits the beam to pass on through to the crt screen.

The INTENSITY control varies the control grid of the crt from about —20 volts to —150 volts with respect to the cathode. Connections are provided on the rear of the oscilloscope cabinet to couple an ac signal to the control grid to provide intensity modulaton of the trace if desired.

CALIBRATOR

The Calibrator provides a 25-millivolt square wave and a 500-millivolt square wave for use in calibrating the gain of the Vertical Amplifier. The two amplitudes are obtained by tapping off at different points in a voltage divider network.

The square wave is produced by the turning off and on of B886. This is accomplished by the combined action of B886, B883, and C883. B886 and B883 are neon tubes which nominally drop about 60 volts when they are conducting. However, if they are not conducting, they require about 80 volts across them to start conduction.

During the time that B886 is turned off, B883 is conducting. This causes C883 to discharge, which allows both plates of B883 to move in a positive direction (60 volts apart). When the common connection at the top of the two neon tubes reaches a potential of about +80 volts with respect to ground, B886 conducts. The current through R886 and R887 produces a 500-millivolt drop across them and the voltage at the upper end of B886 is, therefore, about +60.5 volts with respect to ground. Since the upper plate of C883 is now at about +20 volts with respect to ground, the potential across B883 is only about 40 volts, and B883 stops conducting. With no current through B883 to maintain or build up the charge on C883, the upper plate of C883 starts to move in a negative direction. The upper end of B883 is held steady at +60.5 volts by the drop across B886, R886, and R887, so when the potential on the upper plate of C883 becomes —20 volts with respect to ground, B883 conducts. This drops the voltage at the upper end of the two neon tubes to about +40 volts, and B886 cuts off, completing one cycle of the square wave.

It should be noted that the potentials mentioned in the foregoing discussion (except the drop across R886 and R887) are typical nominals only, and may vary considerably among different units. The only effect will be a slight variation in the frequency and symmetry of the output waveform.

The CAL. ADJ. adjustment, R880, provides a means of adjusting the voltage drop across R886 and R887 to exactly 500 millivolts by controlling the current through them.

POWER SUPPLY

T601 provides B+ voltage (about 500 volts) for the power supply oscillator tube, V620, and filament power for the graticule lights and all of the tubes, except the first stage of the Input Amplifier. The rest of the voltages used in the oscilloscope are provided by the secondary of T620.

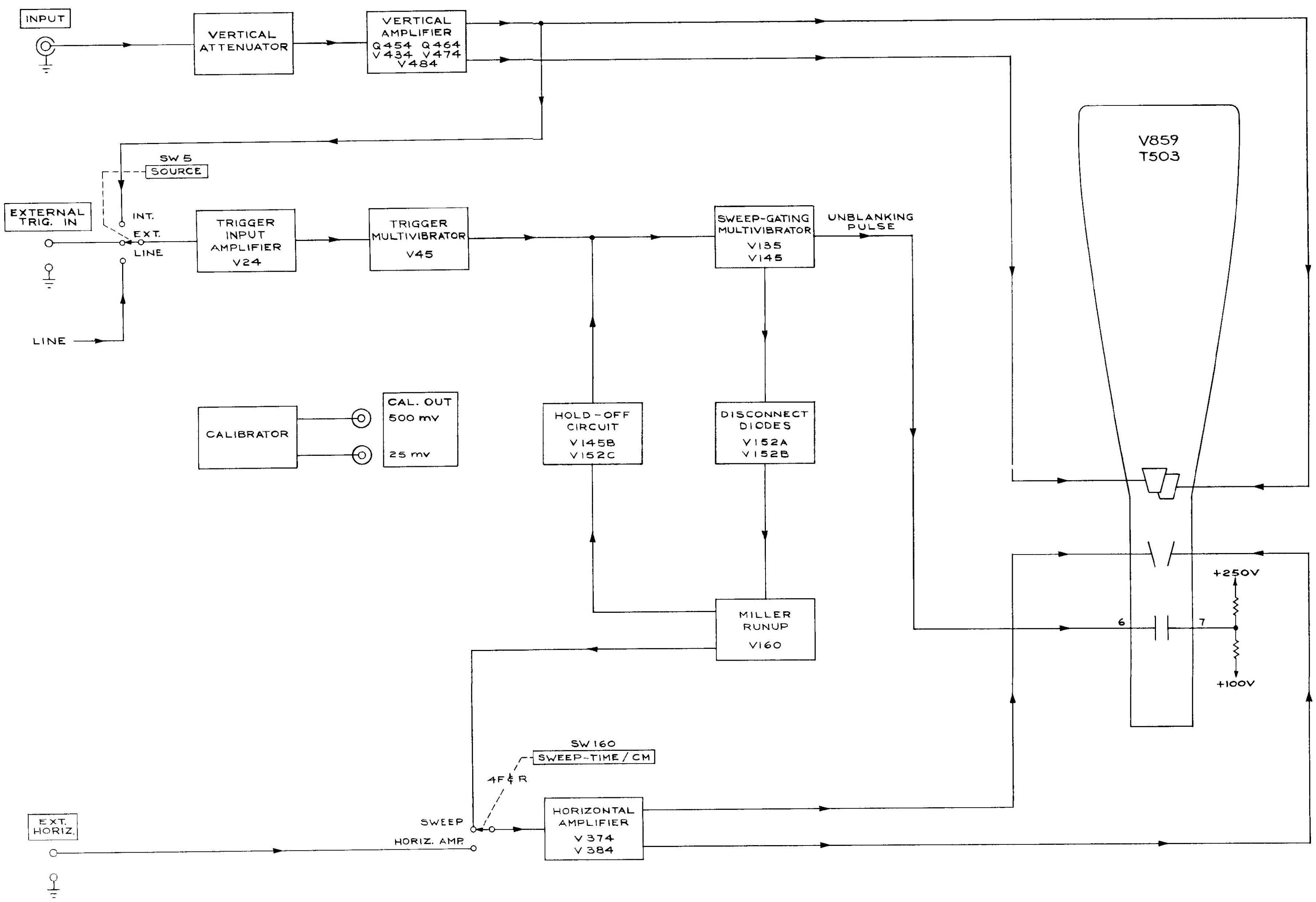
V620, the primary of T620, and part of the secondary of T620 form an Armstrong oscillator circuit to drive T620 at about 25 kc. Each of the outputs of the secondary of T620 bears a fixed turns ratio to the others such that a change in one effects a proportional change in each of the others. Adjustment and regulation of all of the output voltages, then, is accomplished through adjustment and regulation of just one output, the —100-volt output. This, in turn, is referenced to the 85-volt drop across the voltage regulator tube, V659.

Adjustment of the output voltages is accomplished by means of the —100 ADJ., R641. Moving the wiper arm of this adjustment in a positive direction reduces the bias on V634B. This, in turn lowers the voltage at the plate of V634B and, therefore, at the grid of V634A. This causes an increase in voltage at the plate of V634A which, in turn, increases the screen voltage of V620. Increasing the screen voltage of V620 increases the G_m and therefore the gain, of the tube, and thereby increases the amplitude of oscillations in the secondary of T620. This results in a greater output from all of the supplies.

