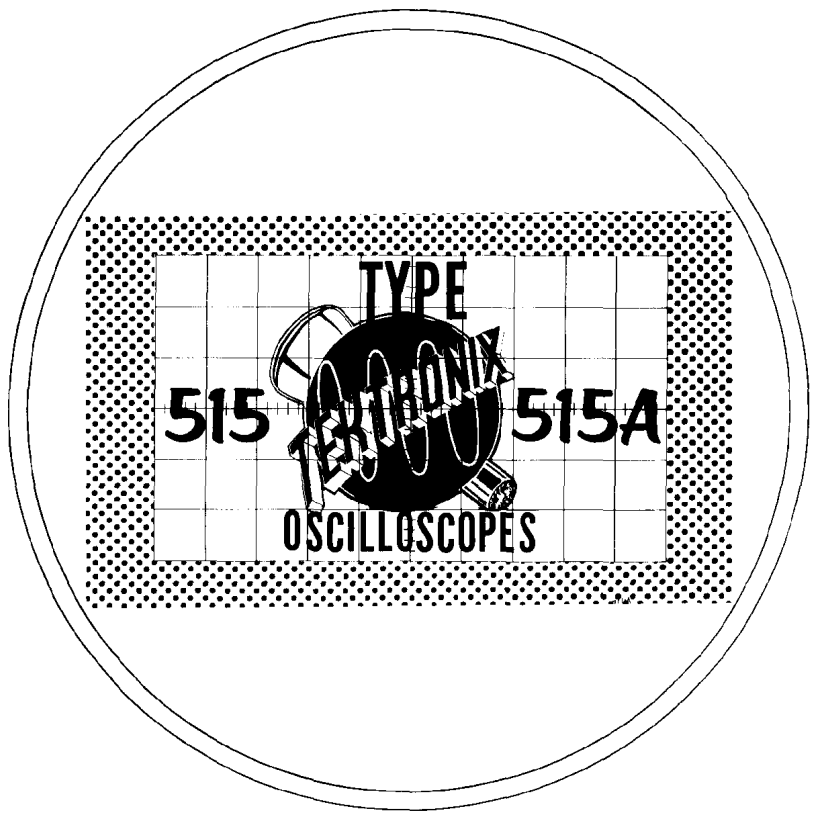
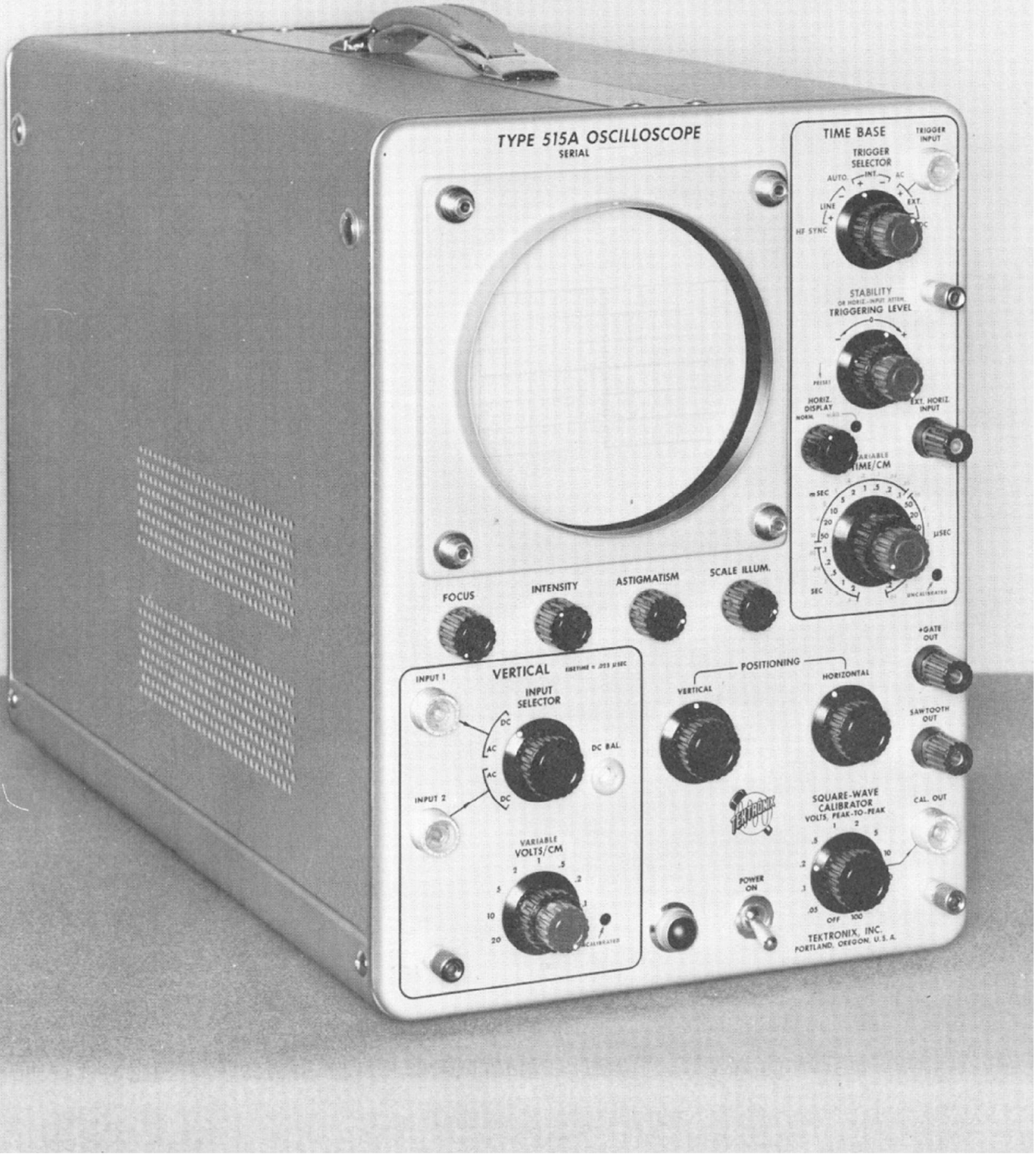
INSTRUCTION MANUAL

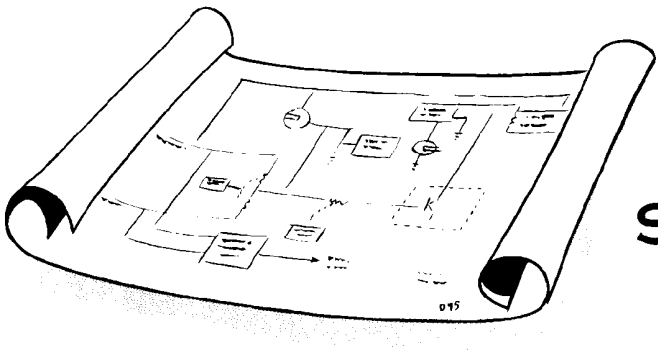


S. W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon ● Phone MI 4-0161 ● Cables: Tektronix

070-247


TYPE 515A OSCILLOSCOPE
SERIAL
TIME BASE
TRIGGER INPUT
TRIGGER SELECTOR
AUTO.
INT.
AC
LINE
EXT.
HF SYNC.
STABILITY
TRIGGERING LEVEL
PRESET
HORIZ. DISPLAY
NORM.
EXT. HORIZ. INPUT
VARIABLE TIME/CM
m SEC
µSEC
SEC
UNCALIBRATED
FOCUS
INTENSITY
ASTIGMATISM
SCALE ILLUM.
+GATE OUT
VERTICAL
RISETIME = .035 µSEC
INPUT 1
INPUT SELECTOR
DC
AC
DC BAL.
INPUT 2
VARIABLE VOLTS/CM
POSITIONING
VERTICAL
HORIZONTAL
SAWTOOTH OUT
SQUARE-WAVE CALIBRATOR
VOLTS, PEAK-TO-PEAK
CAL. OUT
OFF
POWER ON
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.

SECTION 1



SPECIFICATIONS

The Type 515/515A Oscilloscope is a compact, portable, general purpose oscilloscope. The dc-coupled amplifier and wide range of sweep rates, combined with reduced size, make the Type 515/515A a versatile field or laboratory instrument.

Vertical-Deflection System

Deflection Factor-.05 volt/cm ac or dc. (.1 volt/cm ac or dc S/N 101-1000)

Frequency Response-dc to 15 mc, 2 cycles to 15 mc ac. (Down not more than 3 db at above limits.)

Rise Time-.023 microseconds.

Linear Deflection-6 cm.

Step Attenuator-Nine positions, calibrated, from .05 v/cm (.1 v/cm S/N 101-1000) to 20 v/cm, (50 v/cm S/N 101-1000) accurate within 3% when set on any one step.

Maximum Allowable Combined DC and Peak AC Voltage Input-600 v.

Input Impedance-1 megohm, 30 $\mu\mu$f; with P410 probe-10 megohm, 10.5 $\mu\mu$f. With P6000 probe, 10 megohm, 11.5 $\mu\mu$f.

Horizontal-Deflection System

Time Base Range
Twenty-two calibrated time bases from .2 μsec/cm to 2 sec/cm.
Accuracy-3 per cent.
Continuously variable, uncalibrated between ranges and to 6 sec/cm.

Magnifier
Expands sweep 5 times to right and left of screen center. Extends fastest sweep rate to .04 μsec/cm.
Accuracy-5 per cent.

Unblanking-DC coupled.

Trigger Requirements
Internal-2 mm of deflection.
External-.2 volts to 20 volts.
Frequency Range-dc to 15 mc.

Horizontal Input
Deflection Factor-1.4 v/cm.
Frequency Response-DC to 500 kc, 3 db down.

Other Characteristics

Cathode-Ray Tube
Type T55P2.
P1, P7, and P11 phosphors optional.

Accelerating Potential-4,000 volts.

Deflection Factor at Plates
Vertical-5 v/cm.
Horizontal-20 v/cm.

Voltage Calibrator
Eleven fixed voltages from .05 volts to 100 volts, peak to peak.
Accuracy-3 per cent.
Waveform-square wave at about 1 kc.

