OPERATING AND SERVICE MANUAL

MODEL 130B/BR

SERIALS PREFIXED: 201

OSCILLOSCOPE

00013-3 Printed: JAN 1962

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SPECIFICATIONS

SWEEP

Sweep Range:
0.2 μsec/cm to at least 12.5 sec/cm. 21 calibrated sweeps, accurate within ±5%, in a 1-2-5-10 sequence, 1 μsec/cm to 5 sec/cm. Vernier permits continuous adjustment of sweep time between calibrated steps and extends slowest sweep time to at least 12.5 sec/cm.

Magnifier:
X5 Magnifier may be used on all ranges and expands fastest sweep to 0.2 μsec/cm. Accuracy within 10%.

Synchronization:
Internally from line voltage or from signals causing 1/2 centimeter or more vertical deflection. Externally from 0.5 volts peak-to-peak or more.

Trigger Point:
Continuously adjustable from approximately -30 to +30 volts on either positive or negative slope of external synchronizing signal, or from any point of the vertical signal presented on the screen.

Preset Triggering:
Switch position on sweep mode control selects optimum setting for automatic triggering.

INPUT AMPLIFIERS

Vertical and horizontal amplifiers have same characteristics.

Sensitivity:
1 mv/cm to at least 125 v/cm. 15 calibrated ranges, accurate within ±5%, in a 1-2-5-10 sequence, 1 mv/cm to 50 v/cm. Vernier permits continuous adjustment between ranges and decreases sensitivity of 50 v/cm range to at least 125 volts/cm. Input voltage rating 600 volts dc or rms.

Phase Shift:
Within ± 1° relative phase shift at frequencies up to 50 kc between vertical and horizontal amplifiers with verniers in cal.

Stability:
1 mv/hr after warmup.

Bandwidth:
DC Coupling: dc to 300 kc. AC Coupling: 2 cps to 300 kc. Specified bandwidth is independent of sensitivity setting.

Balanced Input:
On 1, 2, 5, 10, 20 and 50 mv/cm ranges. Cabinet Mount input impedance: 2 megohms shunted with approximately 25 pf. Rack Mount input impedance 2 megohms, approximately 125 pf shunt capacity. Disconnecting the wires at the front panel which connect to the rear terminals reduces the input capacity to approximately 25 pf.

Common Signal Rejection:
(Balanced input only):
Rejection at least 40 db. Common signal must not exceed 1.5 volts.

Single Ended Input:
Cabinet Mount input impedance: 1 megohm shunted with approximately 50 pf. Rack Mount input impedance: 1 megohm, approximately 200 pf shunt capacity. Disconnecting the wires at the front panel connecting to the rear terminals reduces the input capacity to approximately 50 pf.

Internal Calibrator:
300 millivolts peak-to-peak ± 2%, 300 cycles squarewave applied to vertical or horizontal amplifiers by CAL position of input attenuators.

SPECIFICATIONS (CONT'D.)

GENERAL

External Graticule (Standard):
Edge lighted graticule with controlled illumination, 10 cm x 10 cm, marked in centimeter squares with 2 mm subdivisions, on major horizontal and vertical axes.

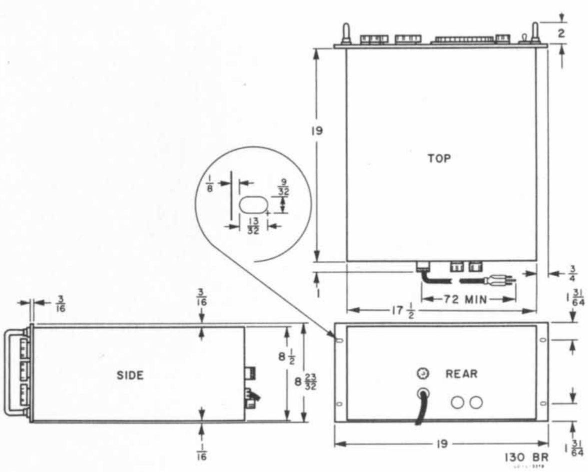
Internal Graticule (Optional):
10 cm x 10 cm, major horizontal.

CRT Plates:
Direct connection to deflection plates via terminals on rear. Sensitivity approximately 20 volts/cm.

Intensity Modulation:
Terminals on rear; 20 volts positive signal blanks CRT at normal intensity.

Dimensions:
Cabinet Mount: 9-3/4 in. wide, 15 in. high, 21-1/4 in. deep.

Rack Mount:



Weight:
Cabinet Mount: Net 41 lbs, shipping 54 lbs.
Rack Mount: Net 47 lbs, shipping 62 lbs.

Cathode Ray Tube:
5 AQP mono-accelerator flat face type with 3000 volt accelerating potential. Available with P1, P2, P7 or P11 screen.

Power Supply:
115/230 volts ● 10%, 50/1000 cycles, 160 watts.

Filter Supplied:
Color of filter compatible with screen phosphor. Green for P1 and P2, Amber for P7, Blue for P11.

Rack Mount:
Has rear terminals in parallel with front panel. connections.

Accessories Furnished:
Supplied with Rack Mount.
130B-12P and Q Mounting Brackets (pair).
Two 125-57 Plugs (mate with rear terminals).
Two 125-59 Clamps for 125-57 Plugs.

Accessories Available:

AC-83A Viewing Hood; face-fitting molded rubber. Price $5.00.
Additional Mounting Brackets. 130B-12P (left) and 130B-12Q (right)'; $2.50 a pair.

Price:

Model 130B, Cabinet Mount: $650.00
Model 130BR, Rack Mount: $650.00
Options:
2. P-2 CRT (installed)
3. Internal graticule CRT (installed)
7. P-7 CRT (installed)
11. P-11 CRT (installed)

Figure 1-1. Model 130B/BR Oscilloscope

SECTION I
GENERAL DESCRIPTION

1-1 GENERAL

The Hewlett-Packard Model 130B Oscilloscope is a general purpose oscilloscope. It can be used with either internal or external sweeps which can be either internally or externally synchronized and it can be obtained in either the cabinet or rack type mounting. Because of its high sensitivity and balanced input, the Model 130B may often be used directly with transducers, enabling you to see a direct presentation of phenomena desired without having to resort to preamplifiers.

Some of the special features of this oscilloscope are as follows:

A. LINEAR INTEGRATOR SWEEP GENERATOR

The accurate direct reading sweeps are obtained from a Miller-integrator sweep circuit which insures a high order linearity and stability. This type of sweep generator, is more reliable and independent of tube characteristics than other types of sweep generator.

B. X5 SWEEP EXPANSION

You speed observation and analysis of transients by expanding a two centimeter segment of the trace to 10 centimeters for easy viewing of detail. This X5 sweep expander, may be used on all sweep time settings and expands the fastest sweep time to .2 microsecond/cm.

C. CALIBRATED AMPLIFIERS

Voltage measurements of various waveforms are quickly made with the 130B, accurate within ±5%. A built-in calibrator which is accurate within ±2% permits quick verification and standardization of the amplifier gain.

Phase shift measurements can be made accurately with this oscilloscope over a wide range of input frequencies.

1-2 DAMAGE IN TRANSIT

This instrument should be thoroughly inspected when it is received. If any damage is evident, refer to the "Claim for Damage in Shipment" paragraph on the Warranty sheet in this manual.

1-3 POWER LINE VOLTAGES

The Oscilloscope is shipped from the factory wired for 115 volts ac line operation, unless otherwise specified. However, the instrument may also be operated from a 230 volts ac line source if the proper conversion is made to the power transformer. This conversion is described in the Maintenance Section (Section IV).

1-4 POWER CORD

The three conductor power cable supplied with the instrument is terminated in a polarized three prong male connector recommended by the National Electrical Manufacturers' Association. The third contact is an offset round pin, added to a standard two-blade ac plug, which grounds the instrument chassis when used with the appropriate receptacle. An adapter should be used to connect the NEMA plug to a standard two contact output. When the adapter is used, the ground connection becomes a short lead from the adapter which should be connected to a suitable ground for the protection of operating personnel.

1-5 INSTALLATION OF RACK MOUNT

The ⓗⓟ 130BR is designed so that it can be supported in a 19 inch rack by the front panel in the usual manner; or, the dust cover may be rigidly mounted in the rack with brackets as shown in Figure 1-1. In the latter case, the chassis is supported by the dust cover and may be slipped in or out easily; the screws through the front panel merely holding the chassis in place. To rack mount the 130BR using the brackets:

1) Mount the bracket as shown in Figure 1-3 with screws through the outside holes of the brackets. The length of these screws may be chosen to space the front panel from the panel rails as desired. The brackets at the rear are not necessary in most installations but can be used if added support is required. These brackets are available from the Hewlett-Packard Company as an accessory item.

2) Remove the dust cover from the 130BR and mount it in the brackets with the 10-32 trusshead screws provided.

3) Slip the 130BR into the dust cover and fasten in place with screws through the front panel.

1-6 CATHODE RAY TUBE WARRANTY

The cathode ray tube (crt) supplied with the oscilloscope and replacement crt's purchased from Hewlett-Packard company are guaranteed against electrical failure for one year from the date of sale by Hewlett-Packard. Cathode Ray Tube Warranty sheet is illustrated in figure 1-2. A sheet for your use is included in the appendix of this manual.

CATHODE RAY TUBE WARRANTY

The cathode ray tube supplied in your Hewlett-Packard Oscilloscope and replacement cathode ray tubes purchased from ⓗⓟ, are guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. Broken tubes or tubes with burned phosphor are not included in this guarantee.

Your local Hewlett-Packard representative maintains a stock of replacement tubes and will be glad to process your warranty claim for you. Please consult him.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow shipping instructions carefully to insure safe arrival, since no credit can be allowed on broken tubes.

SHIPPING INSTRUCTIONS

1) Carefully wrap the tube in 1/4" thick cotton batting or other soft padding material.
2) Wrap the above in heavy kraft paper.
3) Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.
4) Surround the tube with at least four inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.
5) Tubes returned from outside the continental United States should be packed in a wooden box.
6) Ship prepaid preferably by AIR FREIGHT or RAILWAY EXPRESS. We do not recommend parcel post or air parcel post shipment.

HEWLETT-PACKARD CO. PAGE MILL ROAD, PALO ALTO, CALIF. U.S.A.

CRT WARRANTY CLAIM

FROM: DATE: ________

NAME: ________

COMPANY: ________

ADDRESS: ________

Person to contact for further information:

NAME: ________

TITLE: ________

COMPANY: ________

ADDRESS: ________

To process your claim quickly please enter the information indicated below:

1) ⓗⓟ INSTRUMENT MODEL ________ SERIAL ________
2) TUBE TYPE ________ SERIAL ________
3) ORIGINAL TUBE ________ REPLACEMENT TUBE ________
4) YOUR PURCHASE ORDER NO. ________
5) DATE PURCHASED ________
6) PURCHASED FROM ________
7) COMPLAINT: (Please describe nature of trouble) ________
8) OPERATING CONDITIONS: (Please describe conditions prior to and at time of failure ________

SIGNATURE ________

Figure 1-2. Cathode Ray Tube Warranty

SECTION II
OPERATING INSTRUCTIONS

2-1 CONTROLS AND TERMINALS

Front panel operation controls are shown in Figure 2-1. This description of the operating controls enables you to operate the instrument if you have a basic knowledge of oscilloscope technique. Detailed operating procedures are given in the operating plates.

INTERNAL SWEEP CONTROLS

SWEEP TIME/CM -
This switch determines the speed at which the crt beam crosses the screen. HORIZ. SENSITIVITY switch must be in an INT. SWEEP position or internal sweeps are not generated. Associated with the SWEEP TIME/CM switch is a concentric VERNIER which provides continuous adjustment of sweep speed between steps. A X5 sweep magnifier operates on all ranges.

SYNC -
This three position switch lets the sweep be triggered either internally or externally. Internal triggering can be accomplished from a line frequency signal or from an applied vertical input signal of sufficient amplitude to produce a one-half centimeter deflection. External triggering can be produced by signals having amplitude greater than 0.5 volt, peak-to-peak.

SWEEP MODE -
As this control is rotated from the extreme clockwise position, the sweep generator will pass from an un-synchronized free-running (FREE RUN) condition through a condition where only triggered operation is possible (TRIGGERED) to a position in which sweeps will not occur. At the extreme counterclockwise position the control switches into a PRESET position. This position provides optimum triggering bias for nearly all waveforms.

TRIGGER LEVEL -
This continuous control selects the level on the sync waveform where triggering is to occur. When the TRIGGER LEVEL control is set to zero, the trigger circuits are the most sensitive.

TRIGGER SLOPE -
This two-position switch, concentric with TRIGGER LEVEL, permits triggering to occur on either the positive or negative slope of internal, external or line voltage sync signals.

Horizontal or Sync INPUT -
A set of three binding posts used for receiving external sync voltages and external generated sweeping voltages. On the rack mount model only, a 3-conductor receptacle J102, mounted at the rear of the instrument, is connected in parallel with the binding posts.

2-2 REAR-ACCESS TERMINALS

------DANGER - HIGH VOLTAGE-----

The following terminals are accessible through the rear access plate of the instrument cabinet: Horizontal and vertical deflection plates, and a terminal for crt intensity (Z-axis) modulation. See Figures 2-8 and 2-10.

2-3 WARM-UP DRIFT

When the oscilloscope is first turned on, drift in the trace will be quite noticeable, particularly at high sensitivities, the trace drift is fastest immediately following turn-on, becoming slower as the instrument warms up. Because of this drift, fine adjustment of amplifier balance should not be attempted until the instrument is thoroughly warm. For most purposes a 5 minute warm-up will be adequate.

2-4 AC OR DC COUPLING

AC coupling permits high gain to be employed without regard for the dc level involved. In the AC position the input signal (vertical or horizontal) is coupled to the amplifier through a capacitor which removes the dc component from the input. This coupling circuit has a low frequency cut-off at 2 cps. To avoid degrading input pulses or square waves below 200 cps it is advisable to use dc coupling. WHEN USING DC COUPLING THE AVERAGE VALUE OF THE DC DETERMINES THE POSITION OF THE SWEEP ON THE OSCILLOSCOPE. IF YOU ARE UNABLE TO FIND THE TRACE WITH THE VERTICAL POSITION CONTROL WHEN USING DC COUPLING, TRY AC COUPLING. When AC coupled the maximum dc that may be applied is 600 volts.

2-5 BALANCED INPUTS

The instrument will accept balanced input signals on the six most sensitive ranges. This arrangement is shown in Figure 2-7.

Driving the instrument from a balanced source can be very effective in removing the unwanted stray pickup that would otherwise obscure the desired information. To take advantage of the noise reduction that is possible with a balanced input, you must be sure that neither terminal of the source is connected to ground, and use double conductor shielded cable between the source and oscilloscope. The input cable shield must be connected to a suitable ground, either at the oscilloscope or some other point. With these precautions in the external input circuit, any stray signals (noise, hum, etc.) will be coupled equally to the two input terminals, and be cancelled by the differential amplifiers. Since the desired information is applied between the two input terminals, it will be amplified and displayed in the normal manner. Since the noise is a problem mainly at low level, the fact that balanced input is available only on the most sensitive ranges is generally not a serious limitation.

The common-mode signal rejection will be at least 40 db (1/100 of the input signal). When using a balanced input certain limitations must be considered. The proper operating levels must be maintained on the input amplifier: The COMMON-MODE SIGNAL VOLTAGE MUST NOT EXCEED 1.5 VOLTS EITHER POSITIVE OR NEGATIVE, ON EITHER INPUT TERMINAL. Note that this is the sum of all voltages (dc plus peak ac).

NOTE

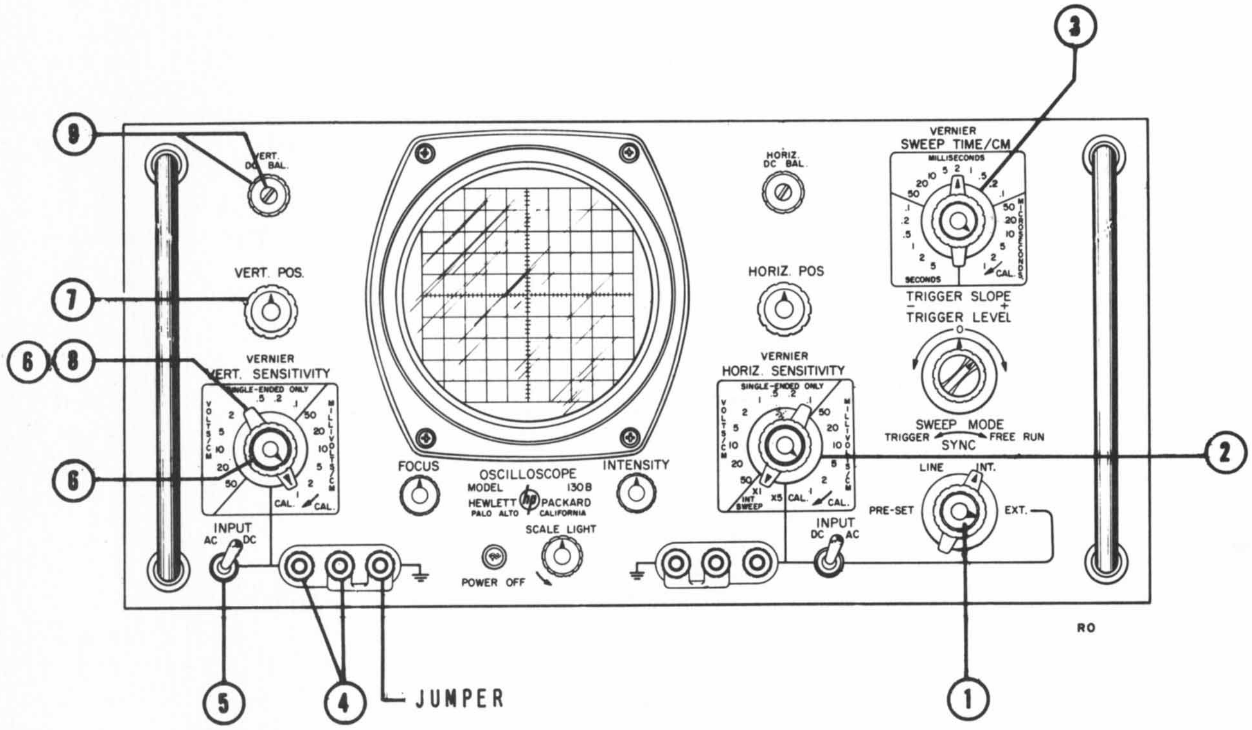
If balanced ac coupling is desired, it is necessary to connect a capacitor in the external signal path to the middle terminal, since a dc voltage on this terminal only unbalances the amplifier. This arrangement is shown in Figure 2-7.

