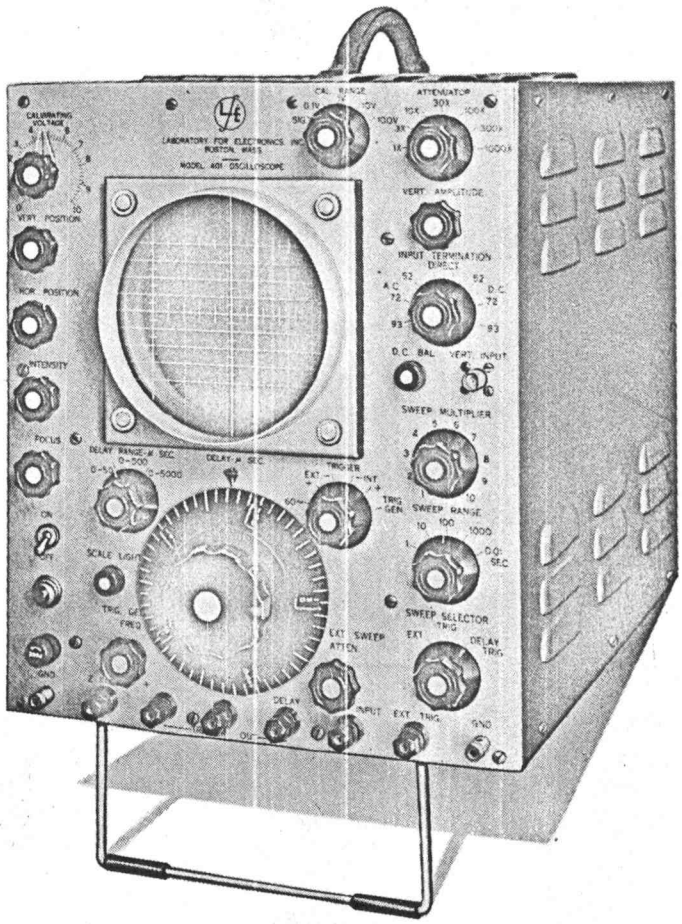
Instruction Manual
CATHODE RAY OSCILLOSCOPE
Model 401



LABORATORY FOR ELECTRONICS, INC.

BOSTON, MASSACHUSETTS

WARRANTY

This instrument is guaranteed against defects in material (other than the cathode ray tube) and workmanship for a period of one year from the date of purchase. Any instrument proving defective within the guarantee period will be repaired or replaced at our discretion provided notice of said defect is promptly given to us. Should emergency repairs be necessary they should be made only by a qualified electronics engineer. In such cases defective parts must be returned to us together with a full statement of the defect encountered before credit for parts will be allowed. No allowance will be made for labor required to repair this instrument if it is not returned to the factory.

Before this Oscilloscope is returned to the factory a full statement of the nature of the defect must be submitted to Laboratory for Electronics, Inc., or their authorized engineering representative, and shipping instructions must be requested. It is understood that shipping charges both ways are to be borne by the purchaser.

Except for burned out filament or broken envelope, the cathode ray tube included with this equipment is guaranteed for a period of six months from the date of purchase. The cathode ray tube will be replaced only after inspection at the Laboratory for Electronics factory.

This guarantee is void unless the attached guarantee card is properly filled out and mailed to Laboratory for Electronics, Inc., immediately upon receipt of the instrument.

LABORATORY FOR ELECTRONICS, INC.
75 PITTS STREET, BOSTON 14, MASSACHUSETTS

THE MODEL 401
CATHODE RAY OSCILLOSCOPE

A Manual Covering Operation, Circuit Analysis and Maintenance

Section I — General Description

1. ELECTRICAL DESCRIPTION

The Laboratory for Electronics Model 401 Oscilloscope is a high-gain, wide-band laboratory instrument carefully designed for the most versatile reproduction of pulses and complicated waveforms encountered in electronic research. The video amplifier is designed to permit examination of signals ranging in frequency from d-c to over 10 megacycles and in amplitude from less than 15 millivolts per cm. to 50 volts per cm. Stabilized trigger shaper circuits permit easy synchronization of six decade ranges of sweep speeds. Accurate calibration voltages permit measurements by the comparison method of signal amplitudes below 0.01 volts and up to 100 volts. A precision sweep delay network, variable between two and 5000 microseconds, is capable of accurate interval differentiation to 0.1 microsecond on the shortest delay.

2. PHYSICAL CHARACTERISTICS

DIMENSIONS..... 12½ inches wide, 15 inches high, 19 inches deep.

WEIGHT..... 60 pounds (with power cord and probe)

POWER REQUIREMENTS..... 105 to 125 volts or 210 to 250 volts single phase a-c, 50–60 cycles, 400 watts.

CATHODE RAY TUBE..... Type 5YP1 medium persistent screen (P7 or P11 screens optional).

3. SPECIFICATIONS

INPUT IMPEDANCE..... Direct — 1 megohm, 30 uuf
Probe — 10 megohm, 10 uuf.

ATTENUATOR..... 1X, 3X, 10X, 30X, 100X, 300X, and 1000X.

INPUT TERMINATION.... Direct, 52, 72, or 93 ohms, followed by a-c or d-c coupling to the attenuator.

MAXIMUM SIGNAL INPUT 600 volts peak. 1 watt when input termination is 52, 72, or 93 ohms.

VIDEO AMPLIFIER

- Deflection Sensitivity..... 15 millivolts peak to peak per centimeter.
- Frequency Response..... D-c to 10 megacycles at — 3 db. point.
- Transient Response..... Rise time (10% to 90%) 0.035 microseconds.
- Signal Delay..... 0.25 microseconds.
- Deflection..... Maximum undistorted video output is two inches uni-polar deflection.

EXTERNAL SWEEP INPUT

- Deflection Sensitivity..... 3 volts peak to peak per cm.
- Band Width..... 1 cycle to 500 kc.

SWEEP SYSTEM..... Triggered and delayed sweeps are available.

- Time Range..... 0.1 microseconds per centimeter to 10,000 microseconds per centimeter: calibration accurate to within ± 5 per cent.
- Repetition Rate of..... 500 cycles to 5 kc.
  Internal Trigger Generator
  External Trigger
  Requirements..... 0.5 volt to 100 volts peak to peak, either polarity.

DELAYED SWEEP

- Delay Range..... 2–5000 microseconds in three ranges.
- Dial Scale..... 500 divisions in ten turns.

Accuracy..... 1% of full scale for the absolute value of delay, and 0.1% of full scale for the incremental delay between 50 and 500 on the dial.

TRIGGER OUTPUT.....Positive and negative trigger, and positive delayed trigger available. Output impedance is 250 ohms for the positive trigger and 2000 ohms for the negative trigger.

Trigger Amplitude..... 20 volts peak-to-peak.

CALIBRATING VOLTAGE..60 cycle square wave.

Six Amplitude Ranges.....0.1 volt to 100 volts full scale with fine adjustment on each range.

Z AXIS INPUT

Input Impedance.....40,000 ohms, 70 uuf.

Sensitivity.....15 volts peak will blank beam.

CATHODE-RAY TUBE

Accelerating Voltage.....3000 volts.

Section II — Operation

1. GENERAL

The Model 401 Oscilloscope may be placed on any convenient table or bench near a power source. At least one inch clearance should be provided at the top, back, and sides of the case to permit adequate ventilation. The instrument should be placed in a location where bright light will not fall on the face of the cathode ray tube. The metal stand attached to the front base of the Oscilloscope permits raising the front of the instrument for easier viewing.

WARNING: The sweep delay system range is limited to a minimum dial setting of approximately 20. This represents the optimum setting for greatest calibration accuracy. *Do not* attempt to adjust the dial for "0" minimum. Any re-alignment of dial calibration must be done in accordance with the procedures outlined in Section IV, paragraph 3 of this manual.

2. INITIAL OPERATION

When placing the Oscilloscope in operation for the first time, the following control settings should be made before power is applied:

ON-OFF Switch	— Place in OFF position
INTENSITY	— Turn to minimum (fully counter-clockwise)
SWEEP SELECTOR	— Place in TRIG. position
TRIGGER	— Place in TRIG. GEN. or 60 position

Plug Oscilloscope into a source of 50–60 cycle, 105–125 volt power capable of supplying 400 watts (or a 210–250 volt source if the connections to the primary of the power transformer are changed as described in Section IV).

Place the ON–OFF Switch in the ON position. Wait at least 60 seconds for the tubes to warm up.

Slowly advance the INTENSITY control until a trace appears on the screen. Adjust the INTENSITY control until the trace is of the desired brightness.

Adjust the FOCUS control for the clearest and sharpest trace. (There is some interaction between the INTENSITY and FOCUS controls so that adjustment of one control may require readjustment of the other.)

Adjust the HOR. POSITION control until the trace is centered horizontally on the screen.

Adjust the VERT. POSITION control until the trace is centered vertically on the screen.

Vary the VERT. AMPLITUDE, noting any change in the centering of the trace. If any change is observed adjust the D.C. Bal. control until there is no change in centering due to the VERT. AMPLITUDE control adjustment (as described in Sect. II., paragraph 4, items 1–6).

The Oscilloscope is now ready for full operation.

3. CONTROL IDENTIFICATION

Control knobs of the Model 401 Oscilloscope are grouped functionally, and each group is assigned a distinctive color. Related control knobs are given this color so that the group controls are identified at a glance.

Y-axis controls.....Blue

Calibrating voltage and scale light controls..Gray

Sweep controls.....Red

Trigger delay controls.....Green

Cathode ray tube controls.....Yellow

Function and location of each control is covered in the function of controls table and drawing of front panel.

FUNCTION OF CONTROLS

CALIBRATING VOLTAGE	Provides fine adjustment of the amplitude of the calibrating voltage applied to the video amplifier.
VERT. POSITION	Controls the vertical position of the trace by varying the d-c level of the voltage applied to each vertical deflection plate of the cathode ray tube.
HOR. POSITION	Controls the horizontal position of the trace by varying the d-c level of the voltage applied to each horizontal deflection plate of the cathode ray tube.

INTENSITY	Controls the brightness of the trace by varying the cathode to grid voltage of the cathode ray tube.
FOCUS	Controls the sharpness of the electron beam by varying the voltage applied to the focussing electrode of the cathode ray tube.
ON OFF	Applies power from the line cord to the power transformer, energizing the Oscilloscope.
DELAY MULTIPLIER	Selects the maximum delay time of the delayed trigger by inserting various values of charging capacitor into the delay sawtooth generating tube circuit.
SCALE LIGHT	Controls the brightness of the lamps illuminating the plastic screen in front of the cathode ray tube.
TRIG. GEN. FREQ.	Varies sweep frequency when TRIGGER switch is on TRIG. GEN.
DELAY — μ SEC	Fine adjustment of the delay time of the delayed trigger by varying the point on the sawtooth at which the triggering multivibrator fires.
EXT. TRIG.	Connection for any external triggering voltage used to initiate the sweeps.
Z INPUT	Connection for an external voltage used to intensity modulate the cathode ray tube.
TRIGGER OUT	Provides positive and negative and delayed triggering voltages synchronized with the trigger source.
CAL. RANGE	Applies calibrating voltages of various maximum amplitudes or signal voltage to the video amplifier.
ATTENUATOR	Inserts various steps of attenuation between the input signal and the video amplifier.
VERT. AMPLITUDE	Controls the gain of the video amplifier.
INPUT TERMINATION	Permits termination of the input signal in various impedances and allows for direct connection to the amplifier or for a-c coupling through a capacitor.
D. C. BALANCE	Balances the d-c amplifier so that vertical positioning is not affected by adjustment of VERT. AMPLITUDE control.
VERT. INPUT	Connection for signal input to video amplifier by means of a UG-290/U coax type connector.
SWEEP MULTIPLIER	Fine adjustment of the sweep rise rate by varying the charging resistance of the sweep generator circuit.
SWEEP μ SEC/CM	Determines the rise rate of the sweep by inserting various values of charging capacitor into the sweep generator circuit.
SWEEP SELECTOR	Selects whether an internally generated or an external sweep is applied to the horizontal deflection plates.
TRIGGER	Selects the type of trigger used by the trigger generating circuits to initiate each sweep.
EXT. SWEEP ATTEN.	Provides variable attenuation of any sweep voltage applied to the SWEEP INPUT jack.
SWEEP INPUT	Connection for any external sweep voltage which is to be used for horizontal deflection of the trace.
GND.	Connection to the chassis of the Oscilloscope.

4. OPERATION OF VERTICAL DEFLECTION AMPLIFIER

a. Y-AXIS AMPLIFIER. The VERT. INPUT connector will accept any signal within the limitations of the INPUT TERMINATION settings. In A. C. DIRECT or D. C. DIRECT this limit is 600 volts peak, *but in any terminated position the maximum average signal power is one watt.* Signals may be fed in through the probe furnished or through a piece of r-f cable joined to a BNC connector, as the user desires. When the equipment is set up and the signal is ready for viewing, step by step operation of the Y-Axis (blue) controls is as follows:

(1) Place the CAL. RANGE switch in the SIG. position.