Output Waveforms Available
Positive gate of same duration as sweep, approx. 20 volts. Positive going sweep sawtooth, 150 volts.

Power Supply
Electronic Regulation.
Power Requirements-105 to 125, or 210 to 250 v, 50-60 cycles, 275 watts.

Mechanical Specifications

Ventilation-Filtered, forced-air ventilation.

Finish - Photo-etched, anodized panel, blue wrinkle, perforated cabinet.

Dimensions-9 3/4" wide, 13 1/2" high, 21 1/2" deep.

Weight-40 pounds.

Accessories Included

1-P6017 probe.

1-A510 Binding Post Adapter.

1-F510-5 green filter.

1-Instruction manual.

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.

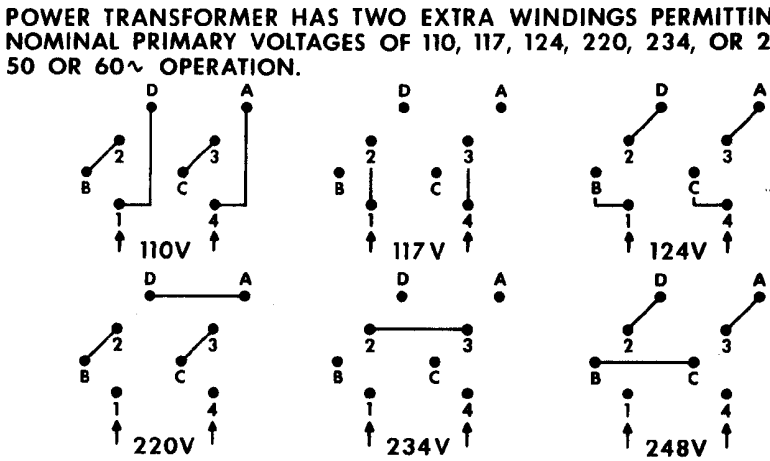


Fig.1. The power transformer has two extra windings permitting nominal primary voltages of 110, 117, 124, 220, 234, 248 volts, 50 or 60 cycle operation.

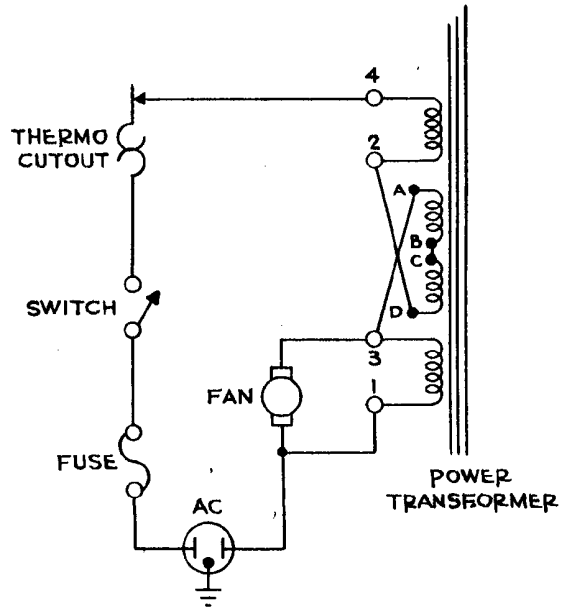
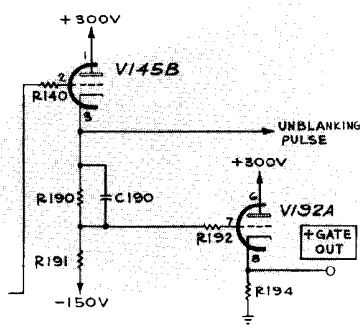


Fig. 2. When connecting the power transformer for operation with a supply voltage of 200 volts or more, be sure that the fan is connected between pins 1 and 3 of the primary. This is to insure that the fan is supplied with no more than 125 volts. Fig. 2 shows a typical high-voltage fan connection, using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

SECTION 3

CIRCUIT DESCRIPTION



BLOCK DIAGRAM DESCRIPTION

The block diagram shows the interconnection of the functional parts of the oscilloscope, except the power supplies. Functions of the switches are shown instead of their actual connections. This diagram, as well as the ones which follow, is designed to fold out so that the diagram can be studied along with the text without turning any pages.

The vertical amplifier has a sensitivity of .05 volt per centimeter (.1 volt per centimeter S/N 101-1000) and provides push-pull output to drive the deflection plates. The balanced delay line is connected between the output amplifier and the deflection plates.

The trigger cathode follower applies a sample of the vertical signal to the trigger-amplifier stage to provide internal triggering.

The trigger amplifier and shaper provide a sharp trigger pulse which triggers the multivibrator. The multivibrator gates the time-base generator and is prevented from recycling by the holdoff cathode follower until the generator has had time to run up and return.

The time-base generator is a Miller run-up type and provides a 150-volt sawtooth for the horizontal amplifier.

The horizontal amplifier converts the time-base sawtooth for push-pull applications to the deflection plates.

The unblanking cathode follower applies a positive gate to the crt grid via the high-voltage power supply. It also supplies a gate to the gate-out cathode follower which provides a positive gate at a front-panel binding post.

The calibrator provides a square wave of known amplitude for checking the gain of the oscilloscope amplifiers and auxiliary equipment.

VERTICAL-DEFLECTION SYSTEM

General

The Type 515/515A vertical amplifier has a maximum sensitivity of .05 volt per centimeter (.1 volt per centimeter S/N 101-1000), ac or dc. The circuit consists of two stages of amplification, each stage preceded by cathode followers.

Input Connectors

There are two input connectors which can be switched into the input circuits by SW 301, the INPUT SELECTOR switch. This switch is wired physically so as to reduce coupling between inputs to a minimum. Blocking capacitor C301 is shorted out in the DC positions of the selector switch.

Input Attenuators

The VOLTS/CM switch inserts frequency-compensated attenuators into the input circuit. Four attenuators are used singly or in tandem pairs to produce nine fixed sensitivities.

DC Balance

The DC BAL control, R338, provides an adjustable, dc grid voltage for V340 so that the cathode of V360 is at the same potential as the cathode of V350. When this control is properly set, no change in vertical positioning will result when the VARIABLE position is rotated.

Input Cathode Follower

The input cathode follower, V330, isolates the input circuits from changes in capacitance as the VARIABLE control is rotated. R330 is a current-limiting resistor to limit grid current in the event an excess voltage is applied to the input. The opposite cathode follower, V340, balances the drift in V330 caused by heater-voltage changes.

Input Amplifier

The input amplifier stage is a common-cathode phase-splitter amplifier. Coils L351 and L361 provide high-frequency peaking. The VARIABLE VOLTS/CM control, R356, varies the gain by varying the degeneration in the cathode circuit.

Vertical positioning is produced by two dual potentiometers, R368, connected to the plates of the amplifier so that current through one plate load is increased as current through the other plate load is decreased. Since the amplifier is dc coupled, the change in the plate voltage which occurs changes the position of the trace on the cathode-ray tube.

The rc networks, R352, C352 and R362, C362, provide compensation for the reduction in gain at very-low frequencies which is a characteristic of high-conductance amplifiers.

Output Amplifiers

Cathode followers V370A and V370B drive the output amplifiers through series peaking coils L390 and L400. The GAIN ADJ. control, R396, sets the gain of the amplifier to agree with the front-panel calibration. Plate current for the output amplifiers is supplied by the delay-line termination resistors, R485 and R486.

Delay Line

The balanced delay line delays the signal until the sweep starts and the crt is unblanked. The trigger signal is taken from a coil which serves as the first section of the delay line. Each section of the line is turned for optimum response to a square wave.

HORIZONTAL-DEFLECTION SYSTEM

Trigger Amplifier

The TRIGGER SELECTOR switch with the black knob, SW20, selects the source of triggering voltage and arranges the trigger-amplifier input circuit to produce negative-going output for either negative-going or positive-going portions of the input signal.

The trigger amplifier, V10, is a grounded-grid cathode-coupled amplifier. A capacitor, C4, can be switched into the grid circuit to remove the dc component of the trigger signal. Output is always taken from the pentode plate, but the TRIGGER SELECTOR switch connects either the pentode grid or the triode grid to the input-signal source. The opposite grid is connected to a dc bias source, adjustable by means of the TRIGGERING LEVEL control. This bias voltage determines the voltage on the pentode plate. In the AC and DC positions of the TRIGGER SELECTOR switch, the voltage on the pentode plate is dc coupled to the grid of V30A.

Trigger Shaper

The trigger-shaper stage consists of V30 connected as a dc-coupled multivibrator. In the normal, or quiescent, state the V30A section is conducting and its plate is down. The grid of the V30B section is dc coupled to the V30A plate through divider R38, R39 and R40, which holds the "B" grid below plate-current cutoff. As the trigger signal drives grid of V30A in the negative direction the cathodes of both tubes follow the grid down until V30B starts to conduct. At this point the plate voltage of V30A and the B grid rises with it. The V30B cathode rises with its grid carrying the "A" cathode with it and V30A cuts off. The transition occurs very rapidly, regardless of how slowly the V30A grid signal falls.

The steep negative-going step at the plate of V30B is differentiated by an rc network including C109 shown in the sweep diagram, and the sharpened pulse trips the sweep multivibrator.

Trigger Mode Switch

The TRIGGER SELECTOR switch with the red knob, SW5, has four positions which arrange

the circuits for four types, or modes, of triggering. In the DC position, the triggering signal is dc coupled as far as the trigger-shaper stage. In the AC position, blocking capacitor C4 removes the dc component of the signal.

In the AUTO. position of SW5, the plate of the A section of the trigger shaper, V30, drives the grid of the B section just as it also drives its own grid through R45, a resistance of several megohms. This plate-to-grid coupling allows the trigger shaper to free-run when no triggering signal is present. The addition of R45 causes the trigger shaper to free run when no trigger signal is present. For example, when the plate of V30A rises, the grid of V30B also rises, carrying with it the right-hand end of R45. The left-hand end of R45 is connected to the A grid through R22. The time constant of the rc circuit between the B grid and ac ground through C20, R22 and R45 is of such length that it takes about .01 second for the V30A grid to rise exponentially from its starting point below cutoff to a point where plate current can flow.