2-6 OPERATING PROCEDURES

Basic operating procedures are described in the following illustrations. Positions of controls are different on the cabinet model but their functions are identical to those of the rack model.

Figure	Description
2-2	VERTICAL BALANCE ADJUSTMENT
2-3	HORIZONTAL BALANCE ADJUSTMENT
2-4	INTERNAL SWEEP-INTERNAL SYNCHRONIZATION
2-5	INTERNAL SWEEP-EXTERNAL SYNCHRONIZATION
2-6	EXTERNAL HORIZONTAL INPUT
2-7	AC COUPLING BALANCED INPUT
2-8	CONNECTION TO CRT DEFLECTION PLATES
2-9	EXTERNAL INTENSITY MODULATION
2-10	ALIGNING SCOPE TRACE WITH GRATICULE

VERTICAL BALANCE ADJUSTMENT



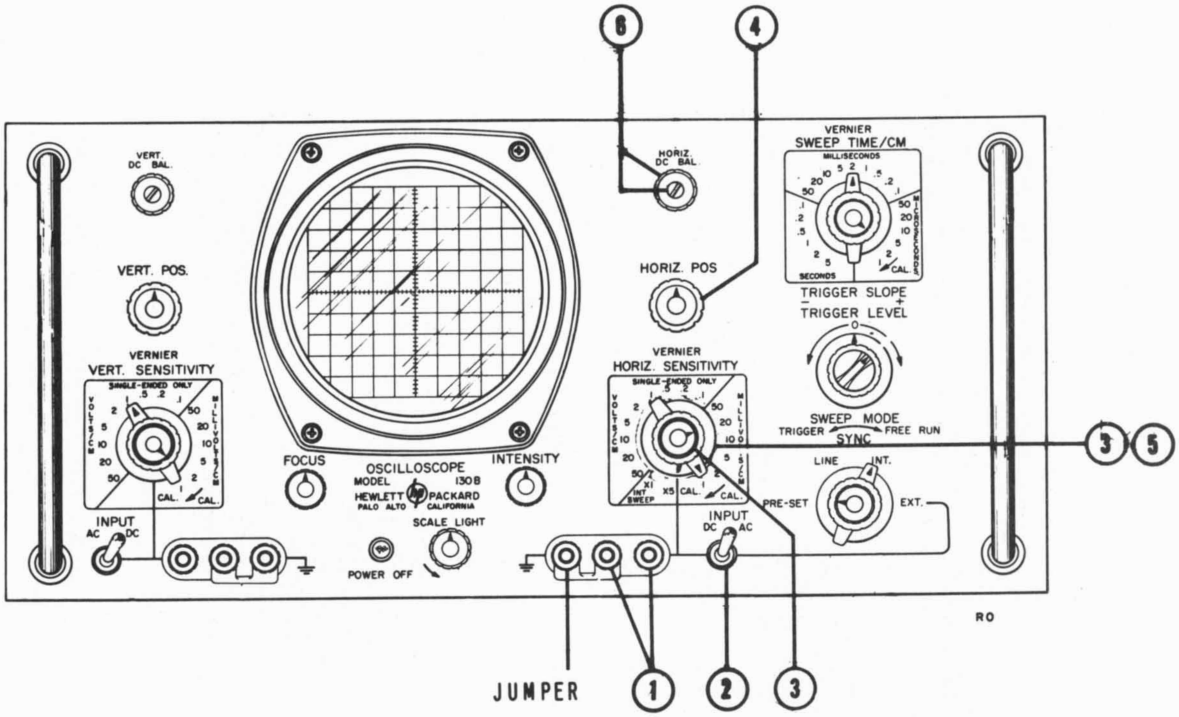
After Warm-up:

1. Turn SWEEP MODE control to FREE RUN.
2. Set HORIZ. SENSITIVITY switch to INT. SWEEP X1.
3. Set SWEEP TIME/CM switch so that a convenient base line is formed. (Any sweep time faster than 50 MILLISECONDS/CM is satisfactory.)
4. Short vertical input terminals together.
5. Set AC-DC switch to DC.
6. Set VERT. SENSITIVITY to CAL. Turn VERNIER to CAL.
7. Center bottom portion of calibration signal trace using VERT. POS. control.
8. Set VERT. SENSITIVITY to 1 MILLIVOLTS/CM.
9. Center trace with coarse (screwdriver) VERT. DC BAL. control or with fine (knob) control if unbalance is slight.
10. Repeat steps 6, 7,8 and 9 if necessary.

NOTE: A separate adjustment (Bal. Adj. on the etched board) is provided to balance the VERNIER.

Figure 2-2

HORIZONTAL BALANCE ADJUSTMENT



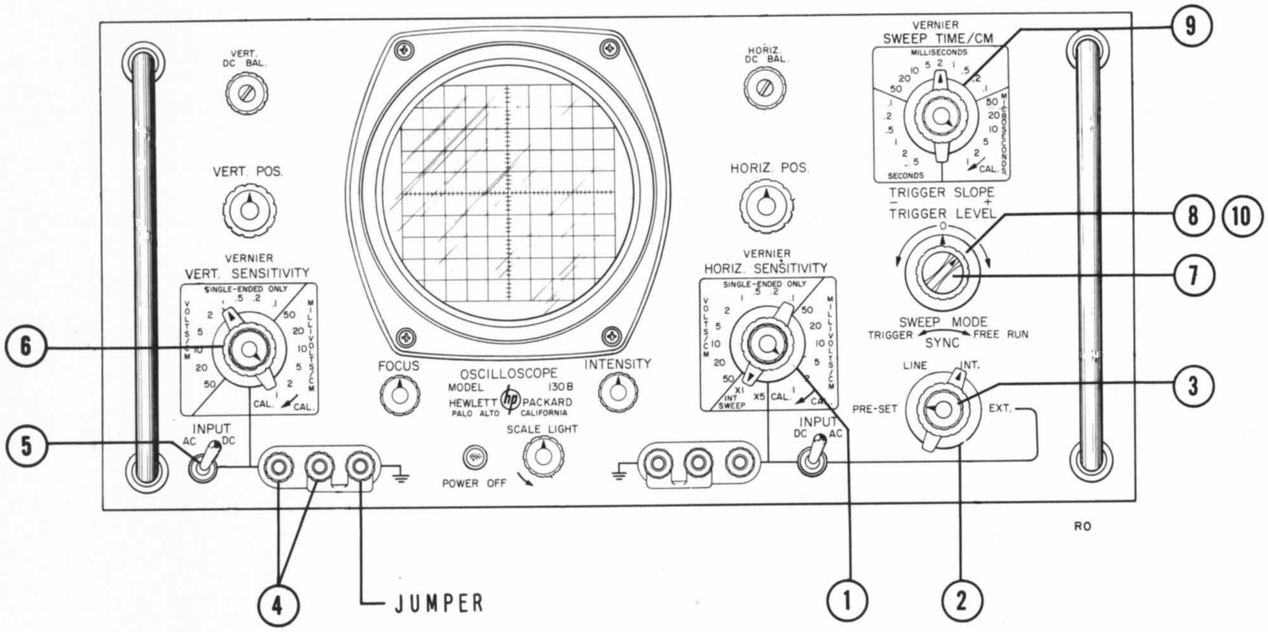
After warm-up:

1. Short together the horizontal INPUT terminals.
2. Set AC-DC switch to DC.
3. Set HORIZ. SENSITIVITY to CAL. Turn VERNIER to CAL.
4. Adjust the HORIZ. POS. control to place the left edge of the calibrating signal trace on the major vertical axis.
5. Set HORIZ. SENSITIVITY to 1 MILLIVOLT/CM.
6. Return the spot to the major vertical axis with the coarse (screwdriver) HORIZ. DC BAL. control or with the fine (knob) control if the unbalance is slight.
7. Repeat steps 2, 3 4, and 5 if necessary.

NOTE: A separate adjustment (Bal. Adj. on the etched board) is provided to balance the VERNIER.

Figure 2-3

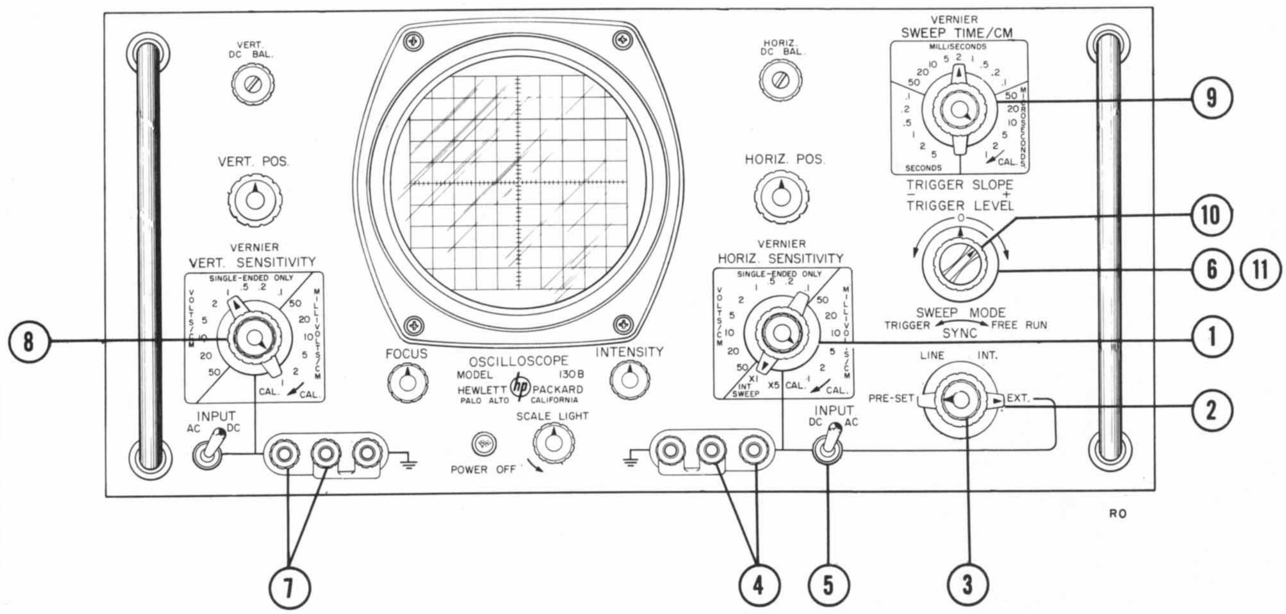
INTERNAL SWEEP - INTERNAL SYNCHRONIZATION



1. Set HORIZ. SENSITIVITY switch to INT. SWEEP X1 (or to X5 for magnified sweeps)
2. Set SYNC switch to INT.
3. Set SWEEP MODE to PRESET.
4. Connect vertical input signal into vertical input terminals.
5. Set AC-DC switch for type coupling desired.
6. Adjust VERT. SENSITIVITY for desired sensitivity.
7. Set TRIGGER SLOPE switch for triggering on positive or negative slope of input signal, as desired.
8. Set TRIGGER LEVEL control to 0.
9. Select desired sweep speed with SWEEP TIME/CM switch.
10. Adjust TRIGGER LEVEL to start trace at desired level. In some cases, it may be necessary to switch SWEEP MODE from PRESET to an individual adjustment for the particular trace being viewed.

Figure 2-4

INTERNAL SWEEP - EXTERNAL SYNCHRONIZATION



1. Set HORIZ. SENSITIVITY switch to INT. SWEEP X1 (or to X5 for magnified sweeps).

2. Set SYNC switch to EXT.

3. Set SWEEP MODE to PRESET.

4. Feed synchronizing signal (0.5 volts p-p or more) to the horizontal input terminals.

5. Set AC-DC switch for type coupling desired.

6. Set TRIGGER LEVEL to 0.

7. Feed vertical input signal into vertical input terminals.

8. Adjust VERT. SENSITIVITY for desired sensitivity.

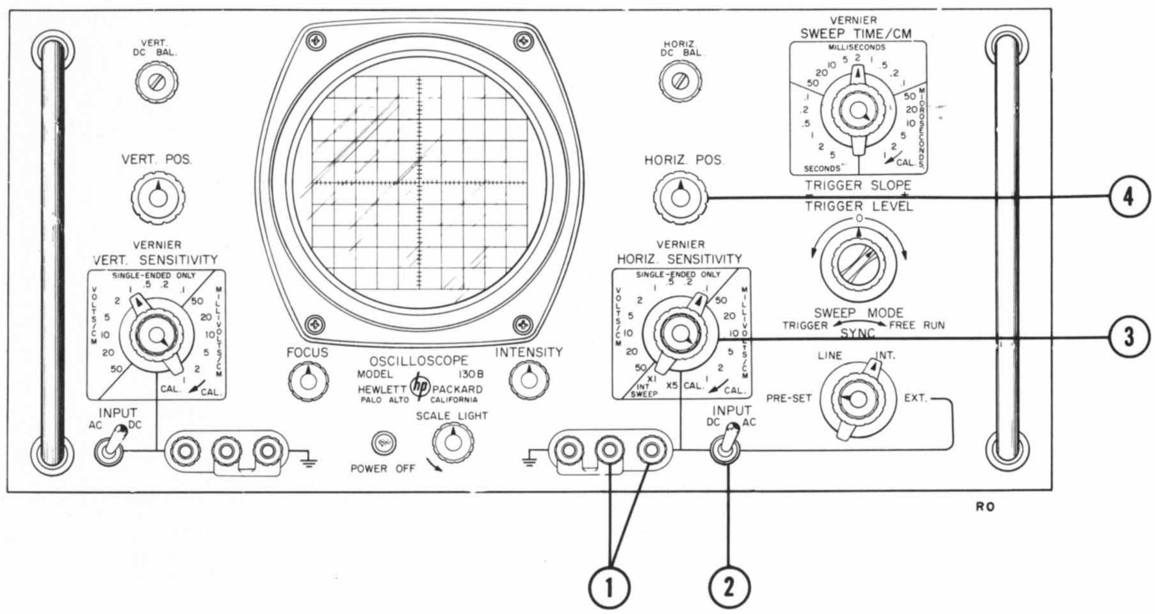
9. Select desired sweep speed with SWEEP TIME/CM switch.

10. Set TRIGGER SLOPE for triggering on positive or negative slope, as desired.

11. Adjust TRIGGER LEVEL to start trace at desired level. In some cases, it may be found necessary to switch SWEEP MODE from PRESET to an individual adjustment for the particular trace being viewed.

Figure 2-5

EXTERNAL HORIZONTAL INPUT

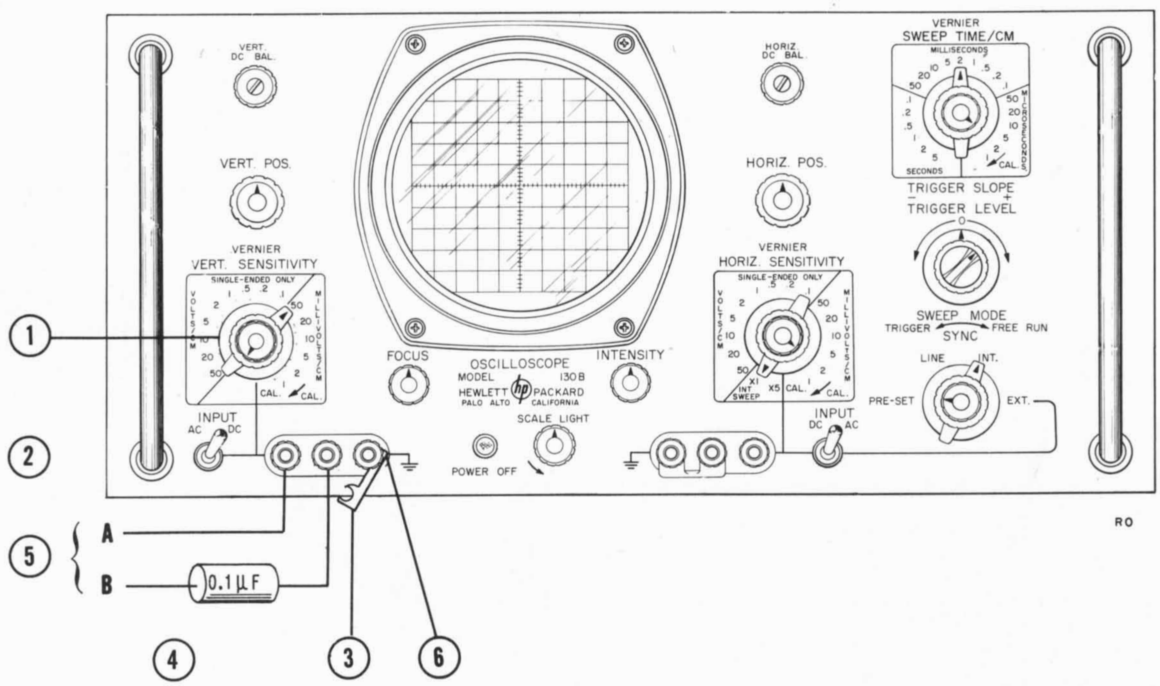


1. Feed horizontal signal to horizontal input terminals.
2. Set AC-DC switch for type of input coupling desired.
3. Set HORIZ. SENSITIVITY switch for desired sensitivity.
4. Adjust horizontal position of pattern with HORIZ. POS. control.

This type of input will be found useful for viewing Lissajous patterns, etc.

