

1-13-65 Elft

# Haydon timing motor

1. Reset acrotimer Series BR (rear mounted)

- a. Reset electrically
- b. can be bought for 1hr operation
- c. priced out about 1½ yrs ago for \$40.
- d. dimensions

$3\frac{37}{64}$  deep X  $3\frac{7}{16}$

PM15 MOD 760A

September 5, 1958

Consumer Scope for G.E. Schenectady  
Modified 515 (proposed)

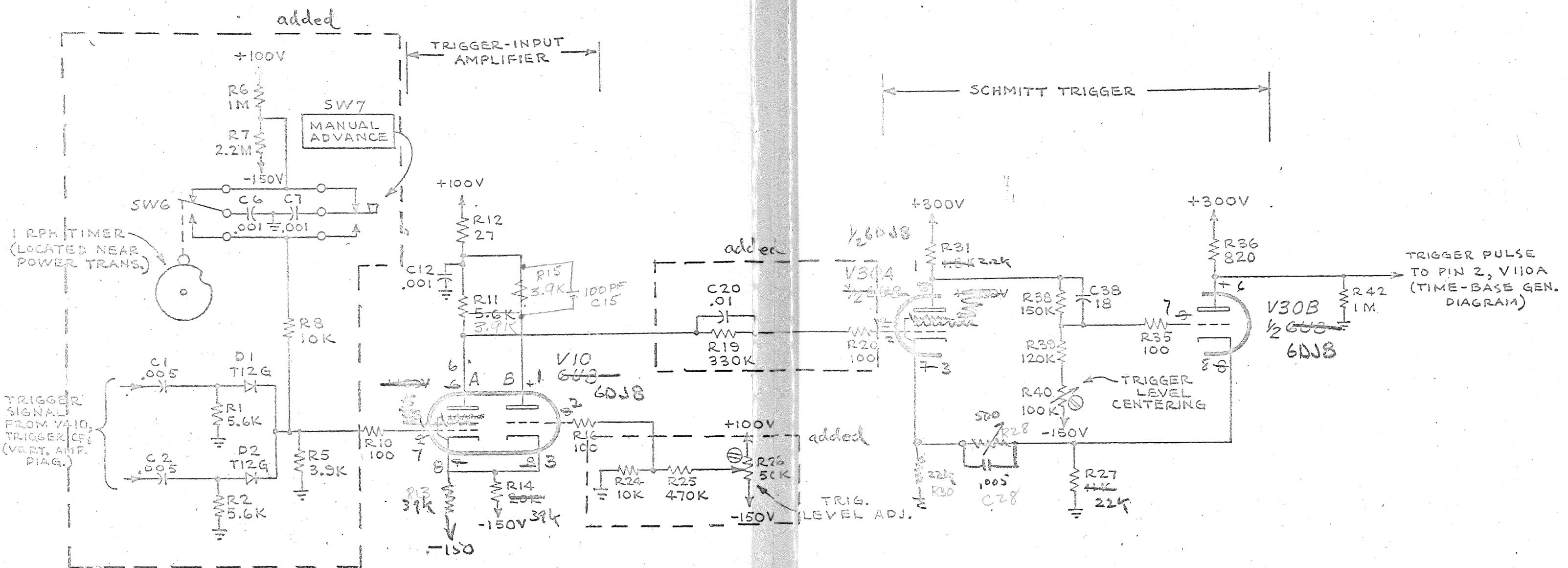
*Mod 209-D*

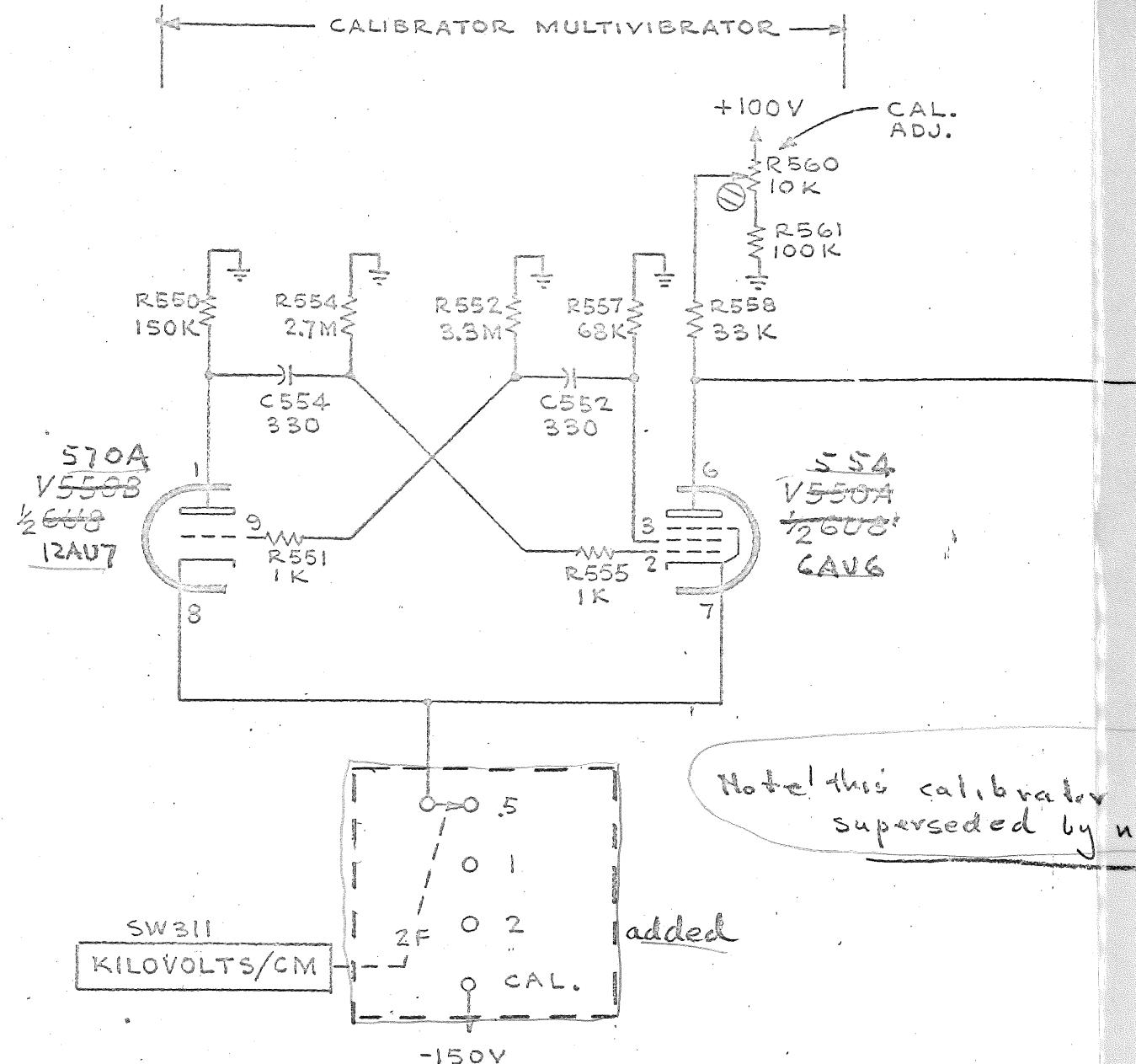
*P.G.*

1. Triggering from transients on power line.
2. Direct connection to vertical deflection plates (AC coupled).
3. No vertical amplifier or calibrator.
4. Signal delay cable would be necessary.  
Could be supplied either by customer or Tek  
Would probably mean price difference of \$100  
.25/ft. - 150 ft.
5. Provide pulse for advancing film 75V into  $500\Omega$ .
6. Pulse for auto film advance every 4 hours. - ~~[Redacted]~~

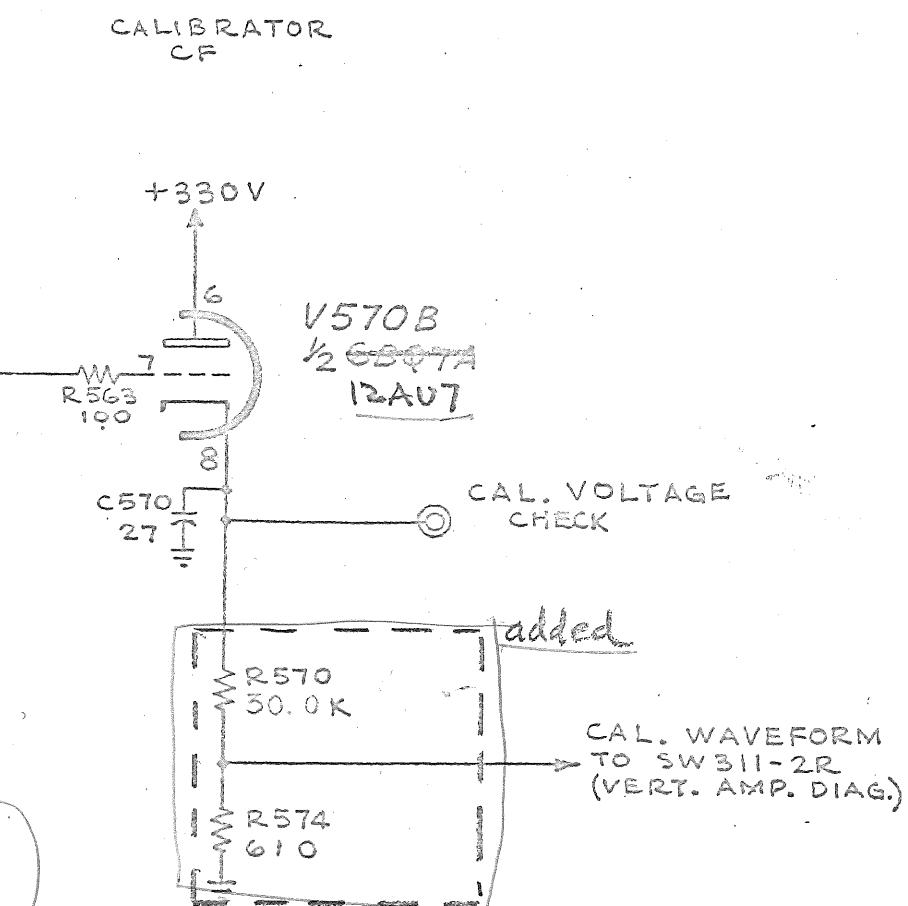
We would propose modifying a standard 515 such that it would incorporate the above features and at the same time all controls would be removed from the front panel with the exception that Focus, Intensity, and Astig. controls would be accessible as screwdriver adjustments from the front panel.