When V30A plate current flows, the plate drops, forcing the V30B grid down, and thus the right-hand end of R45 is forced down. The left-hand end of R45 and the A grid immediately begin to drop exponentially toward cutoff. When the A grid reaches cutoff again it has completed one cycle of the approximately 50-cycle triangular waveform. The range of the V30A grid voltage between A cutoff and B cutoff is about 3 volts for the circuit used in the AUTO. mode. This is increased from about .5 volt for the AC and DC modes by the addition of R45 to the circuit.

Since the V30A grid is never more than 3 volts from cutoff, a trigger signal with a peak-to-peak voltage of three volts or more can drive the grid to cutoff at any time and produce a trigger output. Smaller signals can also trigger the shaper but only if they occur at a time when the grid is within their peak voltage of cutoff. The duty cycle of operation of the time-base generator is somewhat reduced therefore with smaller trigger signals.

This circuit configuration is useful because with it the time-base generator can be synchronized with repetitive signals over a wide range of frequencies without readjustment. When not triggered externally, the generator continues at a 50-cycle rate, and in the absence of any vertical signal, generates a base line that shows that the oscilloscope is adjusted so as to display any signal that might be connected to the vertical-deflection system.

In the H F SYNC position of SW5, the trigger amplifier and trigger shaper stages are bypassed and the trigger signal is applied directly to the swep multivibrator. In this mode the STABILITY control is set so the sweep is superimposed on the negative-going trigger-holdoff waveform at the grid of V110A and will cause the multivibrator to synchronize at a submultiple of the triggering signal frequency. This circuit is suitable for signals in excess of five megacycles.

Schmitt Multivibrator

The dc-coupled multivibrator, shown in the time-base diagram, turns on the time-base generator upon receipt of a negative trigger from the trigger shaper, and holds off subsequent trigger signals until after the sweep is completed. The multivibrator consists of V110A and V120 with both common-cathode and plate-to-grid coupling. Plate-to-grid coupling is by means of a cathode follower.

In the quiescent state V110A is conducting and its plate is down. Cathode-follower V110B holds the grid of V120B below cutoff through voltage divider R115, R116. Cathode-follower V110B isolates the plate of V110A from the various loads, and thereby permits a faster step.

When the negative trigger pulse from the trigger-shaper stage reaches the grid of V110A it is coupled to V120B and V120B starts to conduct. The multivibrator switches quickly to its second state with V120B conducting and V110A cut off. The biases and plate loads are adjusted so that when V110A is conducting, the grid of V120B is held below cutoff, and when V120B is conducting the cathode of V110A is held above cutoff.

There are thus two stable states, in either of which the multivibrator will remain until a signal of the proper polarity and amplitude to the grid of V110A switches it to the other state. To return the multivibrator back to the quiescent state with V110A conducting, a

positive voltage is required at the grid of V110A which is high enough to cause plate current to flow. The positive voltage for returning the multivibrator to its quiescent state is supplied from the time-base generator when it has completed its sweep.

The STABILITY and PRESET controls adjust the grid voltage of V110A near the point of free running.

Time-Base Generator

The time-base generator is a Miller integrator circuit. The circuit includes disconnect diodes V150A and V150B, cathode-follower V160A, timing capacitor C160 and the Miller tube, V160B. In the quiescent state between sweeps, the plates of diodes V150A and V150B rest at -2.5 volts. Very little current flows through V150B to the grid circuit of V160B, and the grid of V160B rests at -2.5 volts. More current flows through V150A so that its cathode is about .5 volt lower at -3 volts. The timing capacitor, C160, which is connected between these two points, therefore has a charge of about .5 volt.

The grid of cathode-follower V160A is connected to the plate of Miller tube V160B through neon glow tube B160. The grid of V160A therefore follows the plate changes of V160B but remains 55 volts below the plate. Network C161, R161, improves the risetime of the circuit.

The -2.5 volt bias on the grid of V160B places the tube in the class A region of its operating characteristic, where the plate-to-cathode voltage is inversely proportional to the grid to cathode voltage. The plate rests at about +55 volts. The negative step from the multivibrator to the plates of diodes V150A and V150B lowers the plates below their cathodes and they no longer conduct. The Miller-tube grid, and the cathode follower are thus released to seek their own voltage levels. The grid of Miller tube V160B, which is returned to -150 volts through R150, starts negative. When the grid starts negative the plate starts positive carrying cathode-follower V160A grid and cathode positive. This raises the top end of C160 positive which thus tends to prevent the Miller tube grid from going negative.

The gain of the Miller tube as a class-A amplifier is so high that the plate signal coupled back through charging capacitor C160 keeps the grid voltage constant within a fraction of a volt. Meanwhile, C160 is charging with current through R150 from the -150-volt bus. Since the grid of V160B remains constant within a fraction of a volt, the current through R150 remains constant, and C160 thus charges at a constant rate. As C160 charges the voltage of the upper end therefore rises linearily. Any departure from a linear rise of the cathode of cathode follower V160A will result in a change in Miller-tube grid voltage in the direction that will correct for the error. A bootstrap capacitor, C165, increases the plate current in V160B at the higher sweep speeds to help maintain a linear voltage rise.

The linear rise of the cathode of V160A is used as the time-base sawtooth. Charging capacitor C160 is selected by means of a step switch, SW155, labeled TIME/CM on the front panel. Charging resistor R150 is also selected by the TIME/CM switch so that both the size of the capacitor being charged and the current charging the capacitor can be selected to cover a wide range of sawtooth slopes.

The cathode of V160A continues to rise linearly until a positive step from the multivibrator, V120B, returns the disconnect diode plates back to their quiescent state raising the Miller tube grid. When the Miller tube grid rises, its plate drops carrying cathode-follower V160A with it until its cathode clamps again through V150A at the quiescent level of -2.5 volts. The Miller-tube plate will always rest at about +55 volts after the sweep, because, as V150A begins to conduct, its plate drops slightly. This reduced plate voltage allows the Miller-tube grid to go slightly more negative, stopping the fall in plate voltage.

Sawtooth Amplitude

The positive step from multivibrator V120B, which stops the sweep, occurs when a positive voltage is delivered to the grid of multivibrator V110A. The time-base sawtooth is applied to the multivibrator through cathode followers V140A and V140B from a tap on the cathode-load resistor of V160A. This tap is adjustable by means of potentiometer R156, labeled Sawtooth Amplitude, a screwdriver adjustment. When the voltage of this tap is properly set, the sawtooth will terminate when the spot has passed the right-hand limit of the graticule. C130 on the grid of V140B retards the return

of V140B grid to the quiescent level after the passage of the positive voltage. This prevents any trigger signals from retriggering the multivibrator until all other capacitances in the circuit have had time to reach their quiescent voltage levels. Proper sizes of capacitor C131 are switched with the TIME/CM switch so that more recovery time is permitted for the slower sweep rates and the least necessary recovery time is allowed for the faster sweep rates.

Horizontal Amplifier

The time-base waveform passes through the frequency-compensated positioning network, R210, R211, to the grid of cathode-follower V210B. This cathode follower provides the necessary low impedance to drive the switch capacitances and the second cathode follower, V210A. In the NORM. position of the HORIZ. DISPLAY switch, an attenuation network is inserted between the cathode of the Input C.F., V210B and the Driver C. F., V210A. In the MAG. position of the HORIZ. DISPLAY switch, this attenuator network is bypassed, so that the amplitude of the input signal to the Amplifiers is multiplied by a factor of five. In the EXT position, the HORIZ. DISPLAY switch connects the amplifier to the EXT. HORIZ. INPUT binding post to display the signal applied to this binding post.

Cathode-follower V210A applies the signal to the output amplifier, V250A and V270A. The output amplifier, converts the signal for push-pull application to the deflection plates. R259 varies the degeneration in the cathode circuits to set the gain of the amplifier. C260 provides high-frequency compensation of the output amplifier by reducing the high-frequency degeneration. R214B provides horizontal positioning when the HORIZ. DISPLAY switch is in the EXT. position.

The waveform at the plates of the output amplifier is applied to the crt horizontal-deflection plates via cathode followers V250B and V270B. Bootstrap capacitors C246 and C272 increase the current in the output amplifiers at the high sweep rates to improve time-base linearity. Neon diodes NE253 and NE280 protect the cathode followers from excess grid to cathode voltage when the instrument is first turned on.

CALIBRATOR

The calibrator is a symmetrical multivibrator with V550A and V550B connected so as to turn cathode-follower V570 on and off as it oscillates. During the negative pulse at multivibrator V550A, the grid of the cathode follower is driven well below cutoff, so the cathode is at ground voltage. During the positive pulse at the multivibrator, the plate is cut off and rests slightly below +100 volts. The voltage of the plate during cutoff is determined by the setting of R560, part of a divider between +100 volts and ground. R560 is a screwdriver adjustment labeled CAL. ADJ.

Cathode follower V570 has a tapped, calibrated voltage divider for its cathode resistor. When the CAL. ADJ. control is properly set, the cathode-follower cathode is at +100 volts when V510B is cut off. The taps on the divider provide eleven fixed calibrated amplitudes. No internal connection from the calibrator to the vertical-deflection circuits is provided.

POWER SUPPLY

Transformer

Plate and heater power for the Type 515/515A is provided by a single power transformer, T600. The transformer has two equal 117-volt windings that can be connected either in parallel for 117-volt operation, or in series for 234-volt operation.

Rectifiers

The ac voltage from the high-voltage windings is rectified by bridge-connected full-wave selenium rectifiers.

-150-Volt Supply

All dc voltage furnished by the power supply are regulated with the exception of the +360-E volt supply which is used only to supply circuits which are insensitive to voltage variations. Reference voltage for the regulators is established by means of a gas-diode voltage reference tube, V602. The voltage-reference tube determines the grid voltage of a comparator amplifier, V607, in the -150-volt supply.

The grid potential of V607B is compared with the voltage obtained from a divider, R616,

R617, R618, between the -150-volt bus and ground. R617, labeled -150 ADJ., determines the percentage of the total voltage that appears at the grid of V607A and thus determines the total voltage across the divider.