Figure 2-6

AC COUPLING BALANCED INPUT



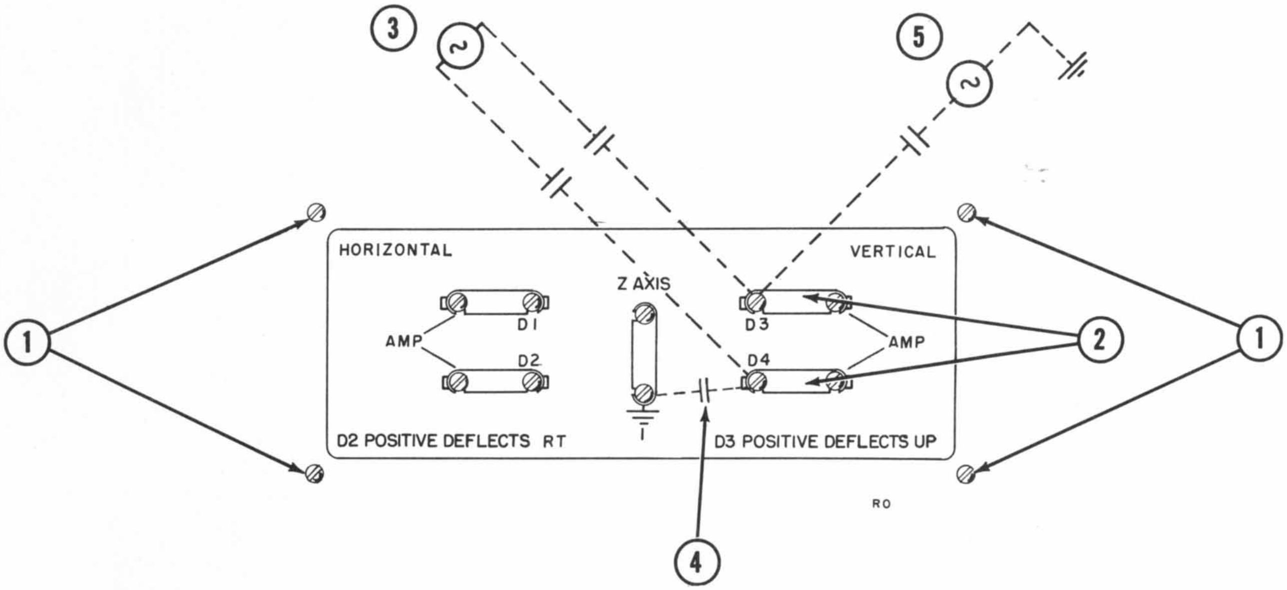
The following procedure is for the vertical input, but is the same for the horizontal input.

1. Set VERT. SENSITIVITY to 50 MILLIVOLTS/CM, input not balanced on higher ranges.
2. Set AC-DC switch to AC.
3. Disconnect shorting strap.
4. Connect 0.1 microfarad capacitor to mid-terminal.
5. Connect input signal to A and B.
6. Ground input at the black terminal.

The capacitor must be used to block any dc.

Figure 2-7

CONNECTION TO CRT DEFLECTION PLATES



The following procedure is for connecting external signals to the vertical deflection plates, but is the same for the horizontal plates.

1. Remove rear access plate fastened by four screws.

2. Remove the shorting bars between the Vertical Amplifier and terminals D3 and D4 and replace them with 1 megohm, 1/2 watt resistor.

For balanced AC coupling:

3. Connect balanced signal through appropriate capacitor to D3 and D4.

For single-ended AC coupling:

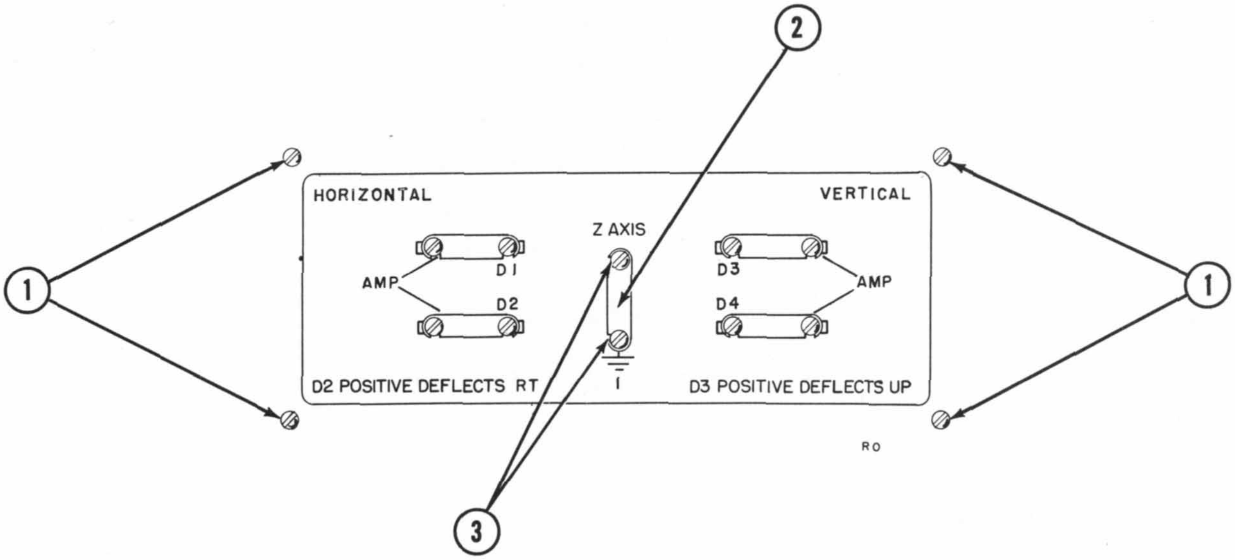
4. Bypass D4 to chassis with an adequate capacity.

5. Connect the signal to D3 through an appropriate capacitor.

NOTE: If it is desired to have positive voltage deflect the beam downward, bypass D3 to chassis and connect the signal to D4.

Figure 2-8

EXTERNAL INTENSITY MODULATION



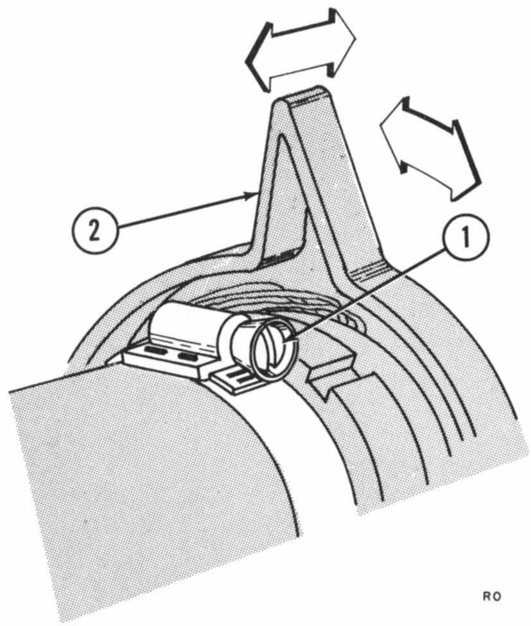
CAUTION: Dangerous Voltages are present on this terminal board. Be sure the instrument is turned off when making this connection.

To intensity modulate the CRT with external signals:

1. Remove rear access plate fastened by four small screws at rear of dust cover.
2. Remove shorting bar.
3. Connect modulating signal to these terminals. A positive voltage of 20 volts peak will blank the CRT trace from normal intensity.

Figure 2-9

ALIGNING SCOPE TRACE WITH GRATICULE



CAUTION: DANGEROUS VOLTAGES ARE PRESENT INSIDE THE INSTRUMENT

Remove two screws at rear of dust cover and slide cover off to rear. Fiber lever (2) controls both radial and longitudinal positioning of CRT and is locked by clamp (1).

To align sweep trace with graticule loosen clamp (1) with a screwdriver. Rotate fiber arm (2) until the trace is parallel to horizontal lines on graticule. Tighten clamp (1) after adjustment has been made.

Figure 2-10

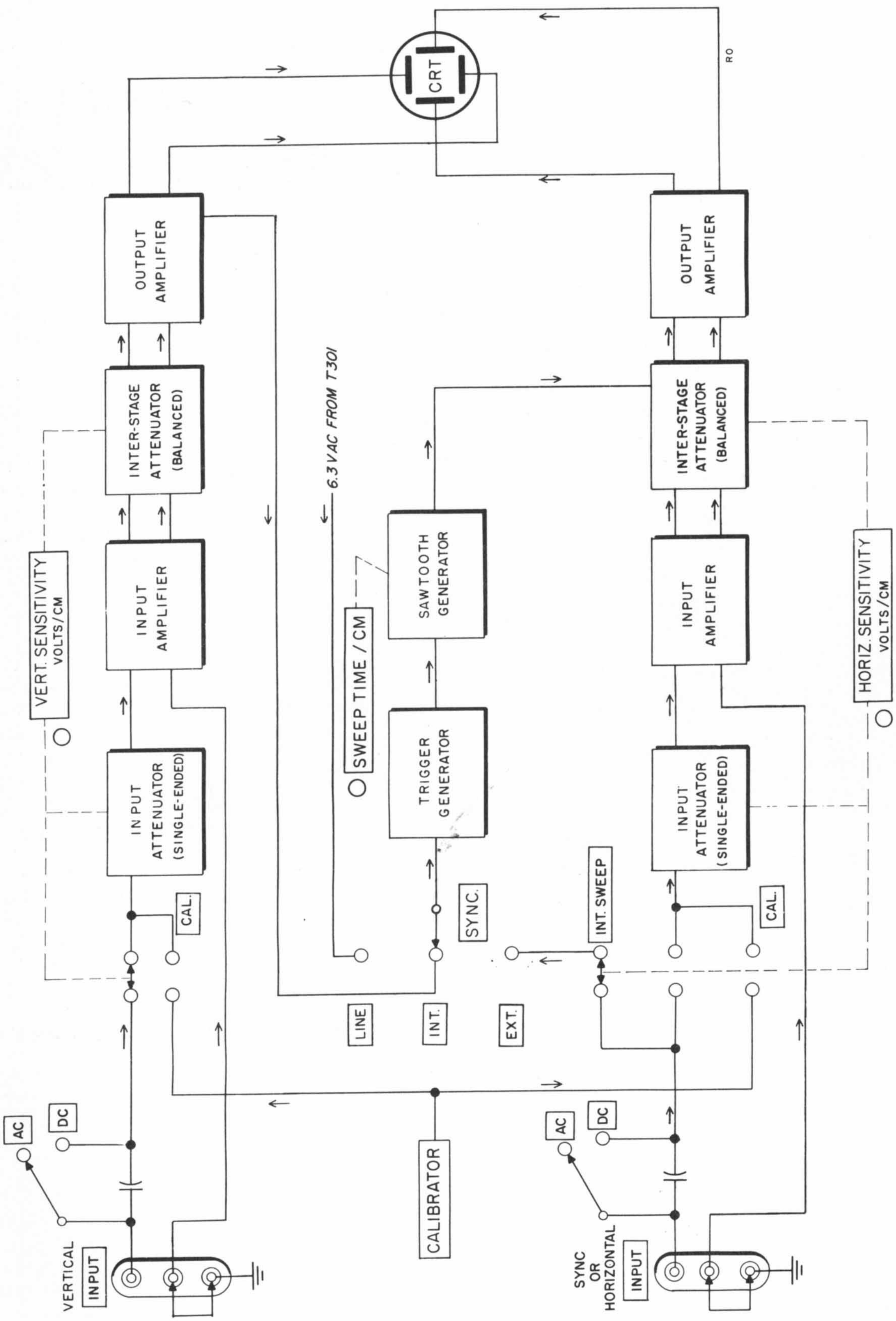


Figure 3-1. Model 130B Block Diagram

SECTION III
THEORY OF OPERATION

3-1 GENERAL CONTENT

This section contains a brief description of the over-all operation of the Model 130B Oscilloscope, description of each major section and detailed description of a Schmitt trigger.

3-2 OVER-ALL OPERATION

The block diagram in Figure 3-1 shows the basic circuits of the Model 130B Oscilloscope.

A. VERTICAL AMPLIFIER

The Vertical Amplifier receives the input signal, amplifies it, and drives the vertical deflection plates of the cathode ray tube. In addition, this amplifier determines the vertical position of the spot on the screen and supplies a signal for synchronizing the sweep with the vertical input signal.

B. HORIZONTAL AMPLIFIER

The Horizontal Amplifier receives its signal either from the horizontal INPUT jack or from the Sweep Generator, amplifies it and drives the horizontal deflection plates of the cathode ray tube. Except for the provisions in the Horizontal Amplifier for amplifying the internally-generated sawtooth voltage, it is essentially the same as the Vertical Amplifier.

C. SWEEP GENERATOR

The Sweep Generator forms a sawtooth voltage to control the horizontal movement of the spot across the face of the cathode ray tube. The Sweep Generator is divided into two parts: 1) a sawtooth generator, 2) a trigger generator, which starts the sawtooth. The trigger generator controls allow the operator to choose the point at which the sawtooth sweep begins.

In addition to forming the internal sweep of the oscilloscope, the Sweep Generator also supplies the required unblanking pulse which brightens the trace during each sweep.

D. CALIBRATOR

An internal square-wave calibrator, with a nominal frequency of 300 cps, is provided for setting the basic gain of the amplifiers. Turning either the VERT. or HORIZ. SENSITIVITY switches to CAL., turns on the calibrator supply voltage and connects its output to the appropriate amplifier.

E. CATHODE RAY TUBE

The cathode ray tube is a 5AQP - mono-accelerator type. It is normally supplied with a P1 phosphor screen but is available in the P7 and P11 phosphors also and P2 upon special order. All are electrically interchangeable and the tube is easily changed. The mono-accelerator anode makes possible a simple astigmatism adjustment which requires no resetting when adjusting the FOCUS or INTENSITY controls. The deflection plate terminals are connected through removable jumpers at the rear of the instrument so that direct connections to the plates can be made easily.

3-3 VERTICAL AMPLIFICATION CHANNEL

The vertical amplification channel consists of three parts: the AC-DC switch, the input attenuator, and the amplifier section proper.

A. AC - DC SWITCH

The signal comes into the input terminals and is fed to the AC-DC switch. For ac coupling, a capacitor is switched into the signal path. In the DC position, the signal goes directly to the input attenuator.

B. INPUT ATTENUATOR

The input attenuator is a sixteen position switch having fifteen calibrated ranges (1 MILLIVOLT/CM to 50 VOLTS/CM) and a calibrate position. When the switch is in the CAL. position, the input of the amplifier is directly connected to the output of the internal calibrator. On ranges less sensitive than 50 MILLIVOLTS/CM, single-ended frequency-compensated attenuators are inserted ahead of the Vertical Amplifier. On the six most sensitive ranges, balanced-type attenuators are inserted between the second differential amplifier (V2) and the third differential amplifier (V3). On the six most sensitive ranges, balanced input signals may be applied to the input terminals after removing the jumper to the ground terminal. The sensitivity may be varied continuously between ranges by means of the VERNIER control.

C. VERTICAL AMPLIFIER

The Vertical Amplifier consists of four stages of balanced differential amplifiers* in cascade. The first stage (V1) has the VERT. DC BAL. adjustment (R10A, B) in its cathode circuit which adjusts the current division between the two halves of the stage. The second stage has a VERNIER control in the cathode circuit which varies the gain of the amplifier between ranges of the VERT. SENSITIVITY switch, and another dc balance adjustment (R20) is also provided. In the last three stages, neutralizing capacitors are used to cancel the coupling effects between the input and output of the amplifier arising from the inter-electrode capacitances. The output of the second stage is fed to the balanced attenuator of the VERT. SENSITIVITY switch. The output of the balanced attenuator is connected to the third balanced differential amplifier (V3). The third stage has two potentiometers in its cathode circuit, one controls the vertical position of the pattern (VERT. POS) and the other adjusts the basic gain of the Vertical Amplifier (R40, Gain Adj.). The fourth balanced differential amplifier (V4) is the output stage. The neon lamps in the grid-cathode circuit of V4 protect the tube when the Model 130B is first turned on. The output of V4 drives the vertical deflection plates of the cathode ray tube. In addition, synchronization signals are coupled from the plates of V4 and coupled into the Sweep Generator to trigger the sweep during either INTERNAL + or INTERNAL - synchronization. As a precaution against drift and hum, a regulated dc supply is used for the heaters of the first three stages.

* Valley and Wallman, "Vacuum Tube Amplifier", Massachusetts Institute of Technology Radiation Series, vol. 18, pp 441-451. McGraw-Hill Book Company, Inc., New York, 1948.

3-4 HORIZONTAL AMPLIFICATION CHANNEL

The Horizontal Amplifier is essentially identical to the Vertical Amplifier, except in the INT. SWEEP X1 and X5 position of the HORIZ. SENSITIVITY switch. In these positions, the sawtooth signal from the Sweep Generator is fed through the sweep attenuator to the grid of V103, the third balanced differential amplifier. In the INT. X5 position, R164, X5 Mag. Adj., in the cathode circuit of V104 sets the gain of the amplifier to obtain sweep magnification of X5. The output of V104 drives the horizontal deflection plates of the cathode ray tube.

3-5 SWEEP GENERATOR

The sweep generator provides a sawtooth voltage to produce linear horizontal movement of the spot across the face of the cathode ray tube when the HORIZ. SENSITIVITY switch is set to INT. SWEEP (X1 or X5). In addition, the sweep generator furnishes the pulse required to unblank the cathode ray tube during each sweep.

The sweep generator consists of a Trigger Generator, a Sawtooth Generator, and a Gate Out Cathode Follower.

A. TRIGGER GENERATOR

The purpose of the Trigger Generator is to receive a synchronizing signal and convert it into a fast, constant-amplitude pulse to start the Sawtooth Generator.

The Trigger Generator consists of a SYNC selector switch (S201), a Trigger Amplifier (V201), and a Trigger Generator (V202). The SYNC selector switch accepts a signal from:

1) the Vertical Amplifier (internal synchronization, + or -),
2) an internal 6.3 volt source (line-frequency synchronization), or
3) the horizontal INPUT terminals (external synchronization).