Regulation is accomplished in virtually the same manner. A lowering of the source voltage to which the oscilloscope is connected, or a lowering of any of the output voltages due to loading, causes the volts per turn in the secondary of T620 to decrease. This causes the —100-volt supply to drop (move positively) with the resulting rise in the grid voltage of V634B. This results, as before, in a rise in the screen voltage of V620 and an increase in the amplitude of oscillations, bringing the power supply outputs back to their nominal values.

An increase in any of the output voltages, whatever the reason, has the opposite effect on the screen voltage of V620 and decreases the amplitude of oscillations in T620.

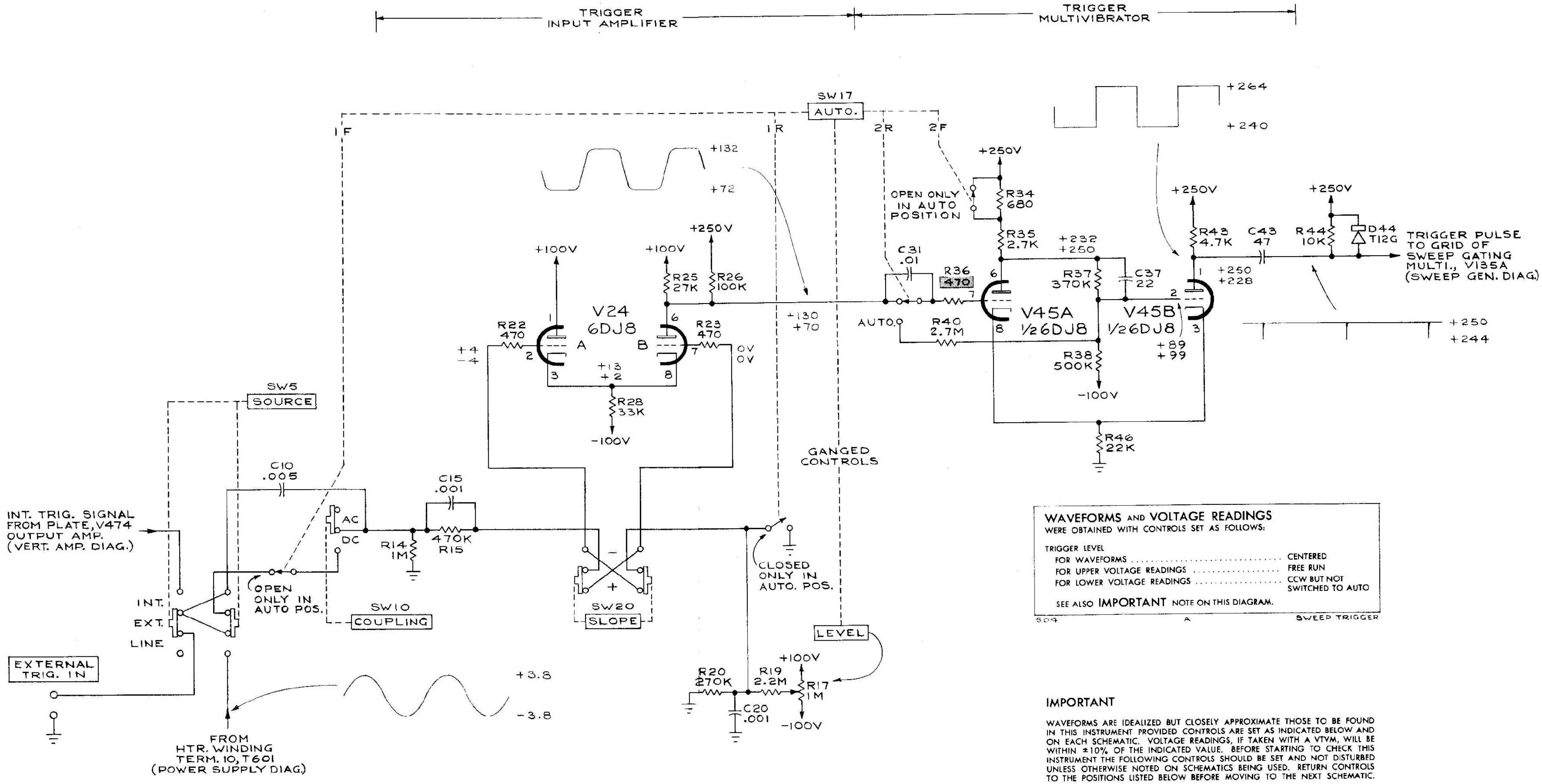
Regulation of the power supply outputs will be accomplished as long as the source voltage remains within the limits described in Section 2 of this manual.



A

MRH
4-12-60

BLOCK DIAGRAM



WAVEFORMS AND **VOLTAGE READINGS**
WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

TRIGGER LEVEL

FOR WAVEFORMS	CENTERED
FOR UPPER VOLTAGE READINGS	FREE RUN
FOR LOWER VOLTAGE READINGS	CCW BUT NOT SWITCHED TO AUTO

SEE ALSO **IMPORTANT** NOTE ON THIS DIAGRAM.