(2) Set the ATTENUATOR to 1X and the VERT. AMPLITUDE control to maximum (fully clockwise.)

(3) Adjust the VERT. POSITION control so that the trace is exactly in the center of the scope.

(4) Adjust VERT. AMPLITUDE control to minimum (ccw) noting any vertical shift in the trace; reset to maximum again.

(5) Adjust D.C. BAL. control to set trace to the maximum shift observed in step 4. Reset VERT. POSITION control to center trace.

(6) Repeat steps 4 and 5 until adjustment of VERT. AMPLITUDE control causes no shift in the vertical position of the trace.

(7) Set the ATTENUATOR to 1000X and the VERT. AMPLITUDE control to minimum.

(8) Apply the signal to be viewed to the VERT. INPUT terminal.

(9) Set the INPUT TERMINATION switch to the characteristic impedance of the line carrying the input signal. If only the a-c component of the signal is desired (i.e., above 2 cps), choose the characteristic impedance from one of the A.C. positions of the switch. If the d-c level of the signal is also desired, choose the characteristic impedance from one of the D.C. positions of the switch.

NOTE: If the probe is used, the INPUT TERMINATION switch *must* be in the DIRECT position.

(10) Turn up the VERT. AMPLITUDE control and decrease the attenuation inserted by the ATTENUATOR until the desired height of the signal on the screen is obtained. (The maximum visible deflection obtainable is three inches because of the length of the deflection electrodes of the 5YP1 cathode ray tube).

b. CALIBRATING VOLTAGE. An accurate variable calibrating voltage is included in the Model 401 Oscilloscope to permit measurement of signal amplitude by comparison. This is accomplished as follows:

(1) Apply a signal to the Oscilloscope as described above.

(2) Adjust the VERT. POSITION and VERT. AMPLITUDE controls so that the signal just fills the space between two of the ruled lines on the scale in front of the cathode ray tube.

(3) Place the CAL. RANGE switch in one of the calibrating voltage positions and adjust it and the CALIBRATING VOLTAGE control until the square wave is exactly the same height as the previous video signal.

(4) The settings of the CAL. RANGE switch and the CALIBRATING VOLTAGE control now indicate the amplitude of the signal. The CAL. RANGE switch is calibrated to indicate the maximum voltage applied to the video amplifier when the CALIBRATING VOLTAGE control is in the maximum position. The figures on the CALIBRATING VOLTAGE control scale represent tenths of the maximum voltage indicated by the CAL. RANGE switch.

5. OPERATION OF THE HORIZONTAL SWEEPS

The versatility of the Model 401 Oscilloscope arises partly because of the wide variety of horizontal sweeps available. Step by step operation of each feature is given below:

a. TRIGGER GENERATOR. An internal trigger generator of adjustable frequency is incorporated in the Oscilloscope. This permits triggering of the sweeps and at the same time provides synchronous and delayed trigger outputs to trigger external circuits.

(1) Place the SWEEP SELECTOR switch in the TRIG. position.

(2) Place the TRIGGER switch in the TRIG. GEN. position.

(3) Adjust the TRIG. GEN. FREQ. control for the desired sweep frequency.

(4) Adjust the SWEEP μ SEC/CM and the SWEEP MULTIPLIER to the desired sweep. This adjustment is independent of TRIG. GEN. FREQ. control.

b. INTERNALLY TRIGGERED SWEEPS. The sweep voltage applied to the horizontal deflection plates of the Oscilloscope may be triggered by input signals of greater than ½ cm deflection on the CRT.

(1) Place the SWEEP SELECTOR switch in the TRIG. position.

(2) Place the TRIGGER switch in the −INT. or +INT. position depending upon the polarity of the video signal. This polarity may be determined by placing the TRIGGER switch momentarily in the TRIG. GEN. or 60~ positions and applying the video signal voltage to the vertical amplifier. If the beam is deflected upward the signal is positive; if downward the signal is negative. For a bipolar signal the operator can synchronize the sweep to start with either the negative or positive signal.

c. EXTERNALLY TRIGGERED SWEEP. The sweep voltage may be synchronized by any external triggering voltage between 0.5 volt and 100 volts peak to peak amplitude as follows:

(1) Apply the external trigger to EXT. TRIG. binding post.

(2) Place the SWEEP SELECTOR switch in the TRIG. position.

(3) Place the TRIGGER switch in the − EXT. or + EXT. position depending upon the polarity of the triggering voltage.

(4) Adjust the SWEEP μ SEC/CM and SWEEP MULTIPLIER controls for the desired sweep rate.

d. EXTERNAL SWEEP. To operate the horizontal deflection plates from an external sweep voltage, proceed as follows:

(1) Place the SWEEP SELECTOR switch in the EXT. position.

(2) Connect an external sweep voltage to the SWEEP INPUT jack.

(3) Adjust the EXT. SWEEP ATTEN. control so that the trace is of the desired length.

e. DELAYED SWEEP. Any of the triggered sweeps may be delayed from less than five microseconds to 5000 microseconds after the triggering voltage. The delayed sweep is set up as follows:

(1) Place the SWEEP SELECTOR switch in the DELAY TRIG. position.

(2) Place the TRIGGER switch in the position for the desired type of triggering voltage.

(3) Adjust the DELAY MULTIPLIER switch for the minimum range in which the desired delay in microseconds occurs. If the exact delay between different signals on the Oscilloscope is unknown it may be calculated approximately by noting the distance between the signals and the time per centimeter of deflection represented by settings of the SWEEP μ SEC/CM and SWEEP MULTIPLIER controls.

(4) Adjust the DELAY vernier control for the exact delay desired. Each division on the vernier scale represents 1 μ sec times the multiplier selected by the DELAY MULTIPLIER switch.

6. SCALE LIGHT OPERATION

Lines on the plastic graticule will reflect white or red light depending on whether the scale side-lighting shines through clear or red-stained holes in the plastic. The Oscilloscope is shipped with the graticule oriented for red scale lighting. For white lighting remove bezel and rotate graticule 180 degrees.

Section III — Circuit Analysis

1. Y-AXIS AMPLIFIER

The Y-axis amplifier consists of two parallel channels having a common input circuit and a common connection to the vertical plates of the cathode ray tube. One channel, referred to as the d-c channel, covers the frequency spectrum from d-c to approximately five kc, and the parallel one, known as the a-c channel, takes over at five kc and has sufficient bandwidth to cover the spectrum to ten mc.

Video signals may be introduced through the compensated probe furnished with the Oscilloscope. S101 (Input Termination) must be in the A-C DIRECT or D-C DIRECT position when the probe is used. If desired, the signal may be introduced directly to the Vertical Input connector through a coaxial cable with S101 set in a position to terminate the cable properly. The signal enters from the Termination Switch to CAL RANGE selector switch S102. When this CAL RANGE switch is in SIG position, the video output signals are passed to ATTENUATOR (S103); when it is in any of the other positions a 60 c.p.s. calibrating square wave is delivered to the attenuator.

ATTENUATOR (S103), controls the amplitude of the signal applied to the grid of V101. The VERT. AMPLITUDE control (R170) functions as a continuous control for fine adjustment of vertical amplifier gain.

Division of the signal between the two channels begins at the cathode follower output of V101. This introductory stage is a dual triode connected as a balanced cathode follower. The second half of the tube, V101B, is a dummy cathode follower which makes use of the fact that triode sections in the same envelope tend to be almost identical in their drift characteristics; any change imposed on one will also be imposed on the other.

Signals to the a-c channel are capacity coupled through C105. The plate circuit of the a-c channel input stage V102 contains a section of RG-65/U r-f cable in series with the signal. This piece of cable acts as a delay line; it introduces a signal delay of 0.25 usec. The delay permits the sweeps to start before the signal to be observed is displayed. Some signal voltage is tapped off at the input of the delay line and delivered to the amplifier stage V103. From this stage a triggering signal goes to the X-axis generator when the TRIGGER switch is in $-$INT. or $+$INT. position. This coupling and control enables the operator to synchronize on a video signal. The second stage of the a-c channel, V104, is a conventional shunt peaked video amplifier except for the cathode R-C network C112-R119, R120 which provides peaking at about 1 mc to compensate for the delay line attenuation above this frequency. The cathode of V105 incorporates a pre-set gain control having a dynamic range of approximately 12 db. Its function is to adjust the gain of the a-c channel to that of the d-c channel whenever it becomes necessary to change a tube. V106 is a cathode coupled phase inverter whose outputs are connected to the a-c output tubes V107 and V108. These output tubes are connected as a push-pull amplifier.

The d-c channel is direct-coupled from the input cathode follower V101. The four stages of the d-c channel, V109 through V112, make up a cascaded

differential amplifier. The interstages consist of compensated R-C dividers. The gain of the d-c channel is stabilized for different operating conditions and for tube changes through the use of the feedback resistors R181 and R186, and thus the gain of the vertical amplifier remains invariant except for cathode ray tube sensitivity. The "cross-over" network R148, R149, C131 and C132 is designed to perform the smooth frequency transition of the a-c and d-c channel summation. The pre-set d-c channel control R174 compensates for initial tolerances in component parts. The VERT. POSITION control R183 offsets the bias condition of V110 and thus, through the direct connection of all stages up to the cathode ray tube vertical plates, leads to vertical control of the trace. The heater regulator tubes V113 and V114 operate as constant current devices. By maintaining the heater voltages constant the gains of the a-c and d-c channels are kept more constant.

2. X-AXIS CIRCUITS

Triggering voltages are introduced to the trigger shaping circuits. The purpose of these is to reduce the variations in the trigger amplitude, polarity and shape to a single set of values which makes it possible to fire the sweep and delay circuits with a trigger whose characteristics are independent of the input trigger. Amplitude variations of the trigger input are compressed by V302, a cathode coupled bipolar limiter. Variations of polarity are taken care of by the selector switch S301 (TRIGGER). Variations in shape of the input trigger are eliminated by the multivibrator stage V304 which produces a pulse whose rise time is practically independent of the trigger input.

Trigger signals come from several sources: A positive or negative trigger input connected to the EXT. TRIG. jack and selected by the EXT. + or − positions of the TRIGGER switch; 60 cycle synchronization achieved through the TRIGGER switch by coupling to the power voltage internally; and synchronization with the video signal by setting the TRIGGER switch on INT. + or −. When switch S302 is on EXT., triggers connected to trigger shaping circuits are still acted upon and trigger outputs (including delay) are available.

The internal trigger developed within the Model 401 Oscilloscope is generated by re-connecting the dual triode V302 to the configuration of an astable multivibrator. This is accomplished in the TRIG. GEN. position of the TRIGGER switch by increasing the plate load resistor of V302B and coupling this plate to the grid of the preceding triode V302A. The PRF of the trigger generator is varied by changing the time constant of this coupling as determined by the setting of R308 (TRIG. GEN. FREQ.).

All triggers going through the shaping circuits become available on the front panel through the TRIGGER OUT jacks. A portion of the gate generated by V304 is differentiated by C314 and R327 and is passed through the isolation amplifier V305A before going to the jacks. When the SWEEP SELECTOR switch is in position EXT. the trigger shaping and delay circuits are operative and the + and — trigger and delay trigger outputs are available.

The output of V304 is differentiated and used to trigger the sweep gate V307A and V316A. The negative gate goes through V307B in cathode follower action and cuts off the sweep generator clamp V316B, allowing the grid of the sweep cathode follower V308B to rise exponentially as determined by the constant presented by the SWEEP MULTIPLIER and SWEEP μSEC/CM positions. The output of the sweep cathode follower is clamped by V306B and drives the sweep output amplifier V319. Horizontal centering is accomplished by changing, through R417 (HOR. POSITION), the relative operating biases of the output amplifier V319 whose plates are connected directly to the deflection plates of the cathode ray tube, V701.

The positive going plate of V319B is clamped by V317B and directly coupled to V318, a monostable multivibrator designed to produce a negative pulse at a preset amplitude of sweep. This negative pulse is applied to the sweep gate generator V316A through coupling diode V317A to turn off the sweep gate and end the sweep.

Shortly after the sweep is started V305B is cut off bringing the plate of V305B and the cathode of V306A up to about +250. In this condition V306A is cut off, which prevents any additional triggers from firing until the sweep circuits themselves have recovered to their quiescent condition.

The stage V307B, in addition to being used as a sweep gate cathode follower, is designed to be an intensity amplifier. The positive intensity gate at the plate of V307B is followed by a low impedance cathode follower V308A which drives the cathode ray tube grid up and intensifies the trace during the sweep time.

The delay circuits are still operative when the trigger sweeps are being used, and a delayed trigger is available for external use or for calibrating sweep ratios.

The delayed sweep operation is obtained when the SWEEP SELECTOR switch is set to the DELAY TRIG. position. In this case the differential output of V304B is used to trigger the start of the delay circuits, and an adjustable-delay trigger is generated which is used to trigger the sweeps.