The synchronizing signal is fed to V201 which amplifies the signal and delivers it in the proper phase, as selected by the TRIGGER SLOPE switch, to the Trigger Generator. Adjustment of the TRIGGER LEVEL control sets the output level of V201, determining the point on the input waveform that will trigger the Trigger Generator (V202). Trigger Generator (V202) is a Schmitt trigger circuit; a discussion of the Schmitt trigger follows:

A Schmitt trigger consists of two amplifiers, A and B, having both plate-to-grid and cathode-to-cathode coupling. The circuit has two stable states: A side conducting, B side cut off; B side conducting, A side cut off. Due to regenerative action the change-over from one state to the other is very rapid, producing fast rise and decay times in the square-wave output. The levels at which the change-over takes place (hysteresis limits) can be adjusted to be close together as in the Trigger Generator (V202) or widely spaced as in the Start-Stop Trigger (V203). To trigger the circuit, the A side grid voltage must cross a particular hysteresis limit to change the state of the circuit. For example, if the A side is conducting, driving the grid voltage positive through the upper hysteresis limit will have no effect, but driving the grid voltage negative through the lower hysteresis limit will put the A side out of conduction and B side into conduction.

B. SAWTOOTH GENERATOR

The Sawtooth Generator consists of Start-Stop Trigger (V203), and Integrator Switch (V205), a Feedback Integrator (V206B), and Integrator Cathode Follower (V206A), and a Retriggering Hold-Off Cathode Follower (V207B).

Start-Stop Trigger (V203), a Schmitt trigger circuit, is fed by Trigger Generator (V202). The square wave output of V203 is fed directly to the Integrator Switch (V205), which in turn controls the action of Feedback Integrator (V206B). When V203 produces a negative pulse,it causes V205 to cut off permitting V206B to commence operation.

Feedback Integrator (V206B), a Miller integrator circuit*, generates essentially a positive linearly rising waveform, which is applied to the Horizontal Amplifier to sweep the trace across the face of the cathode ray tube. The rate at which this sweep takes place is determined by the values of the RC network in the grid circuit of V206B. These values are varied by the SWEEP TIME switch. The output of V206B is fed through a neon lamp (I203) to the Integrator Cathode Follower (V206A). I203 is shunted with a capacitor to improve the high-frequency response of the circuit, and a series resistor is used to eliminate any tendency toward oscillation. I204 through I206 are protective neons for the timing capacitor in the sweep time switch.

The output of the Integrator Cathode Follower (V206A) is fed to two circuits: 1) through the sweep attenuator to the Horizontal Amplifier and 2) to the Retriggering Hold-Off Cathode Follower (V207B) in the Sawtooth Generator feedback circuit. During the Sweep, V207B conducts and the capacitor in its cathode circuit charges. However, at the termination of the sweep, V207B is cut off and the cathode capacitor discharges, maintaining a positive bias on the grid of V203A. This hold-off bias allows sufficient time between sweeps for the Sweep Generator to recover. The bias which determines the triggering level of the Start-Stop Trigger (V203A) is supplied by the Retriggering Bias Control (V207A). The bias is adjusted by the SWEEP MODE control, R218, in the grid circuit of V207A.

C. GATE OUT CATHODE FOLLOWER

Another function of the Start-Stop Trigger is to furnish a pulse to unblank the cathode ray tube. The Gate Out Cathode Follower (V204), couples the required positive unblanking pulse from the Start-Stop Trigger to the grid of the crt for the duration of the sweep.

3-6 LOW VOLTAGE POWER SUPPLY

The low-voltage power supply consists of four regulated voltage supplies, three positive (+585V, +300V, +100V) and one negative (-150V), furnishing the plate voltages and dc filament voltages required for the instrument.

The operation of each of the four regulators is similar; only the -150 volt supply will be discussed. V306, V307 and V308 constitute the voltage regulator circuit for the -150 volt supply. V308, a glow discharge tube, probides a reference voltage for the cathode of V307, the

* Millman and Taub, "Pulse and Digital Circuits" pp 216-228, McGraw-Hill Book Company, Inc., New York, 1956.

Control Tube. V306, a Series Regulator, is controlled by the voltage at the plate of V307. If the output voltage from the rectifier increases, the bias of V307 decreases, causing V307 to draw more current. This lowers the plate voltage of V307 and the grid voltage of V306, resulting in greater plate resistance for V306. Increased plate resistance causes a greater voltage drop across V306, compensating for the increased output voltage from the rectifier and resulting in substantially constant output.

If the output voltage from the rectifier decreases, the reverse of the above action occurs. Changes in supply voltage due to changes in load current are minimized in the same manner. Thus, the output voltage is held essentially constant. The output of the -150 volt supply serves as the reference voltage for the three positive-voltage supplies.

3-7 HIGH-VOLTAGE POWER SUPPLY

The high-voltage power supply provides regulated dc voltage to the cathode and control grid of the cathode ray tube. The high-voltage power supply consists of an RF Oscillator tube (V313), a high-voltage transformer (T302), high-voltage rectifiers (V310,311) and a High-Voltage Control Tube (V312). The RF Oscillator, a Hartley circuit, oscillates at a frequency of approximately 100 kc. The high-voltage transformer has two separate secondaries which feed the High-Voltage Rectifiers.

The output of V310 is connected to the cathode of the cathode ray tube. A fraction of this voltage is fed to the High-Voltage Control Tube V312, a dc-coupled amplifier. The output of V312 is fed back to the screen of RF Oscillator tube (V313) in proper phase to oppose any change in the high-voltage output. The INTENSITY control in the output of this supply determines the voltage on the cathode of the cathode ray tube.

The output of V311 is connected to the control grid of the cathode ray tube, and normally the crt beam is cut off. During the sweep operation, a positive pulse from the Gate Out Cathode Follower (V204) in the Sweep Generator circuit overrides the negative crt grid cutoff voltage and unblanks the cathode ray tube. The brilliance of the trace may be adjusted with the Intensity Adjust potentiometer (R343), in series with grid-voltage supply.

3-8 CALIBRATOR

The Calibrator, a square-wave oscillator, produces an accurate voltage across R244 for application to either amplifier for setting the basic gain. Turning either the VERT. or HORIZ. SENSITIVITY switches to CAL. turns on the Calibrator and connects its output to the appropriate amplifier.

The Calibrator consists of two neon lamps (I 207 and I 208) in a relaxation oscillator circuit. Operation of the Calibrator is as follows:

When the +300 volt supply is applied to the Calibrator, I 207 will ionize first due to higher potential across it compared to the potential across I 208. When I 207 fires it will draw current through R243. However, the voltage at the junction of R242, C213 and R243 will build up slowly because the voltage across a capacitor cannot change instantaneously. As C213 allows this voltage to change, the voltage at the common junction of I 207 and I 208 will also change, since the voltage drop across the ionized neon lamp is constant (approximately 60 volts). As the voltage at the common junction of I 207 and I 208 reaches approximately +70 volts, I 208 will fire. This additional current through R240 and R241 will reduce the voltage across I 207 and it will de-ionize. I 208 remains lit until the voltage across C213 charges through R243 to a voltage approximately 70 volts below the voltage that appears at the common junction of I 207 and I 208. I 207 will now fire and the action will repeat itself.

I 208 is thus alternately turned off and on at a rate of approximately 300 cps. The output of the Calibrator is taken from the current passing through R244 and I 208. The output is approximately a square wave which can be set with R240 to obtain 300 millivolts in amplitude.

SECTION IV
MAINTENANCE

4-1 INTRODUCTION

This section contains instructions for testing, adjusting, and trouble shooting the Model 130B Oscilloscope.

Standard, readily available components are used for manufacture of ⓗⓟ instruments whenever possible. Special components are available through your local ⓗⓟ Representative who maintains a part stock for your convenience.

When ordering parts, specify instrument model and serial number plus the component description and stock number appearing in the Table of Replaceable Parts.

Your local ⓗⓟ Representative maintains complete facilities and specially trained personnel to assist you with any problems you may have with ⓗⓟ instruments.

The material in this section is divided according to circuit functions, each section having a complete set of adjustment instructions. The material in this section is as follows:

The following test equipment is used for testing and adjusting the Model 130B Oscilloscope during manufacture. Equivalent test equipment may be used.

1) A high impedance dc vacuum tube voltmeter, such as an ⓗⓟ Model 410B with an ⓗⓟ Model 459A DC Voltage Multiplier.

2) A high impedance ac vacuum tube voltmeter, such as an ⓗⓟ Model 400D/H/L.

3) A variable power line transformer with a minimum rating of 3 amps.

4) A square-wave generator such as an ⓗⓟ Model 211A.

5) A sine-wave oscillator with a maximum frequency of at least 500,000 cycles, such as an ⓗⓟ Model 200CD.

6) An accurate time mark generator suitable for sweep speed calibration.

4-2 SIMPLE CHECK PROCEDURE

This check should be performed first whenever instrument malfunction is suspected. It is not necessary to remove the instrument from the cabinet.

Set both VERT. and HORIZ. SENSITIVITY switches on CAL. The pattern should be a straight line tilted at 45 degrees. In addition, the deflection should be a total of six centimeters in the horizontal and vertical directions.

If the proper pattern is obtained, it is likely that both the Vertical and Horizontal Amplifier, the Power Supplies and the Calibrator are functioning properly. To check the Sweep Generator proceed as follows:

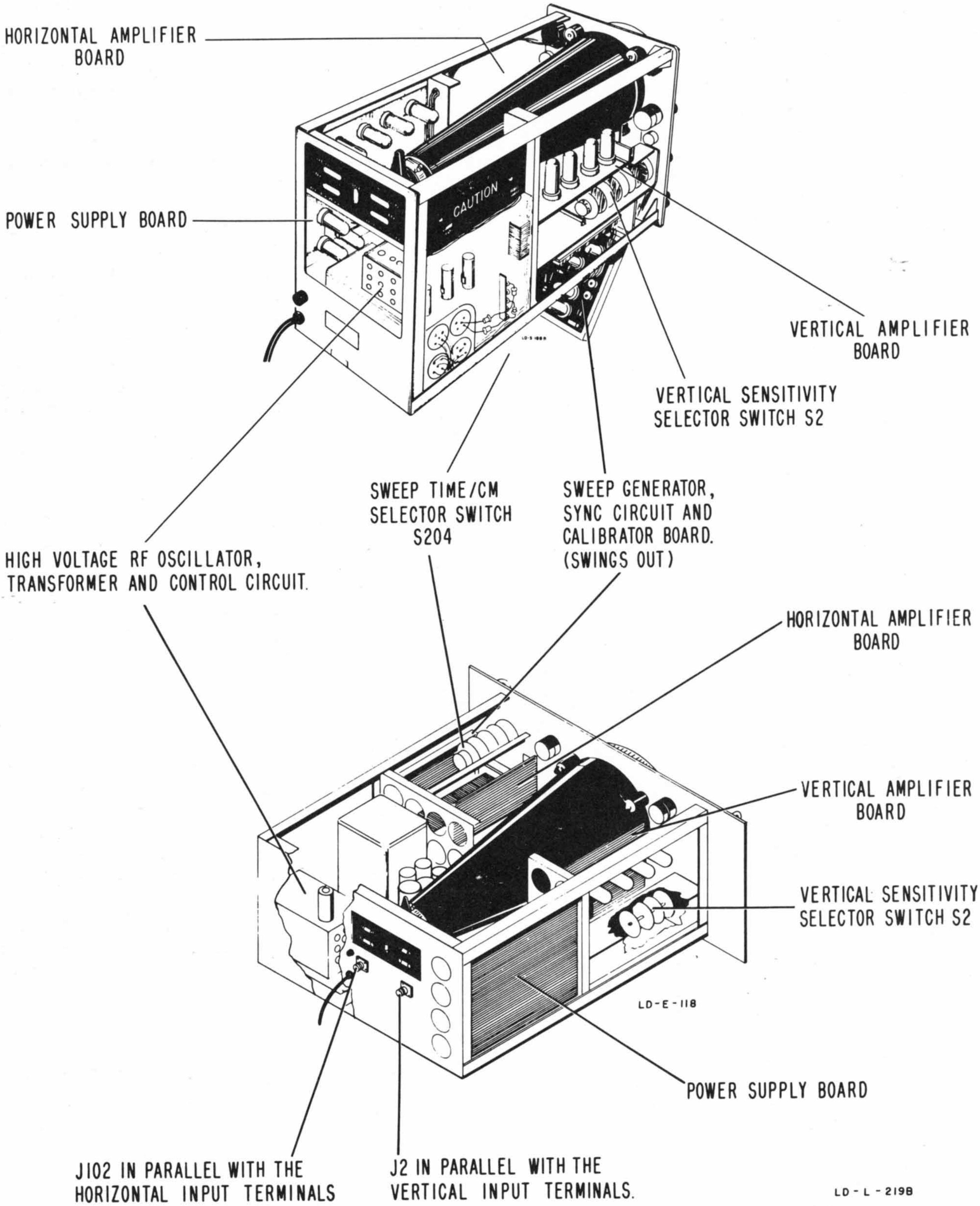


Figure 4-1. Location Diagram for Major Circuits

1) Leaving the VERT. SENSITIVITY switch in CAL, switch HORIZ. SENSITIVITY switch to INT. SWEEP X1.

2) Switch SWEEP TIME/CM switch to 1 MILLISECOND. A six centimeter square-wave pattern should appear on the screen. If no pattern is obtained be sure SWEEP MODE is in PRESET, SYNC switch is in INT., and adjust TRIGGER LEVEL to trigger. If a pattern cannot be obtained, the malfunction is most likely in the Sweep Generator.

4-3 REMOVING THE CABINET

In the cabinet model, remove the two screws at the rear of the cabinet, and push the instrument forward.

If the 130BR has been rack-mounted with brackets as described in Figure 1-3, remove the screws which pass through the front panel, and withdraw the chassis. If the instrument is out of the rack, turn it on its face (handles will protect the controls), remove the two screws at the rear, and lift off the dust cover.

4-4 ISOLATING TROUBLES TO MAJOR SECTIONS

Determining which major section contains a malfunction is usually not a difficult process, if the following general rules are remembered.

1) A failure affecting all major sections can usually be traced to the power supply.

2) A failure occurring in the last two stages of the Horizontal Amplifier also will affect internally generated sweeps, while a failure in the first two stages affects only the Horizontal Amplifier.

3) A sweep Generator failure affects internally generated sweeps only, and does not affect the Horizontal Amplifier.

4) If following the Simple Check Procedure does not produce a trace or spot on the screen, measure the voltages on the deflection plates of the Cathode-Ray Tube (deflection plate terminal board is a convenient place to measure). If, with both VERT. and HORIZ. SENSITIVITY switches set to 50 MILLIVOLTS/CM, these voltages can be set to approximately 480 vdc using the position controls, look for trouble in the high voltage section of the power supplies. If one set of deflection plates has unbalanced voltages, or if the position control must be turned far from its mechanical center to balance these voltages, look for trouble in that amplifier. If both sets of deflection plates have unusual voltages, look for trouble in the power supply.

5) If the series heater string should open, all major sections will be inoperative.

6) The two sides of the direct-coupled differential amplifier, such as are used in the Vertical and Horizontal Amplifiers on the 130B, are balanced and, unless a signal is present, the spot will be motionless in the center of the screen. Any signal, whether this signal is applied to the input terminals or is supplied by an internal source, such as a positioning or balance control, causes the spot to move from the center of the screen. As the instrument ages it is to be expected that a drift will occur which must be compensated by internal adjustments. However, should there be a component failure in either amplifier the spot will be thrown off the screen and usually out of range of adjustment of the balance and positioning controls. To isolate the trouble, begin by shorting together the grids of the amplifier closest to the output. If the trace (spot) returns to the screen, the fault is ahead of this stage. Proceed towards the front of the amplifier. If shorting the grids of one stage does not return the spot to the screen, the fault is in this stage, or if there is a balancing control in this stage, it may be out of adjustment.

7) To check the Sweep Generator quickly, set the SWEEP TIME/CM switch to 5 or 10 MILLISECONDS/CM, turn the SWEEP MODE control to FREE RUN, and observe I201, I202 and I203. These are the three neon lamps near V206 (6AW8) on the Sweep Generator etched circuit board. If these lamps flicker regularly, the Sweep Generator is sweeping. Turning the SWEEP MODE into the TRIGGER region should stop the generation of sweeps and, hence, the flickering of the neon lamps.

4-5 CONNECTING FOR 230 VOLT OPERATION

Unless otherwise requested by the customer, hp instruments are shipped with their power transformer primaries connected in parallel for operation on 115 volt (nominal) power lines.

To convert to 230 volt supply, remove the instrument from its cabinet or dust cover by removing the two screws at the rear of the chassis, and push the chassis forward. At the primary of the power transformer (marked A), remove the wires connecting terminals 2 and 5, and 1 and 4. Then connect 1 to 2 as shown in Figure 4-2, and replace the 2 amp slow-blow fuse (F301) with a 1-1/4 amp slow-blow fuse. The instrument may now be connected to the 230 volt line.

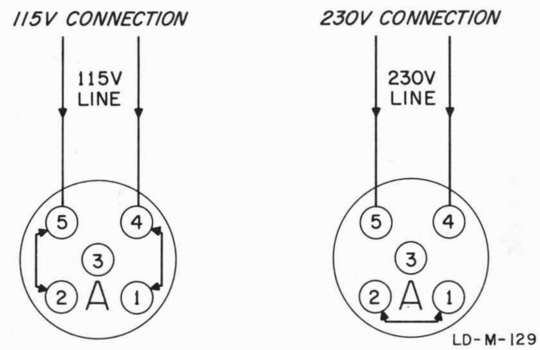


Figure 4-2. Line Voltage Connection

4-6 TUBE REPLACEMENT

In many cases instrument malfunction can be corrected by replacing a weak or defective tube. Before changing the setting of any internal adjustment, check the tubes. Adjustments made in an attempt to compensate for a defective tube will often complicate the repair problem.

It is a good practice to check tubes by substitution rather than by using a "tube checker". The results obtained from the "tube checker" can be misleading. Before removing a tube, mark it so that if the tube is good it can be returned to the same socket. Replace only tubes proved to be weak or defective.

Any tube with corresponding standard EIA (JEDEC) characteristics can be used as a replacement. Where variation in tube characteristics will affect circuit performance, an adjustment is provided. The following table lists the tests and adjustments which should be performed if such tubes are replaced.

The chart in Table 4-2 lists all tubes in the 130B with their functions and adjustments required when replacing tubes. The heaters of some tubes are operated in series from a regulated dc voltage obtained from the Low-Voltage Power Supply. These tubes are identified in the chart with an asterisk and their heaters are shown in the Filament and Primary Detail Schematic. If a tube in the dc string is pulled or burned out, all tubes in the string will be turned off.