504 A SWEEP TRIGGER

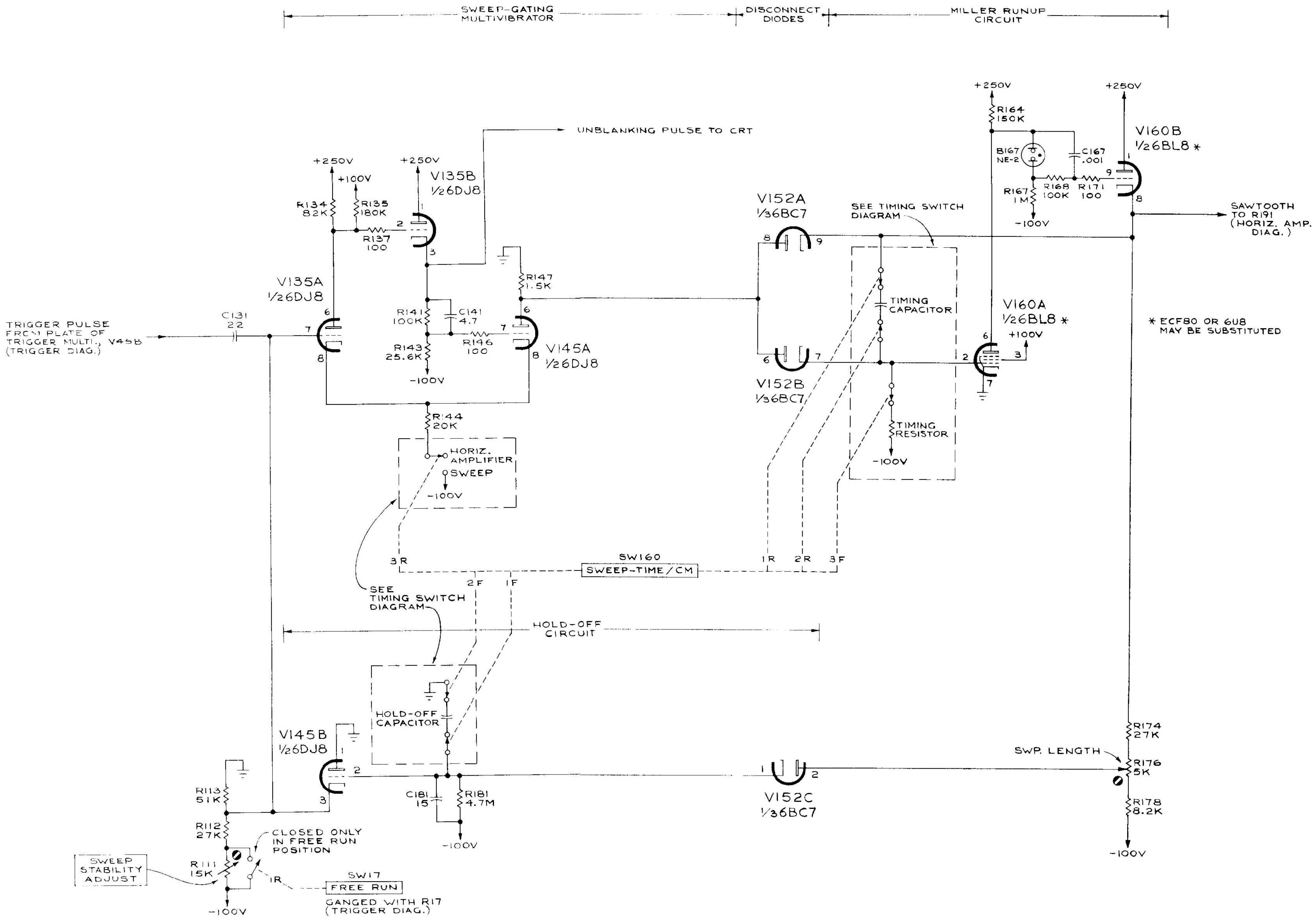
IMPORTANT

WAVEFORMS ARE IDEALIZED BUT CLOSELY APPROXIMATE THOSE TO BE FOUND IN THIS INSTRUMENT PROVIDED CONTROLS ARE SET AS INDICATED BELOW AND ON EACH SCHEMATIC. VOLTAGE READINGS, IF TAKEN WITH A VTVM, WILL BE WITHIN ±10% OF THE INDICATED VALUE. BEFORE STARTING TO CHECK THIS INSTRUMENT THE FOLLOWING CONTROLS SHOULD BE SET AND NOT DISTURBED UNLESS OTHERWISE NOTED ON SCHEMATICS BEING USED. RETURN CONTROLS TO THE POSITIONS LISTED BELOW BEFORE MOVING TO THE NEXT SCHEMATIC.