Operation of the delay circuits is as follows: The differential output of V304 is used to trigger the bistable multivibrator V311. The positive going gate is direct coupled through a compensated divider to the cathode follower V312A which is normally cut off. When V312A is turned on, the cathode of V312B is raised from about −5 volts to +5 volts, and V312B is cut off. This action unclamps the Miller run down stage V313 which produces an accurate negative going sawtooth voltage at the cathode of V313B. This sawtooth voltage is clamped to +250 volts by V314A, and it drives the cathode of V314B down from +250 at a linear rate determined by the sweep delay range switch. The plate of V314B is biased anywhere from + 250 to + 130 volts by the setting of the sweep delay potentiometer R386 (DELAY — μSEC.) When the sawtooth voltage on the cathode of V314B reaches the bias set by R386 V314B conducts and triggers the monostable multivibrator V315. The negative pulse from V315 is used to trigger the sweep gate V311 to its original state. This biases off V312A and clamps the Miller run down grid of V313A to the bias level through V312B set by the resistor-divider R362, R363 and R364.

The tube V309A is used in the same way in the delay circuit that V305B is used in the sweep circuits: to disable the isolation diode and prevent triggering of the delay gate before the Miller sweep has completely recovered to its quiescent condition.

Some of the accuracy of the delay circuit is made possible by designing the delay gate generator to be independent of any time constants. The action of V310B is to prevent the stage from being disabled by misfire.

If no trigger is generated by V315 to restore the delay gate generator to its ordinary condition, the cathode of V313B will continue to go down until the plate of V313A bottoms. Just prior to this V310B will conduct and turn off the delay gate generator.

A part of the delay gate at the plate of V311B is tapped off, differentiated and cathode follower coupled by V309B to the delay trigger output jack.

3. THE R-F PROBE

The r-f probe is a 10:1 R-C compensated attenuator having an input capacitance of less than 10 μuf. This arrangement permits the observation of waveforms in circuits where high stray capacitance to ground of any measuring equipment cannot be tolerated. The probe consists of a 40-inch piece of RG-62/U coaxial cable terminated at one end by the attenuator and at the other by a BNC connector which mates with the VERT. INPUT jack. In order to operate the probe as a perfectly compensated divider the INPUT TERMINATION switch must be set in the DIRECT a-c or d-c position.

SECTION IV—Maintenance and Adjustment

1. REMOVING THE CASE

Access to all components of the Model 401 Oscilloscope is available by removing the screws along the front edge of the top of the instrument case and along the front edge and bottom of the sides of the case. The case may then be lifted off exposing the sides and top of the unit. If access to the back or bottom of the unit is desired the screws holding on the plates may be removed.

CAUTION:

THIS EQUIPMENT REQUIRES VOLTAGES WHICH ARE DANGEROUS AND MAY BE FATAL IF CONTACTED. THE EQUIPMENT SHOULD NEVER BE OPERATED OUTSIDE ITS CASE UNLESS ABSOLUTELY NECESSARY. EXTREME CAUTION SHOULD BE USED IN WORKING ON THE EQUIPMENT. THE HIGH VOLTAGE CAPACITORS MAY RETAIN DANGEROUS CHARGES AFTER THE EQUIPMENT IS TURNED OFF. ALWAYS DISCHARGE THESE CAPACITORS TO GROUND BEFORE HANDLING THE EQUIPMENT WHEN OUTSIDE ITS CASE.

2. POWER SUPPLY

a. OPERATION FROM A 210–250 VOLT SUPPLY. As shown in the schematic diagram, the equipment is shipped with the power transformer primary connected for 105–125 volt operation. To connect the primary for 210–250 volt operation, remove the jumpers between P1S and P2S and between P1F and P2F. Connect a jumper between P1F and P2S. The primaries of the transformer are now connected in series instead of parallel, and the equipment is ready for operation from a 210–250 volt supply.

b. ADJUSTING THE +250 VOLT SUPPLY. For proper operation of the Oscilloscope, the +250 volt supply should be regulated so as to produce exactly +250 volts. It is desirable to set this with the line voltage at 117 v. To adjust this voltage, turn on the equipment and allow to warm up for at least five minutes. Connect an accurate voltmeter between the +250 volt supply (pin 3 or 6 of V508) and ground, and adjust potentiometer R534 until the meter reads exactly +250 volts.

3. ADJUSTMENT OF THE HORIZONTAL SYSTEM

a. SWEEP AMPLITUDE

(1) Place TRIGGER switch in 60 ~ position.

(2) Place SWEEP SELECTOR in TRIG. position.

(3) Place SWEEP μ SEC/CM in 10 position.

(4) Place SWEEP MULTIPLIER in 1 position.

(5) Adjust HORIZONTAL POSITION control until the horizontal trace starts at the left and at the beginning of the 10 cm. calibrated scale.

(6) Adjust R405 until the trace covers the 10 cm. calibrated scale plus one additional cm. (11 cm.)

b. SWEEP SPEED ADJUSTMENT

(1) Place TRIGGER Switch in INT. position.

(2) Place SWEEP SELECTOR in DELAY position.

(3) Place SWEEP μ SEC/CM in 10 position and SWEEP MULTIPLIER AT 10.

(4) Place DELAY MULTIPLIER in 1 position.

(5) Adjust HORIZONTAL POSITION control until the horizontal trace starts at the left and at the beginning of the calibrated scale.

(6) Connect a known 10 kc. calibrating voltage into the VERTICAL INPUT.

(7) Adjust DELAY μ SEC dial until the calibrating signal starts at the left and at the beginning of the calibrated scale.

(8) Adjust R397 until 10 cycles of calibration signal correspond to 10 cm. of horizontal sweep.

(9) Place SWEEP μ SEC/CM in 100 position and SWEEP MULTIPLIER at 1.

(10) Repeat steps 5, 6 and 7 above.

(11) Adjust R385 until 10 cycles of calibration signal corresponds to 10 cm. of horizontal sweep.

c. DELAY CLAMP

(1) Place TRIGGER switch on INT. position with no signal on VERT. INPUT.

(2) Read voltage across R380.

(3) Adjust R364 until voltage across R380 reads 190 volts.

d. MINIMUM DELAY RANGE BIAS

(1) Synchronize the Oscilloscope and a gated range marker generator to a trigger source of approximately 100 cycles.

(2) Set the separation of the marker generator for 1 us. and connect its output to the VERT. INPUT of the scope.

(3) Adjust the gain of the scope to obtain about 1 cm. of marker amplitude on the cathode-ray tube. Adjust SWEEP μ SEC/CM and SWEEP MULT. controls to obtain five range marks during sweep trace.

(4) Couple the DELAY TRIG. output to the Z Axis Input Jack.

(5) Set DELAY control to 50 and DELAY MULTIPLIER to 0.1.

(6) Adjust R393 so as to superimpose the delay trigger on the fifth range mark (corresponding to 5 us).

e. DELAY RANGES

50 MICROSECOND DELAY RANGE

(1) Synchronize the Oscilloscope and a gated range marker generator to a trigger source of approximately 100 cycles.

(2) Set the separation between markers of the marker generator for 10 us. and connect its output to the VERT. INPUT of the scope.

(3) Adjust the gain of the scope to obtain approximately 1 cm. marker amplitude on the cathode-ray tube. Adjust SWEEP μ SEC/CM and SWEEP MULT. controls to obtain six range marks during the sweep trace.

(4) Couple the DELAY TRIG. output to the Z Axis Input Jack.

(5) Set DELAY control to 500 and DELAY MULTIPLIER to 0.1.

(6) Adjust C337 so as to superimpose the delay trigger on the fifth range mark (corresponding to 50 us.).

500 AND 5000 MICROSECOND DELAY RANGES

(1) The same procedure outlined above should be followed, except that the range marker separation should be set for 100 and 1000 us. respectively and capacitors C339 and C341 respectively, should be adjusted.

4. VIDEO AMPLIFIER

a. GENERAL

(1) In all of the following adjustments it is essential that the generator deliver a waveform that is without distortion; otherwise amplifier adjustments will result only in compensating for deficiencies in the applied waveform.

b. VERTICAL CENTERING

(1) Adjust D. C. BAL. See Sect. II, par. 4, (1–6).

(2) Place the VERT. POSITION control on the front panel in the center of its range.

(3) Adjust the preset vertical centering potentiometer, R174, so that the trace is centered.

vertically on the Oscilloscope.

c. D-C CHANNEL INPUT COMPENSATION

(1) Apply a 100 c.p.s. square wave to the VERT. INPUT terminal on the front panel.

(2) Place the ATTENUATOR control in the 1X position.

(3) Set the INPUT TERMINATION switch to an appropriate D.C. termination position to match the cable from the signal source.

(4) Adjust capacitor C144 in the grid circuit of V109, to obtain a flat top on the square wave as observed on the cathode-ray tube.

d. A-C CHANNEL GAIN ADJUSTMENT

(1) Apply a 5000 c.p.s. square wave to the VERT. INPUT terminal on the front panel.

(2) Place the ATTENUATOR control in the 1X position.

(3) Set the INPUT TERMINATION switch to an appropriate D.C. termination position to match the cable from the signal source.

(4) Adjust potentiometer R127 in the cathode circuit of V105 to obtain a flat top on the square wave as observed on the cathode-ray tube.

(5) The above adjustments (c. and d.), equalize the gain of the a-c channel and the d-c channel. This is a necessary condition for fidelity of wave form reproduction.

e. TRANSIENT RESPONSE ADJUSTMENT

(1) The peaking coils associated with the vertical amplifier have been adjusted at the factory for optimum transient response. The coils have been cemented to the cores after adjustment and will not normally require further attention. If it becomes necessary, however, to replace any of the coils, or if a change of other components causes the transient response to deteriorate, the following alignment procedure is recommended.

(2) A voltage source delivering a flat-topped waveform, whose rise time is not greater than 0.03 microseconds, should be connected to a low impedance cable. It is recommended that a one-half microsecond pulse or a one megacycle per second square wave be used, with a one microsecond sweep.

(3) The inter-stage coupling capacitor of the stage to be aligned must be disconnected from the preceding plate.

(4) The properly terminated output of the above cable is then applied to the amplifier stage through the coupling capacitor.

(5) While observing the waveform on the cathode-ray tube, slowly move the coil toward the iron end of the core. Continue until the leading edge of the waveform displays a small overshoot. Move the coil slowly back until the overshoot just disappears.

(6) To adjust coils L108, L109, L110, and L111, the peaking coils associated with the phase-inverter and push-pull output stages of the a-c channel amplifier, the signal should be applied to the grid coupling capacitor C124 of tube V106.

(7) To adjust coil L112, in the cathode circuit of V101, the signal may be applied to the front panel VERT. INPUT connection, with the INPUT TERMINATION switch in the appropriate position for the type of cable employed.

(8) In adjusting the coils associated with the delay line termination, coils L104 and L105 should be adjusted first, followed by the adjustment of L102 and L103.

f. PROBE ADJUSTMENT

(1) Place the ATTENUATOR control in the 1X position.

(2) Set the INPUT TERMINATION switch to D. C. DIRECT.

(3) Attach the probe connector to the front panel VERT. INPUT terminal.

(4) Attach the probe input terminals between the output lead and the ground connection of a 5000 c.p.s. square wave voltage source.

(5) Adjust the probe trimmer capacitor C133 to obtain a flat top on the reproduced waveform.

g. ATTENUATOR ADJUSTMENT. PART I.

(1) Apply a 50,000 c.p.s. square wave to the front panel VERT. INPUT terminal, with the INPUT TERMINATION switch in the correct position for the type of cable employed.

(2) Turn the ATTENUATOR control to the 3X position.

(3) Set the generator output level to obtain about 3 cm. peak-to-peak deflection on the cathode-ray tube.

(4) Adjust trimmer capacitor C153A to obtain a flat top square wave.

(5) Continue in the same manner, adjusting trimmer C153B in the 10X position of the ATTENUATOR; adjust C153C in the 30X position; adjust C153D in the 100X position; adjust C153E in the 300X position; adjust C153F in the 1000X position.

h. ATTENUATOR ADJUSTMENT. PART II.

(1) Disconnect the generator cable from the front panel VERT. INPUT terminal and attach the probe which has been adjusted as in paragraph f. of this section.

(2) Set the INPUT TERMINATION switch in the D–C DIRECT position.

(3) Turn the ATTENUATOR switch to the 3X position.

(4) Connect the probe terminals to the output terminals of a generator producing a 5000 c.p.s. square wave.

(5) Adjust the generator output level to obtain about 3 cm. peak-to-peak deflection on the cathode-ray tube.

(6) Adjust trimmer capacitor C152A to obtain a flat top reproduction of the square wave input.

(7) Continue in the same manner, adjusting trimmer capacitor C152B in the 10X position of the ATTENUATOR; adjust C152C in the 30X position; adjust C152D in the 100X position; adjust C152E in the 300X position; adjust C152F in the 1000X position.

i. CALIBRATING VOLTAGE LEVEL. The level of the calibrating voltages may be adjusted as follows:

(1) Place the Oscilloscope in operation and adjust the VERT. POSITION control so that the trace is centered vertically.