4-7 CONDENSED TEST AND ADJUSTMENT PROCEDURE

All basic tests and adjustments are covered in the following Table 4-1. In most cases, this table will cover all normal adjustment needs for the oscilloscope. For a more complete and detailed test procedure refer to paragraph 4-8.

If the instrument is not operating, refer to paragraphs 4-3 and 4-6.

If a tube is replaced, refer to Table 4-2 and complete the indicated adjustments.

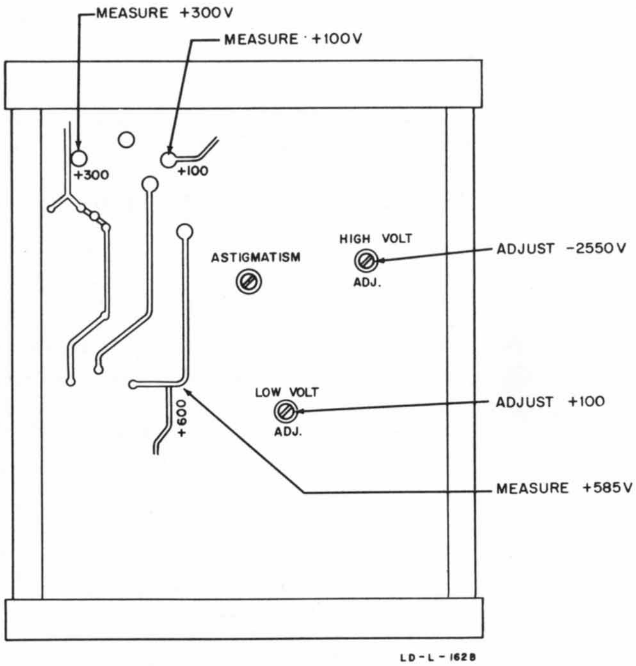
TABLE 4-1. CONDENSED TEST AND ADJUSTMENT PROCEDURE

Test	External Equipment Required	Procedure	Adjust	Notes
1. Low Voltage Power Supply	DC vtvm with 1% accuracy	Measure all low voltage power supply outputs should be within the following limits: -150 ± 6 volts +100 ± 4 volts +300 ±12 volts +585 ±25 volts	If voltages are outside limits, adjust R332 for -150 volts.	Check sweep calibration if -150V is adjusted.
2. Vertical amplifier balance	NONE	HOR.SENS. to INT.SWEEP X1, SWEEP MODE to free-run, SYNC to INT., SWEEP TIME to 1.0 ms/cm, short-circuit input terminals and set INPUT for DC. VERT. SENS. and Vernier to Cal.	Center bottom of calibrating signal with VERT.POS. control	Repeat as required.
		VERT.SENS. to 1 mv/cm, Center VERT.DC.BAL control (knob).	Center trace with coarse balance control. (Screw adjustment in center of DC BAL control.)	
3. Vertical VERNIER balance	NONE	Short circuit input terminals and set INPUT for DC. VERT.SENS. to 1 mv/cm, VERNIER to Cal.	Center spot (or trace) with VERT. POS. control.	Repeat as required.
		VERNIER fully CCW	Return spot to center with R20	
4. Vertical amplifier gain	400 cycle Voltage Calibration Generator	VERT.SENS. to 50 mv/cm. VERNIER to Cal. Connect 300 mv p-p from Calibration Generator to vertical input.	Adjust R40 for 6 cm deflection.	
	Square Wave Generator	Connect 50 kc square wave to Vert. Input. Adjust square wave generator for 6 cm deflection. SYNC to INT, Adjust SWEEP MODE and TRIGGER LEVEL for stable picture.	Adjust C12 for best square wave.	
5. Calibrator	NONE	VERT.SENS. and VERNIER to CAL, SWEEP MODE to free-run; SWEEP TIME to 1 ms/cm.	Adjust R240 for 6 cm deflection.	
6. Horizontal amplifier balance	NONE	Short-circuit input terminals and set INPUT for DC. VERT.SENS. to 50 mv/cm, with no input. HOR.SENS. and VERNIER to CAL.	Center the left spot with the HOR.POS. control.	Repeat as required.
		HOR.SENS. to 1 mv/cm, Center the HOR.DC BAL control (knob).	Center the spot with the coarse balance control (screw driver adjustment in center of DC BAL control).	
7. Horizontal VERNIER balance	NONE	Short-circuit input terminals and set INPUT for DC. HOR.SENS. to 1 mv/cm, VERNIER to CAL.	Center spot with POS. control HORIZ.	Repeat as required.
		VERNIER fully CCW.	Return spot to center with R120.	
8. Horizontal amplifier gain	NONE	HOR.SENS. and VERNIER to CAL.	Adjust R144 for 6 cm between spots.	
	Square wave generator	HOR.SENS. to 50 mv/cm, Connect 50 kc square wave to Hor. input and adjust for 6 cm deflection.	Adjust C114 for best defined spots.	
9. Sweep gain	Time Marker Generator	HOR.SENS. to INT.SWEEP X1 SWEEP TIME to 1 ms/cm, VERNIER to CAL; 1 kc markers from generator to VERT. input. SYNC to INT. Adjust SWEEP MODE and TRIG.LEVEL for stable pattern.	Adjust R134 for one marker/cm	
		HOR.SENS. to INT.SWEEP X5.	Adjust R164 for markers 5 cm apart.	
10. Sweep preset	DC VTVM	HOR.SENS. to INT.SWEEP X1. SWEEP TIME to 1 ms/cm, SWEEP MODE to PRE-SET, SYNC to EXT. with no input. Connect VTVM 30 volt range between center arm of Preset pot (R220) and ground.	Slowly adjust R220 and note voltage just prior to sweep start. Adjust pre-set for 2 volts more positive than voltage noted.	
11. Sweep length	Sine Wave Oscillator	HOR.SENS. to INT.SWEEP X1. SWEEP TIME to 1 ms/cm. SYNC to INT. Connect 500 kc sine wave to vertical input. Adjust level and VERT SENS. to produce 6 cm vertical deflection.	Adjust R229 for a trace about 10.5 cm long.	

TABLE 4-2. TUBE REPLACEMENT CHART

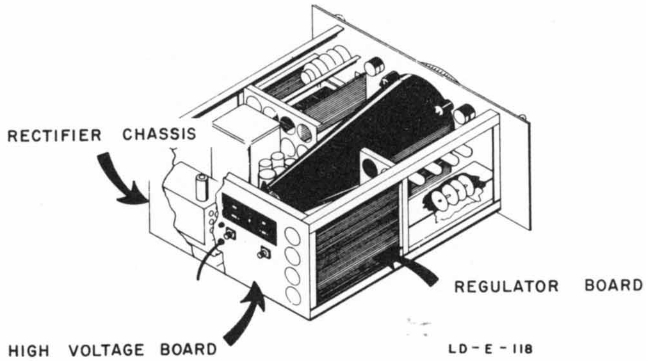
Ref.	Tube	Function	Adjustment
		VERTICAL AMPLIFIER	
V1*	12AU7‡	Phase Inverter Amplifier	Vertical Amplifier (par. 4-13A/B)
V2*	12AU7	Differential Amplifier	Vertical Amplifier (par. 4-13A/B)
V3*	12AT7	Differential Amplifier	Vertical Amplifier (par. 4-13B)
V4*	6DJ8/6BQ7	Differential Amplifier	Vertical Amplifier (par. 4-13B)
		HORIZONTAL AMPLIFIER	
V101*	12AU7‡	Phase Inverter Amplifier	Horizontal Amplifier (par. 4-14A/B)
V102*	12AU7	Differential Amplifier	Horizontal Amplifier (par. 4-14A/B)
V103*	12AT7	Differential Amplifier	Horizontal Amplifier (par. 4-14B)
V104*	6DJ8/6BQ7	Differential Amplifier	Sawtooth Generator (par. 4-17)
		SWEEP GENERATOR	
V201*	6DJ8/6BQ7A	Trigger Amplifier	none
V202	12AT7	Trigger Generator	none
V203	6U8	Sweep Start-Stop Trigger	Adj. Preset, Sweep Length (par. 4-16 and 17, Step 17)
V204	6C4	Gate Out Cathode Follower	none
V205*	12AL5	a. Integrator Switch b. Integrator Switch	none
V206	6AW8	a. Integrator Cathode Follower b. Feedback Integrator	none
V207	12AX7	a. Retriggering Hold Off b. Retriggering Bias Control	none
		POWER SUPPLY	
V301	12B4	+300-volt Series Regulator	none
V302	6AU6	+300-volt Control Tube	none
V303	12B4	+100-volt Series Regulator	none
V304*	6BH6	+100-volt Control Tube	none
V305	6X4	-150-volt Rectifier	none
V306	12B4	-150-volt Series Regulator	none
V307*	6BH6	-150-volt Control Tube	none
V308	5651	Reference Tube	LV Supply (par. 4-10A)
V309	5AQP	CRT	Adj.Vert.& Horiz.Gain (par.4-13,4-14)
V310	1V2	High Voltage Rectifier	none
V311	1V2	High Voltage Rectifier	none
V312	12AU7	High Voltage Control Tube	none
V313	6AQ5	RF Oscillator	none
V314	6DJ8/6BQ7A	a. +585-volt Series Regulator b. +585-volt Control Tube	none none

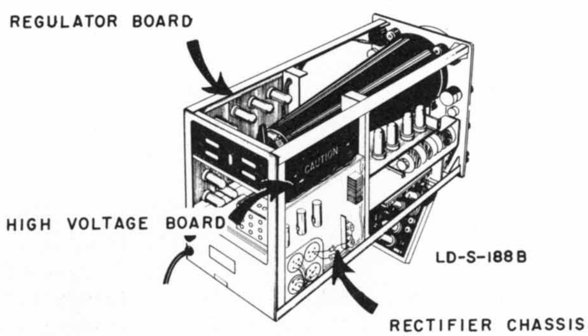
* Series dc heater ‡ Tested part - See Table of Replaceable Parts

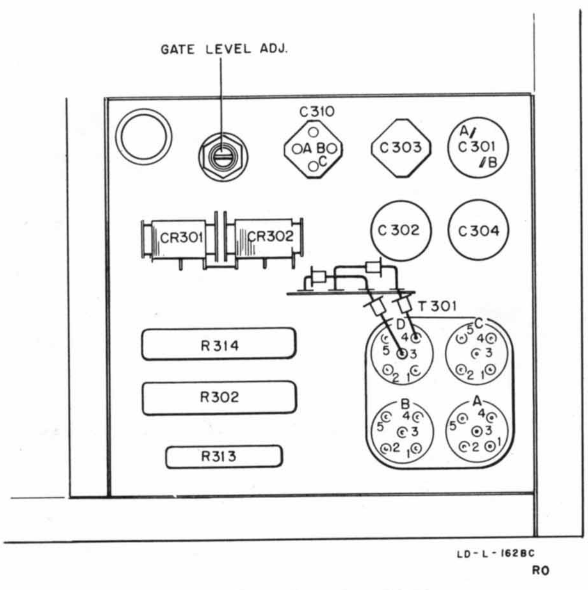


REGULATOR BOARD

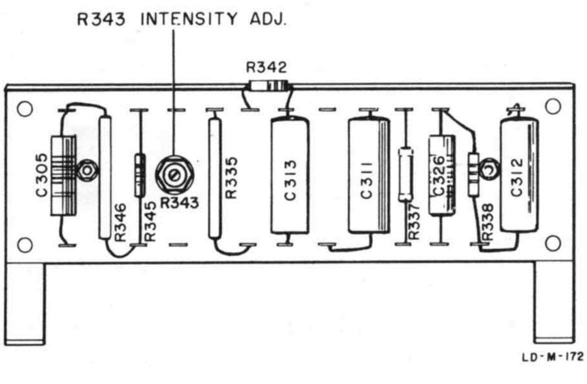
POWER SUPPLY LOCATION DIAGRAM







RECTIFIER CHASSIS



HIGH VOLTAGE BOARD

Figure 4-3. Power Supply Location Diagram

4-8 ADJUSTMENT PROCEDURE

Usually a particular oscilloscope will not need complete testing and calibration. Only one or two tests will be needed and they can be done without completing the entire test procedure.

The following procedures are listed in a recommended sequence for a complete test and calibration operation. In general, tubes are the main cause of trouble and new ones should be tried before making adjustments or other component replacements.

Specifications for the ⓗⓟ Model 130B Oscilloscope are given in the front of this manual. The following test procedures contain extra checks to help you analyze a particular instrument. These extra checks and the data they contain can not be considered as specifications.

A fifteen minute warm-up and power supply output voltage measurements are always recommended before making any other test or adjustment.

4-9 TURN ON

When turning the oscilloscope on for the first time after repair in any circuit, measure resistance from power supplies to ground. They usually will be within 25% of the following:

+100 volt supply	110 ohms
-150	50,000 ohms
+300	9,000 ohms
+585	85,000 ohms

CAUTION

When first turning an oscilloscope on after power supply repairs, turn the intensity and both positioning controls full counterclockwise before applying power. Failure to follow this precaution can cause permanent cathode-ray tube damage.

4-10 POWER SUPPLIES

The power supplies in the oscilloscope are extremely stable and will require infrequent adjustment. The output voltages should be measured at regular intervals but unnecessary adjustments should be avoided.

Power supply voltages may be measured at the points indicated in Figure 4-3.

To adjust the power supply section, refer to Figure 4-3, and proceed as follows:

A. LOW VOLTAGE SUPPLY

1) Turn sweep generator off by turning the HOR. SENS. switch to 50 volt/cm position.

2) Permit the 130B to warm up for at least five minutes at a line voltage of 115/230 volts.

3) Measure power supply voltages with line volts set to 115 volts. The voltages will normally be within the limits given in Table 4-3. Control R332 can be adjusted if necessary to set the +100 volt supply within limits.

If adjustment of the +100 volt supply was necessary, all sweep timing, calibrator and gain adjustments must be checked.

If poor low voltage supply regulation is suspected, the following check may be made:

-- Check the regulation of each power supply voltage as the power line voltage is varied between 103 and 127 volts. All regulated voltages should remain within ±1% over this range of line voltage.

-- Measure the ac ripple on each supply voltage. This ac voltage should not exceed the amount specified in Table 4-3.

TABLE 4-3. REGULATED POWER SUPPLY TOLERANCES

Supply	Tolerance (115/230 volt line)	Variation ±10% line voltage change	Nominal Ripple at 115/230V
+100 V	±4%	±1%	5 mv
-150 V	±4%	±1%	5 mv
+300 V	±4%	±1%	5 mv
+585 V	±4%	±1%	60 mv

If any output does not regulate or has excessive ripple, replace the Series Regulator Tube or the Control Tube of that supply. It must be kept in mind, however, that loss of regulation of the -150 volts will cause the other supplies to lose regulation, and that loss of regulation of the +100 volts will cause the +585 volt and +300 volt supplies to lose regulation also.

SERVICING ETCHED CIRCUIT BOARDS

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

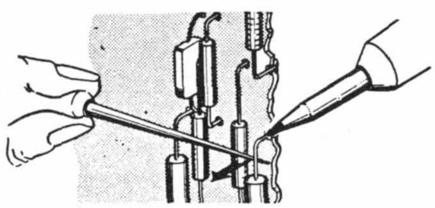
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

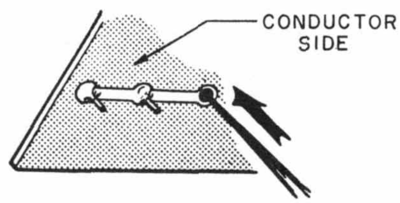
When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

WARNING: If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

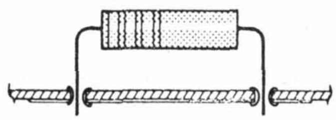
1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component <u>does not</u> pass through an eyelet, apply heat to conductor side of board.



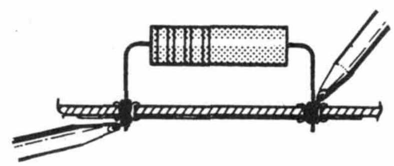
2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole <u>does not</u> have an eyelet, insert awl or a #57 drill from conductor side of board.



3. Bend clean tinned leads on new part and carefully insert through eyelets or holes in board.

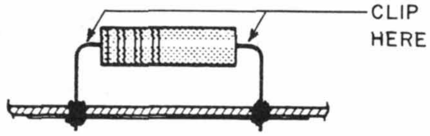


4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

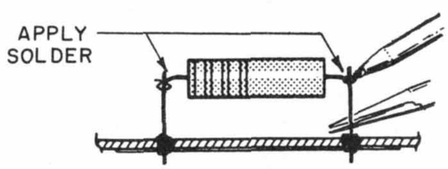


In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.



2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.



This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

Figure 4-4. Servicing Etched Circuit Boards

B. HIGH VOLTAGE SUPPLY

1) The -2550 volt output is measured on the resistor board under the base of the crt. Connect an appropriate dc voltmeter (such as an ⓗⓟ Model 410B VTVM with an ⓗⓟ Model 459A DC Resistive Voltage Multiplier) to the Junction of R338, C312 (marked -2550 CATH. on cover).

2) With the line at 115/230 volts the high voltage should measure -2550 ±4%. Control R334 can be adjusted if necessary to set the -2550 volt supply within limits.

If poor -2550 voltage supply regulation is suspected the following check may be made:

-- Check the regulation by varying the line voltage between 103 and 127 volts. The -2550 should remain within ±1% over this range of line voltage. If the -2550 supply does not regulate check the control tube V312.

3) Set SWEEP TIME/CM to 5 MILLISECONDS.

4) Set HOR. SENS. to INT. SWEEP X1.

5) Set SWEEP MODE fully clockwise to FREE RUN.

6) Set INTENSITY control to 10 o'clock.

7) Set Int. Adj., R343, until the trace is just visible.

8) Set SWEEP MODE fully counterclockwise to PRESET.

9) Set INTENSITY control for a low intensity spot.

10) Center spot and adjust FOCUS control and ASTIGMATISM (R303) to obtain a small round and sharply focused spot.