*C*  
*o ✓*





Note! this calibrator is becoming superseded by new circuit

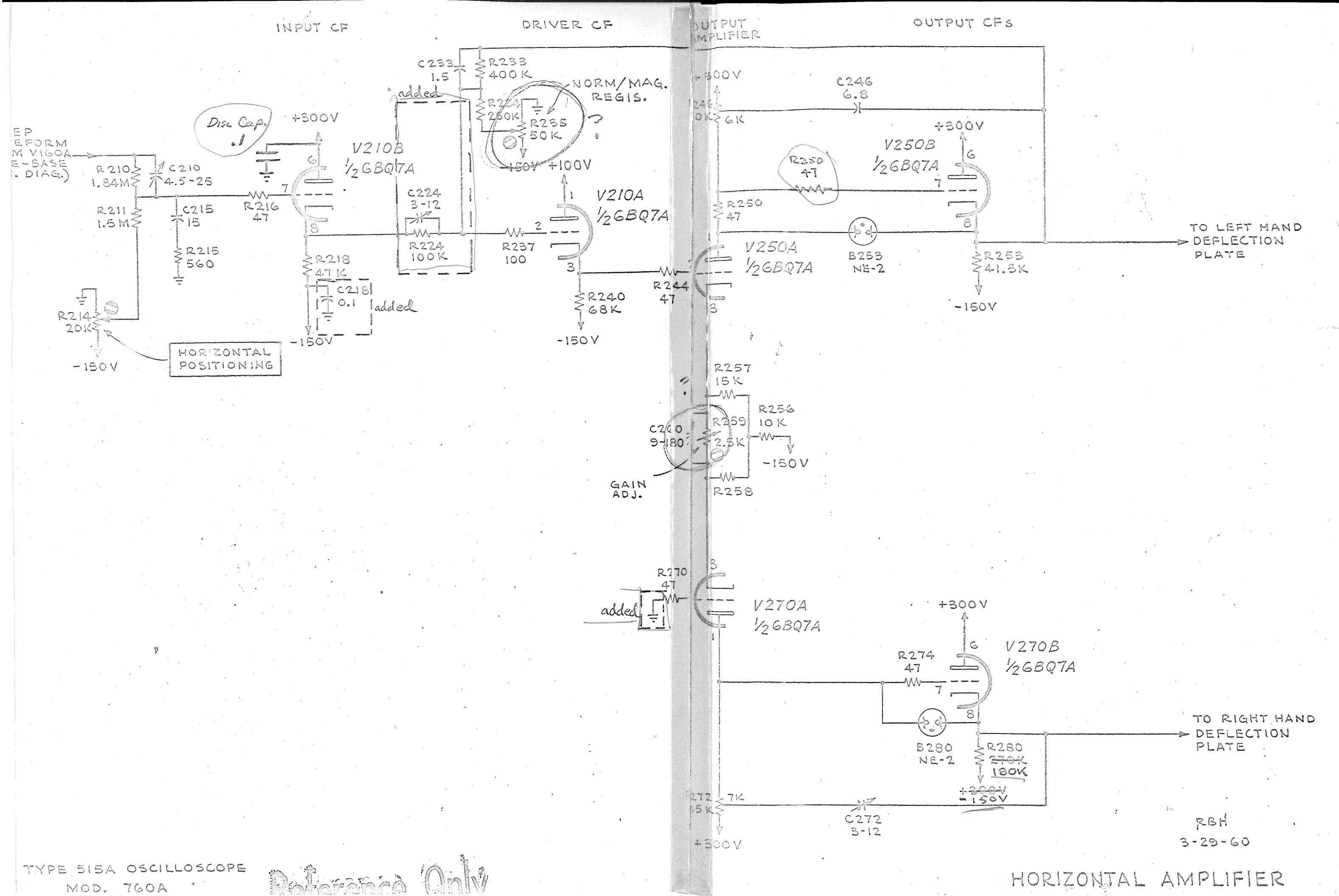


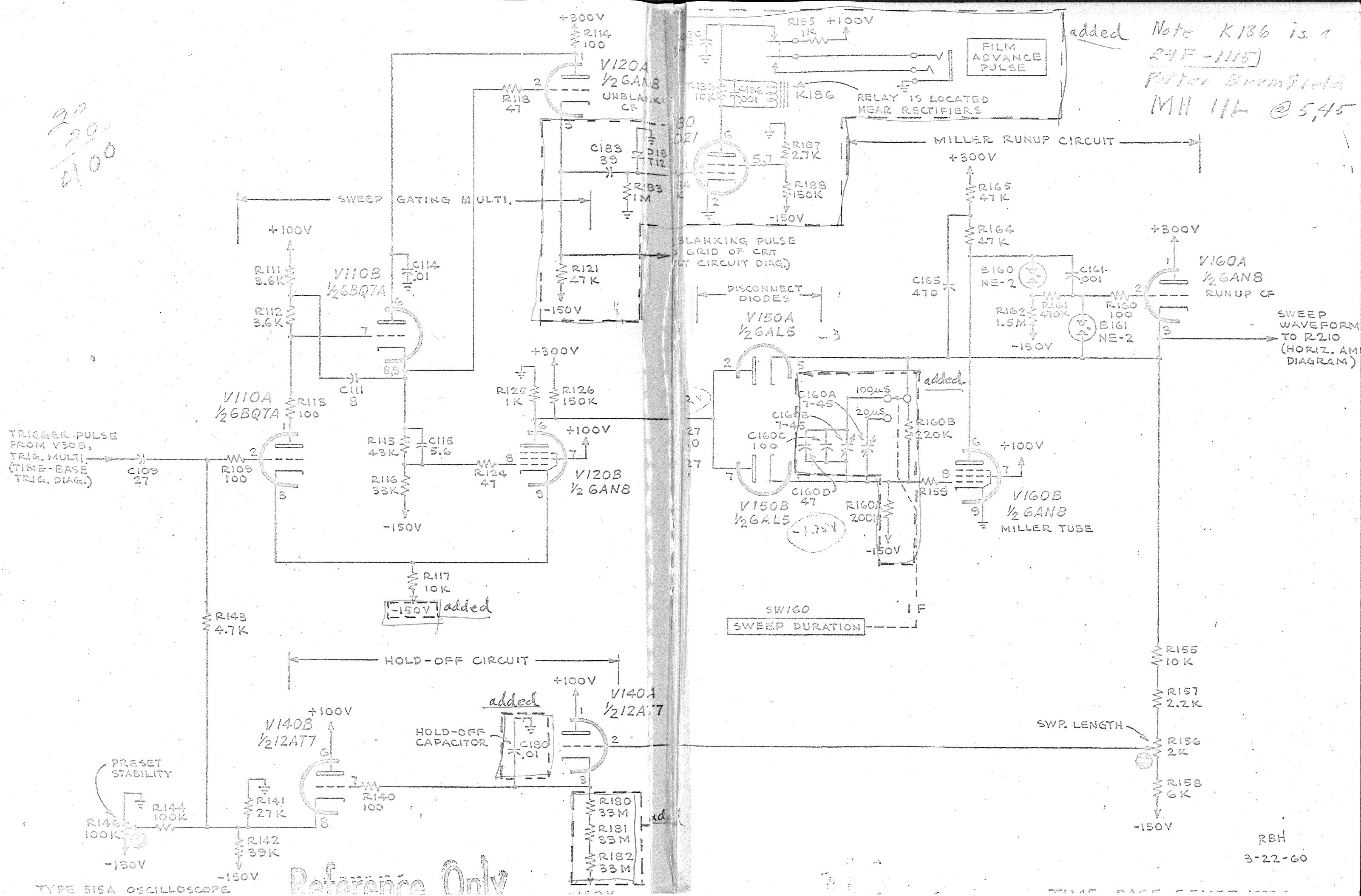
RBH  
3-21-60

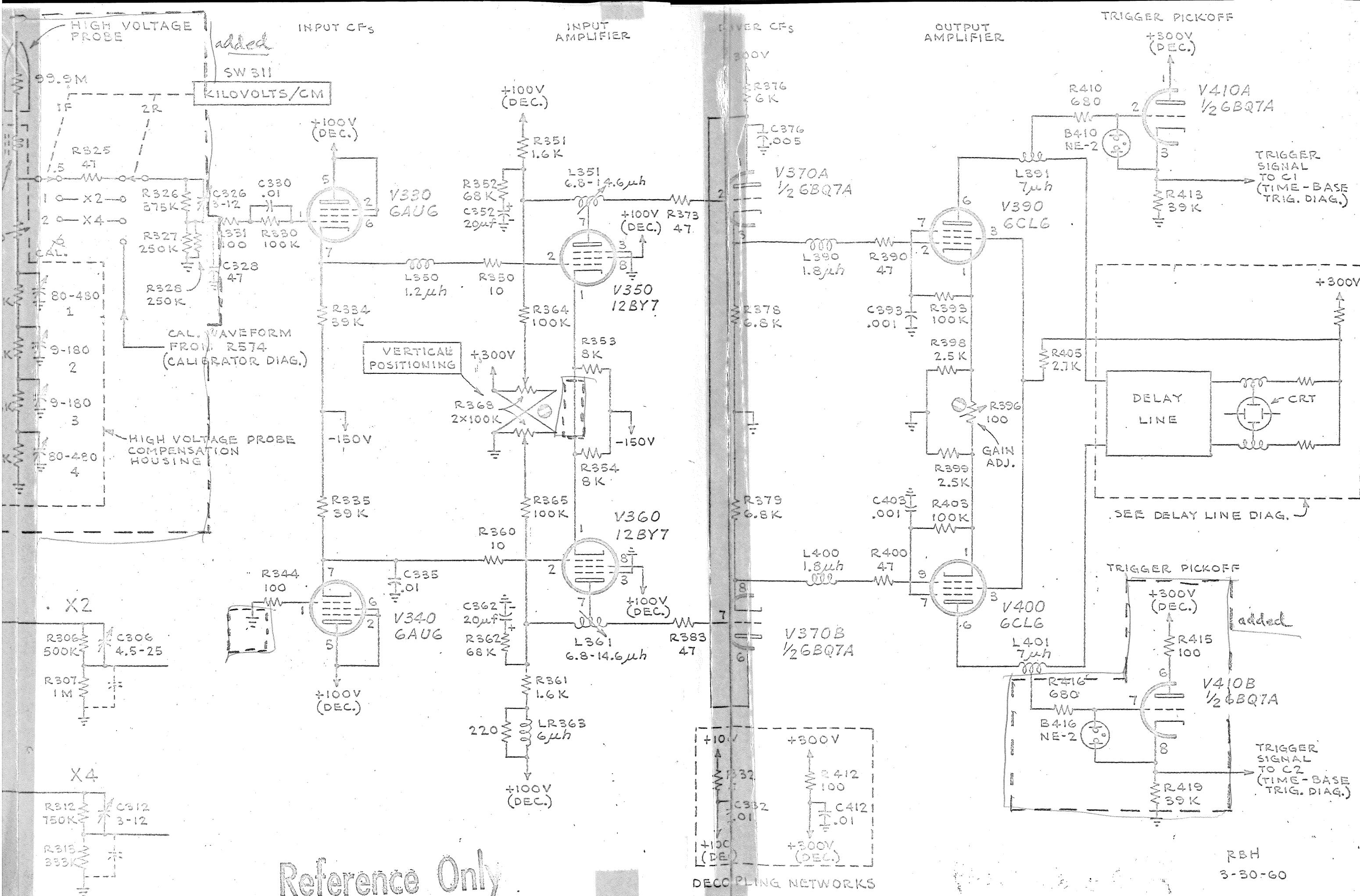
# CALIBRATOR

TYPE 515A OSCILLOSCOPE  
MOD. 760A

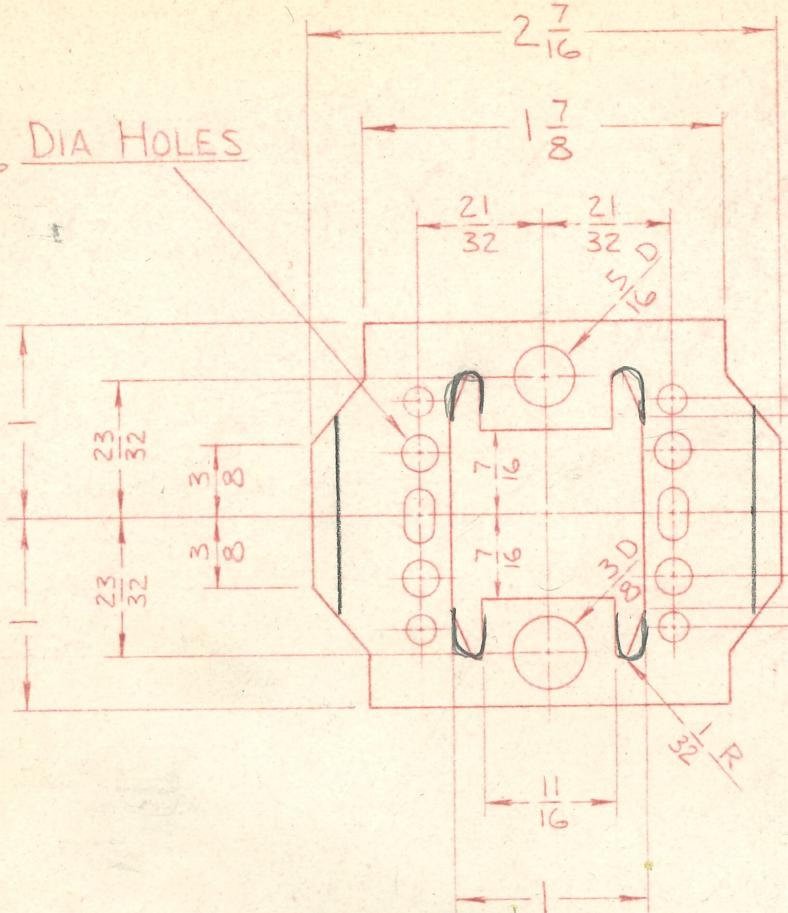
# Reference Only



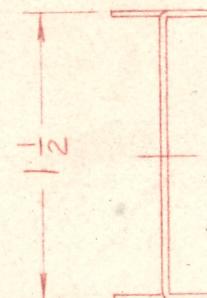




4- $\frac{3}{16}$  DIA HOLES



BEND TO POSITION SHOWN



UNMARKED HOLES  $\frac{5}{32}$  DIA  
UNMARKED SLOTS  $\frac{5}{32} \times \frac{9}{32}$

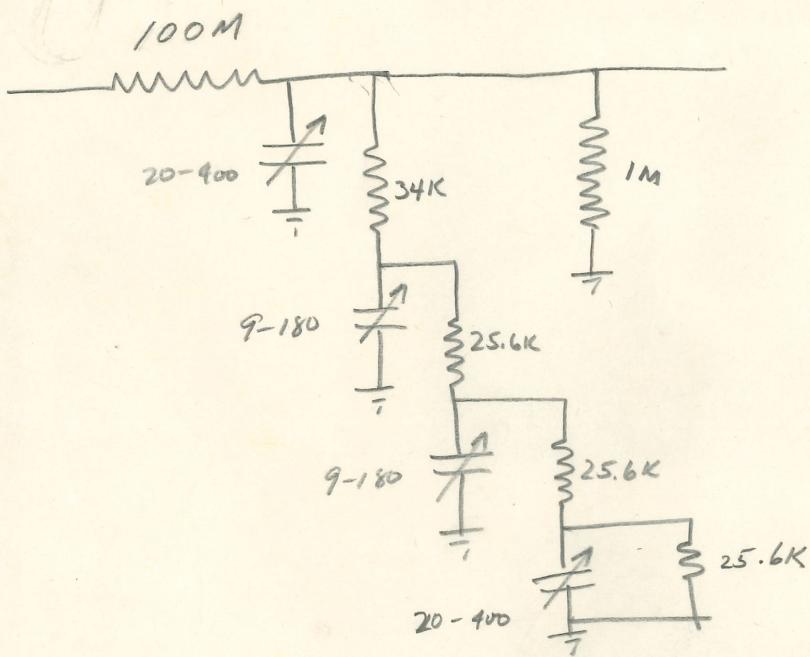
3-18-59

Modified 4-21-59 for 515 MOD 760

TOLERANCES  
FRACTIONAL DIMENSIONS  $\pm \frac{1}{64}$   
DECIMAL DIMENSIONS  $\pm .005$

		TEKTRONIX, INC. PORTLAND, OREGON, U.S.A.			
		TITLE: COMPENSATOR CHASSIS			
		MATERIAL: .032 HALF HARD BRASS 251-333			
		BLANK SIZE: $2 \times 2\frac{7}{16}$			
FINISH: NONE		TYPE: HIGH VOLT. PROBE			
MODIFICATION NOTICE				SCALE: 1" = 1"	
				MOD. NO.	ENGR: PT
				DATE	DR. BY: GT
				BY	PART NO.
					DRG. NO.

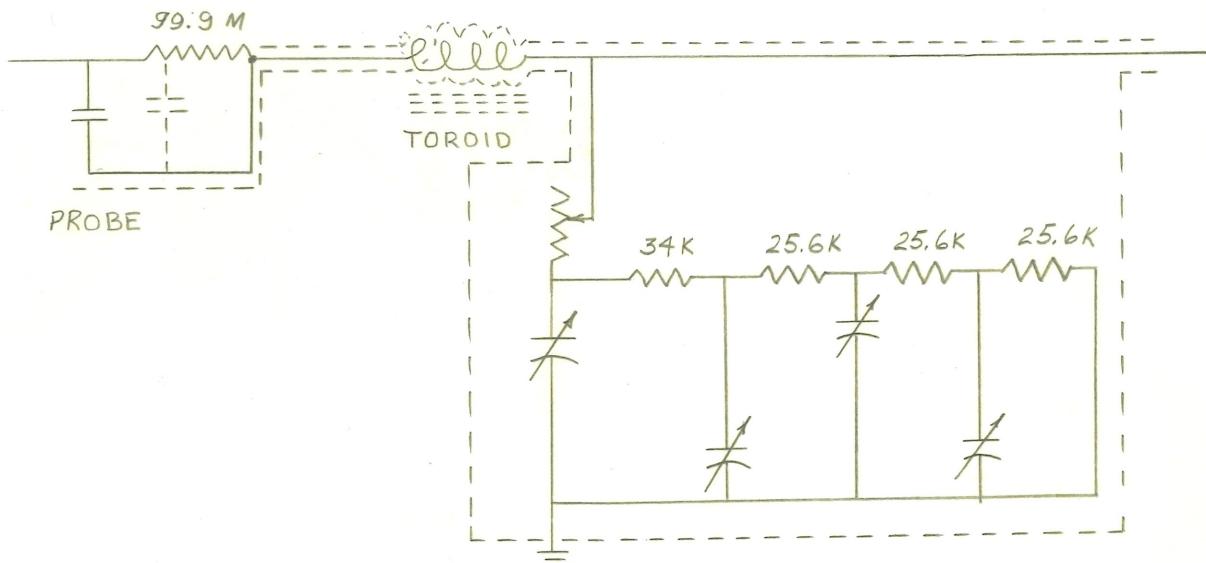
12KV H.V. Probe 515 MOD 760



P-1000 25KV PROBE GENERAL DESCRIPTION

1. Physical Data

- (a) Size: 11" long, 1 3/4" dia. of body, 3 1/2" dia. Safety Flange.
- (b) Weight: Probe weights 10 oz.  
Probe, cable assembly and compensating box weighs 18 1/2 oz.
- (c) Color: Light gray body and dark gray nose and handle.
- (d) Construction Materials: High-dielectric-strength, high-impact-strength thermoplastic covers the probe for electrical and mechanical protection.
- (e) Cable Assembly: The cable assembly may be removed and replaced.
- (f) Connectors: P-1000 probes will be furnished with UHF connectors.
- (g) Length of Cable: 10 feet. The cable has a resistive center conductor. The value of the resistance has been chosen to provide optimum performance of the probe.
- (h) Compensating Box: Compensation for the input capacity of the oscilloscope and the distributed capacity within the probe is accomplished by adjusting four variable trimmer capacitors in the box which attaches to the oscilloscope. The R-C network in the box is arranged to affect the observed shape at different but overlapping points along the first 300  $\mu$ seconds of the pulse. A variable resistor in the network provides peaking adjustment up to 0.3  $\mu$ seconds.