POSITION (HORIZONTAL)	CENTERED
SWEEP TIME/CM	1 mSEC
TRIGGER SOURCE	LINE
TRIGGER COUPLING	AC
SLOPE	+

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED

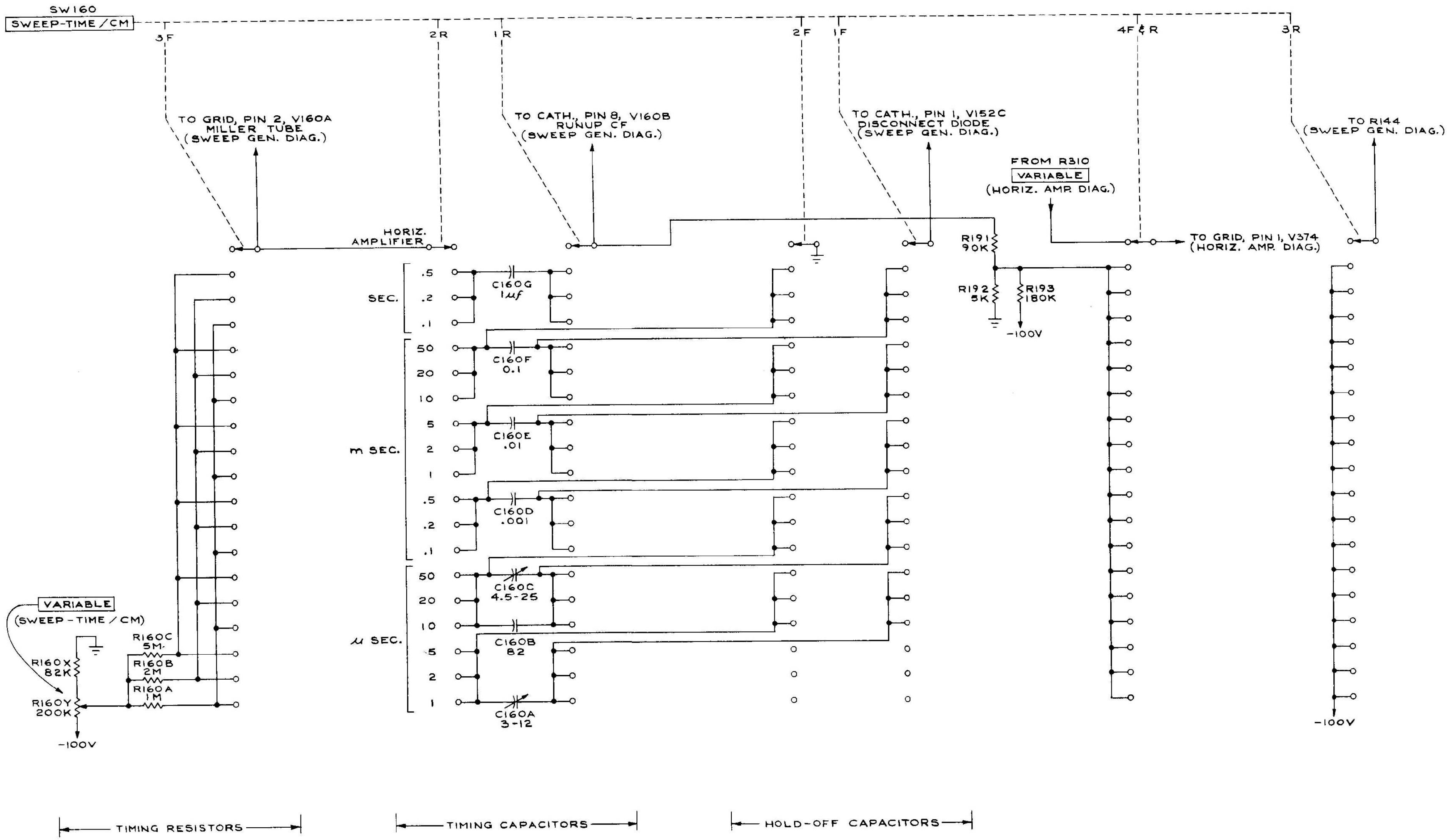
MRH
12-8-60
SWEEP TRIGGER



MRH
4-4-60

A

SWEEP GENERATOR

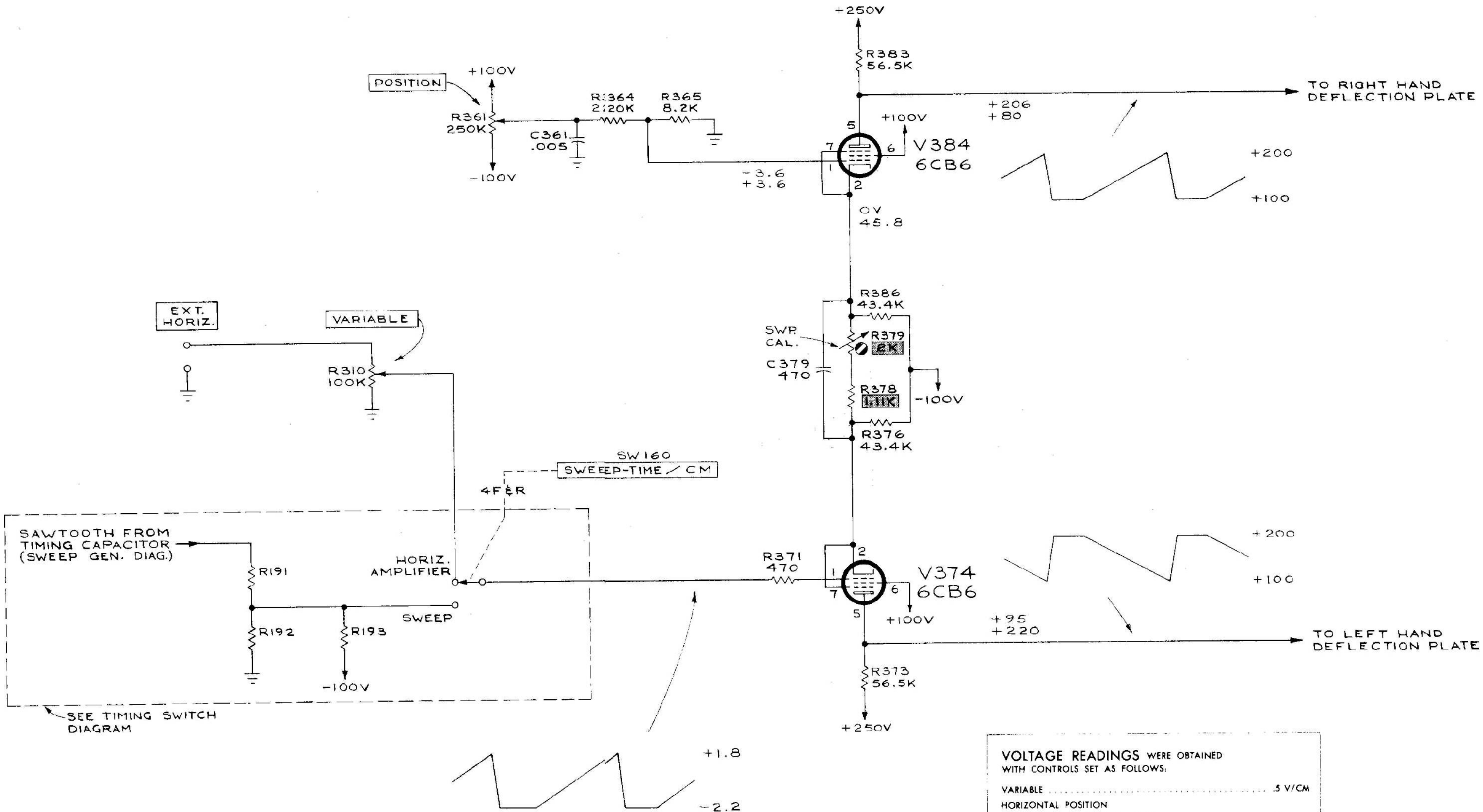


MRH
3-28-60

TIMING SWITCH

TYPE 504 OSCILLOSCOPE

A



VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

VARIABLE .... .5 V/CM

HORIZONTAL POSITION

FOR UPPER VOLTAGE READINGS .... CW

FOR LOWER VOLTAGE READINGS .... CCW

WAVEFORMS SEE NOTE ON TRIGGER DIAGRAM

SEE ALSO **IMPORTANT** NOTE ON SWEEP TRIGGER DIAGRAM.

504 A HORIZ. AMP.

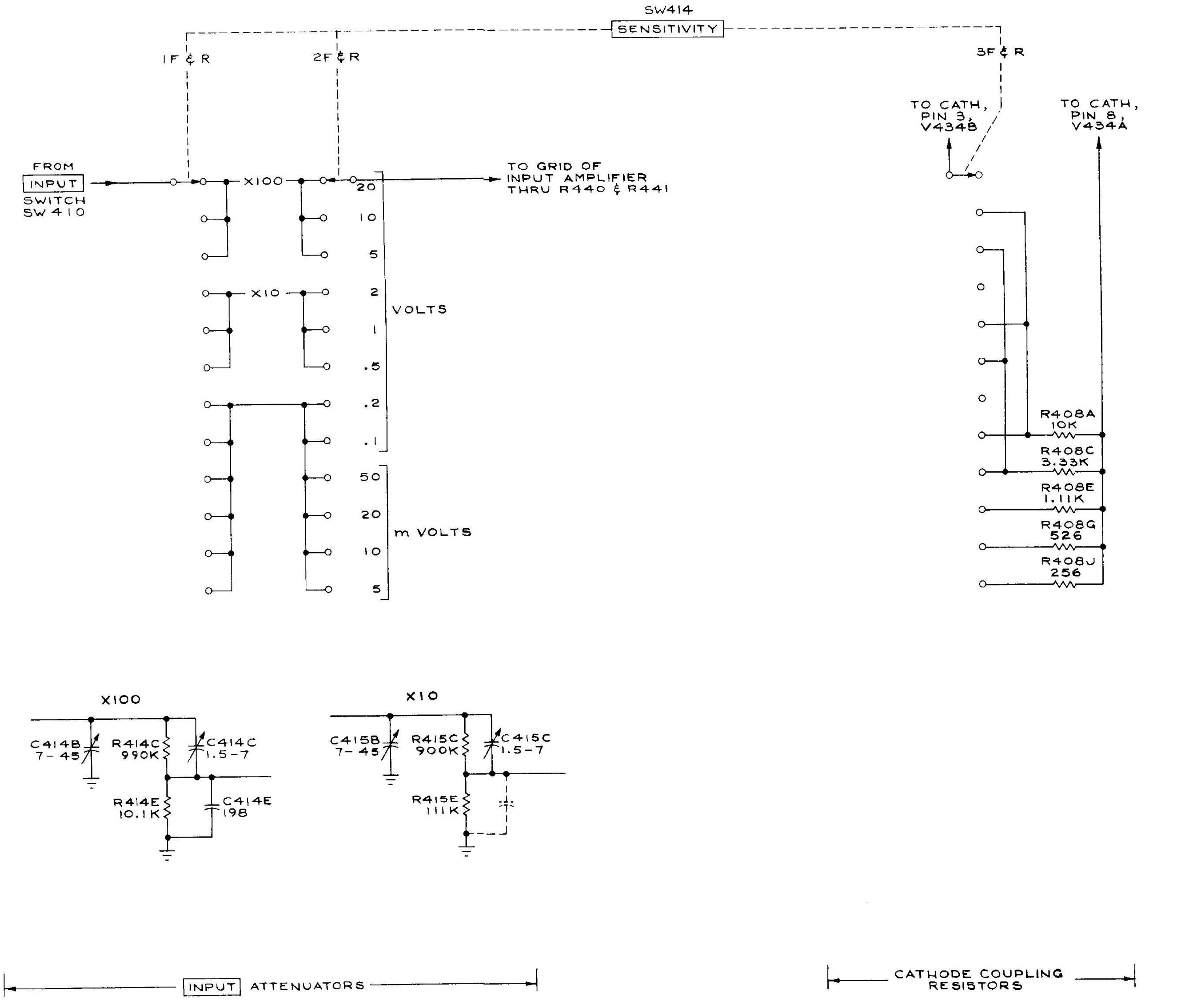
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED

MRH
12-8-60

HORIZONTAL AMPLIFIER

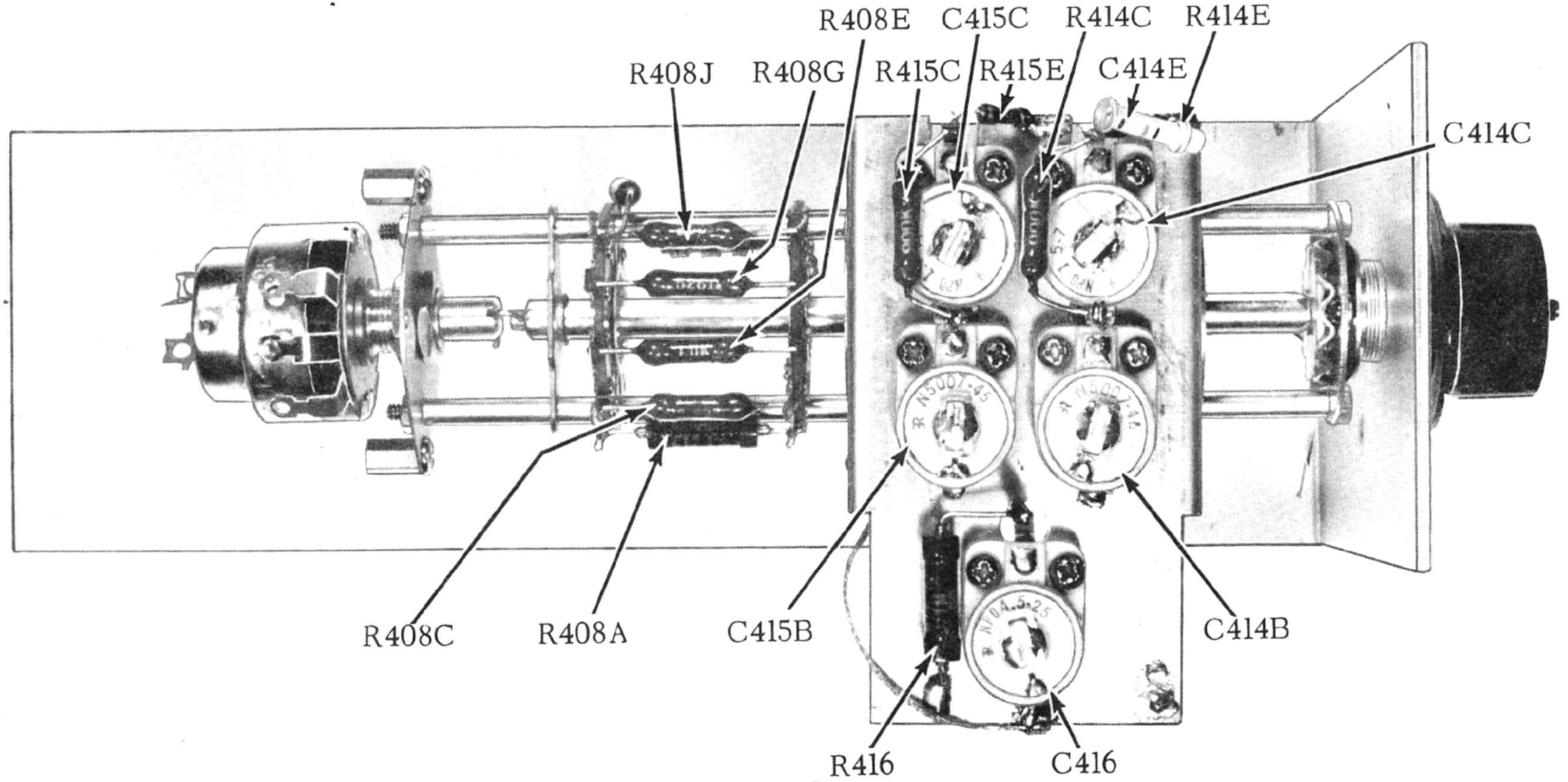
TYPE 504 OSCILLOSCOPE

B

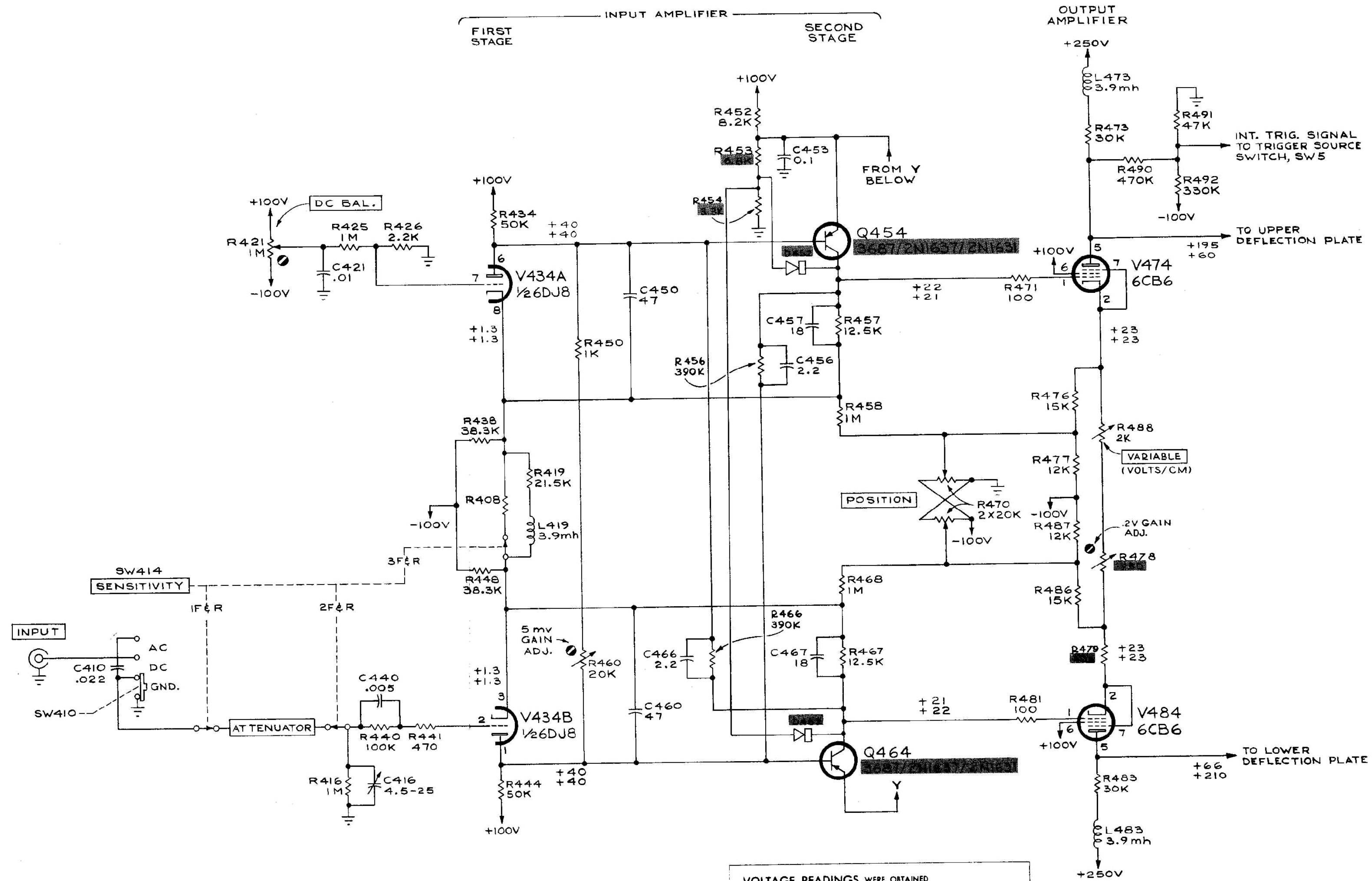


MRH
3-24-60

VERTICAL AMPLIFIER
ATTENUATOR SWITCH



Type 504 **OUTSIDE VIEW SENSITIVITY** A



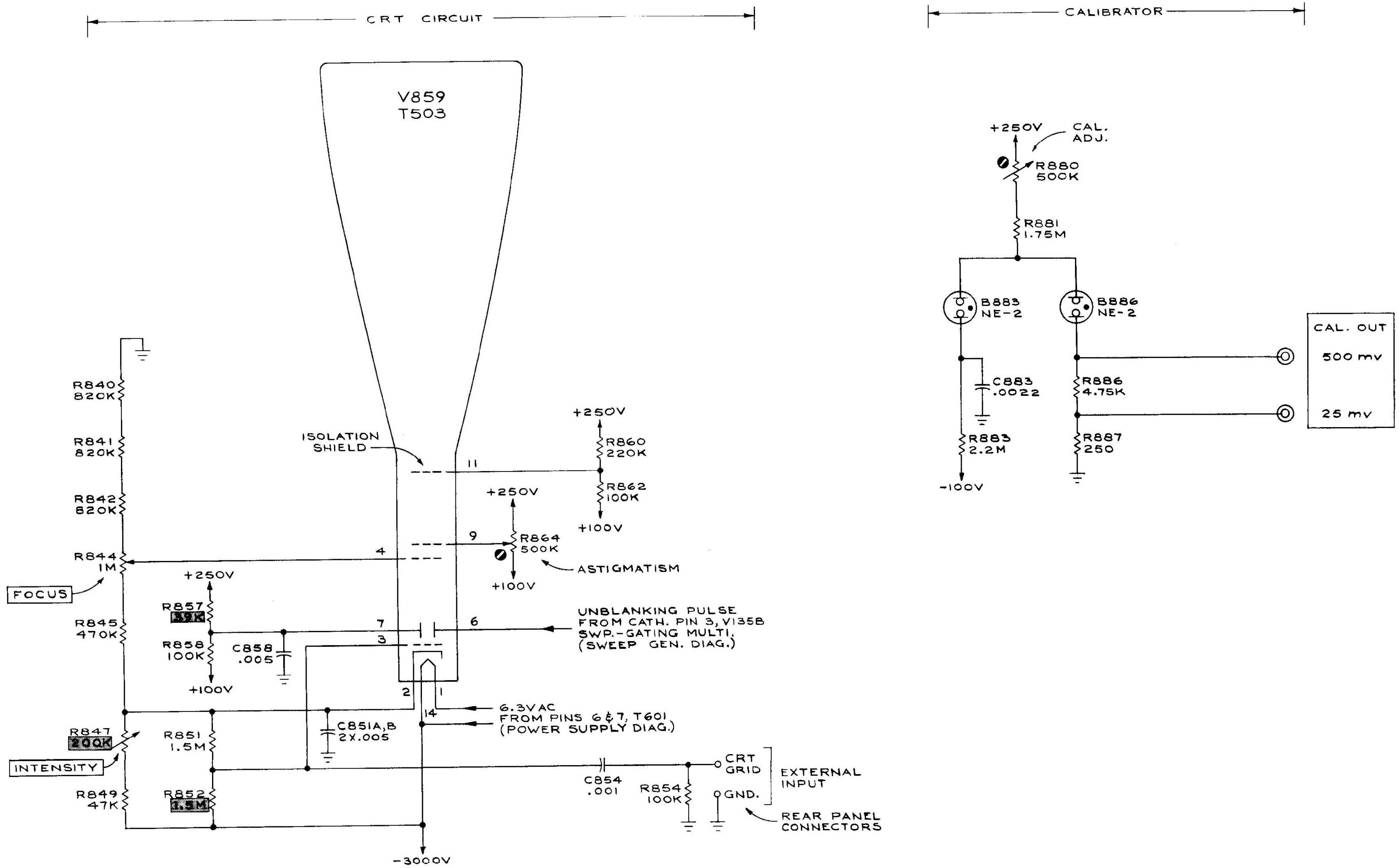
TYPE 504 OSCILLOSCOPE

VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:	
BOTH INPUTS	GND
SENSITIVITY	.2 VOLTS/CM
VERTICAL POSITION	
FOR UPPER VOLTAGE READINGS	CW
FOR LOWER VOLTAGE READINGS	CCW
SEE ALSO **IMPORTANT** NOTE ON SWEEP TRIGGER DIAGRAM.	