4-11 REPLACING AND ADJUSTING THE CRT

To replace the cathode-ray tube, refer to Figure 2-10, and proceed as follows:

1) Turn off and remove the 130B from the cabinet.

2) Loosen the clamp on the crt socket. (Cabinet model; remove cover from High Voltage terminal board to get access for screwdriver through board).

3) Remove the front-panel bezel.

4) With a screwdriver loosen the crt base from socket. Free the crt from the socket by pressing on the center of the tube base with one hand while supporting the front of the crt with the other.

DANGER - Do not apply force on neck of tube.

5) Remove the crt through the front panel.

CAUTION - HANDLE THE CATHODE RAY TUBE CAREFULLY.

6) Insert the replacement crt through the front panel and seat in socket.

7) Replace front-panel bezel.

8) Adjust the socket assembly so that the face of the crt just misses the bezel assembly. Tighten the clamp just enough to hold the crt in place loosely.

NOTE

Turn the INTENSITY control to minimum when first applying power to a crt. The phosphor can be damaged quickly by too much brightness.

----

9) Set the INTENSITY control fully counterclockwise. Turn the 130B on and allow to warm up.

10) Set the SWEEP MODE control to FREE RUN.

11) Adjust the INTENSITY control to obtain a weak trace; adjust the FOCUS control for a sharp trace, and with the vertical position control, center the trace vertically.

12) Align trace with graticule using the alignment handle at rear of crt.

CAUTION - Do not over-tighten crt clamp or tube damage may result.

13) Making certain the crt face is close to but not touching the bezel assembly, tighten the clamp on the crt socket only enough to hold the crt from turning. If the face of the tube touches the bezel assembly, Newton rings may be visible.

14) Readjust the astigmatism; see paragraph 4-10B.

15) Check the gain calibration of the Vertical and Horizontal Amplifiers by setting the VERTICAL and HORIZONTAL SENSITIVITY selectors to CAL, and if necessary, adjusting R40 (Figure 4-5) to obtain 6 cm vertical deflection and R144 (Figure 4-6) to obtain 6 cm horizontal deflection on the trace; see paragraph 4-13B and 4-14B.

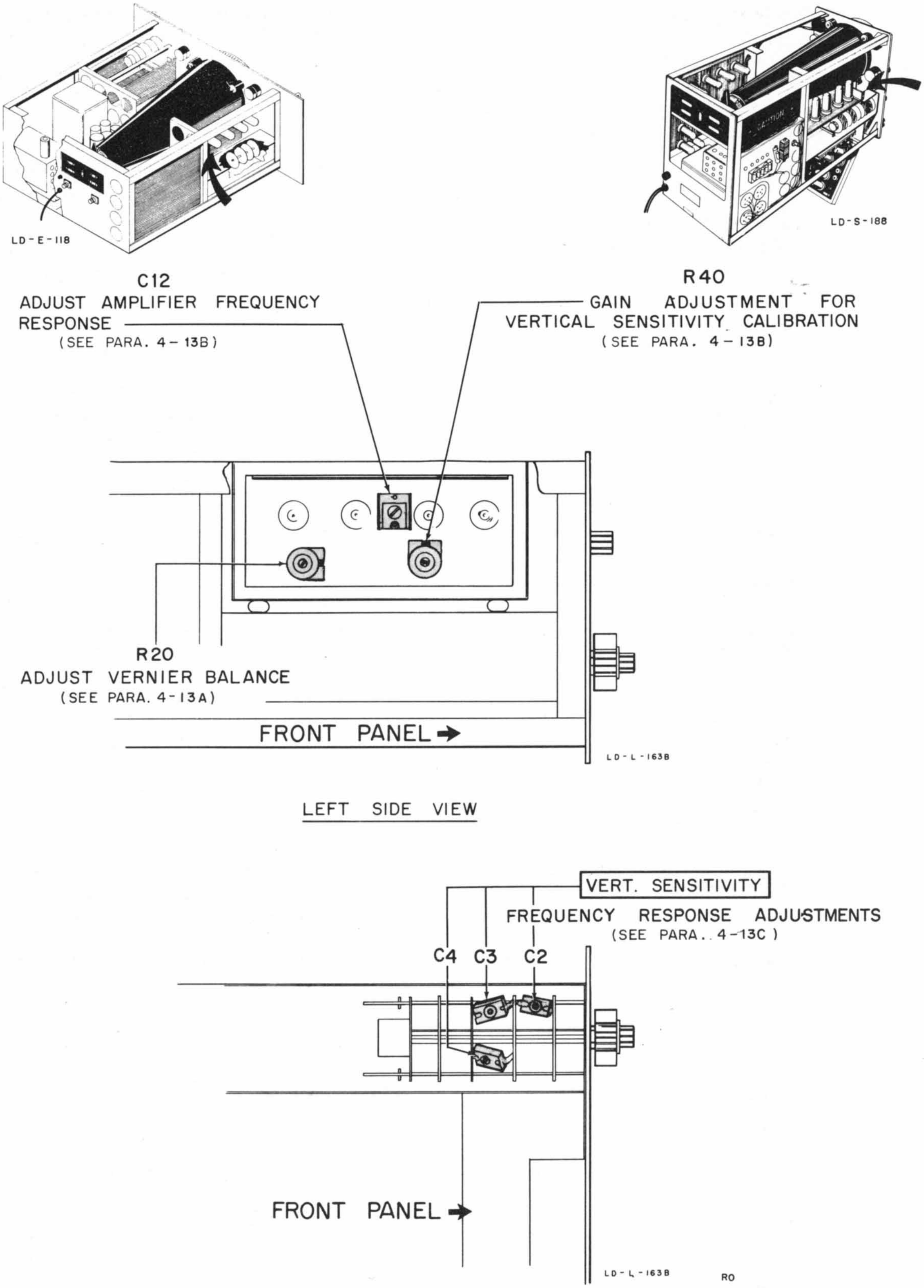


Figure 4-5. Vertical Amplifier Adjustment Location

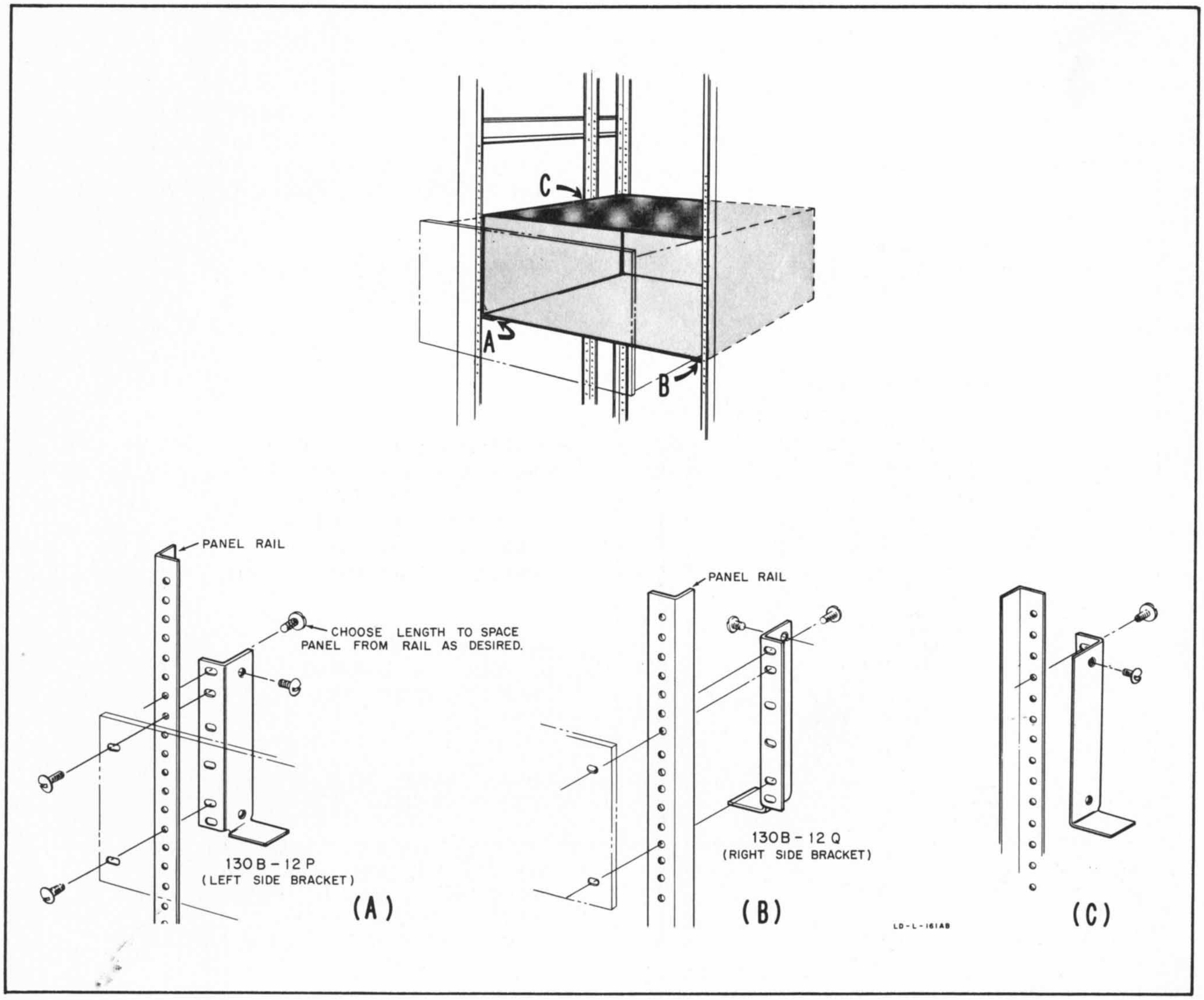
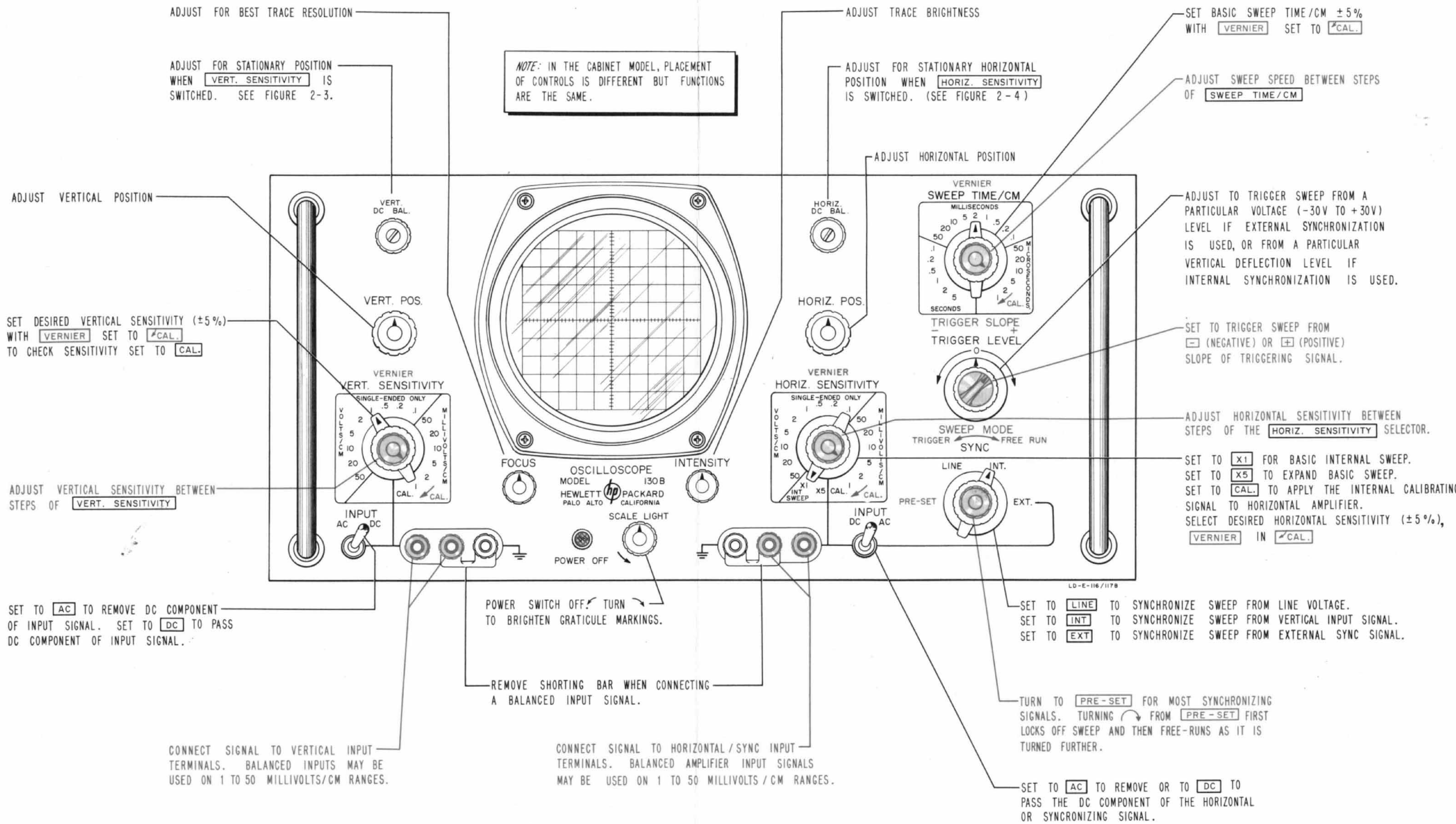


Figure 1-3. Model 130BR Installation


ADJUST FOR BEST TRACE RESOLUTION
ADJUST FOR STATIONARY POSITION WHEN VERT. SENSITIVITY IS SWITCHED. SEE FIGURE 2-3.
NOTE: IN THE CABINET MODEL, PLACEMENT OF CONTROLS IS DIFFERENT BUT FUNCTIONS ARE THE SAME.
ADJUST TRACE BRIGHTNESS
ADJUST FOR STATIONARY HORIZONTAL POSITION WHEN HORIZ. SENSITIVITY IS SWITCHED. (SEE FIGURE 2-4)
ADJUST HORIZONTAL POSITION
SET BASIC SWEEP TIME/CM ±5% WITH VERNIER SET TO CAL.
ADJUST SWEEP SPEED BETWEEN STEPS OF SWEEP TIME/CM
ADJUST VERTICAL POSITION
ADJUST TO TRIGGER SWEEP FROM A PARTICULAR VOLTAGE (-30V TO +30V) LEVEL IF EXTERNAL SYNCHRONIZATION IS USED, OR FROM A PARTICULAR VERTICAL DEFLECTION LEVEL IF INTERNAL SYNCHRONIZATION IS USED.
SET DESIRED VERTICAL SENSITIVITY (±5%) WITH VERNIER SET TO CAL. TO CHECK SENSITIVITY SET TO CAL.
SET TO TRIGGER SWEEP FROM − (NEGATIVE) OR + (POSITIVE) SLOPE OF TRIGGERING SIGNAL.
ADJUST HORIZONTAL SENSITIVITY BETWEEN STEPS OF THE HORIZ. SENSITIVITY SELECTOR.
ADJUST VERTICAL SENSITIVITY BETWEEN STEPS OF VERT. SENSITIVITY
SET TO X1 FOR BASIC INTERNAL SWEEP.
SET TO X5 TO EXPAND BASIC SWEEP.
SET TO CAL. TO APPLY THE INTERNAL CALIBRATING SIGNAL TO HORIZONTAL AMPLIFIER.
SELECT DESIRED HORIZONTAL SENSITIVITY (±5%), VERNIER IN CAL.
VERT. DC BAL.
VERT. POS.
VERNIER
VERT. SENSITIVITY
SINGLE-ENDED ONLY
VOLTS/CM
MILLIVOLTS/CM
CAL.
INPUT
AC
DC
FOCUS
OSCILLOSCOPE
MODEL 130B
HEWLETT PACKARD
PALO ALTO CALIFORNIA
INTENSITY
SCALE LIGHT
POWER OFF
HORIZ. DC BAL.
HORIZ. POS.
VERNIER
HORIZ. SENSITIVITY
SINGLE-ENDED ONLY
X1 INT SWEEP
X5
CAL.
VERNIER
SWEEP TIME/CM
MILLISECONDS
MICROSECONDS
SECONDS
TRIGGER SLOPE
TRIGGER LEVEL
SWEEP MODE
TRIGGER
FREE RUN
SYNC
LINE
INT.
EXT.
PRE-SET
LD-E-116/117B
SET TO AC TO REMOVE DC COMPONENT OF INPUT SIGNAL. SET TO DC TO PASS DC COMPONENT OF INPUT SIGNAL.
POWER SWITCH OFF TURN TO BRIGHTEN GRATICULE MARKINGS.
SET TO LINE TO SYNCHRONIZE SWEEP FROM LINE VOLTAGE.
SET TO INT TO SYNCHRONIZE SWEEP FROM VERTICAL INPUT SIGNAL.
SET TO EXT TO SYNCHRONIZE SWEEP FROM EXTERNAL SYNC SIGNAL.
REMOVE SHORTING BAR WHEN CONNECTING A BALANCED INPUT SIGNAL.
TURN TO PRE-SET FOR MOST SYNCHRONIZING SIGNALS. TURNING FROM PRE-SET FIRST LOCKS OFF SWEEP AND THEN FREE-RUNS AS IT IS TURNED FURTHER.
CONNECT SIGNAL TO VERTICAL INPUT TERMINALS. BALANCED INPUTS MAY BE USED ON 1 TO 50 MILLIVOLTS/CM RANGES.
CONNECT SIGNAL TO HORIZONTAL/SYNC INPUT TERMINALS. BALANCED AMPLIFIER INPUT SIGNALS MAY BE USED ON 1 TO 50 MILLIVOLTS/CM RANGES.
SET TO AC TO REMOVE OR TO DC TO PASS THE DC COMPONENT OF THE HORIZONTAL OR SYNCRONIZING SIGNAL.

4-12 CHECKING AND ADJUSTING THE CALIBRATOR

1) Set HORIZ. SENSITIVITY to INT. SWEEP X1; SWEEP TIME/CM to 1 MILLISECOND; SWEEP MODE to PRESET; SYNC. to INT.; and TRIGGER LEVEL to "0".