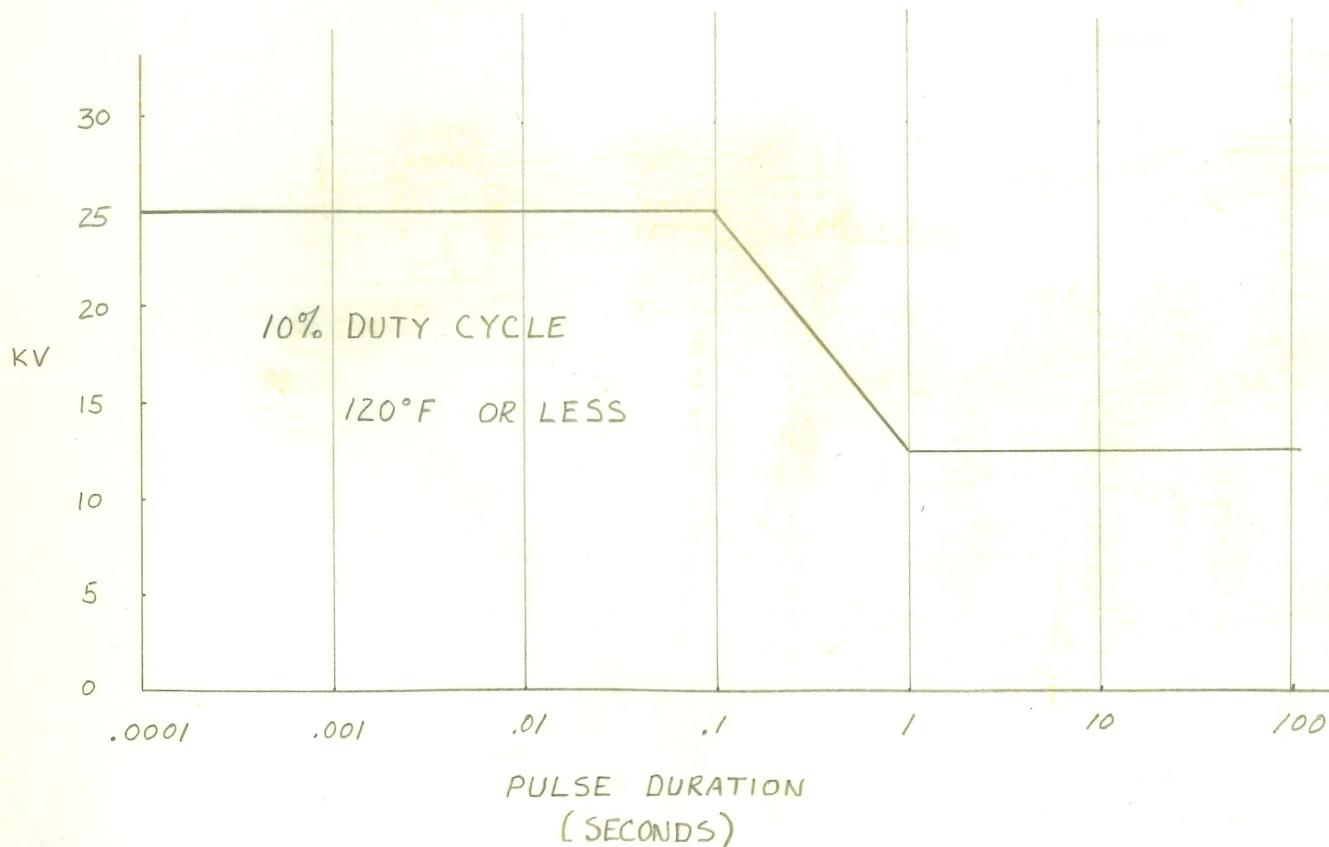


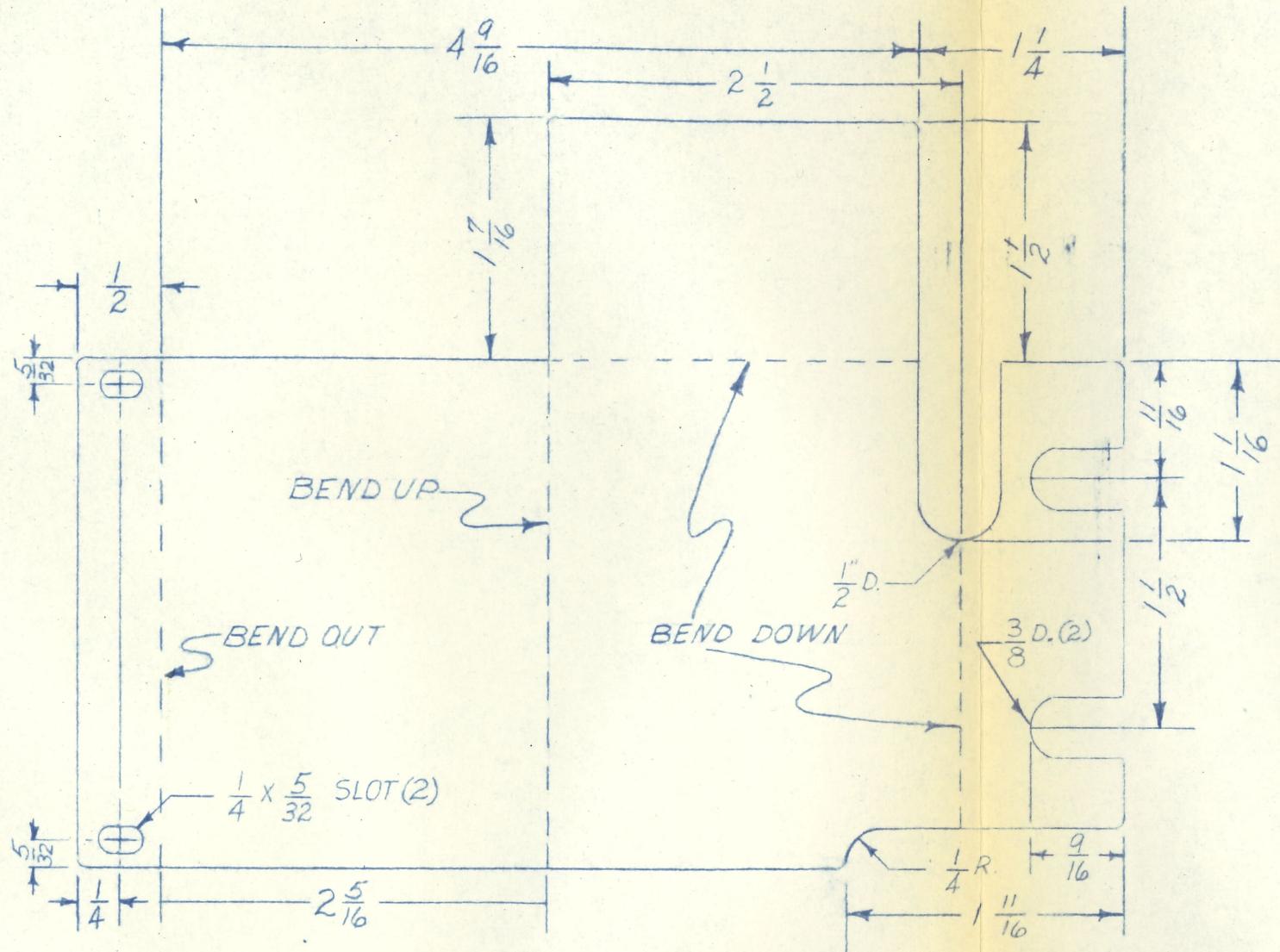
## 1. Physical Data (cont'd)

- (j) **Ground Lead:** A ground lead is provided at the probe. Ground at the probe end is necessary for accurate response to fast-rising waveforms.
- (k) **Probe Handle:** The probe handle is tapped with a 7/8" - 14 thread at the end to allow assembly of an extension stick (provided by the customer)
- (l) **Accessories shipped with the Probe:** Banana Plug Tip and Alligator Tip (threaded 10-32).

## 2. Electrical Characteristics

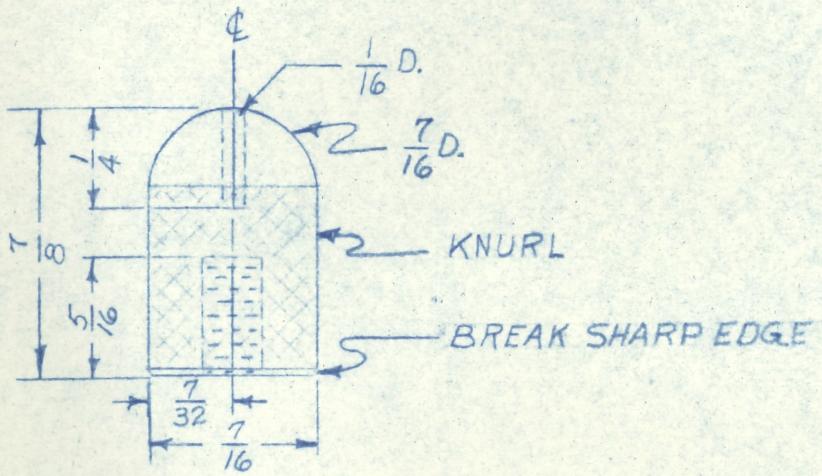
- (a) Attenuation 1000:1
- (b) Input Impedance 100 megohms and less than 3pf.
- (c) Risetime of pulse when used with 545 and K plug-in 12 nsecond (no noticeable effect on instrument risetime.)
- (d) Voltage Rating DC - 12KV  
Peak - 25KV at 10% maximum duty cycle  
maximum pulse duration 0.1 sec.





$1/8"$  R. ALL UNMARKED CORNERS

REVISION	BY	DESCRIPTION OF CHANGE	DATE	
TOLERANCE FRACTIONAL $\pm 1/64$ ANGLES $\pm 2^\circ$ UNLESS OTHERWISE SPECIFIED				TYPE: 515A-760A
ENGR:	BLANK SIZE:		DATE: 6-4-62	
CH. BY:	DR. BY: M.J.T.	SCALE: FULL	DWG. NO. 1	
DO NOT SCALE DRAWING				



REVISION	BY	DESCRIPTION OF CHANGE	DATE	TEKTRONIX, INC. PORTLAND, OREGON, U.S.A.	
				TITLE: ADAPTER, TIP, H.V. LEAD-IN	
				MATERIAL: 7/16" BRASS ROD	
				FINISH: NONE	
				ENGR: BLANK SIZE: TYPE: 515A-760A	
				CH. BY: DR. BY: M. J. T. SCALE: 2X DATE: 6-7-62	
				TOLERANCE FRACTIONAL $\pm 1/64$ ANGLES $\pm 2^\circ$ UNLESS OTHERWISE SPECIFIED	PART NO: DWG. NO:

# CONSUMER OSCILLOSCOPE

Type 515A, MOD 760A

**PURPOSE:** To provide an automatic photographic record of line transients in the range of approximately 200v to 12,000v.

**SPECIFICATIONS:** 3. A four-position switch or Vertical Attenuator

## Vertical-Deflection System

Vertical D.C. Coupled.

D.C. Coupled Main Unit Risetime .023 $\mu$ sec. the variable

Captive 1000:1 passive probe, 12kv D.C. max.

input impedance 100meg $\Omega$ , 2.5 $\mu$ uf.

Calibrated ranges .5, 1 and 2 kv/cm. will be filtered to

.25 $\mu$ sec balanced signal delay line. 1 of the output  
6cm linear deflection.

## Horizontal-Deflection System

Two calibrated non-linear sweeps.

20 and 100 $\mu$ sec/sweep duration.

Sweep voltage rises exponentially at  $t = k \ln(d)$  where eliminated,  
approx.  $d = k(1 - e^{-2.5t})$

$t$  = fraction of total time needed so that a trigger

$d$  = horizontal displacement in cm for a rising or falling

$k$  = approximately 11

Accuracy 3%

Unblanking D.C. coupled generator and 1 trigger/line

Triggering requirements

$\pm 4$ mm of deflection

Max. sweep repetition rate

approximately 3 ~/second

## Other Characteristics

Cathode ray tube

Modified type 5CBP11

Acceleration potential 6375 volts

Voltage Calibrator

One preset range, switched by vertical attenuator  
switch provides a 4cm vertical deflection signal.

Power requirements

105 to 125v or 210 to 250v, 50-60cps, 275w

## Circuit Description

Unless otherwise indicated, refer to standard 515A instruction manual for circuit details and calibrating instructions.

A. Power Supply no modifications necessary

B. Vertical Amplifier

1. A captive 1000X high voltage probe is permanently connected to the input attenuator.

2. Compensating network is incorporated so that a faithful presentation can be made of a fast rise square wave. (Four variable capacitors are factory adjusted for this response. When making this adjustment, place the input attenuator in the .5Kv/cm position to eliminate the possible error of the input attenuator.)
  3. A four-position screwdriver Vertical Attenuator switch has been used, three active positions and a calibrated position to check the gain of the vertical amplifier.
  4. D.C. balance circuit removed since the variable gain circuit is omitted.
  5. The trigger C.F. circuit has been altered to obtain samples from each half of the output push-pull stage.
- In general  
in the  
altered
- C. Delay Line  
no modification necessary.
  - D. Time Base Trigger
    1. Both trigger selection switches were eliminated.
    2. A diode mixer stage was added so that a trigger would be generated with either a rising or falling vertical phenomenon.
    3. A manual trigger generator and 1 trigger/hr circuit added.
  - E. Time Base Generator
    1. Gate and Sawtooth outputs are eliminated.
    2. Horizontal display switch eliminated.
    3. Sweep variable control eliminated.
    4. Miller run up circuit modified for exponential operation.
    5. V180 rewired to provide a positive pulse at the end of a sweep to actuate a film advance relay in the camera.
    6. Hold off time constant changed to limit the sweep repetition rate to that of the camera film advance mechanism to prevent a trace during film advances.
  - F. Horizontal Amplifier
    1. External horizontal input and circuitry eliminated.
    2. Sweep gain adjustment eliminated.

G. Calibrator

1. A fixed divider replaced the step divider and provides a 2 volt  $\pm 3\%$  square wave of approximately 1 Kc.

H. CRT Circuit

1. The positive supply was changed to a voltage doubler to provide a total of 6375 volts required for a higher writing rate.

BURGESS: D

SPECIFICATIONS:

2. A special CRT was built to provide the opaqueness required for long exposures while still retaining the scan and horizontal sensitivity required.

RECALIBRATION PROCEDURE:

In general the 515A, Mod. 760A can be calibrated as outlined in the instruction manual if the following circuits are altered as indicated:

- A. Open the hold-off capacitor .1uf at cathode of V140A. This will allow the sweep circuit to function at a high repetition rate.
- B. Open the 220K, 1% resistor which shunts the time capacitor (located on sweep timing switch). The sweep circuit now functions in a linear manner. This permits adjustment of the linearity controls in the horizontal amplifier.
- C. Dis-able half the trigger pick-off circuit by removing a cathode lead at V410. The sweep will now start with either a rising or falling signal dependent upon which cathode lead is disconnected.
- D. The following technique is suggested when aligning the vertical system:

Other:

1. Connect the Square-Wave Generator (Type 105 or 107) direct to the output of the 10X attenuator (i.e. input to amplifier). Terminate the cable at the output end for best results. The vertical amplifier and delay line can now be adjusted for proper response. (Refer to manual for additional details.)
2. Connect the Square-Wave Generator to the input of the vertical attenuator and compensate the three attenuators X10, X2, and X4 (in the order indicated).

Circuit:

3. Adjustment of the probe will require the use of either a high amplitude mercury pulser, or the use of a test scope to monitor the output vertical amplifier and using the Type 105 Square-Wave Generator.

## CONSUMER OSCILLOSCOPE

Type 515A, Mod 760A  
(Ser. No. 7236 & up)

PURPOSE: To provide an automatic photographic record of line transients in the range of approximately 200v to 12,000v.

### SPECIFICATIONS:

#### Vertical-Deflection System

Vertical D.C. Coupled  
D.C. Coupled Main Unit Risetime .023usec  
Captive 1000:1 passive probe, 12kv D.C. max.  
input impedance 100 meg $\Omega$ , 2.5 $\mu$ uf  
Calibrated ranges .5, 1 and 2kv/cm  
.25usec balanced signal delay line  
6cm linear deflection

#### Horizontal-Deflection System

Two calibrated non-linear sweeps  
20 and 100usec/sweep duration  
Sweep voltage rises exponentially at  
approx.  $d = k(l - e^{-2.5t})$   
 $t$  = fraction of total time  
 $d$  = horizontal displacement in cm  
 $k$  = approximately 11  
Accuracy 3%  
Unblanking D.C. coupled  
Triggering requirements  
   $\pm$  4mm of deflection  
Max. sweep repetition rate  
  approximately 5 cys/second

#### Other characteristics

Cathode ray tube  
Modified type T55P11L  
Acceleration potential approx. 6325 volts  
Voltage Calibrator  
One preset range, switched by vertical attenuator  
switch provides a 4 cm vertical deflection signal.  
Power requirements  
105 to 125v or 210 to 250v, 50-60 cps, 275w

#### Circuit Description

Unless otherwise indicated, refer to standard 515A instruction manual for circuit details and calibrating instructions.

- A. Power Supply  
no modifications necessary
- B. Vertical Amplifier
  1. A captive 1000X high voltage probe is permanently connected to the input attenuator.

2. Compensating network is incorporated so that a faithful presentation can be made of a fast rise square wave. (Four variable capacitors are factory adjusted for this response. When making this adjustment, place the input attenuator in the .5kv/cm position to eliminate the possible error of the input attenuator.)
  3. A four-position screwdriver Vertical Attenuator switch has been used, three active positions and a calibrated position to check the gain of the vertical amplifier.
  4. D.C. balance circuit removed since the variable gain circuit is omitted.
  5. The trigger C.F. circuit has been altered to obtain samples from each half of the output push-pull stage.
- C. Delay Line  
no modification necessary.
- D. Time Base Trigger
1. Both trigger selection switches were eliminated.
  2. A diode mixer stage was added so that a trigger would be generated with either a rising or falling vertical phenomenon.
  3. A manual trigger generator and 1 trigger/hr circuit added.
- E. Time Base Generator
1. Gate and Sawtooth outputs are eliminated.
  2. Horizontal display switch eliminated.
  3. Sweep variable control eliminated.
  4. Miller runup circuit modified for exponential operation.
  5. A circuit added to provide a contact closure of approximately 140msec at the end of a sweep to actuate a film advance relay in the camera.
  6. Hold-off time constant changed to limit the sweep repetition rate to that of the camera film advance mechanism to prevent a trace during film advances.
- F. Horizontal Amplifier
1. External horizontal input and circuitry eliminated.
  2. Sweep gain adjustment eliminated.