(2) Connect a 90-volt B-battery to the VERT. INPUT terminal.

(3) Adjust the VERT. AMPLITUDE control and the ATTENUATOR so that the deflected trace coincides with some convenient line on the scale in front of the cathode-ray tube.

(4) Measure the potential of the B-battery with an accurate voltmeter.

(5) Set the CAL. RANGE switch and the CALIBRATING VOLTAGE control to produce exactly the same potential as the measured potential of the battery.

(6) Adjust potentiometer R509 so that the deflection produced on the Oscilloscope by the calibrating voltage is the same as that produced by the battery.

MEASUREMENT CONDITION

Meter Resistance	-	20, 000 ohm/volt d. c.	Sweep Multiplier	-	10
Sweep Selector	-	TRIG.	Trigger Switch Position	-	Int. or Ext.
Sweep u Sec/cm	-	1000	Meter Scale	-	2. 5 volt
					* 50 volt

Reading not marked for scale were read on 250 volt scale,
1, 000 volt scale, and 5, 000 volt scale as required by magnitude of voltage.

TABLE OF VOLTAGE AND RESISTANCE

(K = 1, 000)

(M = 1, 000, 000)

*50 V. Scale 2. 5 V. Scale

Voltages are D-C to ground and are measured with a 20, 000 ohm/volt meter, unless otherwise specified.

TUBE	PIN#	R TO GROUND	V TO GROUND	CONTROL AFFECTING READING
V101	1	15K	250	
12AX7	2	0	0	
	3	600	1.42	R-167
	4	---	---	
	5	---	---	
	6	15K	250	
	7	1M	0	
	8	600	1.42	R-167
	9	---	---	
V102	1	1M	*8. 7	
6AH6	2	1. 3K	*17	
	3	---	---	
	4	---	---	
	5	20K	162	
	6	20K	167	
	7	1. 3K	*17	
V103	1	1M	0	
6CB6	2	150	1. 35	
	3	---	---	
	4	---	---	
	5	26K	142	
	6	49K	100	
	7	150	1. 35	
V104	1	1M	8. 0	
6CB6	2	1. 2K	*16. 5	
	3	---	---	
	4	---	---	

TUBE	PIN#	R TO GROUND	V TO GROUND	CONTROL AFFECTING READING
	5	21K	155	
	6	21K	163	
	7	1.2K	*16.5	
V105	1	1M	72	
6CB6	2	7K	90	R-127
	3	---	---	
	4	---	---	
	5	16K	238	
	6	15K	246	
	7	7K	85	
V106	1	15K	243	
12AV7	2	1M	57	
	3	2.5K	72	
	4	---	---	
	5	---	---	
	6	15K	243	
	7	62K	67	
	8	2.5K	72	
	9	---	---	
V107	1	1.3K	85	
12BY7	2	250K	78	
	3	1.3K	85	
	4	---	---	
	5	---	---	
	6	---	---	
	7	20K	238	
	8	16K	238	
	9	1.3K	85	
V108	1	1.3K	85	
12BY7	2	250K	78	
	3	1.3K	85	
	4	---	---	
	5	---	---	
	6	---	---	
	7	20K	238	
	8	16K	238	
	9	1.3K	85	
V109	1	180K	135	R-174, R-167
12AX7	2	34K	0, 85	R-167
	3	240K	*2.8	
	4	---	---	
	5	---	---	

TUBE	PIN#	R TO GROUND	V TO GROUND	CONTROL AFFECTING READING
	6	180K	135	R-174, R-167
	7	34K	0.85	R-167
	8	240K	*2.8	
	9	---	---	
V110	1	210K	138	R-183, R-174, R-167
12AX7	2	670K	*18.5	R-183, R-174, R-167
	3	240K	*27	
	4	---	---	
	5	---	---	
	6	210K	138	R-183, R-174, R-167
	7	670K	*18.5	R-183, R-174, R-167
	8	240K	*27	
	9	---	---	
V111	1	160K	123	R-183, R-174, R-167
12AX7	2	670K	30	R-183, R-174, R-167
	3	240K	33	
	4	---	---	
	5	---	---	
	6	160K	123	R-183, R-174, R-167
	7	670K	30	R-183, R-174, R-167
	8	240K	33	
	9	---	---	
V112	1	115K	140	R-183, R-174, R-167
12AU7	2	370K	-33	R-183, R-174, R-167
	3	79K	-27	
	4	---	---	
	5	---	---	
	6	115K	140	R-183, R-174, R-167
	7	370K	-33	R-183, R-174, R-167
	8	79K	-27	
	9	---	---	
V301	1	1M	.6	
6AH6	2	560	*4.5	
	3 & 4	500	3.15 RMS (A-C)	
	5	33K	110	
	6	30K	128	
	7	560	*4.5	
V302	1	15K	250	S-4BTrigger Generator Position
12AT7	2	48K	73	
	3	8.2K	77	
	4 & 5	500	3.15 RMS (A-C)	

TUBE	PIN#	R TO GROUND	V TO GROUND	CONTROL AFFECTING READING
	6	15K	250	
	7	690K	67	S-4B-Trigger Generator Position
	8	8.2K	77	
	9	500	3.15 RMS (A-C)	
V303	1	1M	0	
6AH6	2	430	*2.6	
	3 & 4	500	3.15 RMS (A-C)	
	5	35K	125	
	6	30K	150	
	7	430	*2.6	
V304	1	18K	170	
12AV7	2	340K	55	
	3	6.8K	58	
	4 & 5	500	3.15 RMS (A-C)	
	6	20K	250	
	7	23K	43	
	8	6.8K	58	
	9	500	3.15 RMS (A-C)	
V305	1	1M	0.65	
12AV7	2	3.3M	-0.2	
	3	0	0	
	4 & 5	500	3.15 RMS (A-C)	
	6	17K	240	
	7	47K	negligible	
	8	2.2K	*7.4	
	9	500	3.15 RMS (A-C)	
V306	1	1M	negligible	
6AL5	2	34K	-80	R-417
	3 & 4	500	3.15 RMS (A-C)	
	5	2.2M	-65	
	6	no conxn	no conxn	
	7	2.2M	0.5	
V307	1	30K	100	
12AV7	2	2.2M	0.55	
	3	2.7K	1,4	
	4 & 5	500	3.15 RMS (A-C)	
	6	24K	95	
	7	2.2M	0.55	
	8	47	.7	
	9	500	3.15 RMS (A-C)	
V308	1	15K	310	
12AV7	2	30K	100	

TUBE	PIN#	R TO GROUND	V TO GROUND	CONTROL AFFECTING READING
	3	33K	110	
	4 & 5	90K	100	
	6	15K	250	
	7	350K	negligible	
	8	4.7K	*8	
	9	90K	100	
V309	1	570K	9	
12AT7	2	4.7M	negligible	
	3	0	0	
	4 & 5	500	3.15 RMS (A-C)	
	6	15K	250	
	7	47K	negligible	
	8	2.2K	4.2	
	9	500	3.15 RMS (A-C)	
V310	1	480K	*43	
6AL5	2	170K	0.6	
	3 & 4	500	3.15 RMS (A-C)	
	5	100K	200	
	6	no conxn	no conxn	
	7	170K	40	
V311	1	22K	250	
12AV7	2	170K	*2.0	
	3	3.3K	*44	
	4 & 5	500	3.15 RMS (A-C)	
	6	22K	150	
	7	170K	*40	
	8	3.3K	*44	
	9	500	3.15 RMS (A-C)	
V312	1	25K	250	
12AT7	2	140K	-20	
	3	1.2K	-6	R-364 Delay Clamp Bias
	4 & 5	500	3.15 RMS (A-C)	
	6 & 7	1M	-6	
	8	1.2K	-6	
	9	500	3.15 RMS (A-C)	
V313	1	15K	250	
12AT7	2	230K	200	R-364 Delay Clamp Bias
	3	100K	200	
	4 & 5	90K	100	
	6	230K	200	R-364 Delay Clamp Bias
	7	1M	*-6.0	
	8	0	0	
	9	90K	100	

TUBE	PIN#	R TO GROUND	V TO GROUND	CONTROL AFFECTING READING
V314	1 & 2	2.2M	210	
6AL5	3 & 4	500	3.15 RMS (A-C)	
	5	15K	250	
	6	no conxn	no conxn	
	7	100K	210	R-386 Sweep Delay Range
V315	1	42K	250	
12AT7	2	180K	*-9	
	3	1.5K	11	
	4 & 5	500	3.15 RMS (A-C)	
	6	.33K	110	
	7	520K	11	
	8	1.5K	11	
	9	500	3.15 RMS (A-C)	
V316	1	350K	negligible	
12AV7	2	2.7K	1.5	
	3	0	0	
	4 & 5	500	3.15 RMS (A-C)	
	6	24K	190	
	7	300K	*-13	
	8	47	.7	
	9	500	3.15 RMS (A-C)	
V317	1	2.2M	*-13	
6AL5	2	300K	*-13	
	3 & 4	500	3.15 RMS (A-C)	
	5	47K	negligible	
	6	no conxn	no conxn	
	7	48K	-45	
V318	1	25K	250	R-405 Sweep Amplitude Control
12AT7	2	2.2M	*-14	
	3	6.8K	55	
	4 & 5	500	3.15 RMS (A-C)	
	6	25K	170	
	7	83K	50	R-405 Sweep Amplitude Control
	8	6.8K	55	
	9	500	3.15 RMS (A-C)	
V319	1	47K	200	R-417 Horizontal Position
12AV7	2	2.2M	-60	R-417 Horizontal Position
	3	16K	-70	
	4 & 5	500	3.15 RMS (A-C)	
	6	47K	100	R-417 Horizontal Position

TUBE	PIN#	R TO GROUND	V TO GROUND	CONTROL AFFECTING READING
	7	240K	-60	R-417 Horizontal Position
	8	16K	-70	
	9	500	3.15 RMS (A-C)	
V501	1	no conxn	no conxn	
6AX5	2	0	0	
	3	21	390 RMS (A-C)	
	4	no conxn	no conxn	
	5	19	390 RMS (A-C)	
	6	no conxn	no conxn	
	7	0	0	
	8	18K	380	
V502	1	no conxn	no conxn	
6AX5	2	0	0	
	3	21	390 RMS (A-C)	
	4	no conxn	no conxn	
	5	19	390 RMS (A-C)	
	6	no conxn	no conxn	
	7	0	0	
	8	18K	380	
V503	1	no conxn	no conxn	
6AX5	2	0	0	
	3	21	390 RMS (A-C)	
	4	no conxn	no conxn	
	5	19	390 RMS (A-C)	
	6	no conxn	no conxn	
	7	0	0	
	8	18K	380	
V504	1	18K	-460	
6X4	2	no conxn	no conxn	
	3	0	0	
	4	0	0	
	5	no conxn	no conxn	
	6	18K	-460	
	7	21	390 RMS (A-C)	
V505	2	12K	-150	
OD3	5	0	0	
V506	2	23K	-150	
OD3	5	0	0	
V507	1	100K	150 RMS (A-C)	R-509, R-511
6AL5	2	100K	150 RMS (A-C)	R-509, R-511
	3	500	3.15 RMS (A-C)	
	4	500	3.15 RMS (A-C)	
	5	70K	170	

TUBE	PIN#	R TO GROUND	V TO GROUND	CONTROL AFFECTING READING
	9	600	---	
V514	1	no conxn	no conxn	
1V2	2	no conxn	no conxn	
	3	no conxn	no conxn	
	4	600	---	
	5	600	---	
	6	no conxn	no conxn	
	7	no conxn	no conxn	
	8	no conxn	no conxn	
	9		-1500	R-545, R-547

PARTS LIST

Note: 1. All parts are fixed value unless otherwise indicated
2. List of manufacturer's abbreviations at end of parts list

CAPACITORS

Ref. Sym.	Description	LFE or equivalent mfr. no.	Ref. Sym.	Description	LFE or equivalent mfr. no.
C101	Ceramic disk:1000 uuf, 500 v.	C-D 6TM5D3C	C122	Titanium Dioxide: 4.7 uuf, 500 v.	Stackpole GA-6
C102	Electrolytic : 20 uf,	C-D UP2025	C123	Same as C101	
C103	Same as C101		C124	Same as C104	
C104	Ceramic disk: 0.02 uf,	RMC type B	C125	Same as C101	
C105	Same as C104		C126	Same as C104	
C106	Electrolytic: 12 uf,	C-D BR1225A	C127	Same as C122	
C107	Same as C101		C128	Same as C104	
C108	Electrolytic: 50 uf, 25 v.	C-D BR502A	C129	Silvered Mica: 470 uuf, 300 v.	El Menco 605
C109	Same as C101		C130	Same as C129	
C110	Ceramic disk: 0.02 uf, 500 v.	C-D 8TM5S1C	C131	Same as C129	
C111	Same as C101		C132	Same as C129	
C112	Same as C104		C133	VARIABLE, ceramic: 3-13 uuf, 500 v.	Erie TS2A
C113	Titanium Dioxide: 3.3 uuf, 500 v.	Stackpole GA-5	C134	Metalized paper:0.1 uf, 600 v.	Astron ML-6-1
C114	Same as C106		C135	Same as C101	
C115	Same as C104		C136	Same as C101	
C116	Same as C108		C137	Same as C101	
C117	Same as C101		C138	Same as C101	
C118	Electrolytic: 12 uf, 450 v.	C-D BR1245A	C139	Same as C101	
C119	Same as C113		C140	Metalized paper:0.25 uf, 600 v.	Astron ML-4-25
C120	Same as C101		C141	Same as C104	
C121	Same as C106		C142	Metalized paper:8 uf, 150 v.	Astron MQCS-1.5-8M