NOTE

If PRESET (SWEEP MODE) is maladjusted, you may not obtain a trace. See paragraph 4-16.

----

2) Set the VERT. SENSITIVITY switch to 50 MILLIVOLTS/CM. Place the VERNIER control in CAL.

3) Connect the signal source to the vertical INPUT terminals and set its rms output voltage, read on the vtvm, to 106 millivolts (300 mv/ $2\sqrt{2}$) and its output frequency to 1000 cps.

4) Adjust R40 (see Figure 4-5) to obtain exactly 6 centimeters deflection.

5) Set the VERT. SENSITIVITY switch to CAL.

6) Adjust the R240 (see Figure 4-7) for exactly 6 centimeters deflection.

4-13 ADJUSTING THE VERTICAL AMPLIFIER

The following adjustments are located in the vicinity of the Vertical Amplifier or the VERT. SENSITIVITY switch as shown in Figure 4-5.

A. VERNIER BALANCE ADJUSTMENT

To adjust VERNIER balance, allow the instrument to warm up 15 minutes and adjust Vertical balance as shown by Figure 2-2. Then refer to Figure 4-5 and proceed as follows:

1) Short the INPUT terminals and set the INPUT switch to DC.

2) Set VERT. SENSITIVITY to 1 MILLIVOLT/CM, and VERNIER to CAL.

3) Center spot (or trace) with VERT. POS. control.

4) Turn VERNIER fully counterclockwise and return spot to center with R20, the Bal. Adj.

The trace should now be stationary as the VERNIER is rotated.

B. VERT. AMPL. GAIN AND FREQ. RESP. ADJUSTMENTS

To adjust the Vertical Amplifier gain and frequency response refer to Figure 4-5 and proceed as follows:

1) Adjust Vertical and VERNIER balance as indicated by Figure 2-2 and paragraph 4-13A.

2) Set HORIZ. SENSITIVITY to INT. SWEEP X1 and set the SWEEP TIME/CM switch to 2 MILLISECONDS, SWEEP MODE to PRESET and TRIGGER LEVEL to "0".

3) Place VERTICAL SENSITIVITY switch and its VERNIER in CAL.

4) Adjust R40 for exactly 6 centimeters deflection.

5) Set VERT. SENSITIVITY to 50 MILLIVOLTS/ CM. Set SYNC to INT.

6) Set SWEEP TIME/CM switch to 5 MICROSECONDS.

7) Connect a 50 kc square wave to the Vertical INPUT and adjust the square-wave amplitude for 6 to 8 centimeters deflection.

8) Adjust C12 for best square wave. To give C12 a range of adjustment sufficient to compensate for variations of tube characteristics, C13 may be connected in parallel with C12 to increase the maximum capacity to 1340 $\mu\mu$f.

C. INPUT ATTENUATOR FREQUENCY RESPONSE ADJUSTMENTS

To adjust frequency response of the input attenuator refer to Figure 4-5 and proceed as follows:

1) Connect a 5 kc square wave to the Vertical INPUT.

2) Set SWEEP TIME/CM to obtain 3 or 4 cycles of the square wave.

3) Make the indicated adjustment for best square-wave presentation on the following ranges:

VOLT/CM	ADJUST
10	C2
1	C4
.1	C3

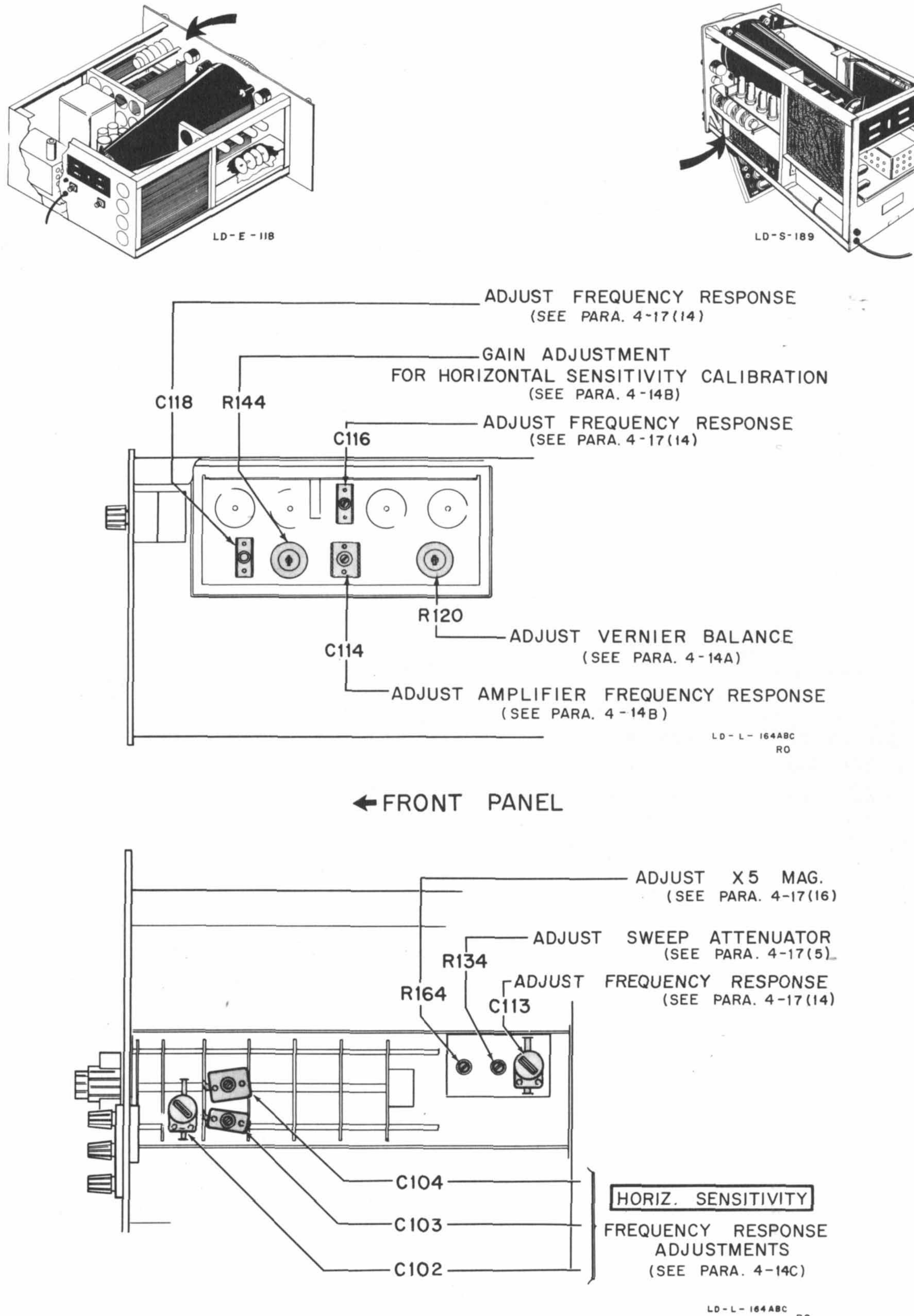


Figure 4-6. Horizontal Amplifier Adjustment Locations

4-14 ADJUSTING HORIZONTAL AMPLIFIER

To adjust the Horizontal Amplifier, refer to Figure 4-6 and proceed as follows:

A. VERNIER BALANCE ADJUSTMENT

To adjust the VERNIER balance allow the instrument to warm up thoroughly and adjust Horizontal balance as shown by Figure 2-3; then refer to Figure 4-6 and:

1) Short the INPUT terminals and set the INPUT switch to DC.

2) Set the HORIZ. SENSITIVITY to 1 MILLIVOLT/CM and the VERNIER to CAL.

3) Center the spot with the HORIZ. POS. control.

4) Turn the VERNIER completely counterclockwise and return the spot to the center with R120, Bal. Adj. The spot will now be stationary as the VERNIER is rotated.

B. AMPLIFIER GAIN AND FREQUENCY RESPONSE ADJUSTMENTS

To adjust the gain and frequency response, refer to Figure 4-6 and proceed as follows:

1) Set HORIZ. SENSITIVITY switch to CAL. and the VERNIER to CAL.

2) Adjust R144 for exactly 6 centimeters deflection.

3) Set VERT. SENSITIVITY to 2 VOLTS/CM.

4) Connect an 8 kc (approximately) sine wave to the Vertical INPUT of the oscilloscope and to the SYNC. IN terminal of the 211A square wave generator; adjust the sine wave for 10 cm deflection.

5) Set HORIZ. SENSITIVITY to 50 MILLIVOLTS/CM.

6) Connect a 50 kc square wave to the Horizontal INPUT, and adjust the square wave amplitude for 6 to 8 cm deflection.

7) Adjust C114 for best square wave response.

NOTE

Some vacuum tubes require more capacity for compensation than the maximum value of C114. Capacitor C115 may be connected in parallel with C114 to increase the maximum capacity to 1340 $\mu\mu$f, permitting a greater percentage of vacuum tubes to be used.

C. INPUT ATTENUATOR FREQUENCY RESPONSE ADJUSTMENTS

To adjust the frequency response at the input attenuator, refer to Figure 4-6 and proceed as follows:

1) Set VERT. SENSITIVITY to 2 VOLTS/CM.

2) Connect an 800 cps (approximately) sine wave to the Vertical INPUT of the oscilloscope and to the Sync-In terminal of the 211A square wave generator; adjust the sine wave for 10 centimeter deflection.

3) Set HORIZ. SENSITIVITY to 10 VOLTS/CM (VERNIER in CAL.).

4) Connect a 5 kc square wave to the Horizontal INPUT and adjust its amplitude for 6 centimeter deflection.

5) Make the following adjustments on the ranges indicated for the best square wave response, adjusting the square-wave amplitude to 6 centimeters on each range.

VOLTS/CM	ADJUST (see Fig. 4-6)
10	C102
1	C104
.1	C103

4-15 PHASE SHIFT ADJUST

Phase shift between Vertical and Horizontal Amplifiers.

If the square wave response of the Vertical and Horizontal Amplifier was carefully set, the relative phase shift between the two amplifiers should not exceed one degree at frequencies below 50 kc.

To check Phase Balance:

1) Set VERT. and HORIZ. SENSITIVITY to 50 MILLIVOLTS/CM and VERNIER to CAL.

2) Apply a 50 kc sine-wave signal to the HORIZ. INPUT and VERT. INPUT. Center pattern and adjust signal amplitude for 6 cm vertical and 6 cm horizontal deflection.

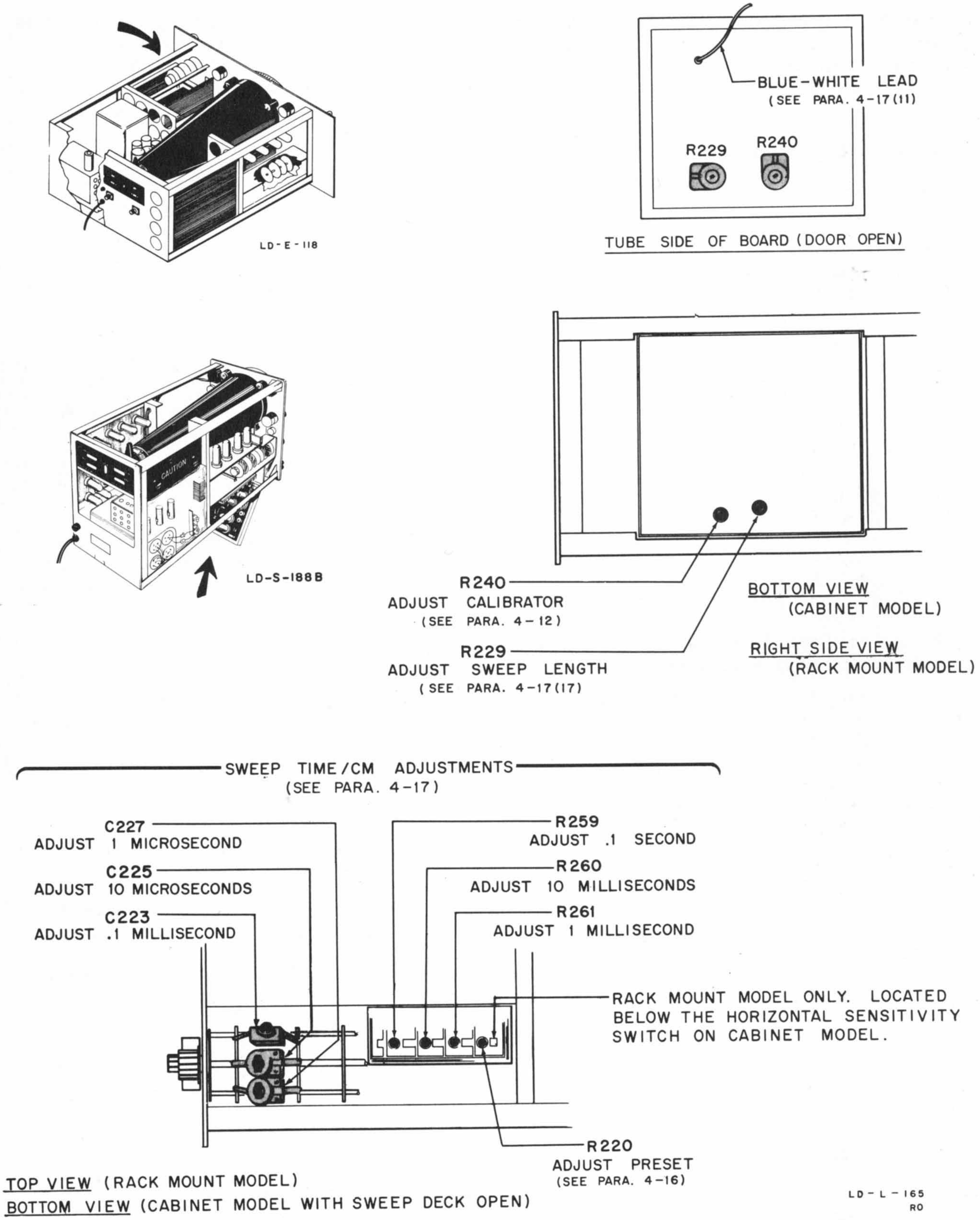


Figure 4-7. Sweep Generator Adjustment Locations

The opening of the pattern, if any, should not exceed a tenth of a centimeter. If necessary to correct phase difference, adjust C114 for closure of the pattern (Figure 4-6).

4-16 ADJUSTING PRESET

To adjust Preset refer to Figure 4-7 and proceed as follows:

1) Set VERT. SENSITIVITY to OFF, SWEEP TIME/CM switch to .1 MILLISECOND and SWEEP MODE control maximum counterclockwise to PRESET. Set SYNC selector to INT.

2) Connect a dc voltmeter between ground (+) and the center tap of R220 the PRESET adjust control.

3) Turn R220 fully counterclockwise. Then slowly adjust R220 clockwise until the sweep generator begins to free fun. Turn R220 counterclockwise until the sweep just stops and record this voltage which should be about -26 volts.

4) Set R220 to give a voltmeter indication exactly 2 volts less negative than the voltage noted.

4-17 ADJUSTING THE SAWTOOTH GENERATOR AND SWEEP AMPLIFIER

To adjust the Sawtooth Generator and Sweep Amplifier refer to Figures 4-6 and 4-7 and proceed as follows:

1) Set SYNC to INT., SWEEP MODE to PRESET and TRIGGER LEVEL to "0".

2) Set HORIZ. SENSITIVITY to INT. SWEEP X1, SWEEP TIME/CM to 1 MILLISECOND, and its VERNIER to CAL.

3) Connect 1 kc (1000 μ sec) time markers to the Vertical INPUT.

4) Set R261, 1 Millisecond Adj., on the potentiometer board, to its mechanical center.

5) Adjust R134, Sweep Attenuator, (Figure 4-6) and HORIZ. POS. for approximately 1 time marker/cm. This is a rather coarse adjustment. Set it as close as is practical. Then make the final adjustment with R261.

6) Set SWEEP TIME/CM to 10 MILLISECONDS and connect 100 cycle (10,000 μ sec) time markers to the Vertical INPUT.

7) Adjust R260 (Figure 4-7) for 1 marker per centimeter.

8) Set SWEEP TIME/CM to .1 SECOND and connect 10 cycle (100,000 μ sec) time markers to the Vertical INPUT.

9) Adjust R259 (Figure 4-7) for 1 marker per centimeter.

10) Disconnect the time mark generator from the Vertical INPUT, set VERT. SENSITIVITY switch to 10 VOLTS/CM, the Vertical and Horizontal input switches to AC, and SWEEP TIME/CM to 5 MICROSECONDS.

11) Disconnect the blue-white lead (Figure 4-7) from the Sweep Generator board and connect it through a 1 microfarad capacitor to the Horizontal INPUT. Set SYNC to EXT.

12) Connect a wire between V206 pin 1 (6AW8) and the Vertical INPUT.

13) Connect a 50 kc square wave from the 600 ohm output of the ⓗⓟ Model 211A to the Horizontal INPUT and adjust its amplitude for about 6 centimeter deflection.

14) Adjust C113 near the HORIZ. SENSITIVITY switch, and C116 and C118 on the Horizontal Amplifier board (Figures 4-6 and 4-7), for best square wave presentation. Remove the wire between V206 pin 1 and the Vertical INPUT.

15) Reconnect the blue-white lead to the Sweep Generator board, and connect the time marker generator to the Vertical INPUT. Make the following adjustment as indicated for 1 time marker per centimeter.

Time Marker	SWEEP TIME/CM	(Fig. 4-7) Adjust
1 μsec (1 mc)	1 MICROSEC.	C227
10 μsec (100 kc)	10 MICROSEC.	C225
.1 msec(10 kc)	.1 MILLISEC.	C223

16) Set HORIZ. SENSITIVITY to INT. SWEEP X5, and adjust R164 (Figure 4-6), for markers 5 centimeters apart.

17) Connect a 500 kc signal to the Horizontal INPUT, set SWEEP TIME/CM to 1 MILLISECOND, set SYNC to EXT, and adjust R229, Sweep Length, (Figure 4-7) for a trace about 10.5 centimeters long.