504 A VERT. AMP.

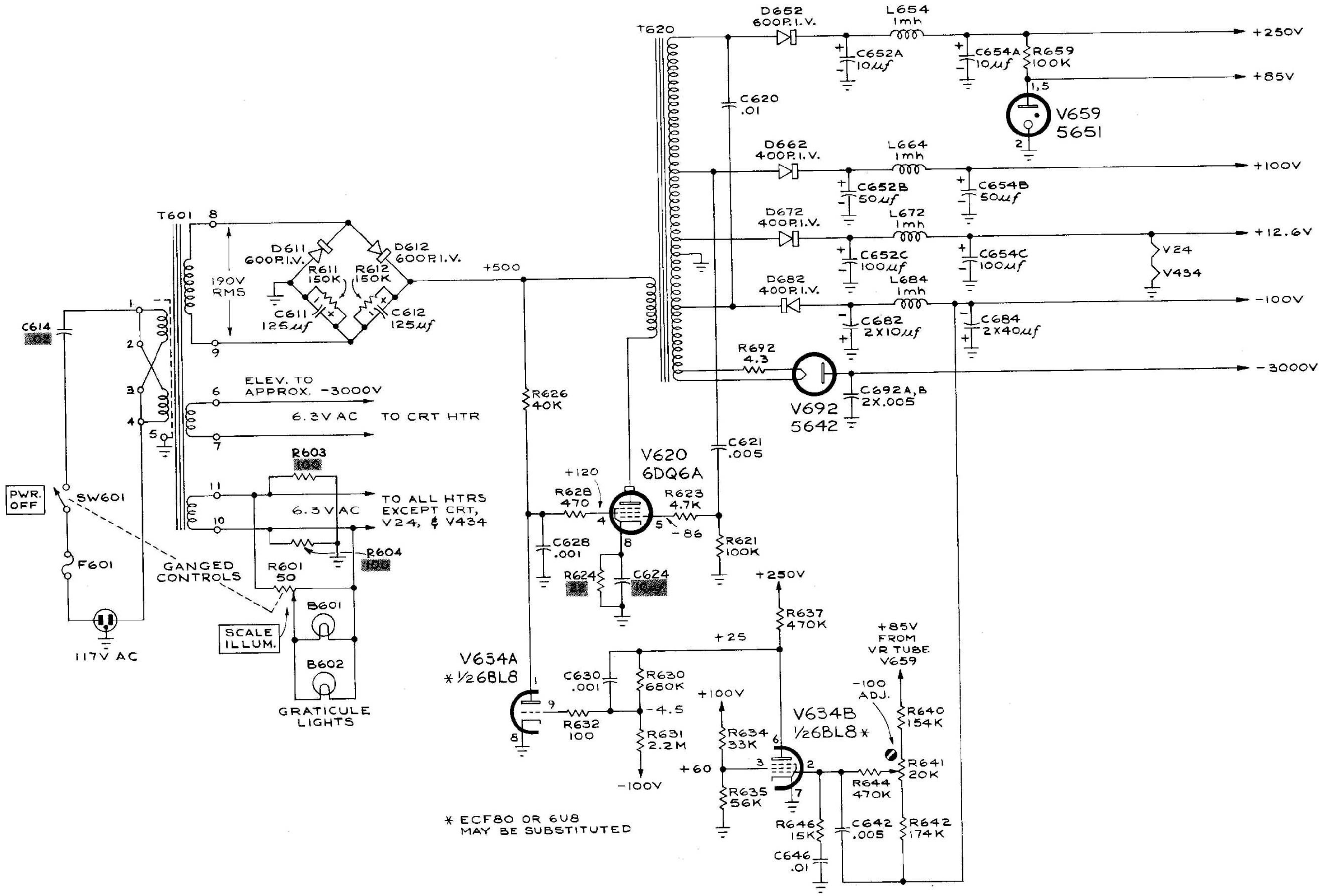
MRH
3-8-62

VERTICAL AMPLIFIER



MRH
7-27-61

CRT CIRCUIT & CALIBRATOR



MRH
3-8-62

POWER SUPPLY

VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

LINE VOLTAGE .... 117 V 60 CPS
TRIGGER LEVEL (SWEEP DISABLED) .... CCW BUT NOT SWITCHED TO AUTO

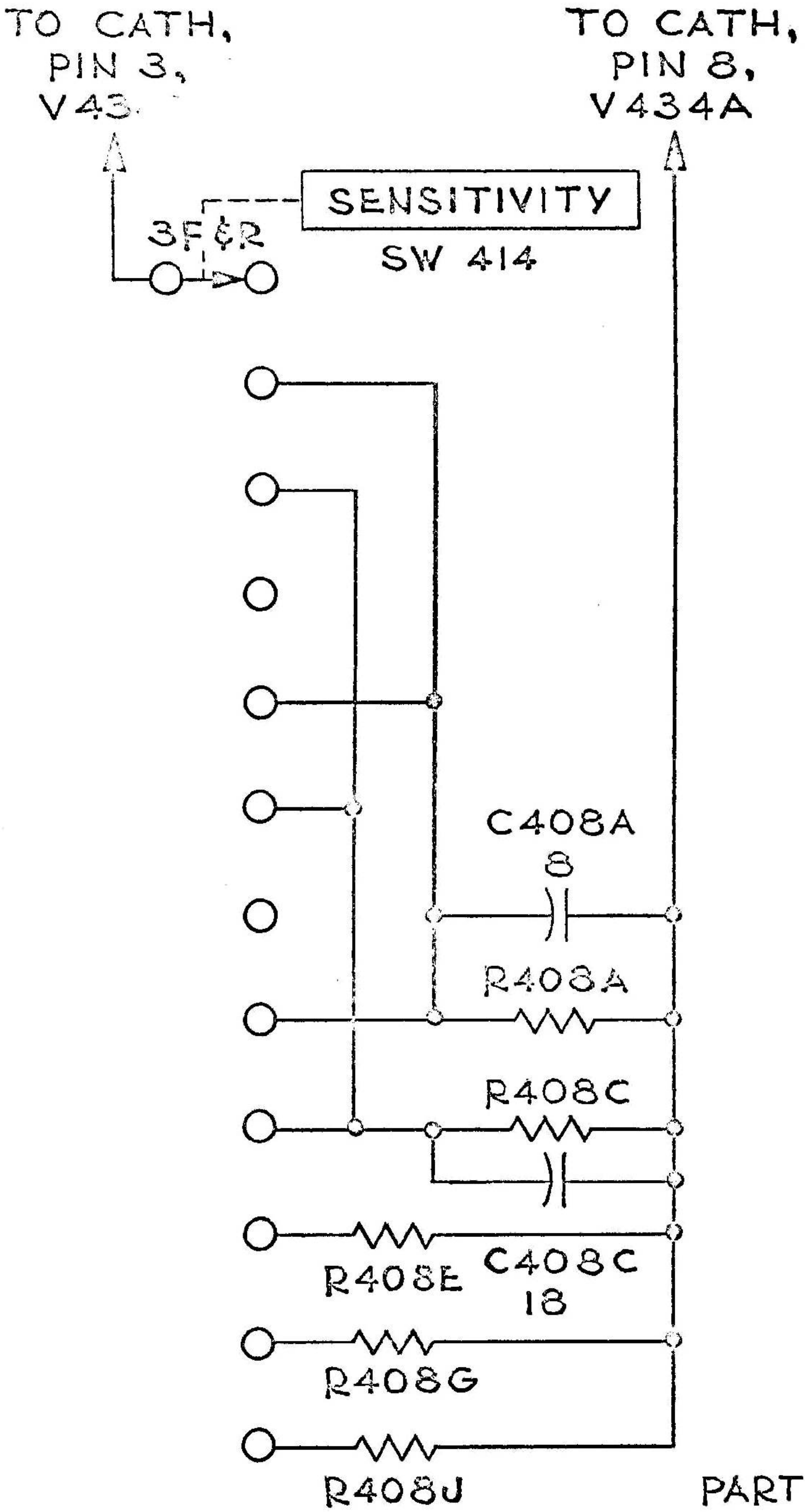
SEE ALSO **IMPORTANT** NOTE ON SWEEP TRIGGER DIAGRAM.