The voltage difference between the two grids of V607 appears as an amplified error signal at the plate of V607B. The amplified error signal is dc coupled to the grid of the series-regulator tube, V610. This dc-coupled error signal controls the plate resistance of the series regulator tube, changing it in the right direction to compensate for any change in output voltage. C613 increases the ac gain of the feedback loop to reduce the ripple.

The screen of V607B has a small amount of the ripple that exists ahead of the series regulator tube connected to it through R605. The phase of this ripple is such as to reduce the ripple of the -150-volt bus. This circuit also improves the regulation in the presence of line-voltage variation. R620 bypasses the series tube to reduce the amount of load current through it.

+100-Volt Supply

The -150-volt supply serves as reference voltage for the +100-volt supply. The voltage at the tap on the voltage divider, R639, R640, is applied to the grid of V631. The error signal is amplified in V631 and applied to the grid of V635B, the series-regulator tube. R633, at the screen of V631, reduces ripple and improves the regulation of the supply. C636 increases the ac gain of the feedback loop.

+300-Volt Supply

Rectified voltage from terminals 8 and 9 of the power transformer is added to the voltage supplying the +100-volt regulator to provide about 400 volts for the +300-volt regulator and other points in the instrument which do not ned a regulated voltage. The +300-volt circuit is similar in operation to the +100-volt regulator.

CRT CIRCUIT

High-Voltage Supply

Accelerating voltage for the cathode-ray tube is obtained by rectifying a 60-kc voltage produced by a vacuum-tube oscillator. V705 is the oscillator tube with the primary of T701 serving as a tapped inductor. Rectifier V720 supplies -1675 volts to the crt cathode and V721 supplies +2325 volts to the post-acceleration helix to provide a total acceleration voltage of 4000 volts.

High-Voltage Regulator

A divider from the crt cathode to the +300-volt bus applies a sample of the negative accelerating voltage to the grid of V710B. R741 varies the voltage at the tap to adjust the high voltage. The -150-volt supply, connected to the cathode of V710B, serves as a reference voltage. The amplified error signal at the plate of V710B is applied to the grid of the shunt regulator tube, V710A. The shunt regulator tube determines the screen voltage of the oscillator tube and thus controls the oscillator output voltage.

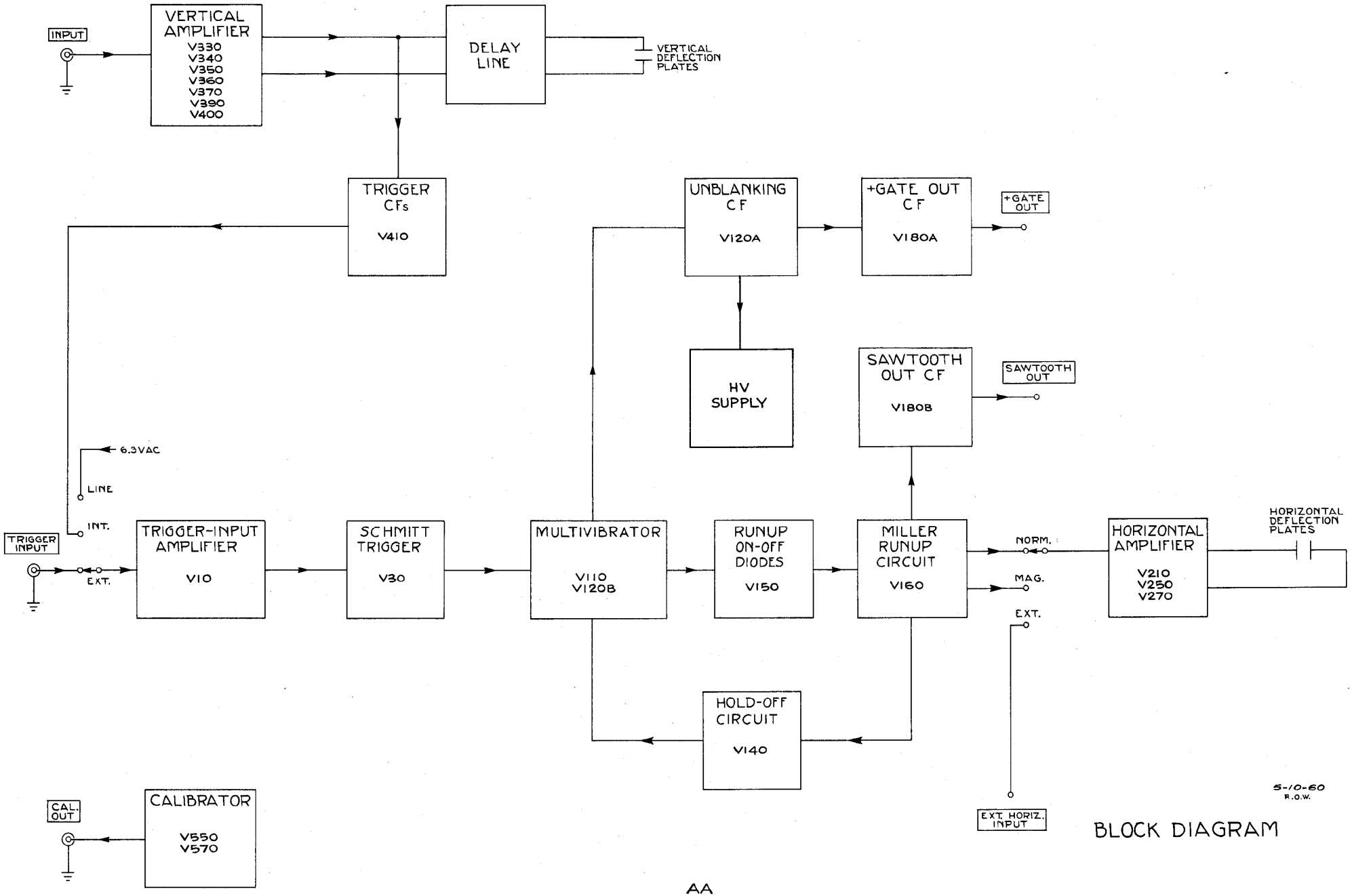
If, for example, the output voltage becomes too high, the regulator reduces the voltage on the screen of the oscillator tube. The output voltage of the oscillator decreases and the output voltage is corrected.

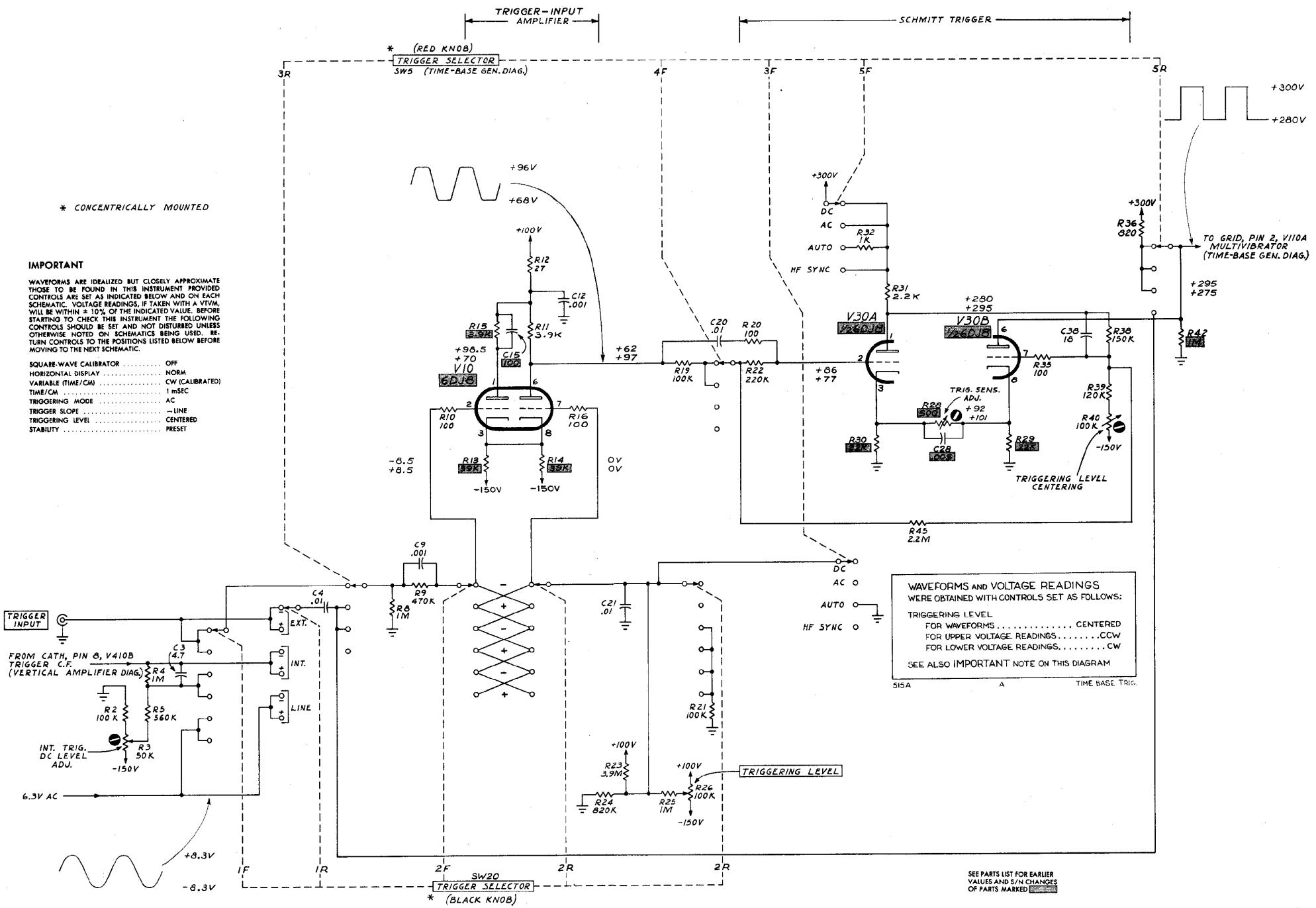
Unblanking

The crt control-grid voltage is produced by a winding and rectifier, V724, similar to the cathode supply but insulated from it. The positive end of the control-grid supply is connected to the unblanking cathode follower. When the unblanking pulse is produced at the cathode of the unblanking cathode follower, it drives the whole grid-voltage supply with it so that the pulse appears at the crt grid. Since this is a dc connection, the unblanking pulse can have any duration with no change in grid voltage. The INTENSITY control, R731, varies the bias on the grid to determine trace brightness.