Ref. Sym.	Description	LFE or equivalent mfr. no.
C143	Silvered Mica: 3300 uuf, 500 v.	El Menco 602J
C144	VARIABLE, mica: 1150-2605 uuf.	Arco El. 313
C145	Silvered mica: 100 uuf, 500 v.	El Menco 603J or 605
C146	Same as C145	
C147	Same as C145	
C148	Same as C145	
C149	Silvered mica: 27 uuf. 500 v.	El Menco 603J or 605
C150	VARIABLE, ceramic: 7-45 uuf.	Erie TS2A
C151	Ceramic disk: 0.01 uf, 500 v.	C-D 8TMS1C
C152a	VARIABLE, ceramic: 3-13 uuf	Erie TS2A
C152b	Same as C152a	
C152c	Same as C152a	
C152d	Same as C152a	
C152e	Same as C152a	
C152f	Same as C152a	
C153a	Same as C152a	
C153b	VARIABLE, ceramic: 1.5-7 uuf.	Erie TS2A
C153c	Same as C153b	
C153d	Same as C153b	
C153e	Same as C153b	
C153f	Same as C153b	
C154a	Ceramic: 10 uuf, 500 v.	El Menco 605
C154b	Silvered mica: 27 uuf, 500 v.	El Menco 605
C154c	Silvered mica: 150 uuf, 500 v.	El Menco 603J
C154d	Silvered mica: 330 uuf, 500 v.	El Menco 605
C154e	Silvered mica: 750 uuf, 300 v.	El Menco 603J
C154f	Silvered mica: 2700 uuf, 500 v.	El Menco 602J
C155	Ceramic: 22 uuf, 500 v.	Erie GP1 K
C156	Not used	
C157	Same as C153b	
C158	Same as C151	
C301	Molded plastic: 0.05 uf, 400 v.	C-D PJ4P5
C302	Silvered mica: 470 uuf, 300 v.	El Menco 605
C303	Ceramic disk: 0.01 uf, 500 v.	C-D 8TM5S1C
C304	Same as C301	
C305	Silvered mica: 3300 uuf, 500 v.	El Menco 602J
C306	Same as C301	
C307	Ceramic disk: 0.02 uf, 600 v.	RMC type B
C308	Same as C104	
C309	Same as C301	
C310	Same as C303	
C311	Silvered mica: 150 uuf, 500 v.	El Menco 603J or 605
C312	Same as C301	
C313	Same as C307	
C314	Ceramic: 47 uuf, 500 v.	Erie, K47
C315	Ceramic: 33 uuf, 500 v.	Erie, K33
C316	Silvered mica: 220 uuf,	El Menco 605
C317	Same as C303	

PARTS LIST

Note:
1. All resistors are fixed composition type except as indicated.
2. All fixed resistors are ±5% except as noted.

RESISTORS

Ref. Sym.	Description	LFE or equivalent mfr. no.	Ref. Sym.	Description	LFE or equivalent mfr. no.
R101	1500 ohms, 1/2 w.	AB EB1525	R127	VARIABLE, composition: 500 ohms	Clarostat 37-B-4-F
R102	22,000 ohms, 1/2 w.	A-B EB2235	R128	6800 ohms, 2 w.	A-B HB6825
R103	150 ohms, 1/2 w.	A-B EB1515	R129	Same as R104	
R104	1 meg., 1/2 w.	A-B EB1055	R130	100 ohms, 1/2 w.	A-B EB1015
R105	10,000 ohms, 2 w.	A-B HB1035	R131	82,000 ohms, 1/2 w.	A-B EB8235
R106	33,000 ohms, 1/2 w.	A-B EB3335	R132	220,000 ohms, 1/2 w.	A-B EB2245
R107	Same as R104		R133	Same as R110	
R108	330,000 ohms, 1/2 w.	A-B EB3345	R134	WIREWOUND, non-inductive: 2500 ohms, 5 w.	Sprague 5N1T
R109	5600 ohms, 2 w.	A-B HB5625	R135	Same as R110	
R110	470 ohms, 1/2 w.	A-B EB4715	R136	Same as R122	
R111	Same as R110		R137	100,000 ohms, 1/2 w.	A-B EB1045
R112	1300 ohms, 1 w.	A-B GB1325	R138	180,000 ohms, 1/2 w.	A-B EB1845
R113	1000 ohms, 1/2 w.	A-B EB1025	R139	Same as R138	
R114	43,000 ohms, 1/2 w.	A-B EB4335	R140	WIREWOUND, non-inductive: 1750 ohms, 5 w.	Sprague 5N1T
R115	470,000 ohms, 1/2 w.	A-B EB4745	R141	1100 ohms, 1/2 w.	A-B EB1125
R116	Same as R104		R142	33 ohms, 1/2 w.	A-B EB3305
R117	Same as R109		R143	47 ohms, 1/2 w.	A-B EB4705
R118	680 ohms, 1/2 w.	A-B EB6815	R144	Same as R143	
R119	10 ohms, 1/2 w.	A-B EB1005	R145	WIREWOUND, non-inductive: 1250 ohms, 10 w.	Sprague 10NIT
R120	Same as R119		R146	Same as R142	
R121	1200 ohms, 1 w.	A-B GB1225	R147	Same as R140	
R122	200,000 ohms, 1/2 w.	A-B EB2045	R148	33,000 ohms, 1 w.	A-B GB3335
R123	Same as R108		R149	Same as R148	
R124	Same as R104		R150	DEPOSITED CARBON: 9.1 meg., 1/2 w.	Wilkor CPSE
R125	330 ohms, 1/2 w.	A-B EB3315	R151	110 ohms, 1 w.	A-B GB1115
R126	Same as R118		R152	Same as R130	

Ref. Sym.	Description	LFE or equivalent mfr. no.
R153	270 ohms, 1 w.	A-B GB2715
R154	Same as R130	
R155	240 ohms, 1 w.	A-B GB2415
R156	Same as R103	
R157	Same as R104	
R158	Same as R113	
R159	Same as R104	
R160	Same as R105	
R161	910,000 ohms, 1/2 w.	A-B EB9145
R162	110,000 ohms, 1/2 w.	A-B EB1145
R163	Deposited Carbon 1 meg. 1/2 w.	Wilkor CPSE
R164	Same as R105	
R165	Same as R110	
R166	680 ohms, 1 w.	A-B GB6815
R167	VARIABLE, wire wound: 200 ohms, 2 w.	Clarostat 43-A-10-B
R168	560 ohms, 1 w.	A-B EB5615
R169	Same as R110	
R170	VARIABLE, composition:1000 ohms, 1/2w.	Clarostat 37-B-4-F
R171	430 ohms, 1 w.	A-B GB4315
R172	Same as R106	
R173	220,000 ohms, 1 w. (balanced with R176 to within 2%)	IRC type BTA
R174	VARIABLE, wire wound: 50,000 ohms, 3 w.	Clarostat 58
R175	Same as R106	
R176	Same as R173	
R177	430,000 ohms, 1/2 w.	A-B EB4345
R178	1 meg, 1 w. (balanced with R180 to within 2%)	IRC type BTA
R179	220,000 ohms,	A-B GB2245
R180	Same as R178	
R181	390,000 ohms, 1 w., (balanced with R186 to within 2%)	IRC type BTA
R182	1.5 meg., 1 w. (balanced with R184 to within 2%)	IRC type BTA
R183	VARIABLE, wirewound: 50,000 ohms, 3 w.	Clarostat 58
R184	Same as R182	
R185	220,000 ohms, 1 w., (balanced with R187 to within 2%)	IRC type BTA
R186	Same as R181	
R187	Same as R185	
R188	Same as R179	
R189	1 meg. 1 w., (balanced with R192 to within 2%)	IRC type BTA
R190	1.5 meg. 1 w. (balanced with R191 to within 2%)	IRC type BTA
R191	Same as R190	
R192	Same as R189	
R193	Same as R132	
R194	220,000 ohms, 1 w. (balanced with R195 to within 2%)	IRC type BTA
R195	Same as R194	
R196	820,000 ohms, 1 w. (balanced with R200 to within 2%)	IRC type BTA
R197	560,000 ohms, 1 w. (balanced with R199 to within 2%)	IRC type BTA
R198	56,000 ohms, 1 w	A B 5635
R199	Same as R197	
R200	Same as R196	
R201	100,000 ohms, 1 w. (balanced with R202 to within 2%)	IRC type BTA
R202	Same as R201	
R203	Not Used	
R204	Not Used	

Ref. Sym.	Description	LFE or equivalent mfr. no.
R205	Not Used	
R206	Not Used	
R207a	Deposited Carbon, 680,000 ohms, 1/2 w.	Wilkor CPSE
R207b	Deposited Carbon, 910,000 ohms, 1/2 w.	Wilkor CPSE
R207c	Deposited Carbon, 1 meg., 1/2 w.	Wilkor CPSE
R207d	Same as R207c	
R207e	Same as R207c	
R207f	Same as R207c	
R208a	Deposited Carbon, 470,000 ohms, 1/2 w.	Wilkor CPSE
R208b	Deposited Carbon, 110,000 ohms, 1/2 w.	Wilkor CPSE
R208c	Same as R106	
R208d	Same as R105	
R208e	3300 ohms, 1/2 w.	A-B EB3325
R208f	Same as R113	
R209	Same as R113	
R210	Same as R113	
R301	15,000 ohms, 2 w.	A-B HB1535
R302	1 megohm, 1/2 w.	A-B EB1055
R303	22,000 ohms, 1/2 w.	A-B EB2235
R304	2700 ohms, 1/2 w.	A-B EB2725
R305	Same as R302	
R306	560 ohms, 1/2 w.	A-B EB5615
R307	Not used	
R308	VARIABLE, composition: 2.5 meg. 2 w.	A-B JU2552
R309	56,000 ohms, 1/2 w.	A-B EB5635
R310	Not used	
R311	Same as R302	
R312	1500 ohms, 1/2 w	A-B EB1525
R313	Same as R306	
R314	Same as R306	
R315	8200 ohms, 2 w.	A-B HB8225
R316	150,000 ohms, 1/2 w.	A-B EB1545
R317	68,000 ohms, 1/2 w.	A-B EB6835
R318	Same as R302	
R319	Same as R301	
R320	4700 ohms, 1 w.	A-B GB4725
R321	430 ohms, 1/2 w.	A-B EB4315
R322	100 ohms, 1/2 w.	A-B EB1025
R323	Same as R302	
R324	510,000 ohms, 1/2 w.	A-B EB5145
R325	Same as R322	
R326	2200 ohms, 1/2 w.	A-B EB2225
R327	47,000 ohms, 1/2 w.	A-B EB4735
R328	Same as R326	
R329	5600 ohms, 2 w.	A-B HB5625
R330	15,000 ohms, 1 w.	A-B GB1535
R331	Same as R330	
R332	1500 ohms, 1/2 w.	A-B EB1525
R333	Same as R332	
R334	Same as R312	
R335	82,000 ohms, 1/2 w.	A-B EB8235
R336	6800 ohms, 2 w.	A-B HB6825
R337	30,000 ohms, 1/2 w	A-B EB3035
R338	Same as R327	

Ref. Sym.	Description	LFE or equivalent mfr. no.
R339	Same as R302	
R340	3.3 megohm, 1/2 w.	A-B EB3355
R341	2.2 megohm 1/2 w.	A B EB2255
R342	560, 000 ohms, 1/2 w.	A-B EB5645
R343	3300 ohms, 2 w.	A-B HB3325
R344	Same as R329	
R345	47 ohms, 1/2 w.	A-B EB4705
R346	10, 000 ohms, 2 w	A-B HB1035
R347	Same as R320	
R348	Same as R317	
R349	Same as R304	
R350	33, 000 ohms, 2 w.	A-B HB3335
R351	1.5 megohm, 1/2 w.	A-B EB1555
R352	Same as R352	
R353	100, 000 ohms, 1/2 w.	A-B EB1045
R354	Same as R327	
R355	4.7 megohms, 1/2 w.	A-B EB4755
R356	470, 000 ohms, 1/2 w.	A-B EB4745
R357	82, 000 ohms, 1/2 w.	A-B EB8235
R358	330, 000 ohms, 1/2 w.	A-B EB3345
R359	220, 000 ohms, 1/2 w.	A-B EB2245
R360	Same as R322	
R361	Same as R346	
R362	27, 000 ohms, 2 w.	A-B HB2735
R363	680 ohms, 1/2 w.	A-B EB6815
R364	VARIABLE, composition: 1000 ohms, 1/2 w.	Clarostat 37-B-76-B
R365	3300 ohms, 2 w.	A-B HB3325
R366	Same as R365	
R367	Same as R322	
R368	Same as R365	
R369	Same as R343	
R370	Same as R327	