#### G. Calibrator

1. A fixed divider replaced the step divider and provides a 2 volt  $\pm 3\%$  square wave of approximately 1 Kc.

#### H. CRT Circuit

1. The positive supply was changed to a voltage doubler to provide a total of approx. 6325 volts required for a higher writing rate.
2. A special CRT T55P11L is provided

#### RECALIBRATION PROCEDURE:

In general the 515A, Mod. 760A can be calibrated as outlined in the instruction manual if the following circuits are altered as indicated:

- A. Open the hold-off capacitor .1μf at cathode of V140A, or shunt R180, R181, R182 with 100K resistor. This will allow the sweep circuit to function at a high repetition rate.
- B. Open the 220K, 1% resistor which shunts the time capacitor (located on sweep timing switch.) The sweep circuit now functions in a linear manner. This permits adjustment of the linearity controls in the horizontal amplifier.  
For sweep timing it is necessary to operate the sweep non-linear requiring original connection of the 220K 1% res.  
Set C160A, C160B mid scale and set the 100μsec pos. with R259 (Mag. gain adj.) then set 20μsec pos. with C160A.  
The Sweep Mag. Res. is set as per manual but R22<sup>4</sup> will have to be shorted to simulate mag. pos.
- C. Disable half the trigger pick-off circuit by removing a cathode lead at V410. The sweep will now start with either a rising or falling signal dependent upon which cathode lead is disconnected.
- D. The following technique is suggested when aligning the vertical system:
  1. Connect the Square-Wave Generator (Type 105 or 107) direct to the output of the 8X attenuator (i.e. input to amplifier.) Terminate the cable at the output end for best results. The vertical amplifier and delay line can now be adjusted for proper response. (Refer to manual for additional details.)
  2. Connect the Square-Wave Generator to the input of the vertical attenuator and compensate the three attenuators X8, X2, and X4 (in the order indicated.)
  3. Adjustment of the probe will require the use of either a high amplitude mercury pulser, or the use of a test scope to monitor the output vertical amplifier and using the Type 105 Square-Wave Generator.

JUL 2 1958

TEKTRONIX, INC.  
PORTLAND, OREGONFUNCTIONAL SPECIFICATIONSSpecial Cathode Ray Oscilloscope For Recording Transient  
Overvoltages On Consumer Circuits**I PURPOSE**

To make photographic records of voltage pulses superimposed upon 60 cps power frequency of 115, 230, and 460 volt circuits, between one line and ground.

**II OBJECTIVE**

A special purpose Cathode Ray Oscilloscope with only the essential features required for the high writing speed described; the lowest possible cost consistent with the final requirements described is essential to permit the volume indicated.

**III NUMBER OF UNITS NOW ANTICIPATED**

One prototype, and ten final designs.

**IV FUNCTIONAL SPECIFICATIONS**

- A.** High writing speed to display a non-repeating voltage pulse having the following limiting dimensions:
  - (1) 0.1 to 5 microseconds time to crest value.
  - (2) 30 microseconds maximum time to decay to one-half value.
  - (3) crest values between 750 and 5,000 volts.
- B.** The input signal will be applied directly to the vertical deflection plates. No vertical amplifier should be used, but provision must be made for focusing the beam.
- C.** A light tight bezel and automatic camera is required.
- D.** The input pulse being written will trip the sweep. The sweep may be logarithmic so as to display the pulse shape clearly, both front and tail.
- E.** The input pulse will also cause a film in the camera to advance one frame after a suitable time delay to photograph the input.
- F.** A separate timer circuit will advance the film one frame each 4 hours regardless of whether a record is made or not to prevent the film becoming fogged, 8 or 16 mm moving picture film is acceptable.
- G.** The instrument is to receive its operating power from a 115 volt

FUNCTIONAL SPECIFICATIONS (Cont.)

- single phase 60 cps source.
- H. The instrument is to be assembled in a grounded metal cabinet, for indoor use.

TYPE 515A OSCILLOSCOPE  
SERIAL

MCC

MANUAL  
ADVANCE

25/64 3/8 ?

This checked 515A panel with mod. 760A chassis.  
Request of Page Illinois, 5/27/49

FILM  
ADVANCE  
PULSE

3/8 7/8 ?  
7/8 7/8

921 SWEEP  
DURATION  
100 μSEC 20 μSEC

25/64 3/8 ?

FOCUS

25/64

INTENSITY

25/64  
3/8

ASTIGMATISM

25/64  
3/8

SCALE ILLUM.

25/64  
3/8

HORIZONTAL  
POSITIONING

25/64 3/8 ?

VERTICAL POSITIONING

5/16

+ 25/64 or 25/64

KILOVOLTS/CM

CAL. 2 1 .5

+ 25/64

Same as 515  
POWER ON  
1/4 - 1/2



TEKTRONIX, INC. PORTLAND, OREGON U.S.A.

for #/4

Hold down  
Screen

515A MOD 760A file

TYPE 515A  
MOD 760A

FOR REFERENCE ONLY

TYPE 515A  
MOD 760A

TYPE 515A  
MOD 760A

The instrument for which this manual was prepared has been modified to provide a photographic record of line transients in the range of 200v to 12kv. The sweep may be triggered by three methods; once each hour by a built-in timer, in the normal manner when a trigger pulse exceeds a preset level, and manually by pressing the MANUAL ADVANCE button.

### SPECIFICATIONS

The specifications listed below are different for this modified instrument from those listed in the Type 515A Instruction Manual.

#### Vertical-Deflection System

Step Attenuator--Three calibrated positions; .5, 1, and 2 kv/cm.  
Maximum Peak Input Voltage To Probe -- 12 kv.  
Input Impedance -- 100 megohm, 2.5pf with captive probe.

#### Horizontal-Deflection System

Two calibrated non-linear sweeps -- 20 and 100  $\mu$ sec sweep duration.  
Maximum sweep repetition rate -- approximately 5 cps.  
Sweep voltage rises exponentially at approx.

$$d=k(1-e^{-2.5t})$$

Where: d = horizontal displacement in cm.  
k = approximatley 10.9.  
t = fraction of total time.

Magnifier --deleted.

Trigger requirements -- 4 mm of deflection.

#### Other Characteristics

Cathode ray tube  
Type T55P11  
Acceleration potential -- Approx. 6325 volts.

07/62

FOR REFERENCE ONLY

Graticule -- Special high-voltage. 1 graticule division equals .85 cm.

Voltage calibrator

One preset range provides a 4 cm vertical deflection signal.  
Switched by vertical attenuator switch.

Output waveforms available -- None

Accessories Included

- 1 - Captive P6013 Probe
- 1 - Tinted Filter
- 2 - Instruction Manuals

FOR REFERENCE ONLY

## OPERATION

All front-panel controls on this instrument are screwdriver adjust controls. Front-panel controls and connectors not needed for the operation of this instrument have been removed. These include: INPUT SELECTOR, INPUT 1 and 2, DC BAL., VARIABLE VOLTS/CM, TRIGGER INPUT, TRIGGER SELECTOR, HORIZONTAL DISPLAY, EXT. HORIZ. INPUT, VARIABLE TIME/CM, +GATE OUT, SAWTOOTH OUT, SQUARE-WAVE CALIBRATOR, and CAL. OUT.

### Triggering

When connected to photograph line transients, this instrument will be triggered by signals with amplitudes producing more than 4 mm of crt display and hourly by pulses from the automatic timer, and may also be triggered manually. Each time the sweep is triggered a relay completes the film advance pulse circuit for operating a camera.

A one revolution per hour timer provides the automatic trigger. Each hour the line voltage is displayed and photographed. In the same manner, when the MANUAL ADVANCE button is pressed, the display is photographed and the film advanced.

When the Trig. Level Adj. is adjusted as described in the calibration procedure which follows, the oscilloscope will be triggered on any signal, either positive- or negative-going, that produces more than 4 mm of vertical deflection. All signals below this level will then be locked out and will not produce a trigger pulse. The triggering level

may be adjusted however, so the oscilloscope will trigger only on signals producing more than 4 mm of vertical deflection. To do this, apply a signal giving the desired minimum deflection and adjust the Trig. Level Adj. to the minimum setting at which a sweep is produced. Do not adjust this control to trigger on signals producing less than 4 mm deflection. If it is set too sensitive, random noise will trigger the sweep.

## CALIBRATION

### PRELIMINARY

### FOR REFERENCE ONLY

Due to the extensive circuit changes in this instrument, the calibration procedure given in the Type 515A Instruction Manual must be changed as follows to calibrate this instrument.

Make the following circuit changes before proceeding with the calibration of the instrument.

- (a) Disable the 2D21 thyratron, V180, and the relay circuit by removing the tube from its socket.
- (b) Shunt R180, R181 and R182 (located in the cathode circuit of V140A) with a 100k resistor. Then, the sweep can be triggered at a higher repetition rate.
- (c) Disconnect one side of the 220k, 1% resistor which shunts the timing capacitors (R160B, located on the sweep timing switch.) The sweep circuit will now function in a linear manner. This permits adjustment of the horizontal amplifier linearity controls. The resistor must be reconnected for the timing adjustment.
- (d) To compensate the input attenuator and the probe, a .05  $\mu$ f capacitor must be placed across the 100  $\mu$ sec sweep timing capacitor (C160B.) This provides a sweep rate of approximately 1 msec/cm.
- (e) Remove the connections to pin 8, V410B so as to disable half of the trigger pickoff circuit. Then, the sweep will always start on the rising portion of the waveform.
- (f) Disconnect the probe lead from the input attenuator switch (make the disconnection at the switch terminal.) Temporarily connect a UHF connector to this switch terminal. Keep the lead length as short as possible and ground the shield to the switch frame. This connector will be used to apply a square-wave directly to the Vertical Amplifier.

## PROCEDURE

Calibrate the instrument using the following procedure.

## POWER SUPPLY

Adjust Power Supply voltages by the procedure given in the Instruction Manual.

## CALIBRATOR ADJUSTMENT

Turn the KILOVOLTS/CM switch to any position except CAL. Connect an accurate voltmeter between ground and the CAL. VOLTAGE CHECK jack located on the side of the instrument. Adjust the CAL. ADJ. control for exactly +100 volts on the meter.

## TRIGGER-CIRCUIT ADJUSTMENTS

**FOR REFERENCE ONLY**

Triggering Level Centering and Trig. Sens. Adj.

Connect the Type 105 Square-Wave Generator to the connector added to the vertical input. Set the output frequency for about 1 kc. Adjust the output amplitude for about 4 mm of deflection. If a display cannot be obtained, check the Stability Preset Adjustment as given in the manual.

Connect a test oscilloscope to the junction of R5, R8, and the diodes D1 and D2. The waveform seen at this point should be positive pulses coincident with the rise and fall of the input square wave. The pulses through these diodes should be approximately equal in amplitude.

Connect a short lead from the junction of R16, R24 and R25 to ground. This corresponds to a zero adjustment of the Trig. Level Adj. control, R26. Adjust the Triggering Level Centering, R40, and the Trig. Sens. Adj. control, R28, for a stable display. Reduce the amplitude of the input signal and readjust the above controls until a stable trigger is obtained with about 2 mm of deflection.

Remove the ground lead from the junction of R16, R24, and R25.

### Triggering Level

With a 1kc square wave signal applied to the connector, adjust the Trig. Level Adj. control, R26, for a stable display of 4 mm amplitude. Set this control so that the display will be unstable with less than 4 mm of deflection. If the control is set too sensitive, the sweep may be triggered by random noise.

# TYPE 515A, MOD 760A

## Preset Stability Adjustment

Adjust the PRESET STABILITY control as given in the manual.

## CRT GEOMETRY ADJUSTMENT

Adjust the Geom. Adj. control as described in the manual.

## VERTICAL AMPLIFIER ADJUSTMENT

### DC Balance Adjustment

The dc balance control has been removed from this instrument.

### Gain Adjustment

**FOR REFERENCE ONLY**

Adjust the Vertical Amplifier Gain as described in the manual with the following exception. Switch the KILOVOLTS/CM control to the CAL. position. Then, adjust the gain control for a four-centimeter display.

### Attenuator Compensation

Follow the calibration procedure given in the manual with the following changes. Start the adjustment with the KILOVOLTS/CM control in the .5 position. Apply 1kc square waves from the Type 105 to the connector and adjust C326 for the proper square wave response. Turn the KILOVOLTS/CM switch to the 1 position and adjust C306. Then, set the switch to 2 and adjust C312 for the proper response.

### Input-Capacitance Adjustment

Set the KILOVOLTS/CM switch to .5. Connect a capacitance bridge or Tektronix Type 130 LC Meter to the connector on the input. Measure the capacitance in this position (should be about 20 pf.) Turn the KILOVOLTS/CM switch to 1 and adjust C305 for the same capacitance reading as obtained in the previous position. Repeat in the 2 kv position and adjust C311 for the correct capacitance.

### High-Frequency Compensation

Use the procedure given in the Instruction Manual.

## TIME-BASE CIRCUIT ADJUSTMENTS

## Approximate Horizontal Amplifier Gain

Disconnect the .05  $\mu$ f capacitor from C160B. Connect 10  $\mu$ sec markers from a Type 180 to the connector on the input. Set the SWEEP DURATION switch to 100  $\mu$ sec. Reconnect the 220k resistor shunting the timing capacitors. Adjust both the Mag. Gain Adj., R259, and the 100  $\mu$ sec sweep timing capacitor, C160B, until the 100  $\mu$ sec timing corresponds to that shown in Table 1. Switch to the 20  $\mu$ sec range and adjust C160A for a total sweep time of 20  $\mu$ sec.

Graticule Divisions	100 $\mu$ sec	20 $\mu$ sec
0	0	0
2	8.5	1.69
4	18.3	3.66
6	32.0	6.40
8	53.0	10.6
10	100.0	20.0

TABLE 1. Above sweep times based on the formula:

$$d = k (1 - e^{-2.5t}) \text{--See Specifications.}$$

## Sweep Linearity

Disconnect the 220k resistor from the timing capacitor. Switch the SWEEP DURATION switch to the 100  $\mu$ sec range. Set the Type 180 for 1  $\mu$ sec markers. If necessary, adjust C160B slightly so that the time marks coincide with the graticule lines, (approximately 3 markers per division.) Adjust C224 for best linearity for the first part of the sweep, and C210 for best overall linearity.

Switch to the 20  $\mu$ sec range and adjust C160A slightly to make the markers coincide with the graticule lines (approximately 1 marker per two centimeter.) Adjust C260 for best linearity over the first part of the sweep. Readjust C224 slightly if necessary to obtain the best overall linearity. Since these adjustments interact, recheck the linearity on both ranges.

## Sweep Timing

Reconnect the 220k shunt timing resistor. Set the Time-Mark Generator for 5 and 10  $\mu$ sec time markers. Set the SWEEP DURATION

**FOR REFERENCE ONLY**

## TYPE 515A, MOD 760A

switch to 100  $\mu$ sec. Adjust both the Mag. Gain Adj., R259, and C160B slightly until the timing over the entire 100  $\mu$ sec range corresponds as near as possible to that shown in Table 1. Do not change the Mag. Gain Adj. setting in any of the following steps.

Change the SWEEP DURATION switch to 20  $\mu$ sec. Apply 1  $\mu$ sec timing markers to the input. Adjust the timing capacitor C160A for a total sweep time of 20  $\mu$ sec. Then, compare the timing over the entire range to the values given in Table 1. If necessary, readjust C224 and C160A slightly to obtain the best overall timing.

### Sweep Length Adjustment

Adjust the Sweep Length control, R156, for a 10 1/2 centimeter sweep.

### Check Sweep Hold-Off Time

## FOR REFERENCE ONLY

Remove the 100k resistor shunting R180, R181 and R182. Set the time-mark generator for 100  $\mu$ sec markers. Connect a test oscilloscope to pin 3 of the Unblanking C.F., and adjust its Time/Cm so that two sweep gating waveforms are displayed. Measure the time between these gate pulses. This time should be about 220 milliseconds, but not less than 140 milliseconds.

### PROBE COMPENSATION

Remove the UHF connector attached to the vertical attenuator switch. Replace the probe lead to the switch. Replace the .05  $\mu$ f capacitor in parallel with C160B. Because of the high attenuation of the captive probe, a special circuit must be used to compensate the probe.

The circuit shown in Fig. 1 is suggested for probe compensation. Be sure that the Type 109 or 110 VOLTAGE RANGE switch is set to EXT. PWR. Keep all lead lengths as short as possible. The mercury switch in the pulse generator is used to produce a large voltage step at a fairly high repetition rate. Apply the 500v to the  $50\Omega$  CHG. LINE 1 connector through the  $100\Omega$  resistor. Take the output from the  $50\Omega$  OUTPUT CONNECTOR.

Adjust the probe compensation as outlined in the P6013 Instruction Manual.