CRT Geometry Control

The second-anode voltage required for best linearity at the extremes of deflection may vary somewhat between tubes. R753, labeled GEOM. ADJ. on the chassis, permits this voltage to be adjusted.


INPUT
VERTICAL AMPLIFIER
V330
V340
V350
V360
V370
V390
V400
DELAY LINE
VERTICAL DEFLECTION PLATES
TRIGGER CFs
V410
UNBLANKING CF
V120A
+GATE OUT CF
V180A
+GATE OUT
HV SUPPLY
SAWTOOTH OUT CF
V180B
SAWTOOTH OUT
6.3VAC
LINE
INT.
TRIGGER INPUT
EXT.
TRIGGER-INPUT AMPLIFIER
V10
SCHMITT TRIGGER
V30
MULTIVIBRATOR
V110
V120B
RUNUP ON-OFF DIODES
V150
MILLER RUNUP CIRCUIT
V160
NORM.
MAG.
EXT.
HORIZONTAL AMPLIFIER
V210
V250
V270
HORIZONTAL DEFLECTION PLATES
HOLD-OFF CIRCUIT
V140
EXT. HORIZ. INPUT
CAL. OUT
CALIBRATOR
V550
V570
5-10-60
R.O.W.
BLOCK DIAGRAM
AA
TYPE 515A OSCILLOSCOPE



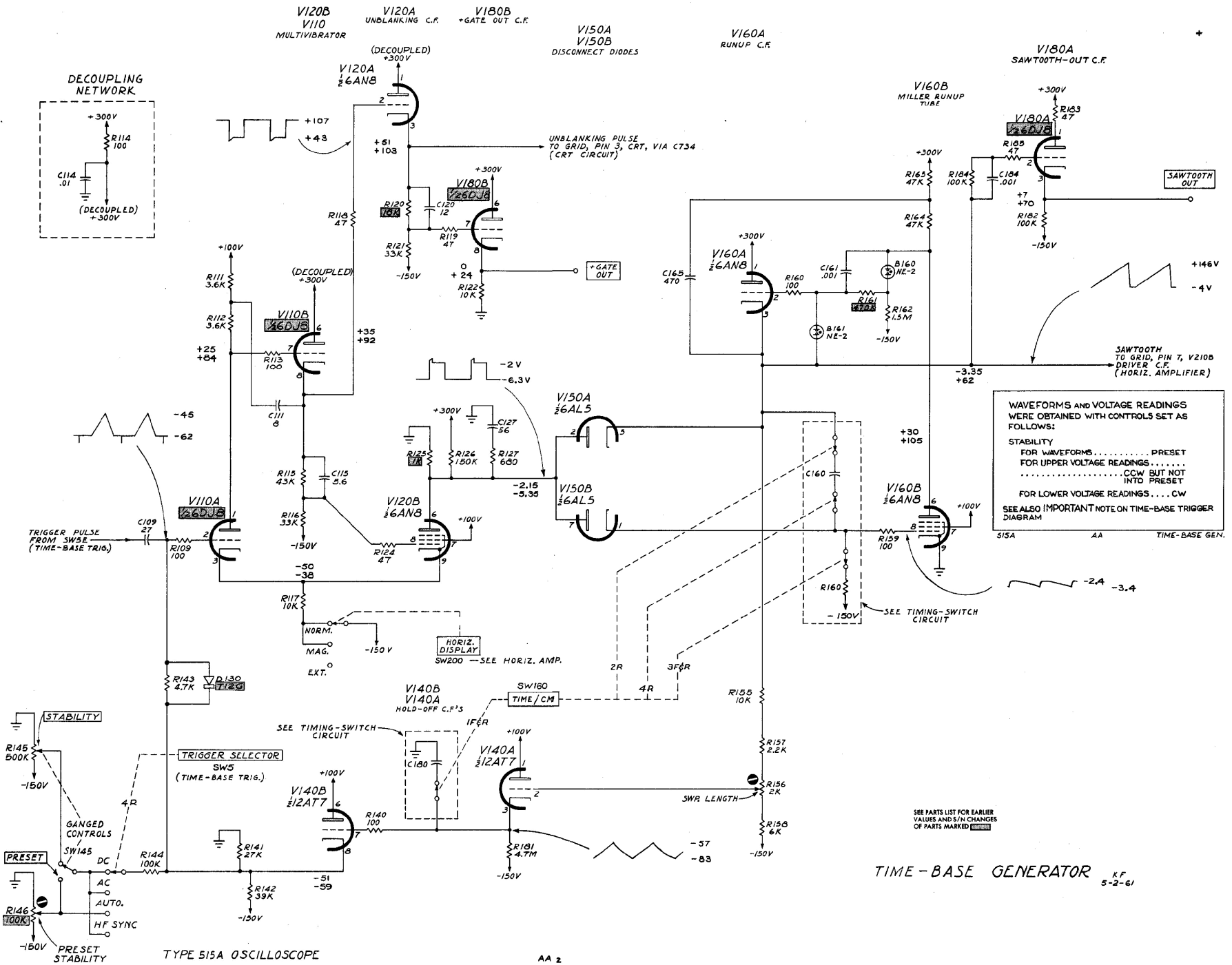
* CONCENTRICALLY MOUNTED

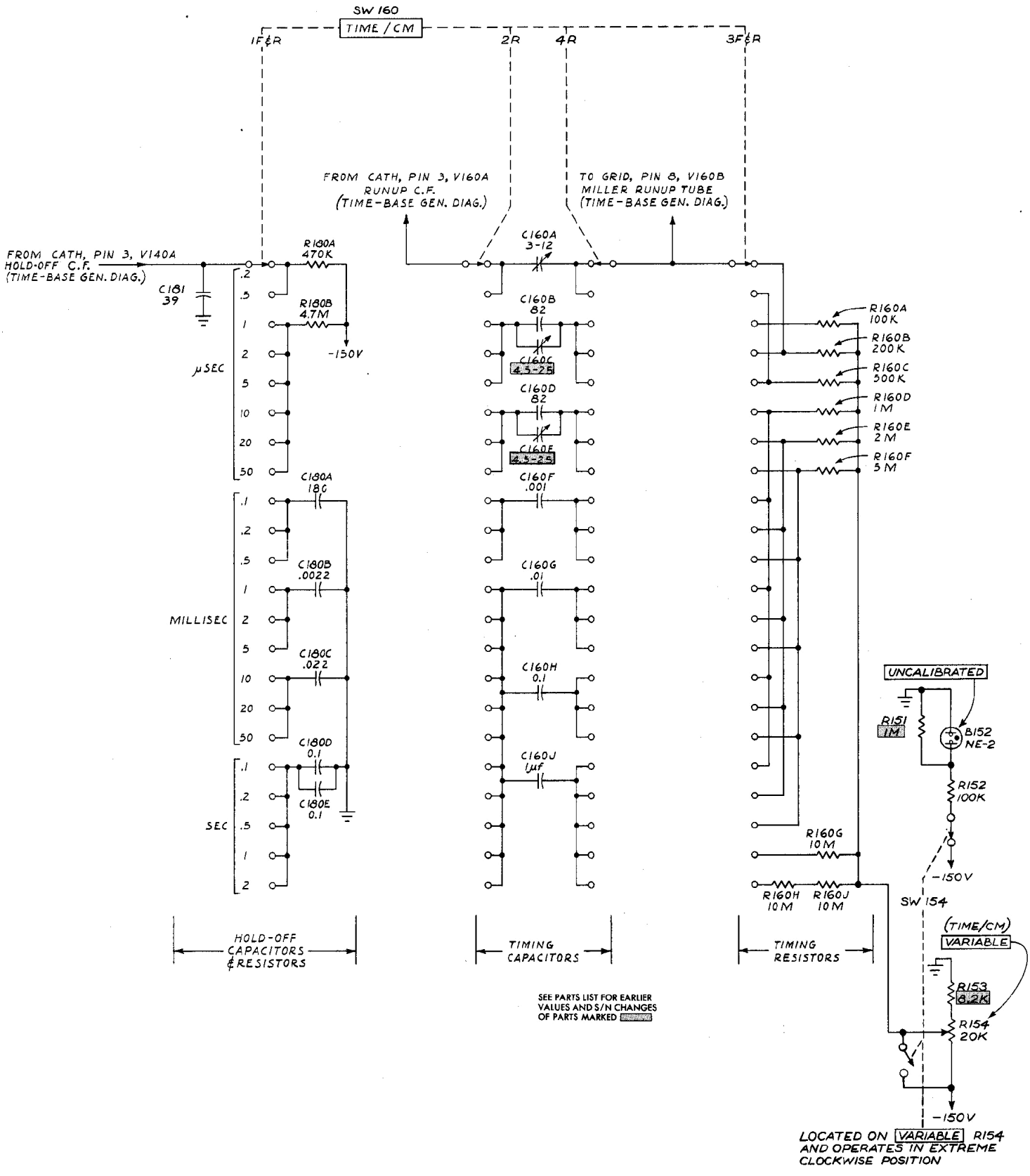
IMPORTANT

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.