Ref Sym.	Description	LFE or equivalent mfr. no.
R371	Same as R326	
R372	Same as R358	
R373	Same as R358	
R374	Same as R358	
R375	Same as R365	
R376	Same as R358	
R377	Same as R359	
R378	Same as R363	
R379	Deposited Carbon, 1 megohm, 1/2 w.	Wilkor CPSE
R380	100, 000 ohms, 1 w.	A-B GB1045
R381	Same as R341	
R382	Same as R327	
R383	470, 000 ohms, 1/2 w.	A B EB4745
R384	110, 000 ohms, 1 w.	A-B GB1145
R385	VARIABLE, composition:100, 000 ohms 1/2 w.	Clarostat 37-B-4-F
R386	VARIABLE, wirewound 100, 000 ohms, 10 turn Heliopot, 0.1% linearity	Beckman Mod B
R387	Same as R341	
R388	18, 000 ohms, 2 w.	A-B HB1835
R389	27, 000 ohms, 1 w.	A-B GB2735
R390	2700 ohms, 1/2 w.	A-B EB2725
R391	Same as R358	
R392	Same as R358	
R393	VARIABLE, composition: 10, 000 ohms, 1/2 w.	Clarostat 37-A-4-F
R394	33, 000 ohms, 1 w.	A-B GB3335
R395	620, 000 ohms, 1/2 w.	A-B EB6245
R396	Same as R329	
R397	VARIABLE, composition:50, 000 ohms, 1/2 w.	Clarostat 37-B-4-F
R398	56, 000 ohms, 1/2 w.	A-B EB5635

Ref. Sym.	Description	LFE or equivalent mfr. no.
R399	Same as R308	
R400	200,000 ohms, 1 w.	A-B GB2245
R401	4700 ohms, 1/2 w.	A-B EB4725
R402	Same as R401	
R403	Same as R327	
R404	Same as R316	
R405	Same as R385	
R406	68,000 ohms, 1/2 w.	A-B EB6835
R407	Same as R356	
R408	10,000 ohms, 2 w.	A-B HB1035
R409	10,000 ohms, 1 w.	A-B GB1035
R410	6800 ohms, 2 w.	A-B HB6825
R411	Same as R341	
R412	150,000 ohms, 1/2 w.	A-B EB1545
R413	68,000 ohms, 1/2 w.	A-B EB6835
R414	Same as R398	
R415	Same as R310	
R416	Same as R413	
R417	10,000 ohms, 1/2 w.	A-B EB1035
R418	24,000 ohms, 1/2 w.	A-B EB2435
R419	62,000 ohms, 1/2 w.	A-B EB6235
R420	Same as R341	
R421	Same as R419	
R422	Same as R385	
R423	Same as R384	
R424	Same as R384	
R425	Same as R408	
R426	Same as R408	
R427	Same as R410	
R428	Same as R359	
R429	Same as R337	
R430	1000 ohms, 1/2 w.	A-B EB1025
R431	Same as R430	
R432	Same as R345	
R433	Same as R341	
R501	220,000 ohms, 1/2 w.	A-B EB2245
R502	150,000 ohms, 1/2 w.	A-B EB1545
R503	VARIABLE, wirewound: 50 ohms, 2 w.	IRC A-2
R504	WIREWOUND:200 ohms, 10 w.	Clarostat AC10F
R505	WIREWOUND:50 ohms, 10 w.	Clarostat AC10F
R506	Same as R504	
R507	Same as R504	
R508	150,000 ohms, 2 w.	A-B HB1542
R509	VARIABLE, composition:250,000 ohms, 1/2 w.	Clarostat 37
R510	47,000 ohms, ±10%, 1/2 w.	A-B EB4731
R511	VARIABLE, composition:100,000 ohms, 1/4 w.	IRC G11-128
R512	22,000 ohms, ±10%, 1/2 w.	A-B EB2231
R513	33,000 ohms, ±10%, 1/2 w.	A-B EB3331
R514	68,000 ohms, ±10%, 1/2 w.	A-B EB6831
R515	39,000 ohms, ±10%, 1/2 w.	A-B EB3931
R516	100 ohms, ±20%, 1/2 w.	A-B EB1012
R517	WIREWOUND:2500 ohms, 25 w.	Clarostat 25K
R518	330,000 ohms, ±10%, 1/2 w.	A-B EB3341
R519	10,000 ohms, ±10%, 2 w.	A-B HB1031
R520	100,000 ohms, ±10%, 1/2 w.	A-B EB1031
R521	Same as R520	

Ref. Sym.	Description	LFE or equivalent mfr. no.
R522	1000 ohms, ± 20%, 1/2 w.	A-B EB1022
R523	1 megohm, ± 20%, 1/2 w.	A-B EB1052
R524	Same as R517	
R525	WIREWOUND:2250 ohms, 10 w.	Clarostat AC10F
R526	Same as R525	
R527	WIREWOUND: 4000 ohms, 5 w.	Clarostat PR5F
R528	Same as R527	
R529	1000 ohms, 2 w.	A-B HB1025
R530	WIREWOUND: 1250 ohms, 10 w.	Clarostat AC10F
R531	Same as R520	
R532	Same as R510	
R533	560, 000 ohms, ± 10%, 1/2 w.	A-B EB5641
R534	Same as R509	
R535	150, 000 ohms, ± 10%, 1/2 w.	A-B EB1541
R536	1500 ohms, 2w.	H-B HB1525
R537	1500 ohms, ± 20 %, 1/2 w.	A-B EB1522
R538	Same as R520	
R539	220 ohms, ± 10% 1/2 w.	A-B EB2211
R540	15, 000 ohms, ± 10%, 1/2 w.	A-B EB1531
R541	470, 000 ohms, ± 10%, 1/2 w.	A-B EB4741
R542	Deposited carbon: 10 meg., 2 w.	IRC type DCH
R543	Same as R514	
R544	VARIABLE, composition:1 meg, 1/2 w. high voltage insulation	Clarostat 37HVC
R545	Same as R510	
R546	1 megohm, ± 10%, 1/2 w.	A-B EB1051
R547	VARIABLE, composition: 2. 5 meg, 1/2 w. high voltage insulation	Clarostat 37HVC
R548	4. 7 megohm, ± 10%, 1 w.	A-B GB4751

PARTS LIST

INDUCTORS

Ref. Sym.	Description	LFE or equivalent mfr. no.	Ref. Sym	Description	LFE or equivalent mfr. no.
L101	Coil, R. F., 50 uh	901-050J	L111	Same as L110	
L102	Coil, R. F., 3.25 uh	T-70051	L112	Coil, R. F., 2.35 uh	T-70077
L103	Same as L102				
L104	Coil, R. F., 6.3 uh	T-70055			
L105	Same as L104				
L106	Coil, R. F., 2.7 uh	T-70053	L301	Coil, R. F., 80 uh, ±5%	7174-7
L107	Same as L106		L302	Coil, R. F., 125 uh, ±5%	7174-10
L108	Coil, R. F., 1.75 uh	T-70052	L303	Same as L302	
L109	Same as L108		L304	Coil, R. F., 2 mh, ±10%	905-520K
L110	Coil, R. F., 10 uh	T-70056-2	L305	Same as L304	

SWITCHES

Ref. Sym.	Description	LFE or equivalent mfr. no.	Ref. Sym.	Description	LFE or equivalent mfr. no.
S101	Wafer	6667	S302	Wafer	6664
S102	Wafer	6929	S303	Wafer	6666
S103	Wafer	6745	S304	Wafer	6665
			S501	Toggle: SPST, 6 amp, 125 v.	Carling 110
S301	Wafer	6744	S502	Push button:normally open, put to close 3 amp., 250 v.	A-H-H- 3391

TRANSFORMERS

Ref. Sym.	Description	LFE or equivalent mfr. no.	Ref. Sym.	Description	LFE or equivalent mfr. no.
T501	Plate and filament type	T-70017	T502	Special plate and filament type, high voltage insulation	T-70087-4

TUBES

Note: Tube call-outs are found on the schematic diagrams, All tubes are standard commercial types. Special descriptions of two tubes are found below:

Ref. Sym.	Description	LFE or equivalent mfr. no.	Ref. Sym.	Description	LFE or equivalent mfr. no.
V113	Regulator type	Amperite 8-4	V114	Same as V113	

MISCELLANEOUS

Ref. Sym.	Description	LFE or equivalent mfr. no.	Ref. Sym.	Description	LFE or equivalent mfr. no.
B501	Motor and fan	Motor no., 9352-1 Fan no., 9476-1	I502	Same as I501	
F501	Fuse:5 amp, 250 v. quick acting	Littel Fuse 4AG	I503	Same as I501	
			J101	Connector, receptacle	UG-290/U
I501	Lamp:bayonet, 6-8 v. 0.15 amp	G-E 47	P101	Connector, plug	UG-260/U
			Z101	Delay line	LFE9766

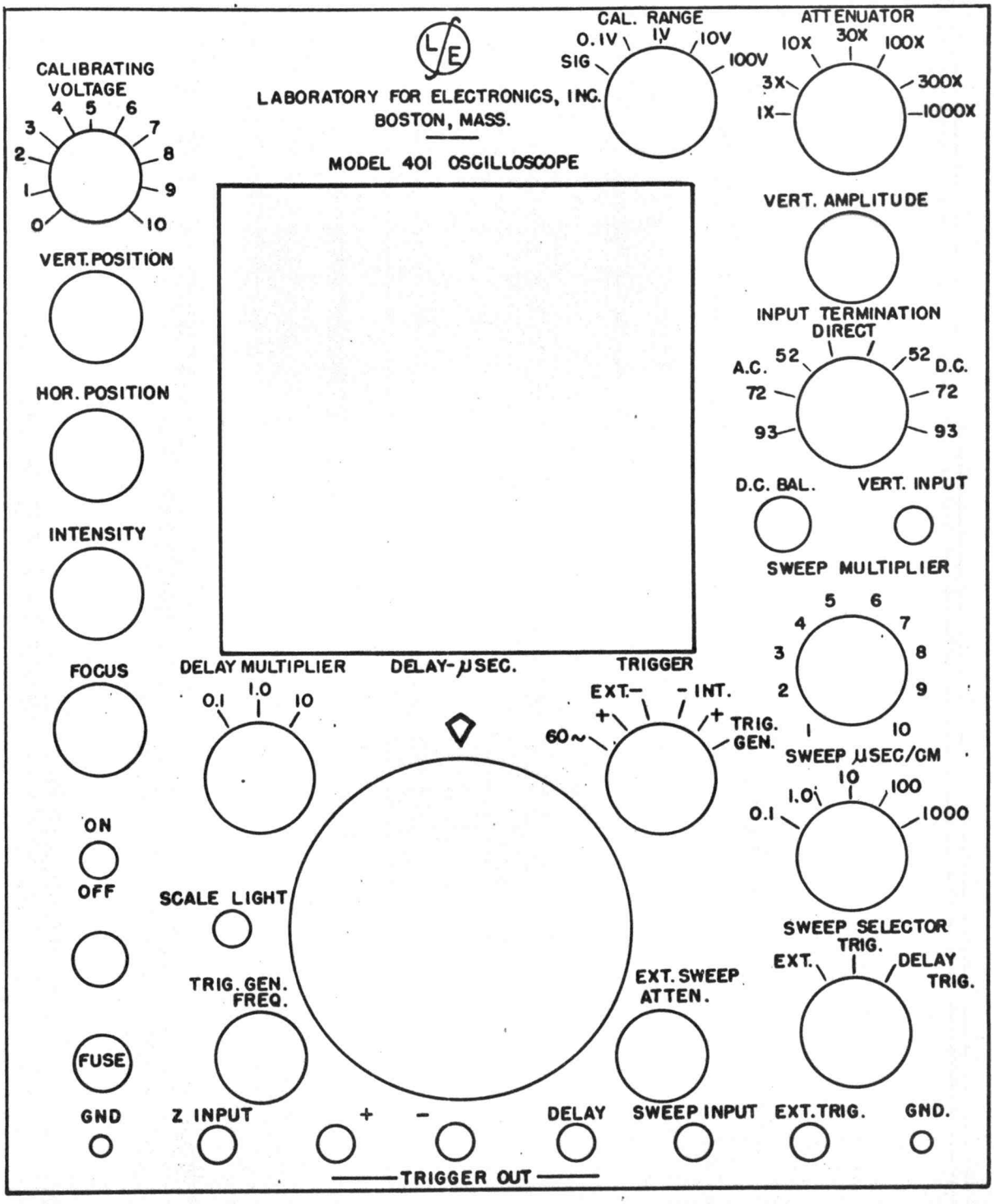
TUBE COMPLEMENT FOR 401 OSCILLOSCOPE

Quantity	Tube Type	Quantity	Tube Type
3	OD3	1	6X4
2	1V2	6	12AT7
3	6AH6	2	12AU7
5	6AL5	8	12AV7
1	6AQ5	4	12AX7
1	6AS7-G	2	12BY7
3	6AX5	2	8-4 Amperite
4	6CB6	1	5YP Dumont (with P1, P7 or P11 screen)