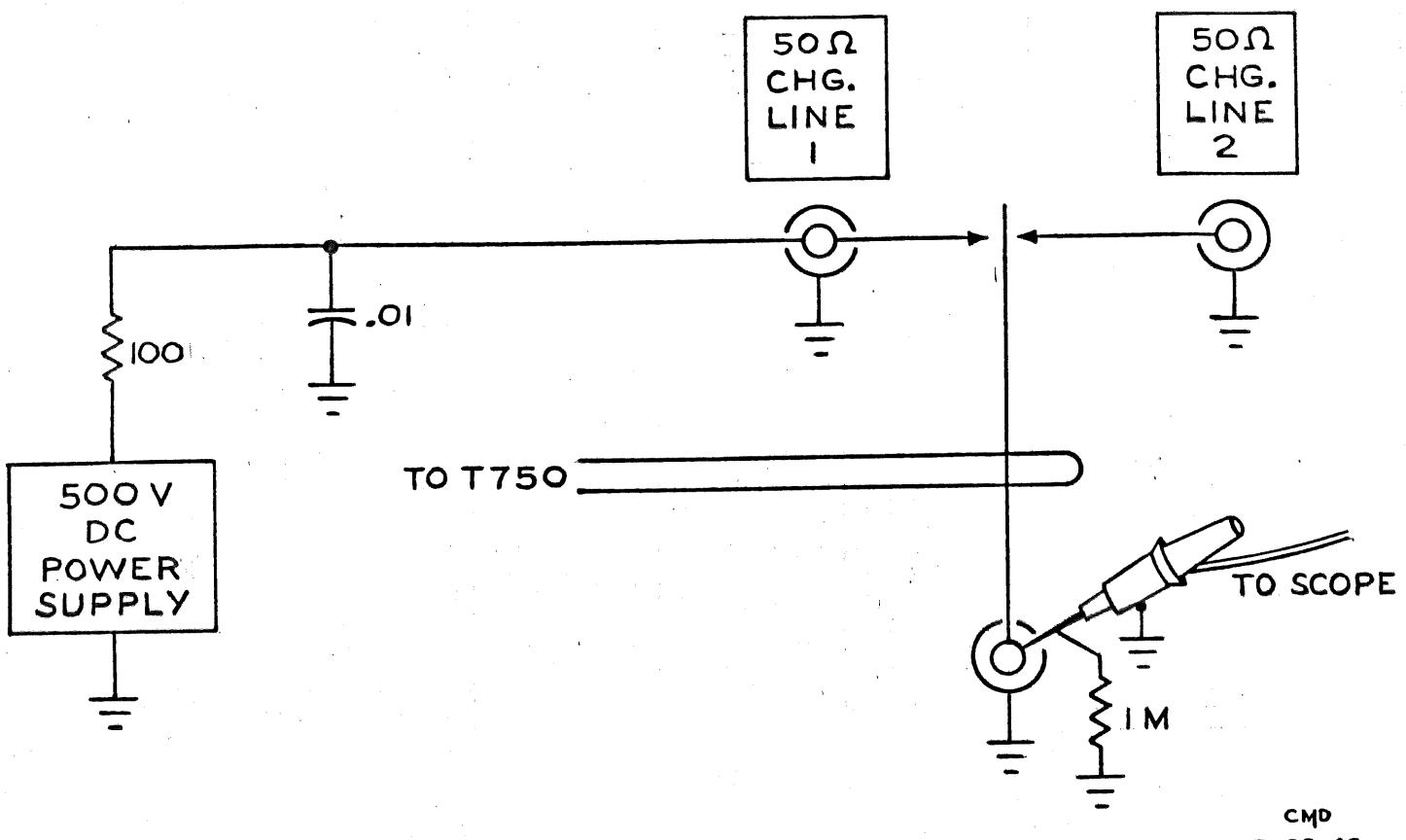


FIG. I

## FOR REFERENCE ONLY

Return the instrument circuit to normal by replacing all connections and tubes, and removing any added components..

### Film Advance Pulse Check

With V180 in place, connect an ohmmeter to the front panel FILM ADVANCE PULSE jack. Connect a test oscilloscope and a 10 k resistor in parallel with the ohmmeter. Connected in this manner, the ohmmeter will produce a small voltage drop across the resistor when the relay contacts are open. This voltage can be seen on the test oscilloscope. Press the MANUAL ADVANCE switch, and measure the time that the relay remains closed as seen on the oscilloscope. This time should be about 140 milliseconds.

**PARTS LIST  
BULBS**

B152	Delete
B222	Delete
B357	Delete

**CAPACITORS**

C1	Add	.005 $\mu$ f	Discap	500v	283-001
C2	Add	.005 $\mu$ f	Discap	500v	283-001
C3	Delete				
C4	Delete				
C6	Add	.001 $\mu$ f	Discap	500v	283-000
C7	Add	.001 $\mu$ f	Discap	500v	283-000
C9	Delete				
C21	Delete				
C120	Delete				
C160A	Change to	7-45pf	Cer	Var	281-012
C160B	Change to	7-45pf	Cer	Var	281-012
C160C	Change to	100pf	Cer		281-523
C160D	Change to	47pf	Cer		281-518
C160E	Delete				
C160F	Delete				
C160G	Delete				
C160H	Delete				
C160J	Delete				
C180	Add	.01	PTM	400v	285-510
C180A	Delete				
C180B	Delete				
C180C	Delete				
C180D	Delete				
C180E	Delete				
C183	Add	.001 $\mu$ f	Cer	500v	281-536
C184	Delete				
C186	Add	.001 $\mu$ f	Discap	500v	283-000
C267	Delete				
C301	Delete				
C305	Add	3-15pf	Cer	Var	281-007
C315	Delete				
C316	Delete				
C317	Delete				
C319	Delete				
C320	Delete				
C321	Delete				

**FOR REFERENCE ONLY**

## TYPE 515A, MOD 760A

C326	Change to	4.5-25pf	Cer	Var	281-010
C328	Add	82pf	Cer	500v	281-528
C334	Delete				
C342	Delete				
C355	Delete				
C401	Delete				
C708A,B	Change to	3 x 10 $\mu$ f	EMC	450v	290-033
C721	Delete				
C723	Add	.0025 $\mu$ f	Discap	6kv	283-036
C724	Add	.0025 $\mu$ f	Discap	6kv	283-036

## DIODES

D1	Add	T12G	Germanium	152-008
D2	Add	T12G	Germanium	152-008

## RESISTORS

R1	Add	5.6k	1/2w	Comp	10%	302-562
R2	Add	5.6k	1/2w	Comp	10%	302-562
R3	Delete					
R4	Delete					
R5	Change to	3.9k	1/2w	Comp	10%	302-392
R6	Add	1M	1/2w	Comp	10%	302-105
R7	Add	2.2M	1/2w	Comp	10%	302-225
R8	Change to	10k	1/2w	Comp	10%	302-103
R9	Delete					
R19	Change to	330k	1/2w	Comp	10%	302-334
R21	Delete					
R22	Delete					
R23	Delete					
R24	Change to	10k	1/2w	Comp	10%	302-103
R25	Change to	470k	1/2w	Comp	10%	302-474
R26	Change to	50k	2w	Var		311-023
R32	Delete					
R45	Delete					
R119	Delete					
R120	Delete					
R121	Change to	47k	1w	Comp	10%	304-473
R122	Delete					
R145	Delete					
R151	Delete					
R152	Delete					
R153	Delete					
R154	Delete					

FOR REFERENCE ONLY

## TYPE 515A, MOD 760A

R160A	Change to	200k	1/2w	Prec	1%	309-051
R160B	Change to	220k	1/2w	Prec	1%	309-052
R160C	Delete					
R160D	Delete					
R160E	Delete					
R160F	Delete					
R160G	Delete					
R160H	Delete					
R160J	Delete					
R180	Add	33M	1/4w	Comp	10%	309-336
R180A	Delete					
R180B	Delete					
R181	Change to	4.7M	1/2w	Comp	10%	302-475
R182	Change to	33M	1/4w	Comp	10%	309-336
R183	Delete					
R184	Change to	10k	1/2w	Comp	10%	302-103
R185	Change to	1k	1/2w	Comp	10%	302-102
R186	Add	10k	1/2w	Comp	10%	302-103
R187	Add	8.2k	1/2w	Comp	10%	302-822
R188	Add	150k	1/2w	Comp	10%	302-154
R222	Delete					
R224	Change to	150k	1/2w	Prec	1%	309-049
R225	Delete					
R230	Delete					
R237	Change to	100Ω	1/2w	Comp	10%	302-101
R265	Delete					
R266	Delete					
R267	Delete					
R270	Change to	100Ω	1/2w	Comp	10%	302-101
R301	Delete					
R302	Delete					
R313	Delete					
R316	Delete					
R317	Delete					
R320	Delete					
R321	Delete					
R326	Change to	875k	1w	Prec	1%	310-096
R327	Change to	250k	1/2w	Prec	1%	309-380
R328	Add	250k	1/2w	Prec	1%	309-380
R338	Delete					
R339	Delete					
R341	Delete					
R342	Delete					
R353	Delete					

FOR REFERENCE ONLY

R354	Delete				
R355	Delete				
R356	Delete				
R357	Delete				
R401	Delete				
R416	Change to 680Ω	1/2w	Comp	10%	302-681
R570	Change to 30k	1/2w	Prec	1%	309-153
R571	Delete				
R572	Delete				
R573	Delete				
R574	Change to 610Ω	1/2w	Prec	1%	309-113
R575	Delete				
R576	Delete				
R577	Delete				
R578	Delete				
R579	Delete				
R580	Delete				

## FOR REFERENCE ONLY

### SWITCHES

SW5 and			
SW20	Delete		
SW6	Add Push-button	MANUAL ADVANCE	260-016
SW145	Delete		
SW160	Change to Rotary	SWEEP DURATION	030-112
SW200	Delete		
SW301	Delete		
SW311	Add Rotary	KILOVOLTS/CM	030-111
SW321	Delete		
SW500	Delete		

### RELAYS

K186	Add	24F-1115, Potter Brumfield MH 11L	Special
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### TUBES

V180	Change to 2D21	154-171
V722	Add 5642	154-051
V859	Change to T55P11	154-127

### MECHANICAL

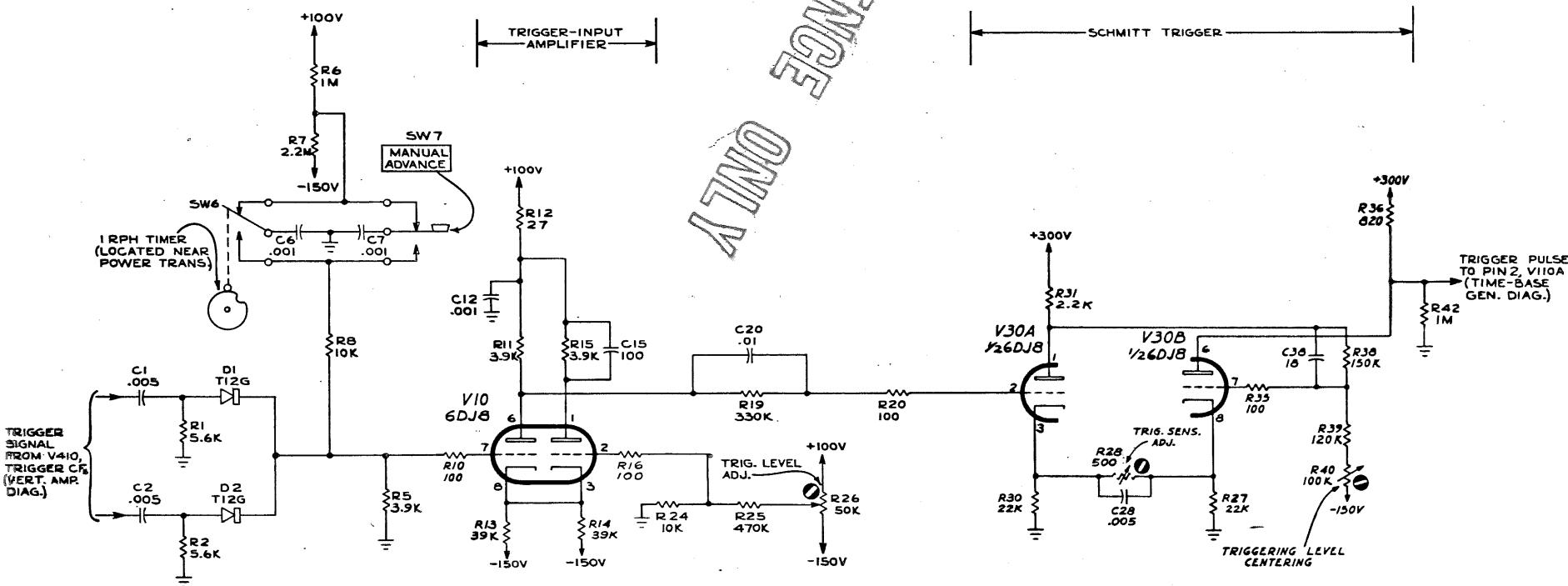
Description	Qty.	Tek. No.
BUSHING, Aluminum	Add 8	358-010
CONNECTOR, UHF	Delete 4	

## TYPE 515A, MOD 760A

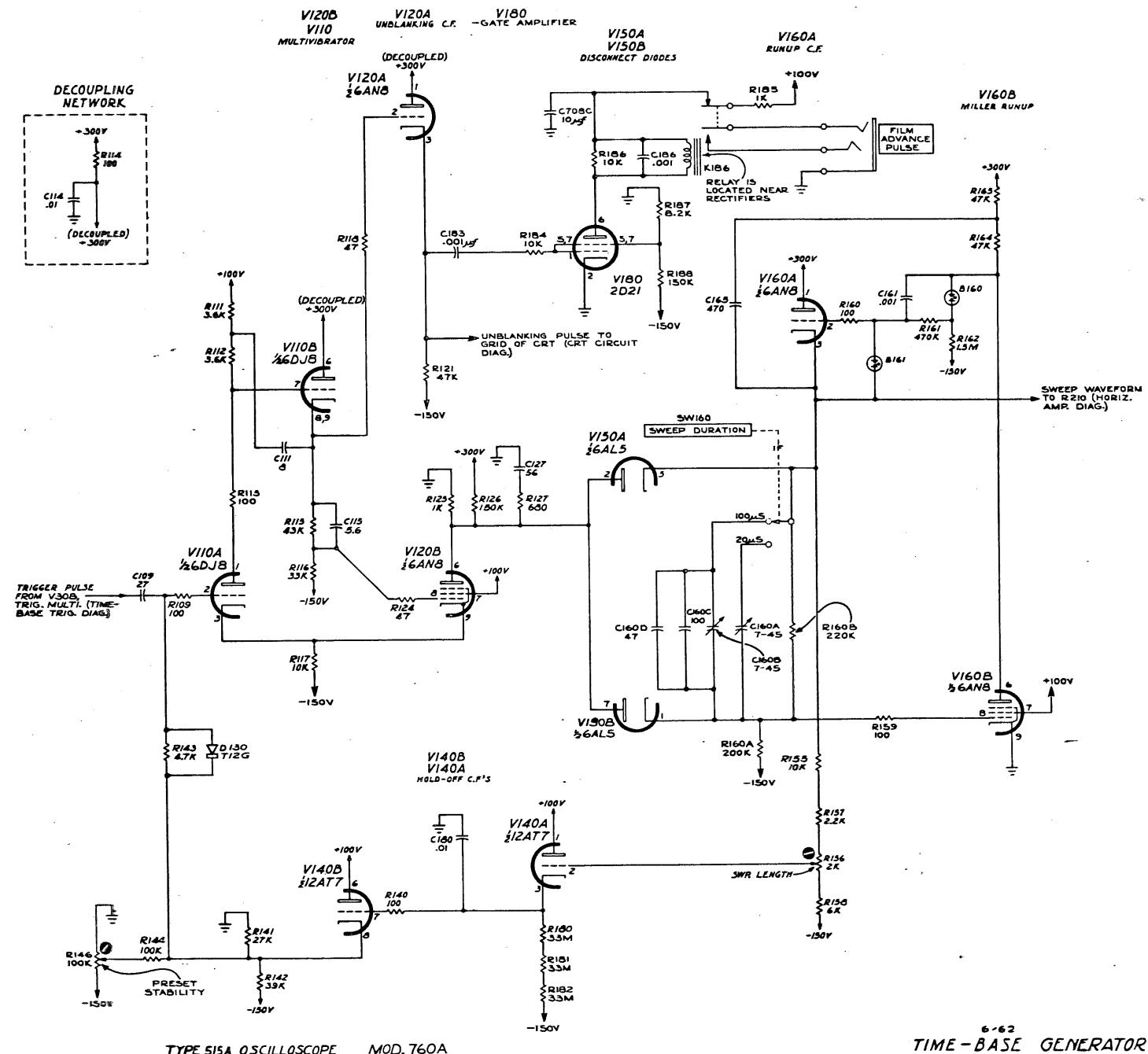
G RATICULE, Special High Voltage	Change to	331-051
GROMMET, Rubber, 5/8	Add 1	348-012
JACK, Phone	Add 1	Switchcraft 12B-JAX
KNOB, Large Black 1.225 Flange 1/4 Insert Hole	Delete 4	
KNOB, Large Black 1.225 Flange 1/4 Conc. Hole	Delete 2	
KNOB, Large Black 1.225 Flange 17/64 Insert Hole	Delete 1	
KNOB, Small Red .694 Dia. 1/8 Insert Hole	Delete 2	
KNOB, Small Red .694 Dia. 3/16 Insert Hole	Delete 1	
KNOB, Small Black	Delete 5	
KNOB, Small Red .780 Dia. 1/8 Insert Hole	Delete 1	
KNOB, Large Black 1.375 Dia. 1/4 Conc. Hole	Delete 1	
MOTOR, Timer, 1RPH	Add 1	Hayden #30677 RX
NUT, Aluminum	Add 1	210-429
NUT, Aluminum	Add 7	210-494
PANEL, Front	Change to	Film #921
POST, Binding, 5-Way	Delete 3	
POST, Ground	Delete 3	
ROD, Nylon	Add 4	385-016
SHIELD, Aluminum	Change to	Dwg. B.S. 55
SOCKET, 7-Pin	Add 1	136-044
SOCKET, 9-Pin	Delete 1	
STRIP, Ceramic, 4-Notch	Add 1	124-088
STRIP, Ceramic, 9-Notch	Add 1	124-090
STRIP, Ceramic, 3-Notch	Add 2	124-092