SQUARE-WAVE CALIBRATOR	OFF
HORIZONTAL DISPLAY	NORM
VARIABLE (TIME/CM)	CW (CALIBRATED)
TIME/CM	1 mSEC
TRIGGERING MODE	AC
TRIGGER SLOPE	– LINE
TRIGGERING LEVEL	CENTERED
STABILITY	PRESET

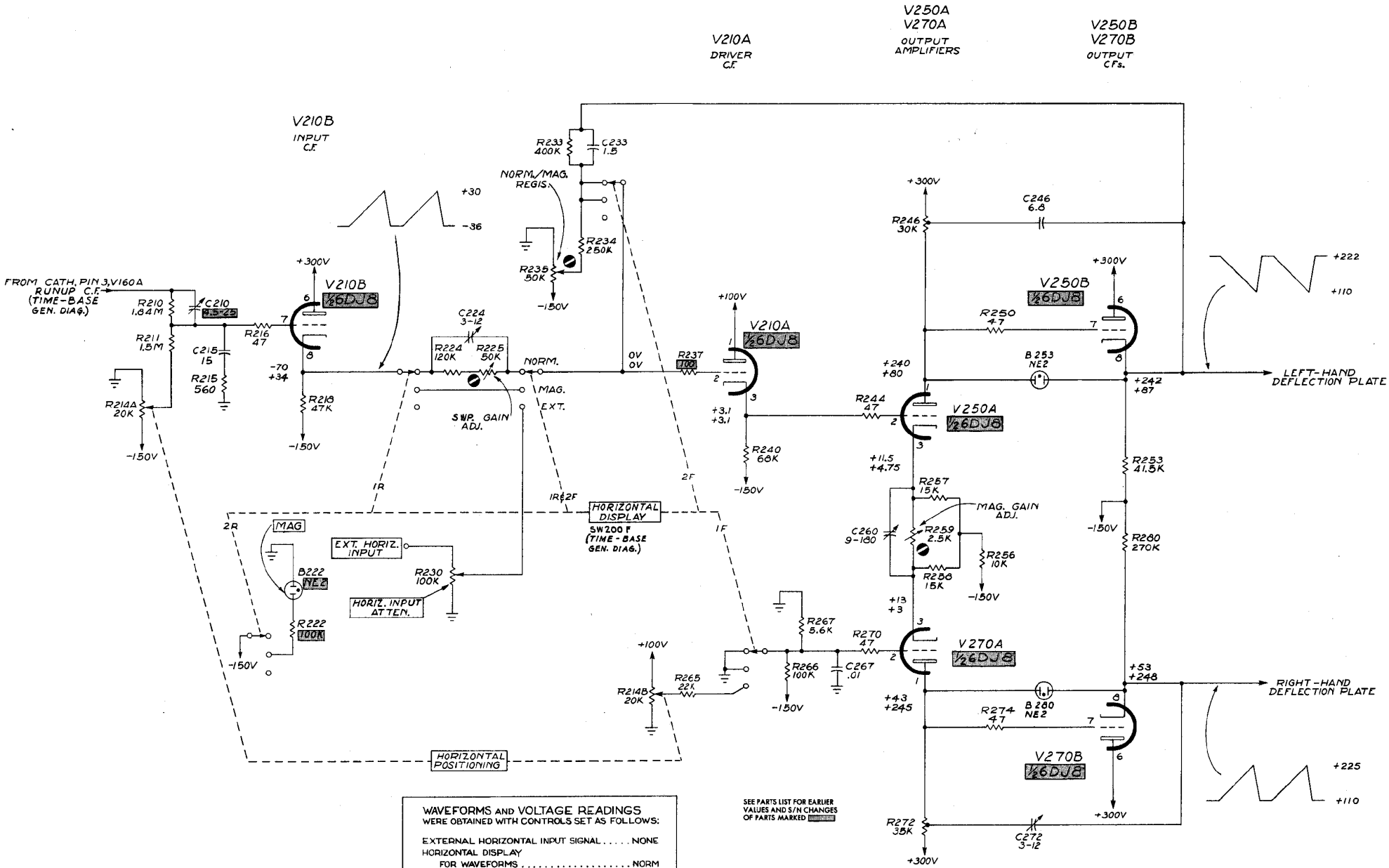
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED ▨


V120B
V110
MULTIVIBRATOR
V120A
UNBLANKING C.F.
V180B
+GATE OUT C.F.
V150A
V150B
DISCONNECT DIODES
V160A
RUNUP C.F.
V180A
SAWTOOTH-OUT C.F.
V160B
MILLER RUNUP TUBE
DECOUPLING NETWORK
+300V
R114 100
C114 .01
(DECOUPLED) +300V
V120A ½6AN8
+107
+43
+51
+103
UNBLANKING PULSE TO GRID, PIN 3, CRT, VIA C734 (CRT CIRCUIT)
V180B ½6DJ8
R120 10K
C120 12
R119 47
R118 47
R121 33K
-150V
+24
R122 10K
+GATE OUT
+100V
R111 3.6K
R112 3.6K
+25
+84
V110B ½6DJ8
R113 100
+35
+92
C111 8
-45
-62
V110A ½6DJ8
TRIGGER PULSE FROM SW5E (TIME-BASE TRIG.)
C109 27
R109 100
-50
-38
R117 10K
NORM.
MAG.
EXT.
-150 V
HORIZ. DISPLAY
SW200 — SEE HORIZ. AMP.
R143 4.7K
D130 TI26
-2 V
-6.3 V
C127 56
R125 1M
R124 150K
R127 680
R115 43K
C115 5.6
R116 33K
R124 47
V120B ½6AN8
-2.15
-3.35
V150A ½6AL5
V150B ½6AL5
+30
+105
C160
V160B ½6AN8
R159 100
R160
SEE TIMING-SWITCH CIRCUIT
-2.4
-3.4
V160A ½6AN8
C165 470
R160 100
C161 .001
B160 NE-2
R161 470K
R162 1.5M
B161 NE-2
R164 47K
R165 47K
R184 100K
C184 .001
V180A ½6DJ8
R163 47
R185 47
+7
+70
R182 100K
SAWTOOTH OUT
+146V
-4V
SAWTOOTH TO GRID, PIN 7, V210B DRIVER C.F. (HORIZ. AMPLIFIER)
-3.35
+62
WAVEFORMS AND VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
STABILITY
FOR WAVEFORMS..... PRESET
FOR UPPER VOLTAGE READINGS.....
.....CCW BUT NOT INTO PRESET
FOR LOWER VOLTAGE READINGS....CW
SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM
515A AA TIME-BASE GEN.
V140B V140A
HOLD-OFF C.F.'S
SW160
TIME/CM
2R
4R
8FER
1FER
R155 10K
SEE TIMING-SWITCH CIRCUIT
C180
V140A ½12AT7
V140B ½12AT7
R140 100
R141 27K
R142 39K
-51
-59
R181 4.7M
-57
-83
R157 2.2K
R156 2K
SWP. LENGTH
R158 6K
STABILITY
R145 500K
TRIGGER SELECTOR
SW5
(TIME-BASE TRIG.)
GANGED CONTROLS
SW145
PRESET
DC
AC
AUTO.
HF SYNC
R144 100K
R146 100K
PRESET STABILITY
TYPE 515A OSCILLOSCOPE
AA 2
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED
TIME-BASE GENERATOR
KF
5-2-61



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

4-28-61
KF



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

EXTERNAL HORIZONTAL INPUT SIGNAL ..... NONE
HORIZONTAL DISPLAY
FOR WAVEFORMS ..... NORM
FOR VOLTAGES ..... EXT.

HORIZONTAL POSITION
FOR UPPER VOLTAGE READINGS ..... CCW
FOR LOWER VOLTAGE READINGS ..... CW

SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM

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

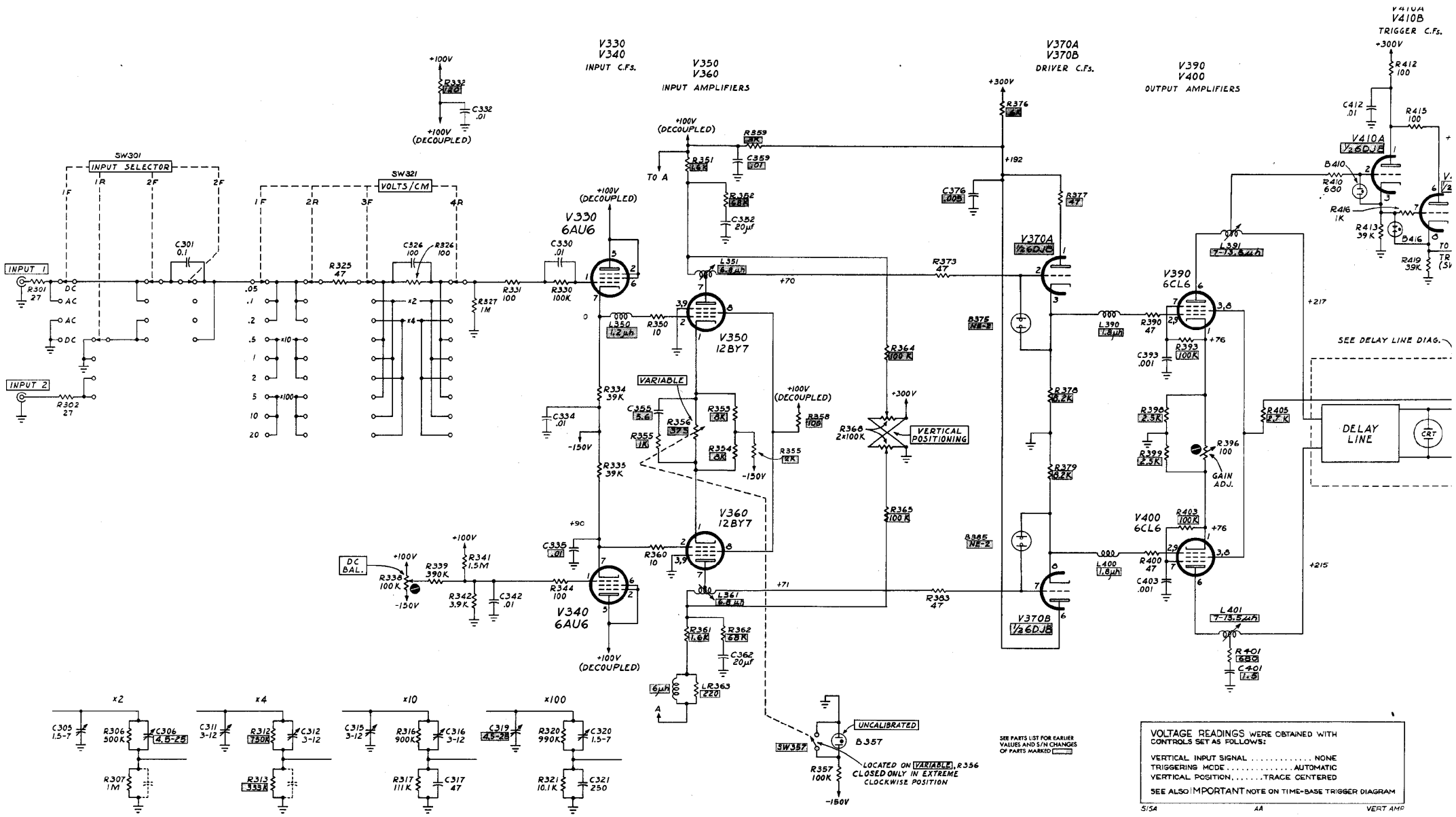
TYPE 515A OSCILLOSCOPE

515A AA HORIZ. AMP.