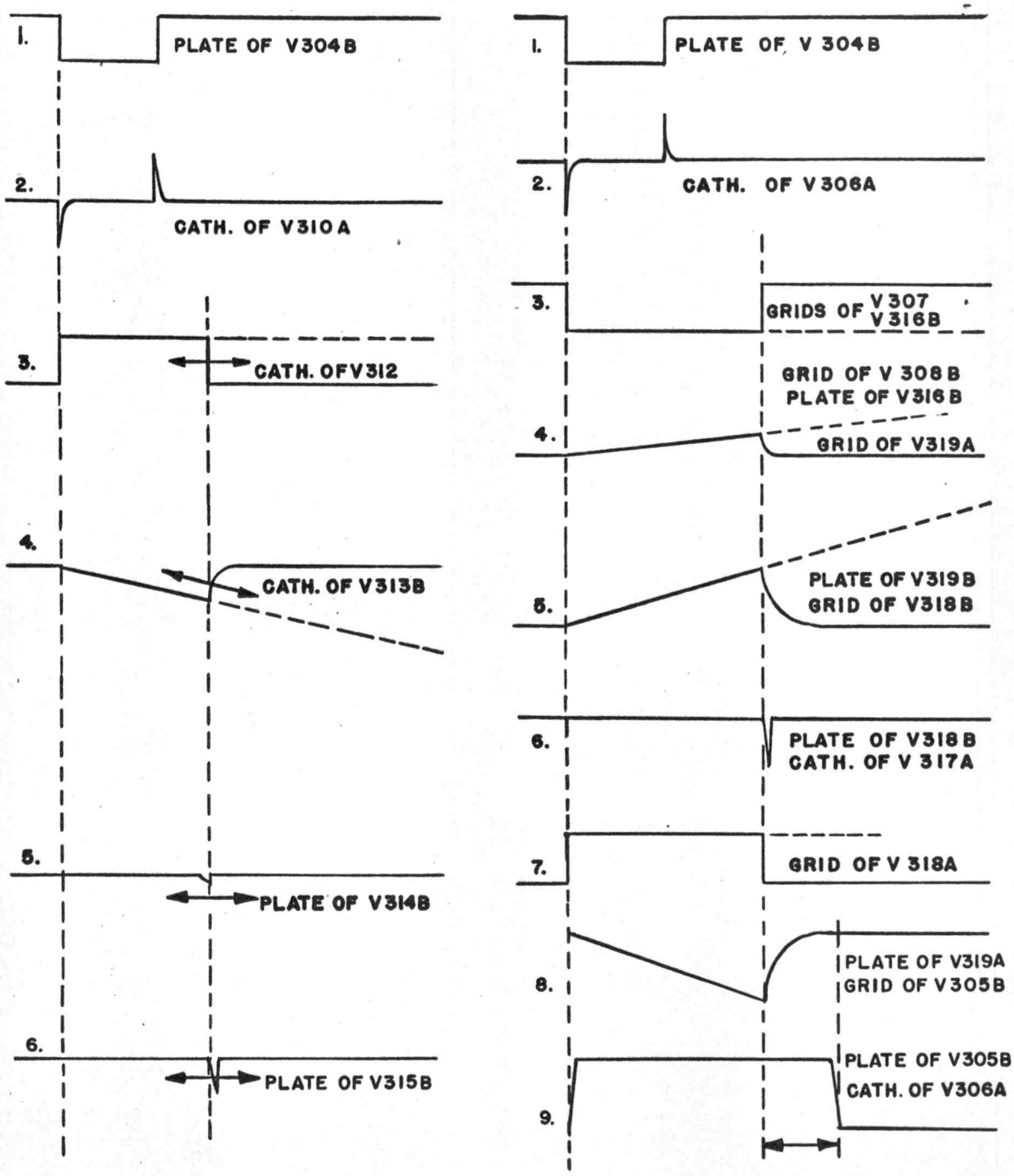
TOTAL TUBES 48

LIST OF MANUFACTURERS

Abbreviation	Name
A-B	Allen-Bradley Co., Milwaukee, Wis.
A-H-H	Arrow-Hart and Hegeman Electric Co., Hartford, Conn.
Amperite	Amperite Co., New York, N. Y.
Arco	Arco Electronics, Inc., New York, N. Y.
Astron	Astron Corporation, East Newark, N. J.
Beckman	The Helipot Corp., South Pasadena, Calif.
Carling	Carling Electric, Inc., West Hartford, Conn.
C-D	Cornell-Dubilier, Electric Corp., S. Plainfield, N. J.
Clarostat	Clarostat Mfg. Co., Inc., Dover, N. H.
El Menco	Electro Motive Mfg. Co., Williamantic, Conn.
Erie	Erie Resistor Corp., Erie, Pa.
G-E	General Electric Company
IRC	International Resistance Co., Philadelphia, Pa.
Littelfuse	Littelfuse, Chicago, Ill.
Mallory	P. R. Mallory Co., Indianapolis, Ind.
RMC	Radio Materials Corp., Chicago, Ill.
Sprague	Sprague Electric Co., North Adams, Mass.
Stackpole	Stackpole Carbon Co., St Marys, Pa.
Wilkor	Wilkor Products, Inc., Cleveland, Ohio

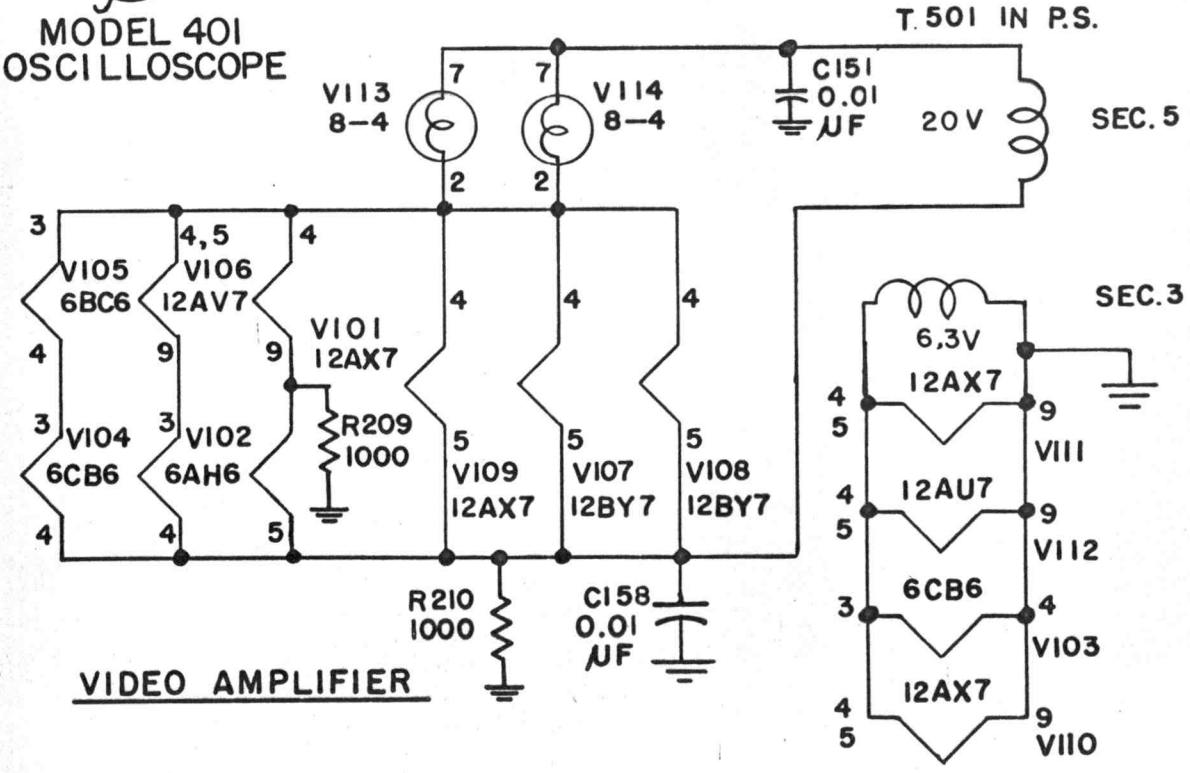


FRONT PANEL CONTROLS

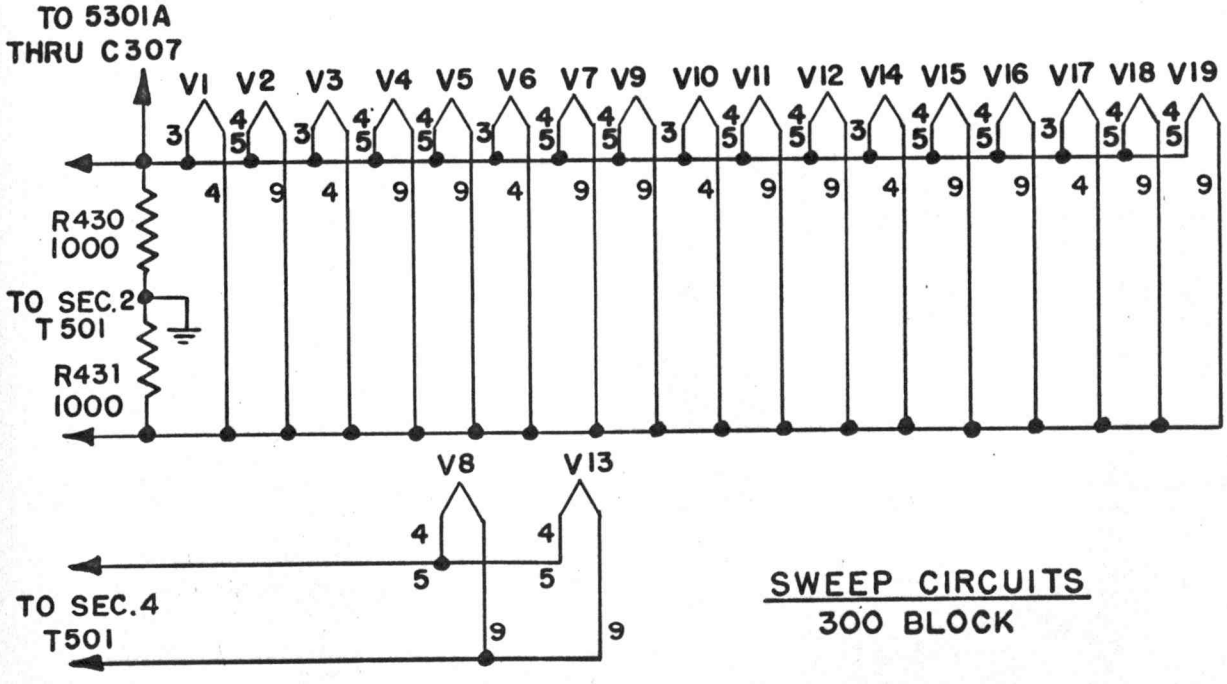


WAVEFORM TIMING DIAGRAMS

MODEL 401
OSCILLOSCOPE



VIDEO AMPLIFIER



SWEEP CIRCUITS
300 BLOCK

FILAMENT SUPPLIES

V301 ERRATA
SUP. IS PIN 2
SCREEN IS PIN 6

TRIGGER GENERATOR AND LIMITER

TRIGGER AMPLIFIER

DELAY MULTIPLIER

DELAY—μSEC.

SWEEP μSEC/CM

SWEEP MULTIPLIER

REGENERATIVE PICK-OFF

HOR. POSITION

EXT. SWEEP ATTEN.