*Panel, Front**Typ, Adaptor, H.V. handle**Change to**C5-64**Add**AS-79***FOR REFERENCE ONLY**

07/62

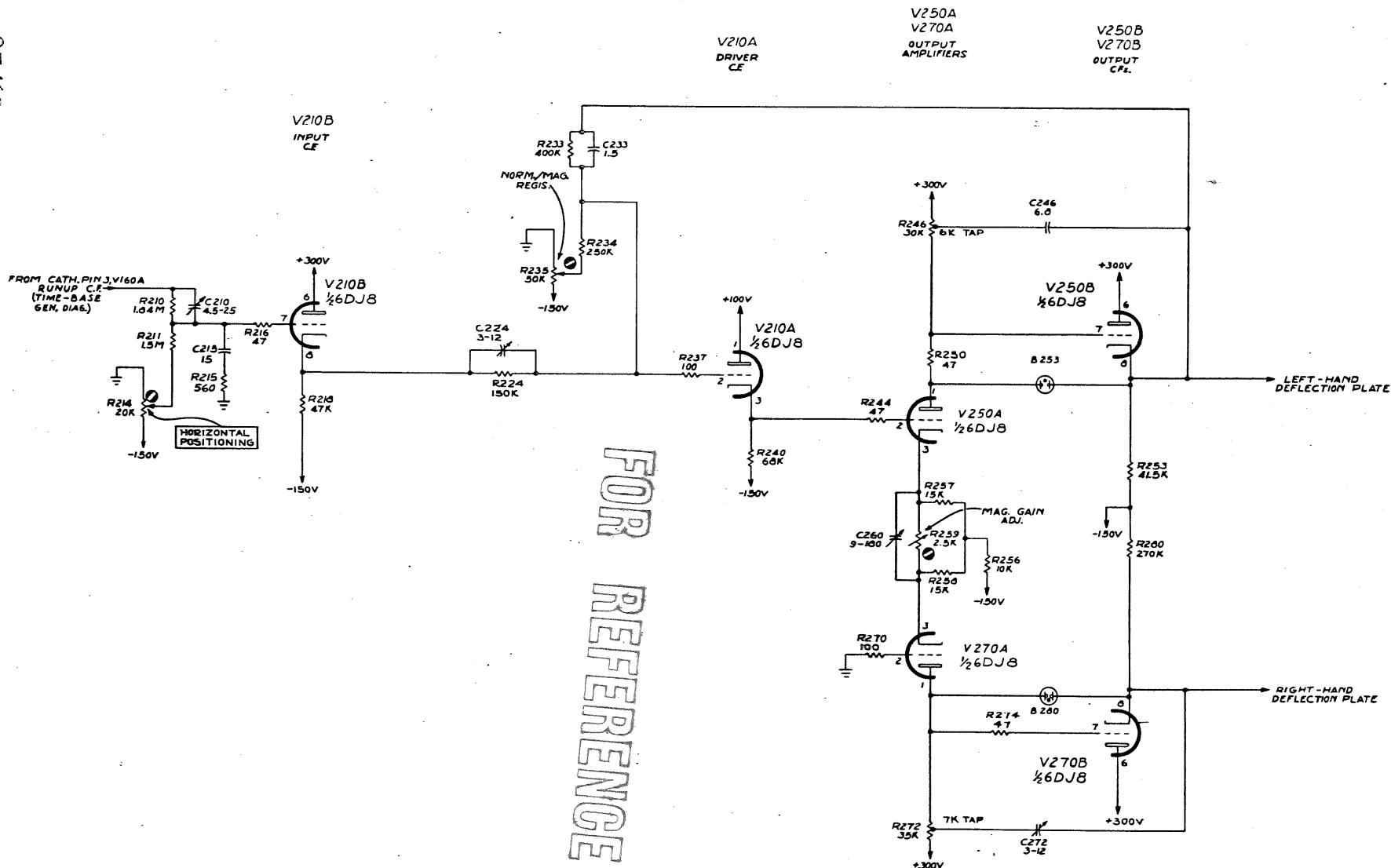
6-62  
TIME-BASE TRIGGER

07 / 62



**6-62**  
**TIME-BASE GENERATOR**

07/62

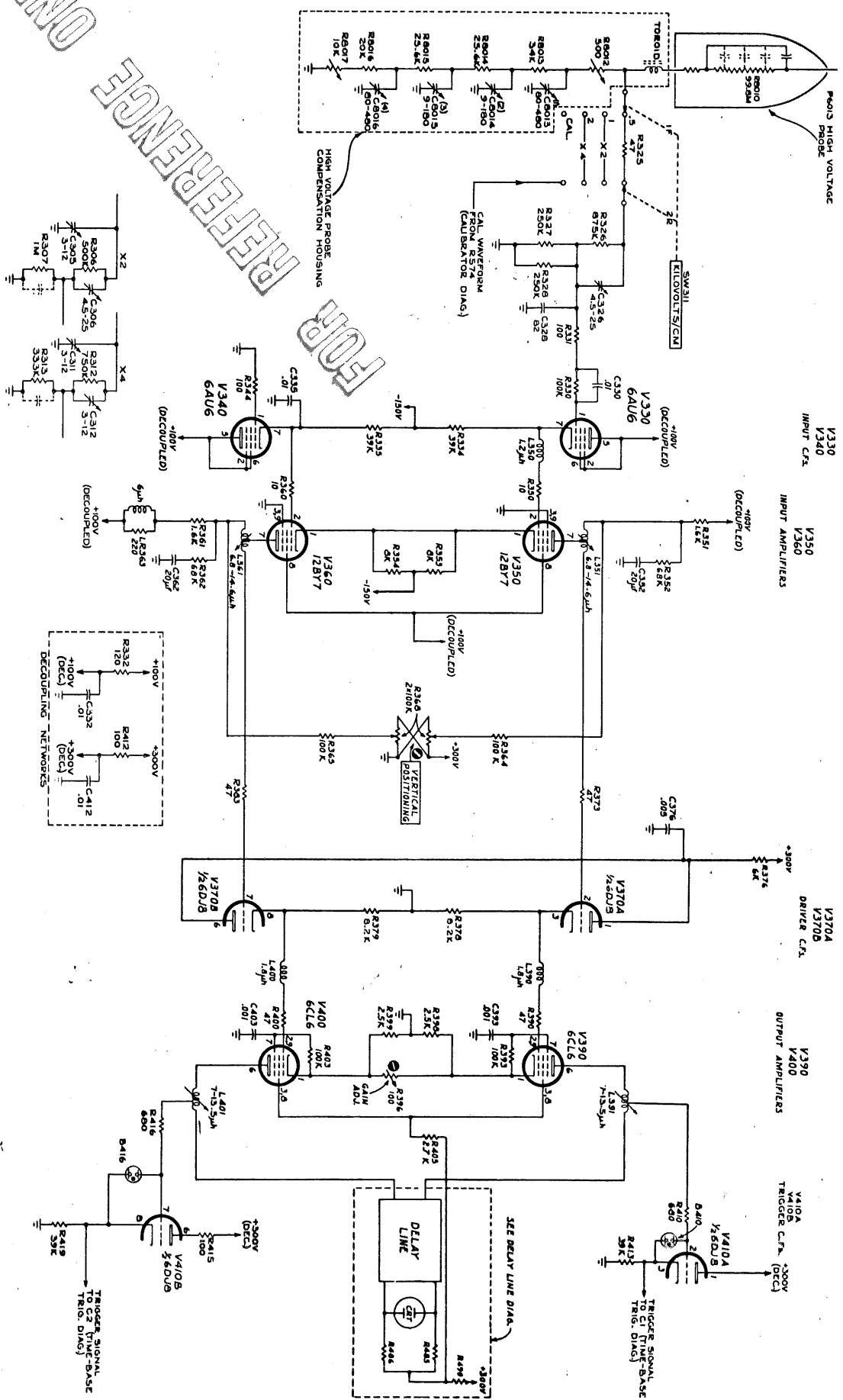


## TYPE 515A OSCILLOSCOPE

MOD. 760A

<sup>6-62</sup>  
**HORIZONTAL AMPLIFIER**

FOR  
REFERENCE  
ONLY



TYPE

A large, bold, italicized word "REFERENCE" is oriented diagonally from the top-left towards the bottom-right. Below it, a smaller technical drawing shows a rectangular component with a central slot and two diagonal lines extending from its right side, labeled "X" at the end of one line.