AA 2

HORIZONTAL AMPLIFIER

R.O.W.
5-2-61



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

VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

VERTICAL INPUT SIGNAL ..... NONE
TRIGGERING MODE ..... AUTOMATIC
VERTICAL POSITION, ... TRACE CENTERED

SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM

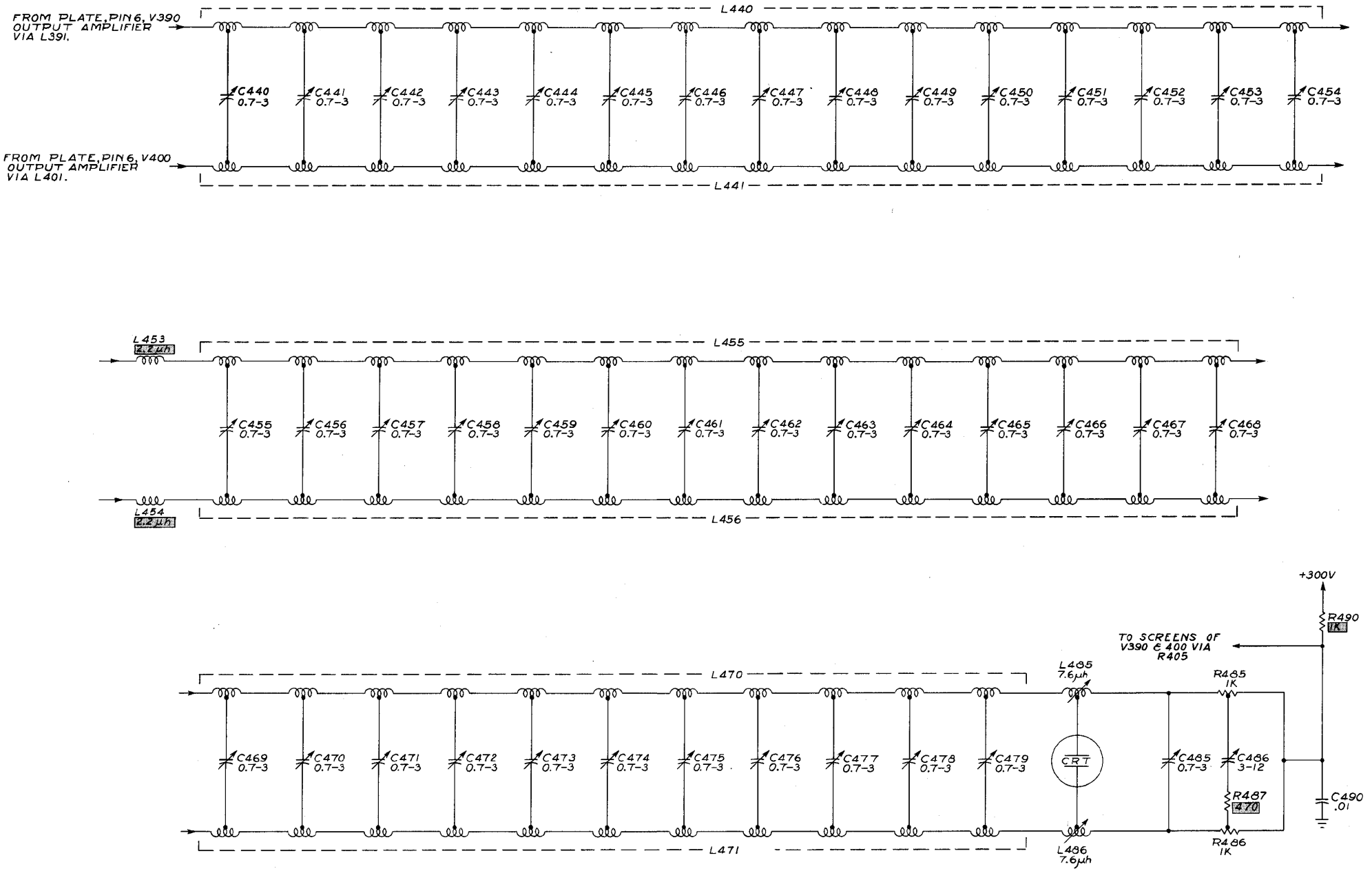
515A AA VERT AMP

VERTICAL AMPLIFIER

KF
5-4-61

\+ TYPE 515A OSCILLOSCOPE

AC



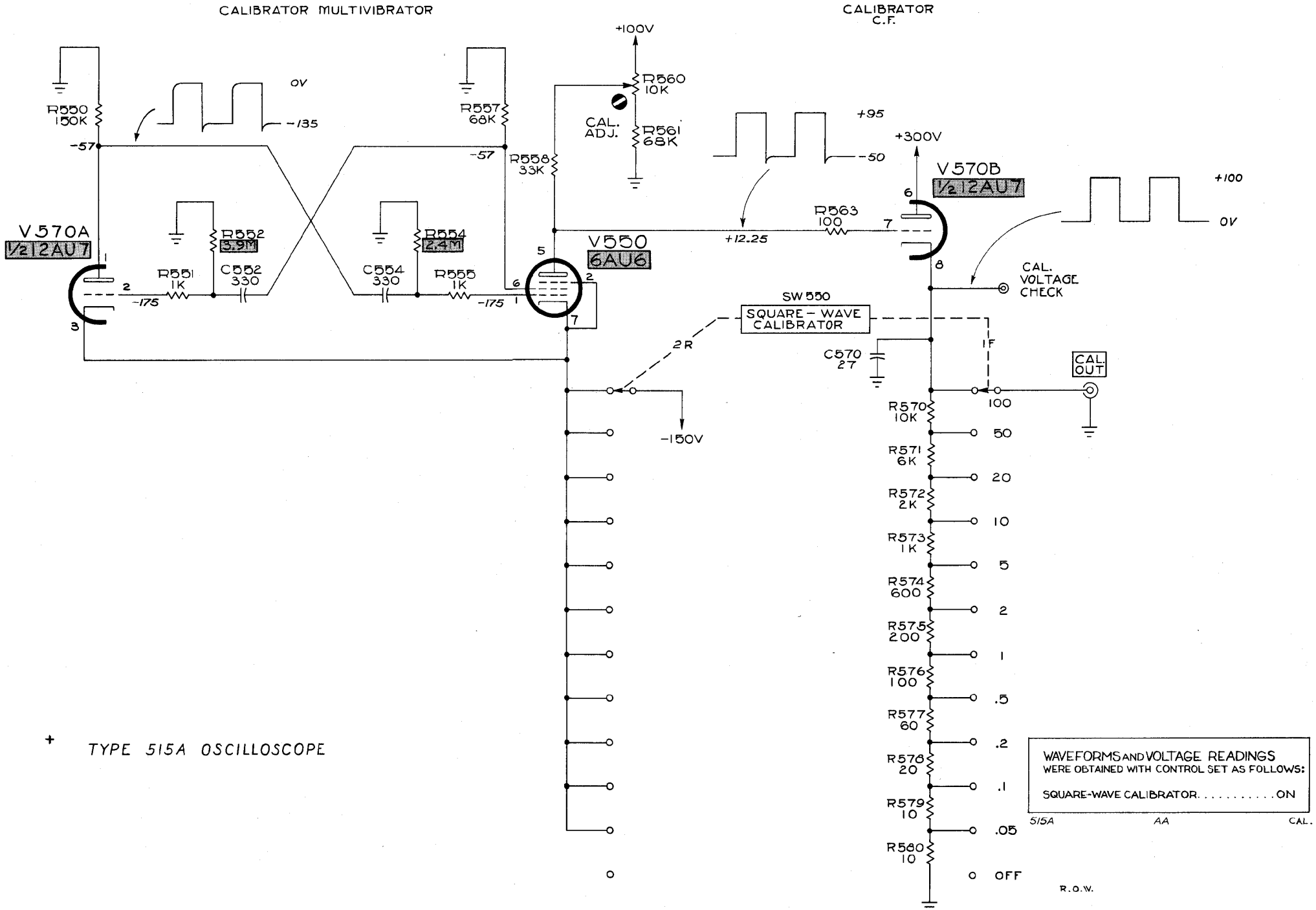
TYPE 515A OSCILLOSCOPE

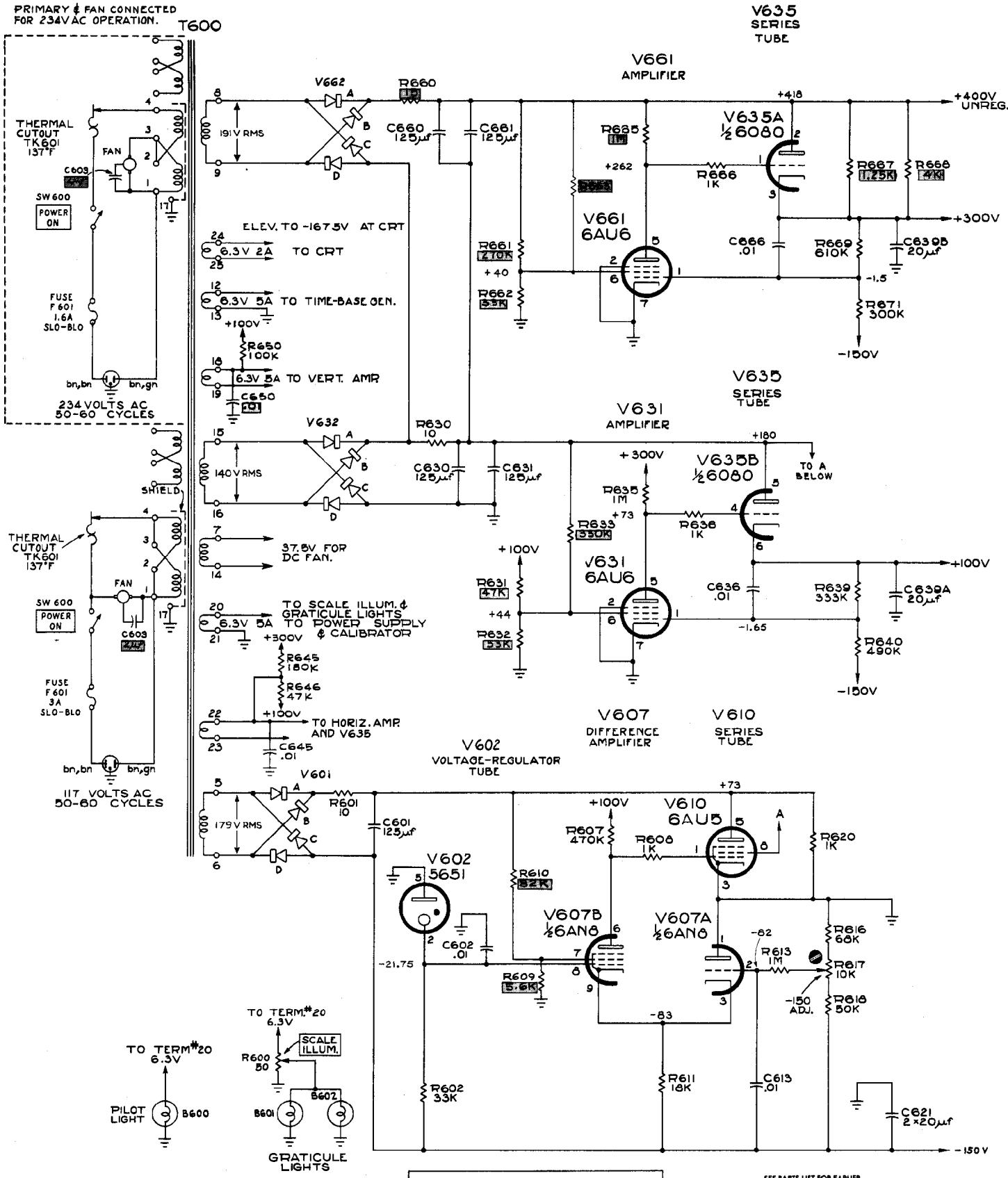
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED

6-16-58 R.O.W.

AA

DELAY LINE


CALIBRATOR MULTIVIBRATOR
CALIBRATOR C.F.
+100V
R560 10K
CAL. ADJ.
R561 68K
R550 150K
R557 68K
R558 33K
0V
-135
-57
-57
+95
-50
+300V
V570B 1/2 12AU7
+100
0V
R563 100
+12.25
V570A 1/2 12AU7
R552 3.9M
R554 2.4M
V550 6AU6
R551 1K
C552 330
C554 330
R555 1K
-175
-175
CAL. VOLTAGE CHECK
SW 550
SQUARE-WAVE CALIBRATOR
2R
1F
C570 27
CAL. OUT
-150V
R570 10K
R571 6K
R572 2K
R573 1K
R574 600
R575 200
R576 100
R577 60
R578 20
R579 10
R580 10
100
50
20
10
5
2
1
.5
.2
.1
.05
OFF
+ TYPE 515A OSCILLOSCOPE
WAVEFORMS AND VOLTAGE READINGS WERE OBTAINED WITH CONTROL SET AS FOLLOWS:
SQUARE-WAVE CALIBRATOR. . . . . ON
515A AA CAL.
AA,
R.O.W.
5-4-61
CALIBRATOR



VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

VERTICAL INPUT SIGNAL	NONE