504 A PWR. SUP.

MANUAL CHANGE INFORMATION

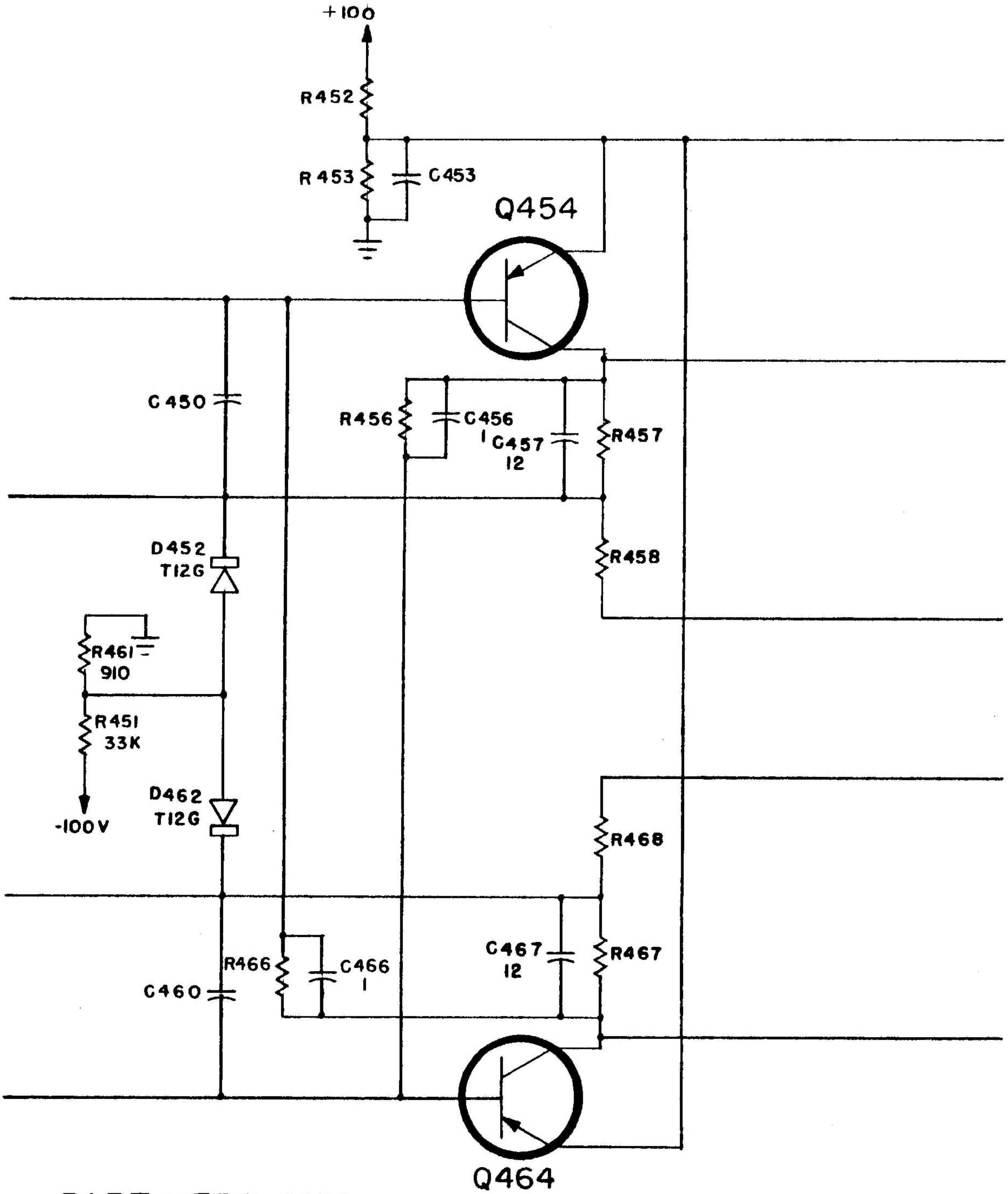
At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

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.

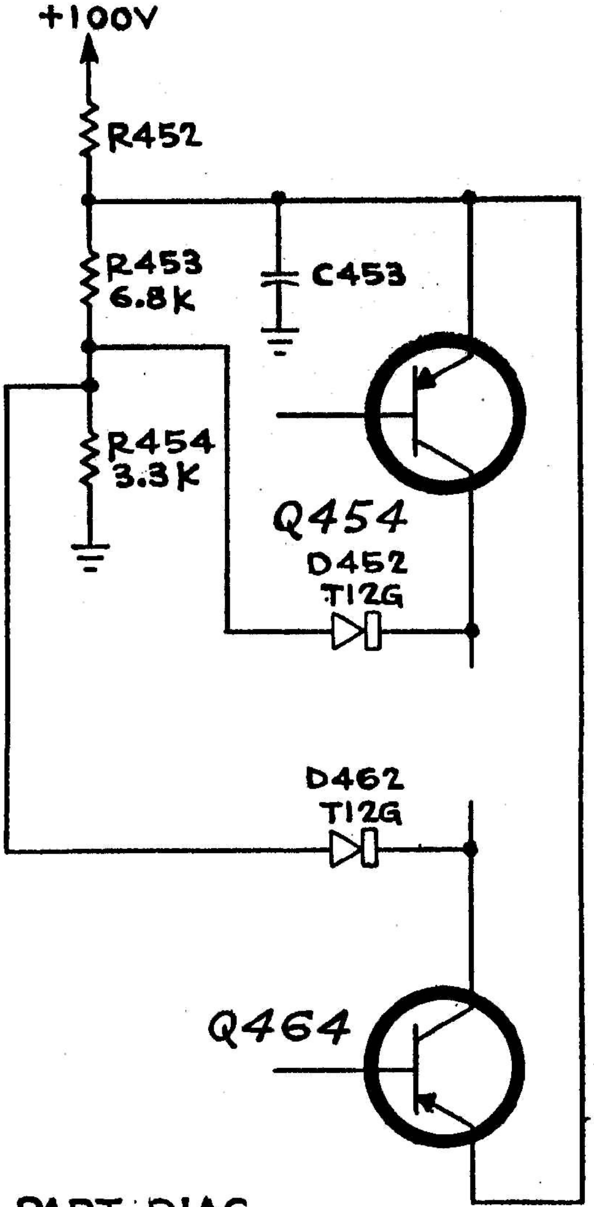


PART VERT. AMP. ATTEN. SW.

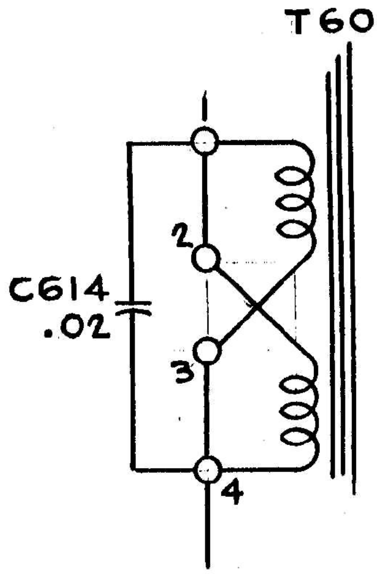
JN
03-62



PART VERT AMP



PART. DIAG.
VERT. AMPLIFIER



PART. PWR. SPLY.
DIAGS.