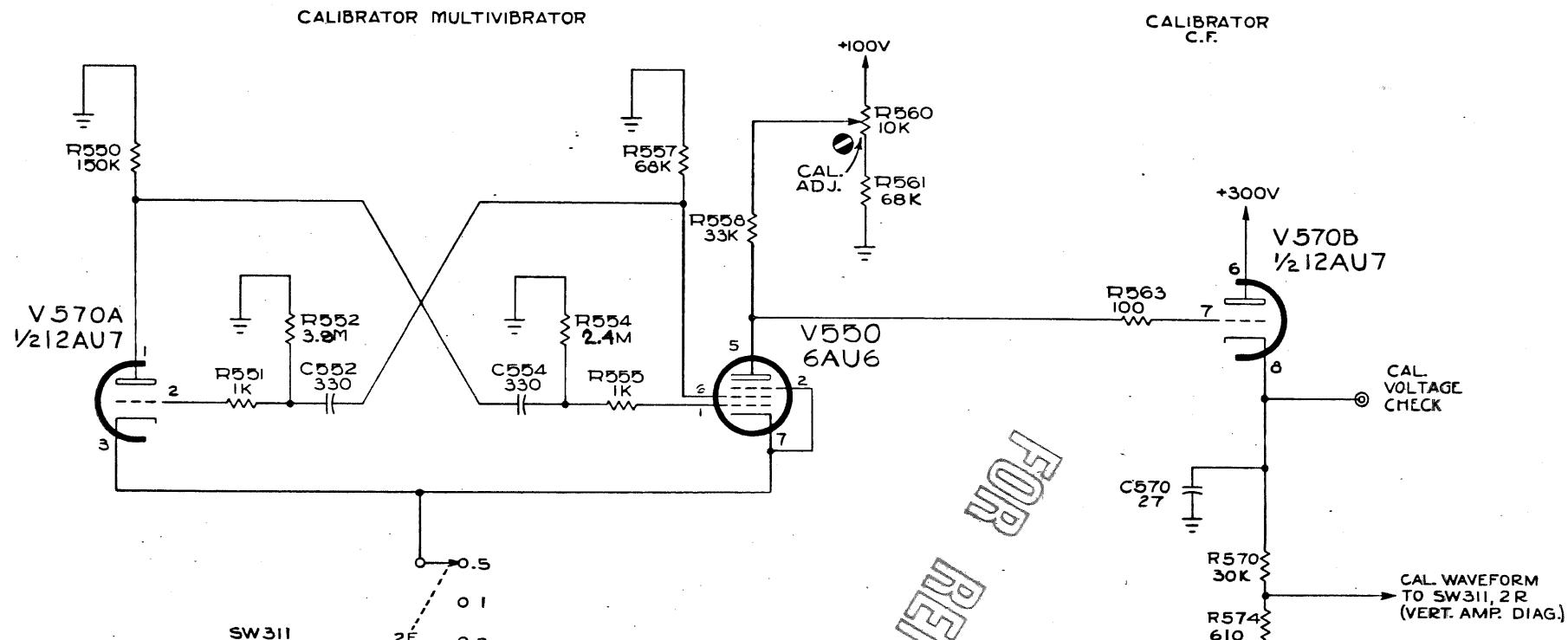
四〇一

### TYPE 515A OSCILLOSCOPE

MOD. 760A

## 6-62 VERTICAL AMPLIFIER

07/62

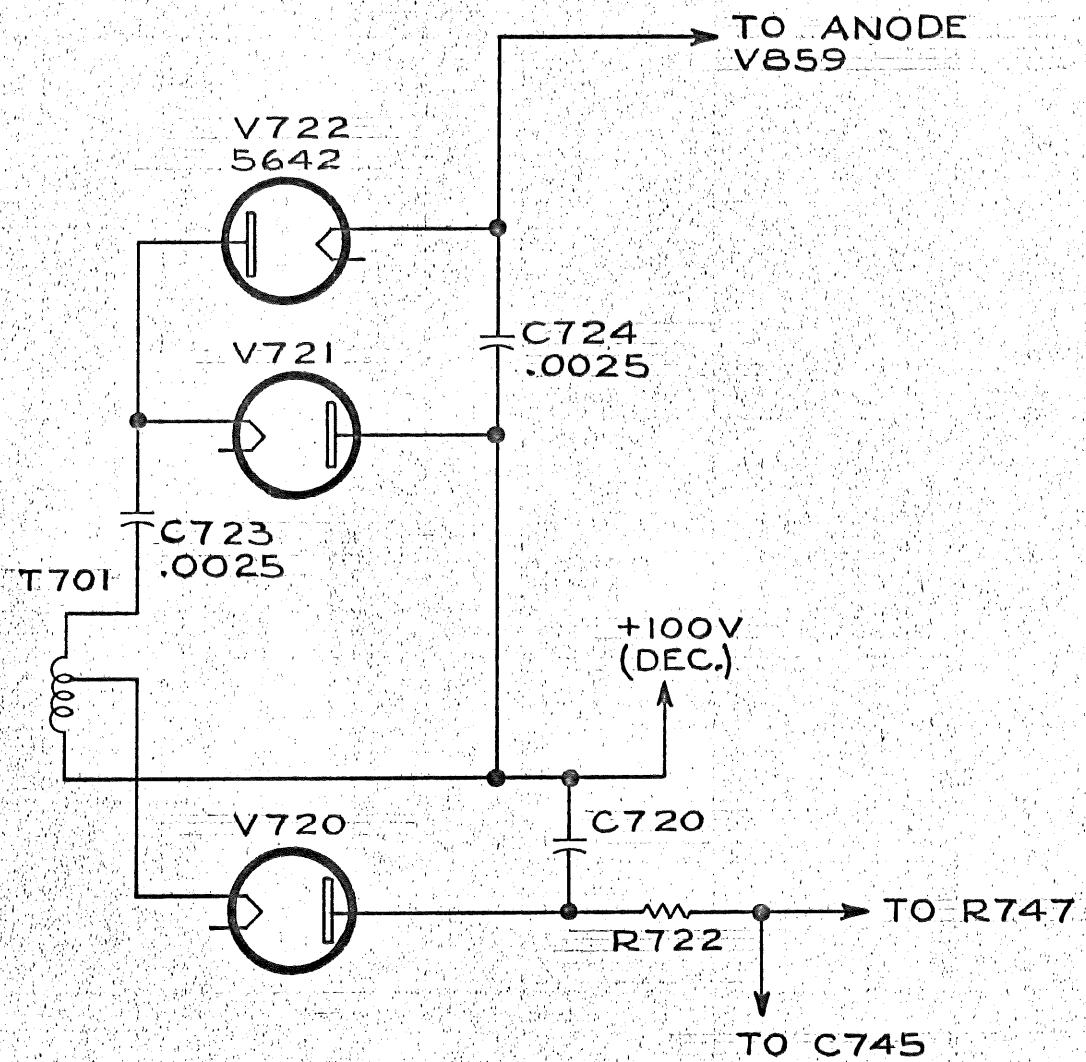


TYPE 515A OSCILLOSCOPE

MOD. 760A

TYPE 515A , MOD 760A

FOR REFERENCE ONLY

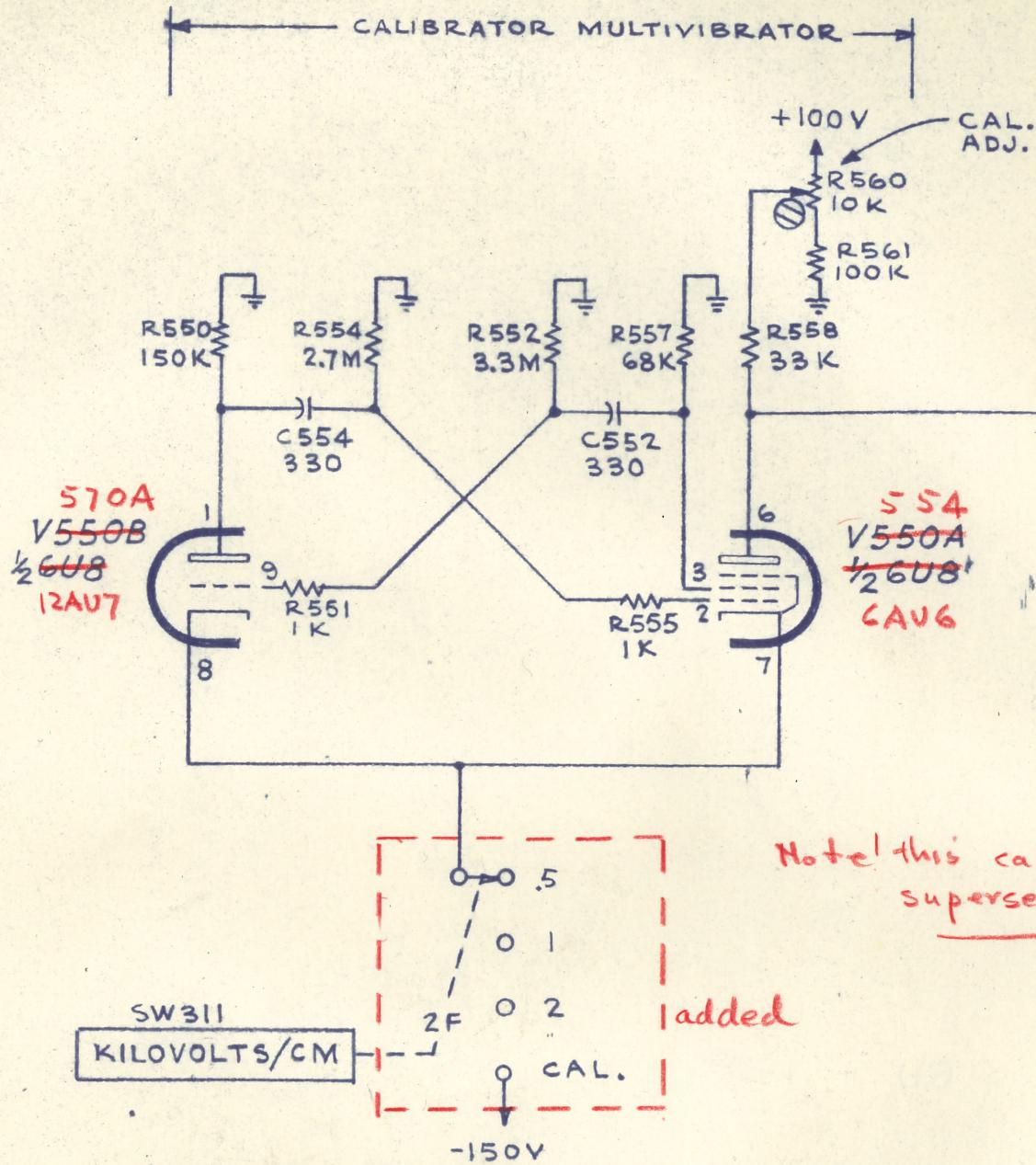


PLM  
6-62

PART. CRT CIRCUIT

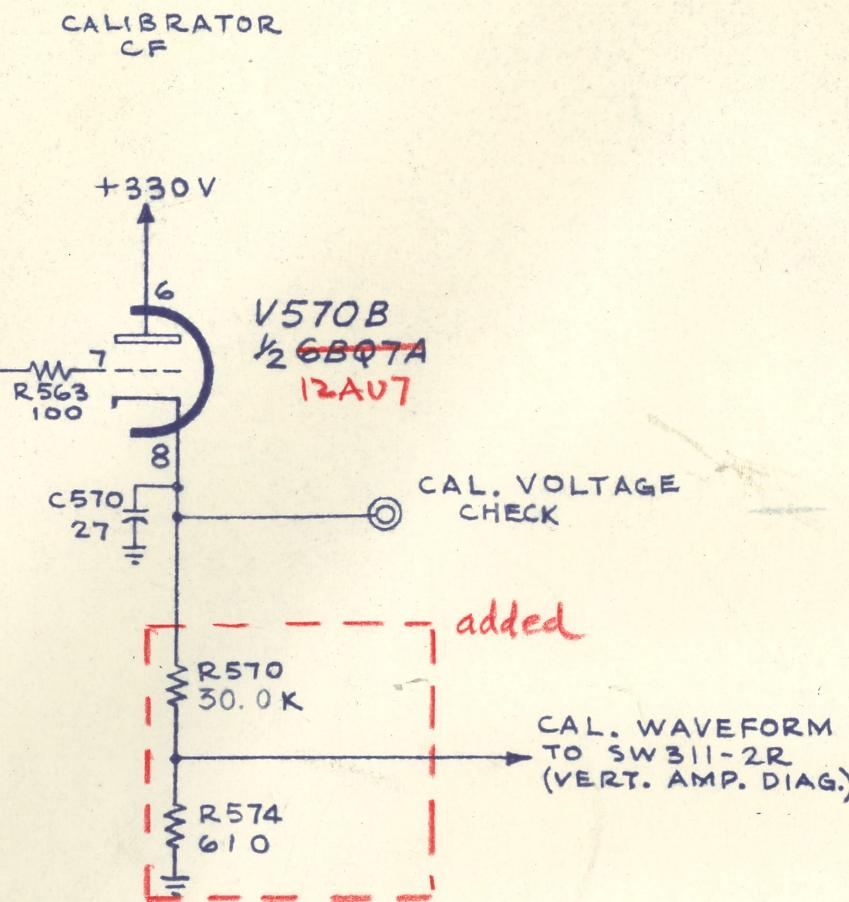
Note:

Original circuit diagrams dated 6-9-59 by R. F. are kept in "C size mech. drawings" drawer, and cards are kept in drawing file under "C gen. info."