SWEEP INPUT

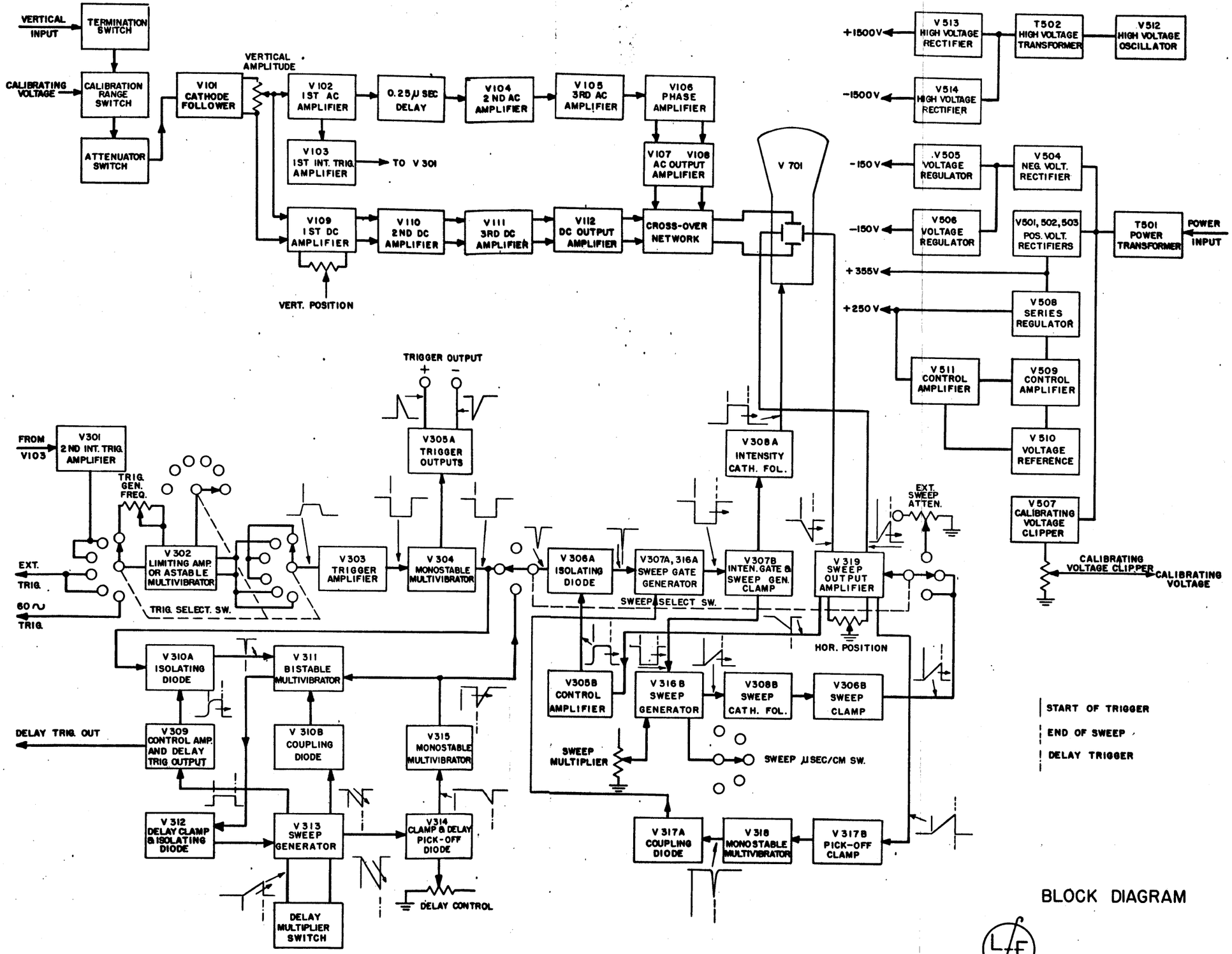
PINS ON NECK OF V701

NOTES:

1. ALL FIXED RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED
2. ALL CAPACITORS ARE IN μμF UNLESS OTHERWISE NOTED.
3. ⊘ =SCREWDRIVER ADJUSTMENT SET AT FACTORY.

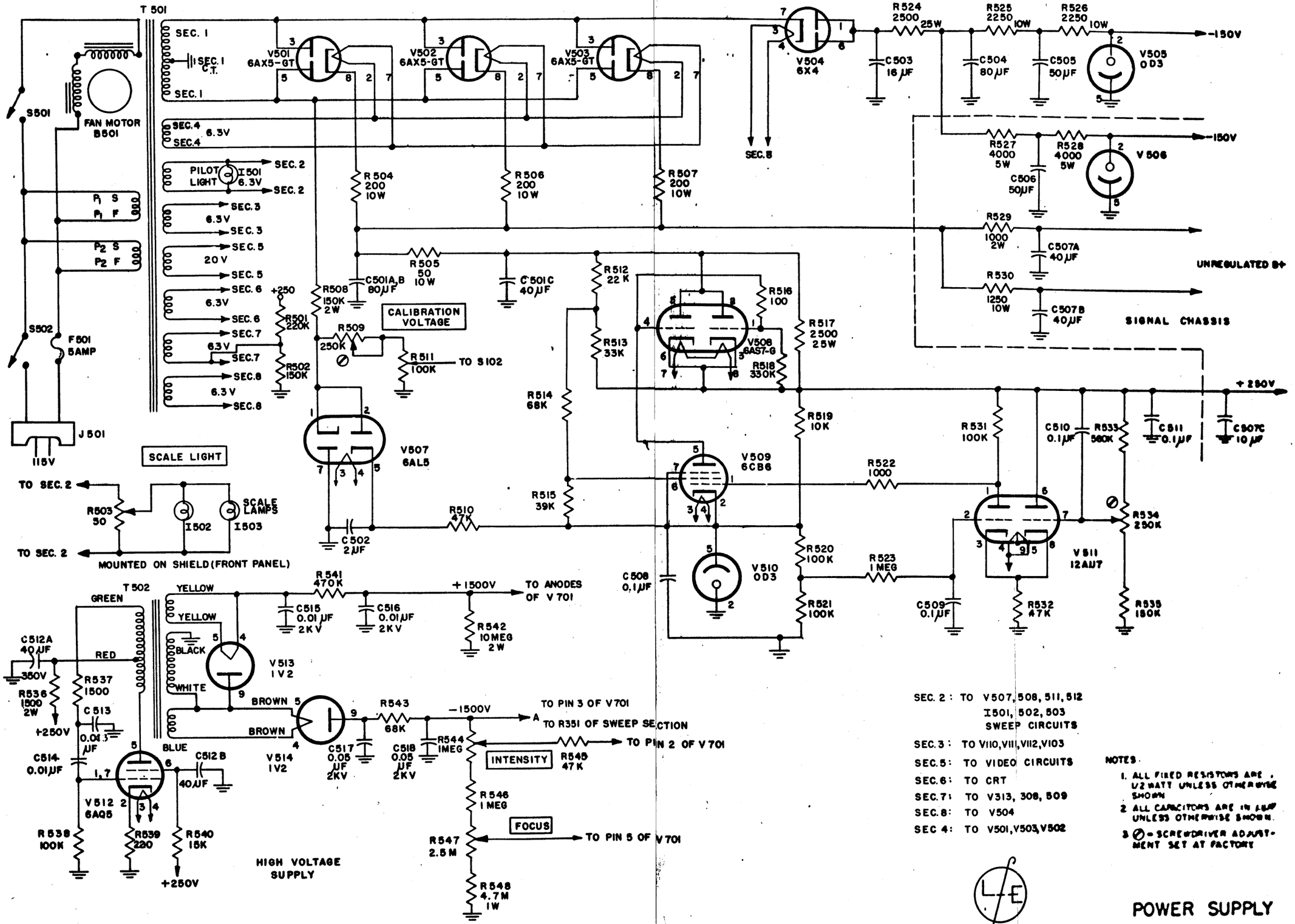
SCHEMATIC DIAGRAM SWEEP GENERATOR

MODEL 401
OSCILLOSCOPE



BLOCK DIAGRAM

MODEL 401
OSCILLOSCOPE



SEC. 2 : TO V507, 508, 511, 512
I501, 502, 503
SWEEP CIRCUITS

SEC. 3 : TO V110, V111, V112, V103

SEC. 5 : TO VIDEO CIRCUITS

SEC. 6 : TO CRT

SEC. 7 : TO V313, 308, 509

SEC. 8 : TO V504

SEC 4 : TO V501, V503, V502

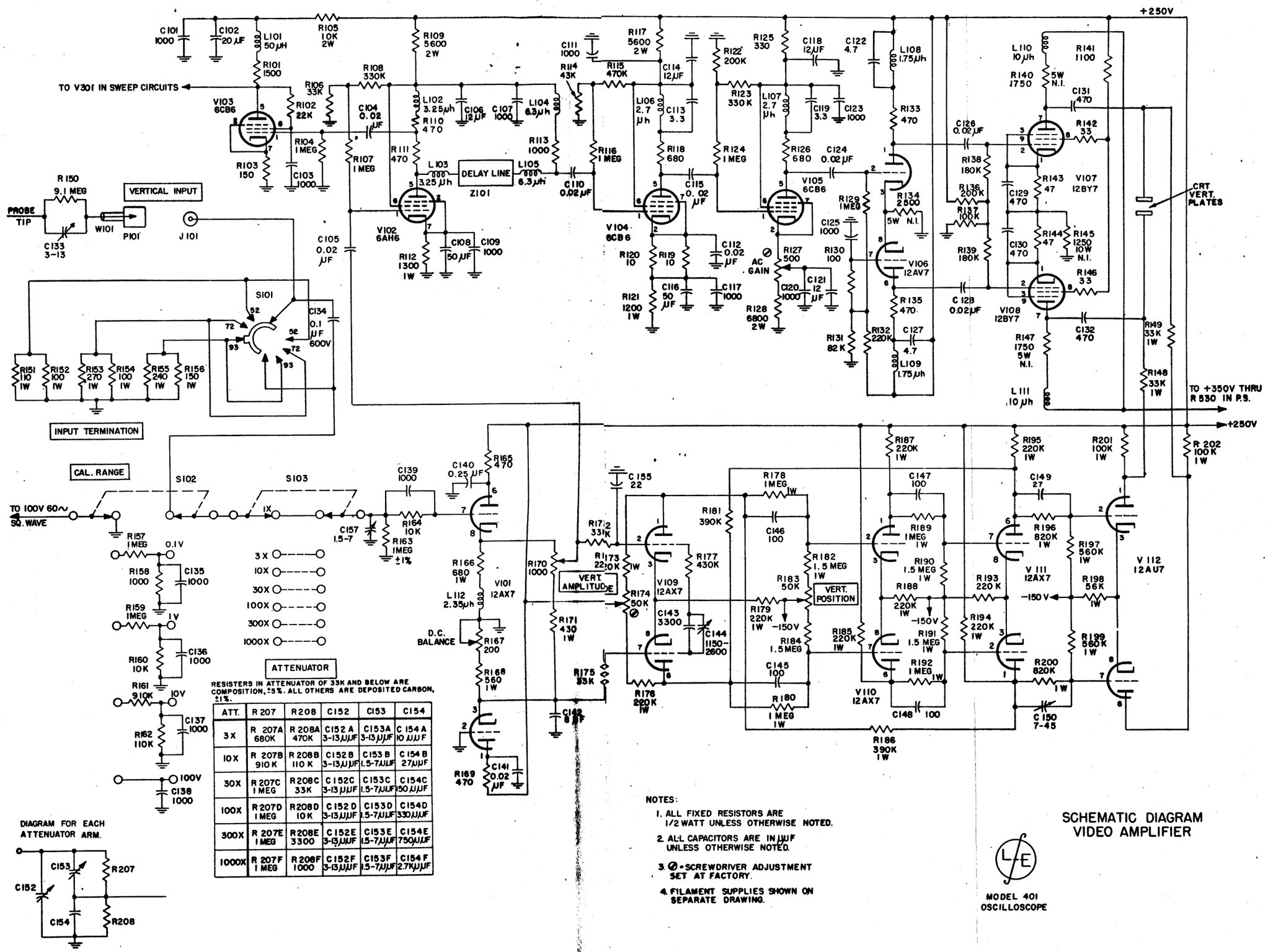
NOTES

1. ALL FIXED RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SHOWN
2. ALL CAPACITORS ARE IN µµF UNLESS OTHERWISE SHOWN.
3. ⊘ = SCREWDRIVER ADJUSTMENT SET AT FACTORY

L/E

MODEL 401
OSCILLOSCOPE

POWER SUPPLY



ATTENUATOR

RESISTERS IN ATTENUATOR OF 33K AND BELOW ARE COMPOSITION, ±5%. ALL OTHERS ARE DEPOSITED CARBON, ±1%.

ATT.	R 207	R 208	C152	C153	C154
3X	R 207A 680K	R 208A 470K	C152 A 3-13 μμF	C153A 3-13 μμF	C 154 A 10 μμF
10X	R 207B 910 K	R 208B 110 K	C152 B 3-13 μμF	C153 B 1.5-7 μμF	C 154 B 27 μμF
30X	R 207C 1 MEG	R 208C 33K	C 152C 3-13 μμF	C153C 1.5-7 μμF	C154C 150 μμF
100X	R 207D 1 MEG	R 208D 10K	C 152 D 3-13 μμF	C153D 1.5-7 μμF	C154D 330 μμF
300X	R 207E 1 MEG	R208E 3300	C152E 3-13 μμF	C153E 1.5-7 μμF	C154E 750 μμF
1000X	R 207F 1 MEG	R208F 1000	C152F 3-13 μμF	C153F 1.5-7 μμF	C154 F 2.7KμμF

DIAGRAM FOR EACH ATTENUATOR ARM.

NOTES:

1. ALL FIXED RESISTORS ARE 1/2 WATT UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE IN μμF UNLESS OTHERWISE NOTED.
3. ⊘ = SCREWDRIVER ADJUSTMENT SET AT FACTORY.
4. FILAMENT SUPPLIES SHOWN ON SEPARATE DRAWING.

SCHEMATIC DIAGRAM VIDEO AMPLIFIER

L/E

MODEL 401 OSCILLOSCOPE