TRIGGER INPUT SIGNAL	NONE
LINE VOLTAGE	117 VAC
STABILITY	CCW BUT NOT INTO PRESET

SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM

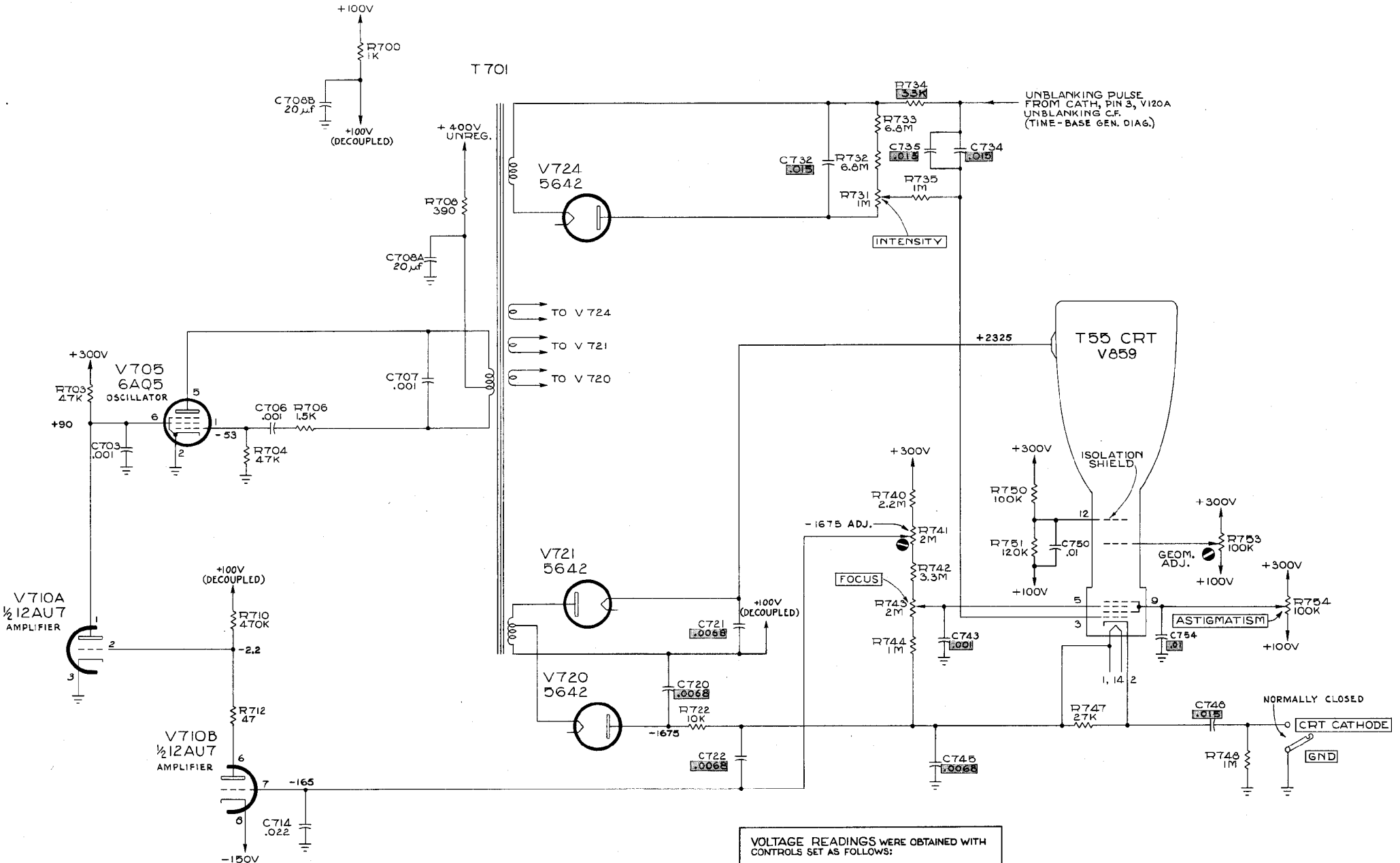
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED

R.O.W. 5-4-61

515A AA LV PWR

TYPE 515A OSCILLOSCOPE

LV POWER SUPPLY


+100V
R700 1K
C708B 20 µf
+100V (DECOUPLED)
T701
+400V UNREG.
R708 390
C708A 20 µf
V724 5642
R734 33K
UNBLANKING PULSE FROM CATH, PIN 3, V120A UNBLANKING C.F. (TIME-BASE GEN. DIAG.)
R733 6.8M
C735 .015
C734 .015
C732 .015
R732 6.8M
R735 1M
R731 1M
INTENSITY
TO V 724
TO V 721
TO V 720
+2325
T55 CRT V859
+300V
V705 6AQ5 OSCILLATOR
R703 47K
+90
C703 .001
C706 .001
R706 1.5K
-53
R704 4.7K
C707 .001
ISOLATION SHIELD
+300V
R740 2.2M
-1675 ADJ.
R741 2M
R742 3.3M
FOCUS
R743 2M
R744 1M
C743 .001
R750 100K
R751 120K
C750 .01
+300V
R753 100K
GEOM. ADJ.
+100V
+300V
R754 100K
ASTIGMATISM
C754 .01
+100V
+100V (DECOUPLED)
V721 5642
C721 .0068
+100V (DECOUPLED)
V710A ½12AU7 AMPLIFIER
R710 470K
-2.2
V720 5642
C720 .0068
R722 10K
-1675
C722 .0068
R712 47
V710B ½12AU7 AMPLIFIER
-165
C714 .022
-150V
R747 27K
C745 .0068
C746 .015
NORMALLY CLOSED
CRT CATHODE
R748 1M
GND
VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
INTENSITY ..... CCW
SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM
R.O.W. 5-4-61
TYPE 515A OSCILLOSCOPE
AB, 5/5A AA CRT
CRT CIRCUIT