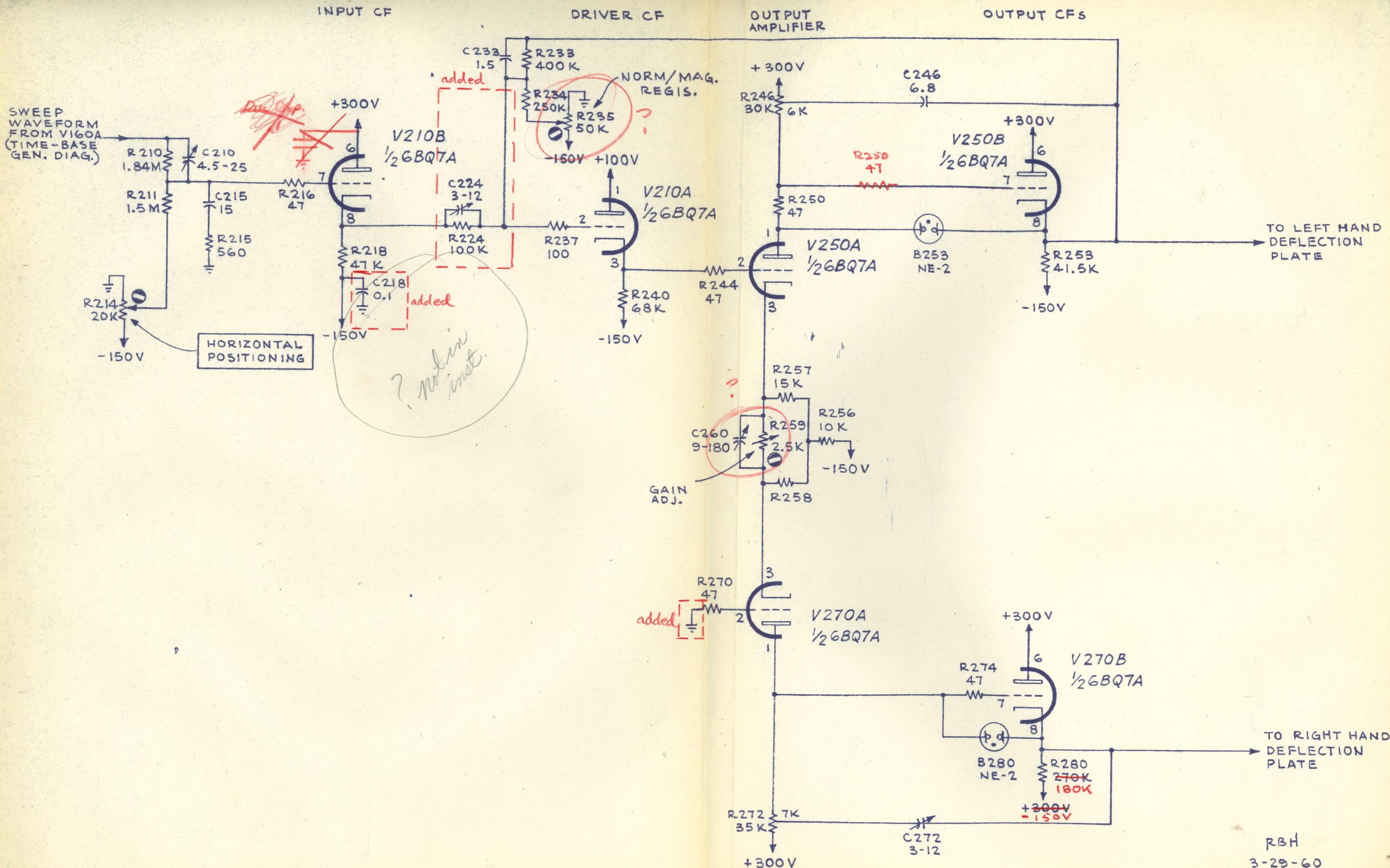
TYPE 515A OSCILLOSCOPE  
MOD. 760A

Reference Only



RBH  
3-21-60

CALIBRATOR



TYPE 515A OSCILLOSCOPE  
MOD. 760A

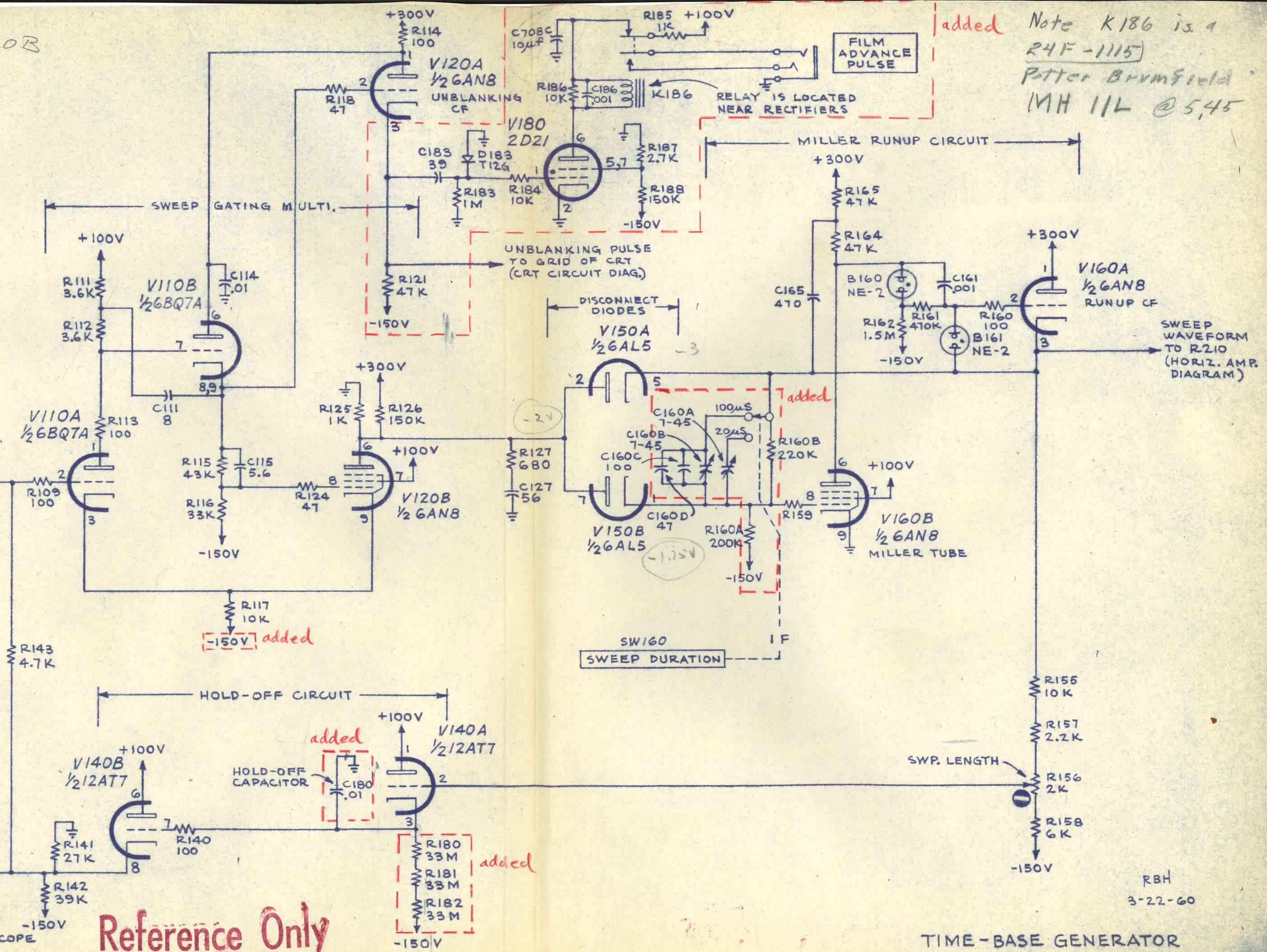
Reference Only

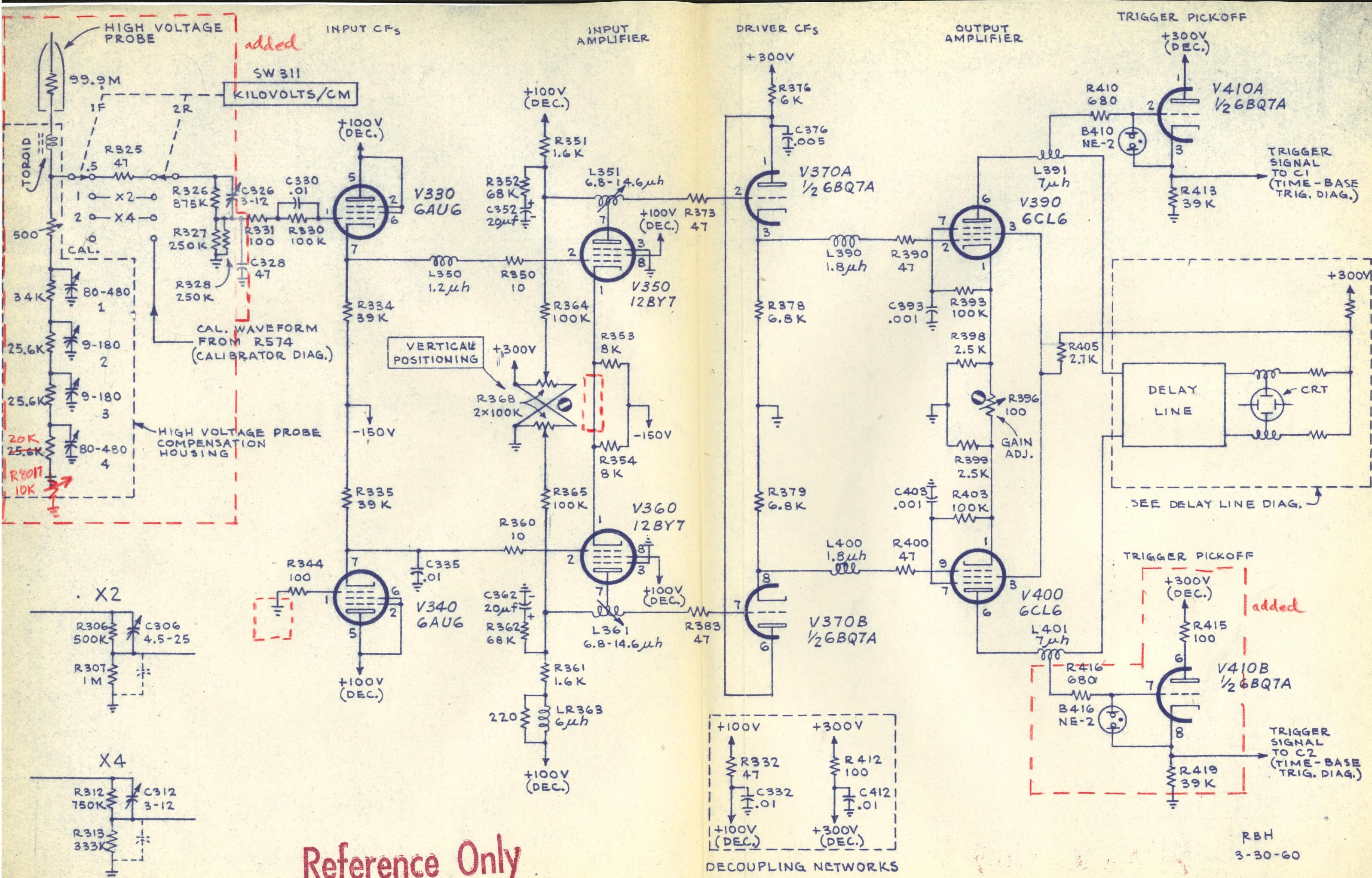
HORIZONTAL AMPLIFIER

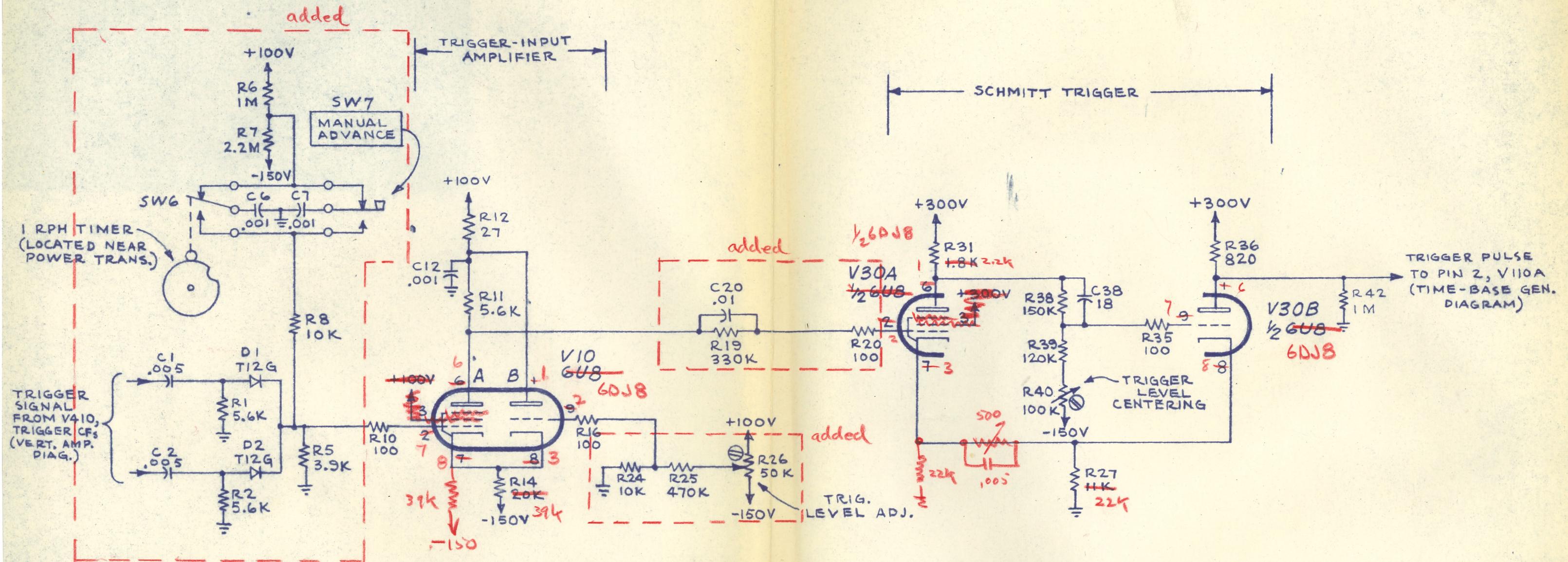
RM 45 420B

7394

20  
20  
X0







RBH  
3-21-60

TYPE 515A OSCILLOSCOPE  
MOD. 760A

TIME-BASE TRIGGER

Reference Only

# 515A Mod 760A

(3)

## G. Calibrator

1. A fixed divider replaced the step divider and provides a 2 volt  $\pm 3\%$  square wave of approximately 1 Kc.

## H. CRT Circuit

1. The positive supply was changed to a voltage doubler to provide a total of approx. 6325 volts required for a higher writing rate.
2. A special CRT T55P1LL is provided

## RECALIBRATION PROCEDURE:

*some respects*

In general the 515A, Mod. 760A can be calibrated as outlined in the instruction manual, if the following circuits are altered changes as indicated will be necessary for various steps in the calibration procedure. ~~Shunt R181 (4.7M resistor in the cathode circuit of V140A)~~

B. Open the hold-off capacitor .1uf at cathode of V140A, or shunt R180, R181, R182 with 100K resistor. This will allow the sweep circuit to function at a higher repetition rate.

C. Open the 220K, 1% resistor which shunts the time capacitor (located on sweep timing switch.) The sweep circuit now functions in a linear manner. This permits adjustment of the linearity controls in the horizontal amplifier.

For sweep timing ~~adjustments~~ it is necessary to operate the sweep non-linear requiring original connection of the 220V 1% ~~reconnect this 220K resistor.~~

Set C160A, C160B mid scale and set the 100usec pos. with R259 (Mag. gain adj.) then set 20usec pos. with C160A. The Sweep Mag. Res. is set as per manual but R224 will have to be shorted to simulate mag. pos.

D. Disable half the trigger pick-off circuit by removing a cathode lead at V410. The sweep will now start with either a rising or falling signal dependent upon which cathode lead is disconnected.

~~D. The following technique is suggested when aligning the vertical system:~~

E. Adjustments of vertical amplifier high frequency compensation, delay line compensation, and input attenuator compensation will require connecting

disconnecting the lead from the probe to the input attenuator switch.

~~(Disconnect this lead at the terminal tip on the switch), and reconnecting~~

~~the 105 square wave generator to~~

1. Connect the Square-Wave Generator (Type 105 or 107) direct to the output of the 8X attenuator (i.e. input to amplifier.) Terminate the cable at the output end for best results. The vertical amplifier and delay line can now be adjusted for proper response. (Refer to manual for additional details.)

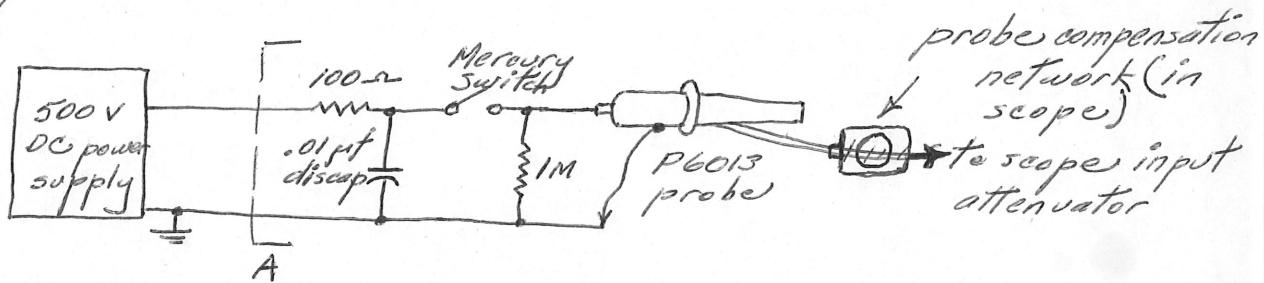
2. Connect the Square-Wave Generator to the input of the vertical attenuator and compensate the three attenuators X8, X2, and X4 (in the order indicated.)

3. Adjustment of the probe will require the use of either a high amplitude mercury pulser, or the use of a test scope to monitor the output vertical amplifier and using the Type 105 Square-Wave Generator.

(4)

the input attenuator at this point. Use lead lengths (both signal and ground leads) as short as possible in connecting from the 50-ohm coax cable termination to the attenuator switch, preferably not over  $\frac{1}{2}$  to  $\frac{2}{3}$  inches. (A convenient method, is to solder in an Amphenol type 50-239 UHF chassis connector <sup>temporarily</sup> at this point. Ground the UHF connector to the switch frame.)

F. Compensation of the high voltage probe will require special equipment, because of the very high attenuation. The following circuit is suggested:



Keep lead lengths from point A to the probe as short as possible. A mercury relay ~~will~~ operating as a switch at a ~~high repetition rate~~ ~~but does not~~ ~~will~~ (such as a Tektronix type 109 or 110 pulse generator) ~~will~~ greatly facilitate making this test.

G. Adjustment of triggering level requires some special means of connecting a fast-rise signal to the vertical amplifier. A circuit

as described in para. F above, but with provision for adjusting the DC voltage from about 150 to 500 volts, would be satisfactory.

An alternative method is to connect a pulse or square wave signal, variable in amplitude, to the input attenuator switch similar to that described in para. E above. (It will not be necessary to disconnect the probe lead in this case.)

~~H. S. Agar~~

## Recalibration (Section 6)

### Para. 6 CRT Geometry

Connect 10  $\mu$  sec. markers or a 100 KC square wave into the vertical input attenuator (See para. E).

### Para 7 Triggering Level Centering

Connect the type 105 square wave generator to the vertical input attenuator (See para. E) Set frequency of the 105 to 1 KC and adjust amplitude to give  $\frac{1}{2}$  mm <sup>about</sup> of vertical deflection.

Connect another oscilloscope to the junction of R5 and the diodes, D1 and D2, at the input to V10. The waveform at this point should be positive pulses coincident with the rise and decay of the square wave. These pulses should be of approximately equal amplitude.

Ground the junction of R16, R21, and R25 with a short lead. (This corresponds to a zero adjustment of Triggering Level.) Adjust the Trig. Level Centering control until a stable display is obtained. (If no display is obtained check adjustment of the Preset Stability control.) Reduce amplitude of the square wave signals, and readjust the Trig. Level Centering until the point of minimum amplitude for stable triggering is reached (about 1 to 2 mm).

Remove the ground lead installed above.

### Para. 8. Int. Trig. DC Level Centering

Not applicable.

→ (A para. could be included here on adjustment of Trig. sensitivity.)

### Add Para 8(a). Triggering Level

Adjust the Trig. Level for a stable display of the <sup>1KC</sup> square wave. Then adjust amplitude of the square wave for the minimum trigger threshold desired. (This is set at about 3 mm at the factory.) Readjust the Trig. Level control as necessary such that no trigger is obtained below the threshold desired, but triggering is stable for amplitudes greater than this. (It is not recommended that the Level be set at less than 3 mm, as noise voltages may cause undesired triggering.)

### Para. 9. Preset Stability

The Preset stability control should be adjusted midway between the counter-clockwise point at which triggering stops when a signal is present, and the clockwise point at which the sweep free-runs without any signal present. (Make this adjustment after the Trig. Level has been set in para. 8(a) above.)

## Para. D Time-Base Generator and Horizontal Amplifier

Adjustment of sweep timing and linearity requires a different procedure than normally used. First, ~~it will be necessary to~~ connect a 180A Time Mark Generator into the vertical input attenuators. This may be done <sup>as</sup> ~~similar to that~~ described in Para E. for the square wave generator, however the 50-ohms termination is not needed.

1. ~~First~~ Establish an appropriate setting of the horizontal amplifier gain. ~~length~~  
~~shunt~~ Connect 10  $\mu$ sec timing markers and set the Sweep Duration switch to 100  $\mu$ secs. (This must be done with the 220K shunt timing resistor connected. See Para. C) Adjust both the Gain Mag. Gain Adjust and 100  $\mu$ sec sweep timing capacitor (C160B) until timing over the 100  $\mu$ sec range corresponds appropriately to that shown in TABLE I. Switch to the 20  $\mu$ sec. range and adjust C160A to give a total sweep time of 20  $\mu$ sec.

2. Sweep linearity. Disconnect the 220 K shunt timing resistor (See Para. C). Two capacitors, C210 and C224, will have most effect on linearity, C260 will have a slight effect, and C272 has almost no effect.

Switch to the 100  $\mu$ sec range and connect

(9)

TABLE I

The ~~histogram~~ table of ~~the~~ sweep time corresponding to graticule divisions is based on the formula:

$$d = 10.9(1 - e^{-2.5t})$$

where  $d$  is the number of graticule divisions, and  $t$  is the fraction of total sweep time.

<u>100 <math>\mu</math>sec sweep</u>		<u>20 <math>\mu</math>sec sweep</u>	
<u>Graticule Divisions</u>	<u>Time</u>	<u>Graticule Divisions</u>	<u>Time</u>
0	0	0	0
2	8.58 $\mu$ sec.	2	1.69 $\mu$ sec.
4	18.3 "	4	3.66 "
6	32.0 "	6	6.40 "
8	53.0 "	8	10.6 "
10	100.0 "	10	20.0 "

1  $\mu$ sec timing markers. Adjust the timing capacitor C1608 a slight amount if necessary until timing marks coincide with graticule lines (approx. 3 markers per division). Adjust C224 for best linearity over the first part of the sweep and C210 for best overall linearity.

Switch to the 20  $\mu$ sec range and adjust the timing capacitor C1608 slightly if needed to make markers coincide with graticule lines (approx 1 marker per 2 divisions.) It may also be desirable to connect a 5MC signal from the 180A through a 50  $\mu$ pf capacitor directly to one of the vertical deflection plates. Adjust C260 for best linearity over the first part of the sweep, and readjust C224 slightly if necessary to obtain best overall linearity.

Some interactions may result between sweep ranges; rechecks linearity on both ranges.

3. Sweep timing. Reconnect the 220K shunt timing resistor (See para. C). Connect 5  $\mu$ sec and 10  $\mu$ sec timing markers, and set the Sweep Duration switch to 100  $\mu$ sec. Adjust both the Mag. Gain Adjust and sweep timing capacitor C1608 slightly until timing over the 100  $\mu$ sec range corresponds as near as possible to that shown in TABLE I.

Change <sup>de</sup> Sweep Duration switch to 20  $\mu$ sec. Do not

change the Mag Gain Adjust setting. Connect the Type 1 timing markers. Adjust the timing capacitor C160A for a total sweep time of 20  $\mu$ sec, then compare timing over the sweep range with that in TABLE I. It will probably be necessary to readjust C224 slightly, as well as C160A, to obtain the best overall timing. (If the linearity adjustments have been properly done in the previous steps, it should be possible to achieve timing accuracy well within 3% on this range.)

4. adjust Sweep Length to 10.5 divisions.

## VE

### Vertical Amplifier

Adjustment of the vertical amplifier will require connecting a <sup>Type</sup> 1105 square wave generator to the vertical input attenuator as described in Para. E.

#### 21. DC Balance

(Not applicable.)

#### 22. Amplifier Gain

Use the Calibrate positions of the KV/cm ~~Input Select~~ switch. Adjust the Gain Adjust (R439) for a 4 cmision display.

### 23. Attenuator High Frequency Compensation

This calibration will require a change in the 100  $\mu$ sec sweep rate in order to display the 1KC signal. See Para. D.

Follow the procedure indicated, except that there is no "straight through" position of the attenuator. Make the first adjustment in the 0.5 KV/cm attenuator position; the sequence of the other two ranges is not important.

### 24. Input Attenuator Capacitance.

The input capacitance is standardized only to the 0.5 KV/cm range. The easiest way to accomplish this is to connect a capacitance bridge, or Tektronix type 130 LC meter, to the attenuator input terminal.

Set the KV/cm switch to 0.5 KV/cm and measure the capacitance (about 20  $\mu$ pf). Reset the KV/cm switch to 1.0 KV, and adjust the shunt capacitance trimmer, C ?, to obtain some capacitance reading. Repeat for the 2.0 KV switch position, adjusting C ?.

### Delay Line and Vertical Amplifier High Frequency Compensation

Use the procedure indicated. The 20  $\mu$ sec sweep range is adequate except for measurement of vertical amplifier risetime. There will be some difficulty in triggering at very

square-wave generator frequencies, thus it will be necessary to adjust both the Triggering Level and square wave frequency to obtain a stable display.

### P6013 High Voltage Probe Adjustment

Refer to Paras. D and F for the test set up. Use procedure outlined in the P6013 probe compensation instructions.

### Camera Control Relay Operation

Install the 2021 thyatron ( $V_1$ ). Connect an ohmmeter across the contacts of the front panel camera circuit jack, and connect a another oscilloscope across these contacts in parallel with the ohmmeter. (A voltage should be obtained from the ohmmeter when the relay contacts are open, and will be shorted out when the relay closes.) Press the Manual Advance switch, and measure the relay closure time with the test oscilloscope. This time should be approx. 140 milliseconds.

## Sweep Hold-off Time

Remove the 100k resistor shunted across R 181 in the sweep hold-off circuit. (Ref. Par. B) Connect 100  $\mu$ sec markers from the 1804 time Mark generator into the vertical input attenuator. (The Trig. Level control must be adjusted if this was not done previously.) Connect another oscilloscope to pin 8 of V100 (Sweep gate cathode follower), and adjust it to display this sweep gate waveform. Increase the sweep time on the test oscilloscope until two successive gate pulses can be seen.

Measure the time between these gate pulses. This time should be about : milliseconds, but in any event must be greater than 140 milliseconds.