SCHEMATIC DIAGRAM NOTES

1. Heavy solid line shows main signal path; heavy dashed line shows control, secondary signal, or feedback path.

2. Heavy box indicates front-panel engraving; light box indicates chassis marking.

3. Arrows on potentiometers indicate clockwise rotation as viewed from the round shaft end, counter-clockwise from the rectangular shaft end.

4. Resistance values in ohms, inductance in microhenries, and capacitance in micromicrofarads unless otherwise specified.

5. Rotary switch schematics are electrical representations; for exact switching details refer to the switch assembly drawings.

6. Relays shown in condition prevailing during normal instrument operation.

7. ‡ indicates a selected part. See parts list.

8. Interconnecting parts and assemblies are shown on cable diagram.

9. * indicated value adjusted at factory. Part may be omitted.

VOLTAGE AND RESISTANCE DIAGRAM NOTES

1. Each tube socket terminal is numbered and lettered to indicate the tube element and pin number, as follows:

*	=	no tube element	P	=	plate
H	=	heater	T	=	target (plate)
K	=	cathode	R	=	reflector or repeller
G	=	control grid	A	=	anode (plate)
Sc	=	screen grid	S	=	spade
Sp	=	suppressor grid	Sh	=	shield
Hm	=	heater mid-tap	NC	=	no external connection to socket
IS	=	internal shield	△	=	indefinite reading due to circuit (see 2.)

The numerical subscript to tube-element designators indicates the section of a multiple-section tube; the letter subscript to tube-element designators indicates the functional difference between like elements in the same tube section, such as t for triode and p for pentode.

A socket terminal with an asterisk may be used as a tie point and may have a voltage and resistance shown.

2. Voltages values shown are for guidance; values may vary from those shown due to tube aging or normal differences between instruments. Resistance values may vary considerably from those shown when the circuit contains potentiometers, crystal diodes, or electrolytic capacitors.

3. Voltage measured at the terminal is shown above the line, resistance below the line; measurements made with an electronic multimeter, from terminal to chassis ground unless otherwise noted.

4. A solid line between socket terminals indicates a connection external to the tube between the terminals; a dotted line between terminals indicates a connection inside the tube. Voltage and resistance are given at only one of the two joined terminals.

VERTICAL AMPLIFIER

VOLTAGE - RESISTANCE DIAGRAM

(VIEWED FROM ETCHED SIDE)

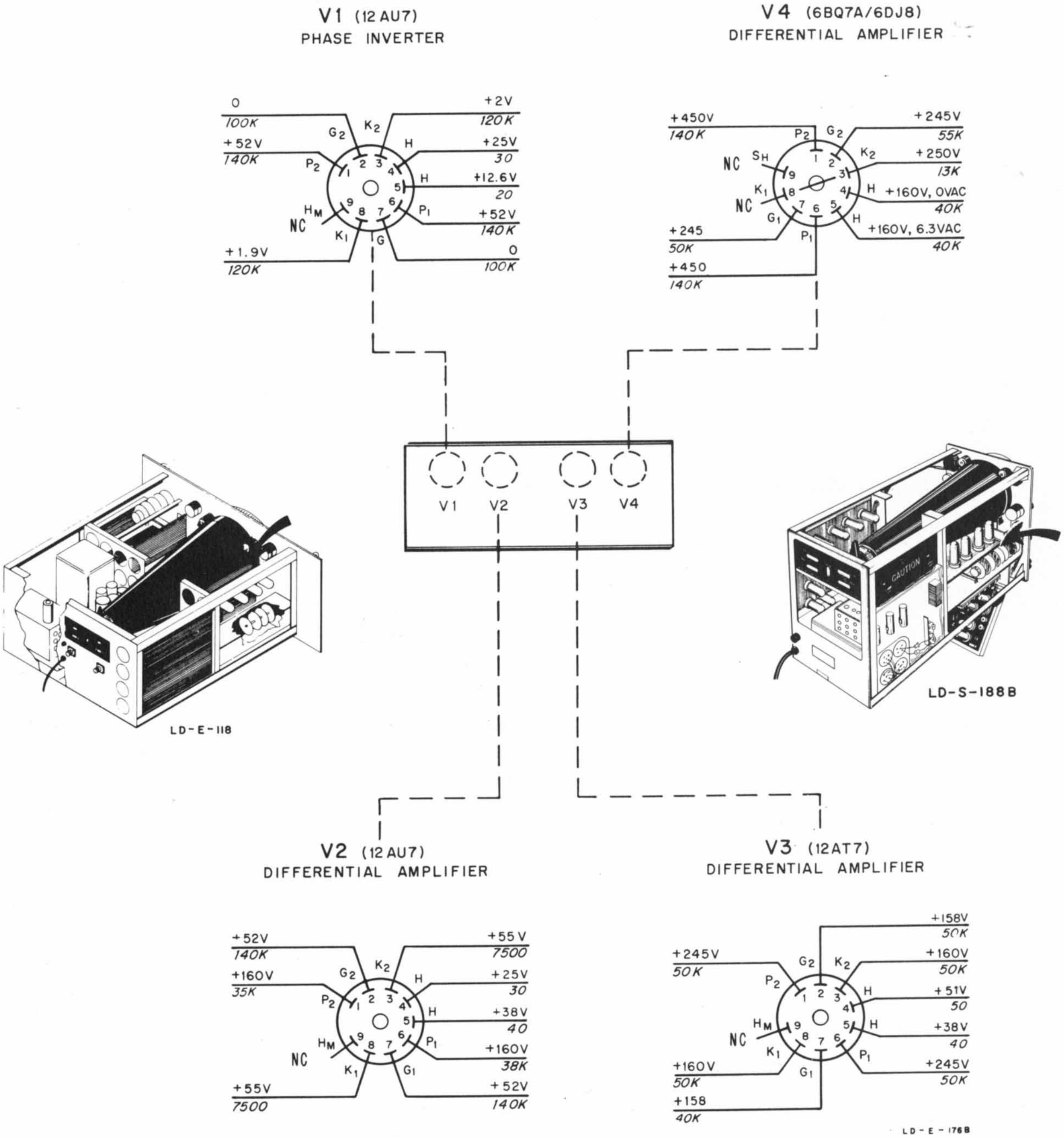


FIGURE 4-8

Table 5-2. Replaceable Parts

ⓗ Stock No.	Description#	Mfr.	Mfr. Part No.	TQ	RS		
AC-10D	Binding Post Assembly: red	28480	AC-10D	4	1		
AC-54A	Insulator, binding post (rack model)	28480	AC-54A	4	0		
AC-54B	Insulator, binding post (cabinet model)	28480	AC-54B	2	0		
G-73N	Tube, elect: 12AT7	80131	12AT7	2	2		
G-73R	Tube, elect: selected	28480	G-73R	2	2		
G-76J	Connector Assembly	28480	G-76J	1	1		
G-76K	Connector Assembly	28480	G-76K	1	1		
G-84B	Lamp, neon: aged and selected, blue code	28480	G-84B	9	9		
130B-19C	Sweep Time/CM Switch Assembly (cabinet model only)	28480	130B-19C	1	1		
130B-19G	Trigger Level Switch Assembly	28480	130B-19G	1	1		
130B-19H	Sync Switch Assembly	28480	130B-19H	1	1		
130B-19J	Sweep Time/CM Switch Assembly (rack model only)	28480	130B-19J	1	1		
130B-95C	Horizontal Sensitivity Switch Assembly	28480	130B-95C	1	1		
130B-95D	Vertical Sensitivity Switch Assembly	28480	130B-95D	1	1		
130B-11B-1	Transformer, rf, high voltage	28480	130B-11B-1	1	1		
0130-0001	var, cer, 7-45 pf, 500 vdcw	72982	503-000-D2PO-33R	3	1		
0130-0006	var, cer, 5-20 pf, 500 vdcw	72982	503000BP2PO28R	2	1		
0131-0001	var, mica, 50-380 pf, 175 vdcw	72136	96W	3	1		
0131-0003	var, mica, 170-780 pf, 175 vdcw	72136	T52910	2	1		
0131-0004	var, mica, 14-50 pf, 500 vdcw	72136	T5-1410-3	4	1		
0140-0004	fxd, mica, 15 pf ±10%, 500 vdcw	76433	RCM15B150K	2	1		
0140-0005	fxd, mica, 27 pf ±10%, 500 vdcw	76433	RCM15B270K	2	1		
0140-0007	fxd, mica, 680 pf ±10%, 500 vdcw	76433	RCM20B681K	1	1		
0140-0009	fxd, mica, 0.01 μf ±5%, 500 vdcw	00656	1467LX"B"	2	1		
0140-0015	fxd, mica, 270 pf ±10%, 500 vdcw	76433	RCM20B271K	1	1		
0140-0025	fxd, mica, 68 pf ±10%, 500 vdcw	00853	DR 1468 B10	1	1		
0140-0027	fxd, mica, 470 pf ±10%, 500 vdcw	76433	RCM20B471K	1	1		
0140-0040	fxd, mica, 75 pf ±5%, 500 vdcw	00853	DR1475E5	3	1		
0140-0044	fxd, mica, 560 *pf ±10%, 500 vdcw	72136	CM20EJ61K	1	1		
0140-0056	fxd, mica, 200 pf ±10%, 500 vdcw	76433	RCM20B201K	2	1		
0140-0090	fxd, silver mica, 200 μf ±5%, 500 vdcw	72136	CM15E201J	1	1		
0140-0091	fxd, silver mica, 820 pf ±5%, 500 vdcw	72136	CM20E821J	3	1		
0150-0009	fxd, cer, 10 pf ±0.5 %, 500 vdcw	04222	CI-1	1	1		
0150-0012	fxd, cer, 0.01 μf ±20%, 1000 vdcw	71590	13C-DISC.	9	2		
0150-0014	fxd, cer, 0.005 μf, 500 vdcw	04222	D1-4	1	1		
0150-0022	fxd, TiO_2, 3.3 pf ±10%, 500 vdcw	82142	JM obd#	4	1		
0150-0023	fxd, cer, 2K pf ±20%, 1000 vdcw	91418	JF.002	1	1		

See introduction to this section

Table 5-2. Replaceable Parts (Cont'd)

ⓗ Stock No.	Description#	Mfr.	Mfr. Part No.	TQ	RS		
0150-0024	fxd, cer, 0.02 μf ±10%, 600 vdcw	91418	B.02GMV	2	1		
0150-0031	fxd, TiO_2, 2 *pf ±5%, 500 vdcw	78488	GA obd#	8	2		
0160-0002	fxd, paper, 0.01 μf ±10%, 600 vdcw	56289	160P10396	2	1		
0160-0006	fxd, paper, 0.001 μf ±10%, 600 vdcw	56289	160P10296	1	1		
0160-0007	fxd, paper, 2200 pf ±10%, 600 vdcw	56289	160P22296	1	1		
0160-0013	fxd, paper, 0.1 μf ±10%, 400 vdcw	56289	160P10494	3	1		
0160-0018	fxd, paper, 0.22 μf, 400 vdcw	56289	160P22494	1	1		
0160-0040	fxd, paper, 0.1 μf ±10%, 1000 vdcw	14655	TST-100	1	1		
0160-0045	fxd, paper, 6800 pf ±10%, 5000 vdcw	56289	184P682950	2	1		
0160-0054	fxd, tubular, 0.01 μf ±20%, 400 vdcw	56289	109P10304	5	2		
0160-0056	fxd, paper, 0.047 μf ±10%, 1000 vdcw	56289	73P473910	2	1		
0160-0061	fxd, paper, 1500 pf ±20%, 5000 vdcw	56289	184P152050	2	1		
0160-0062	fxd, paper, 0.015 μf ±10%, 3000 vdcw	56289	184P153930	1	1		
0170-0017	fxd, my, 0.01 μf ±5%, 400 vdcw	84411	620S obd#	1	1		
0170-0018	fxd, my, 1.0 μf ±5%, 200 vdcw	84411	HEW-4 obd#	2	1		
0170-0019	fxd, my, 0.1 μf ±5%, 200 vdcw	84411	620S obd#	1	1		
0170-0022	fxd, my, 0.1 μf ±20%, 600 vdcw	09134	27	2	1		
0180-0012	fxd, elect, 2 sect, 20 μf/sect, 450 vdcw	00853	PLI obd#	2	1		
0180-0025	fxd, elect, 4 sect 20 μf/sect, 450 vdcw	56289	D32452	1	1		
0180-0030	fxd, elect, 2 sect,*120 x 40 μf, 450 vdcw	56289	D32352	1	1		
0180-0044	fxd, elect, 80 μf, 300 vdcw	37942	103481	1	1		
0686-1025	fxd, comp, 1K ohms ±5%, 1/2 W	01121	EB1025	1	1		
0686-3625	fxd, comp, 3600 ohms ±5%, 1/2 W	01121	EB3625	1	1		
0686-7555	fxd, comp, 7.5M ±5%, 1/2 W	01121	EB7555	1	1		
0687-1011	fxd, comp, 100 ohms ±10%, 1/2 W	01121	EB1011	17	4		
0687-1021	fxd, comp, 1K ohms ±10%, 1/2 W	01121	EB1021	8	2		
0687-1031	fxd, comp, 10K ohms ±10%, 1/2 W	01121	EB1031	2	1		
0687-1041	fxd, comp, 100K ohms ±10%, 1/2 W	01121	EB1041	4	1		
0687-1051	fxd, comp, 1M ±10%, 1/2 W	01121	EB1051	1	1		
0687-1061	fxd, comp, 10M ±10%, 1/2 W	01121	EB1061	1	1		
0687-1221	fxd, comp, 1200 ohms ±10%, 1/2 W	01121	EB1221	1	1		
0687-1241	fxd, comp, 120K ohms ±10%, 1/2 W	01121	EB1241	1	1		
0687-1251	fxd, comp, 1.2M ±10%, 1/2 W	01121	EB1251	2	1		
0687-2231	fxd, comp, 22K ohms ±10%, 1/2 W	01121	EB2231	2	1		
0687-2251	fxd, comp, 2.2M ±10%, 1/2 W	01121	EB2251	1	1		
0687-2721	fxd, comp, 2700 ohms ±10%, 1/2 W	01121	EB2721	1	1		
0687-2731	fxd, comp, 27K ohms ±10%, 1/2 W	01121	EB2731	4	1		
0687-2741	fxd, comp, 270K ohms ±10%, 1/2 W	01121	EB2741	1	1		

See introduction to this section

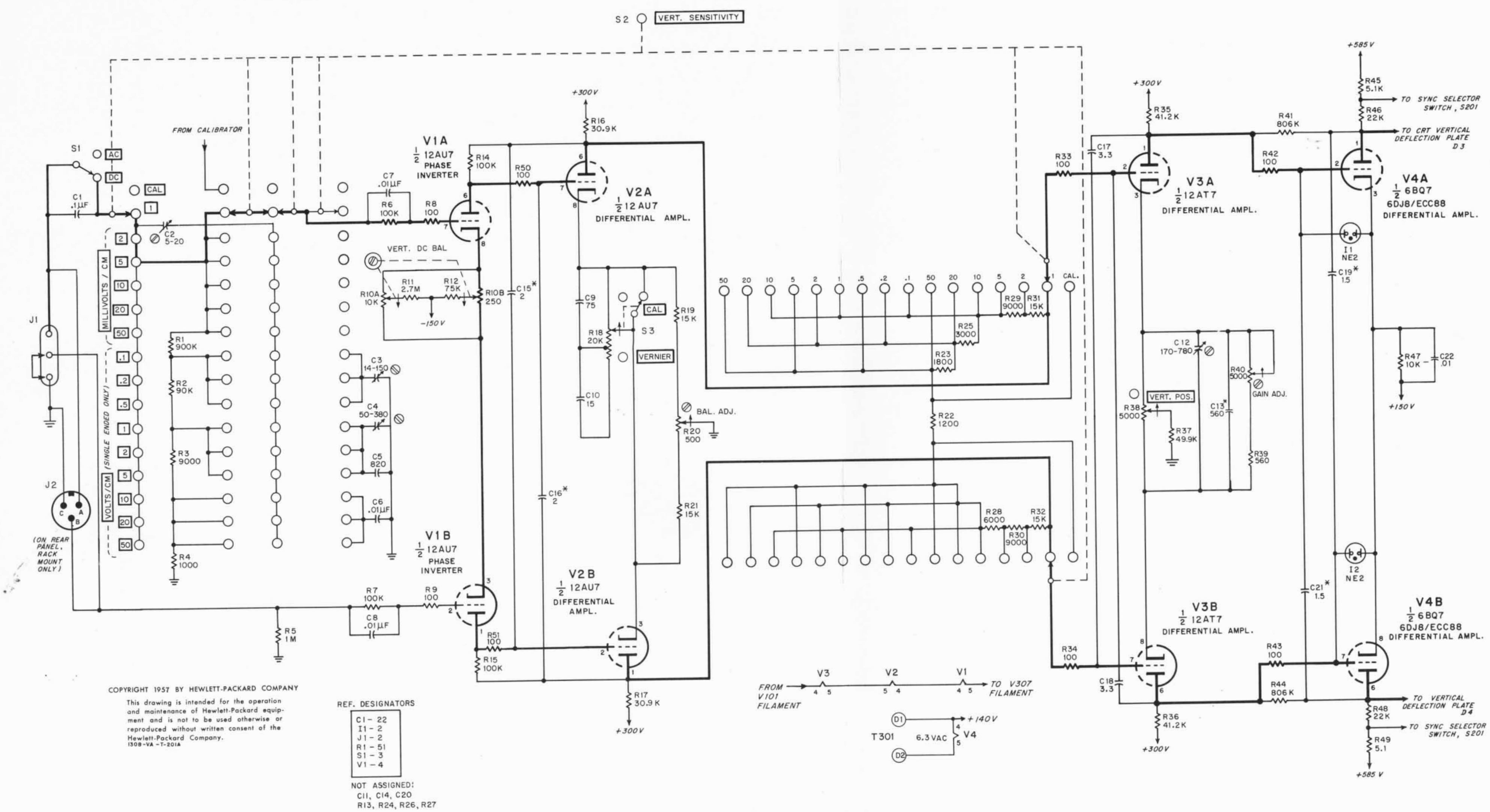


Figure 4-9. Vertical Amplifier

HORIZONTAL AMPLIFIER
VOLTAGE-RESISTANCE DIAGRAM
(VIEWED FROM ETCHED SIDE)

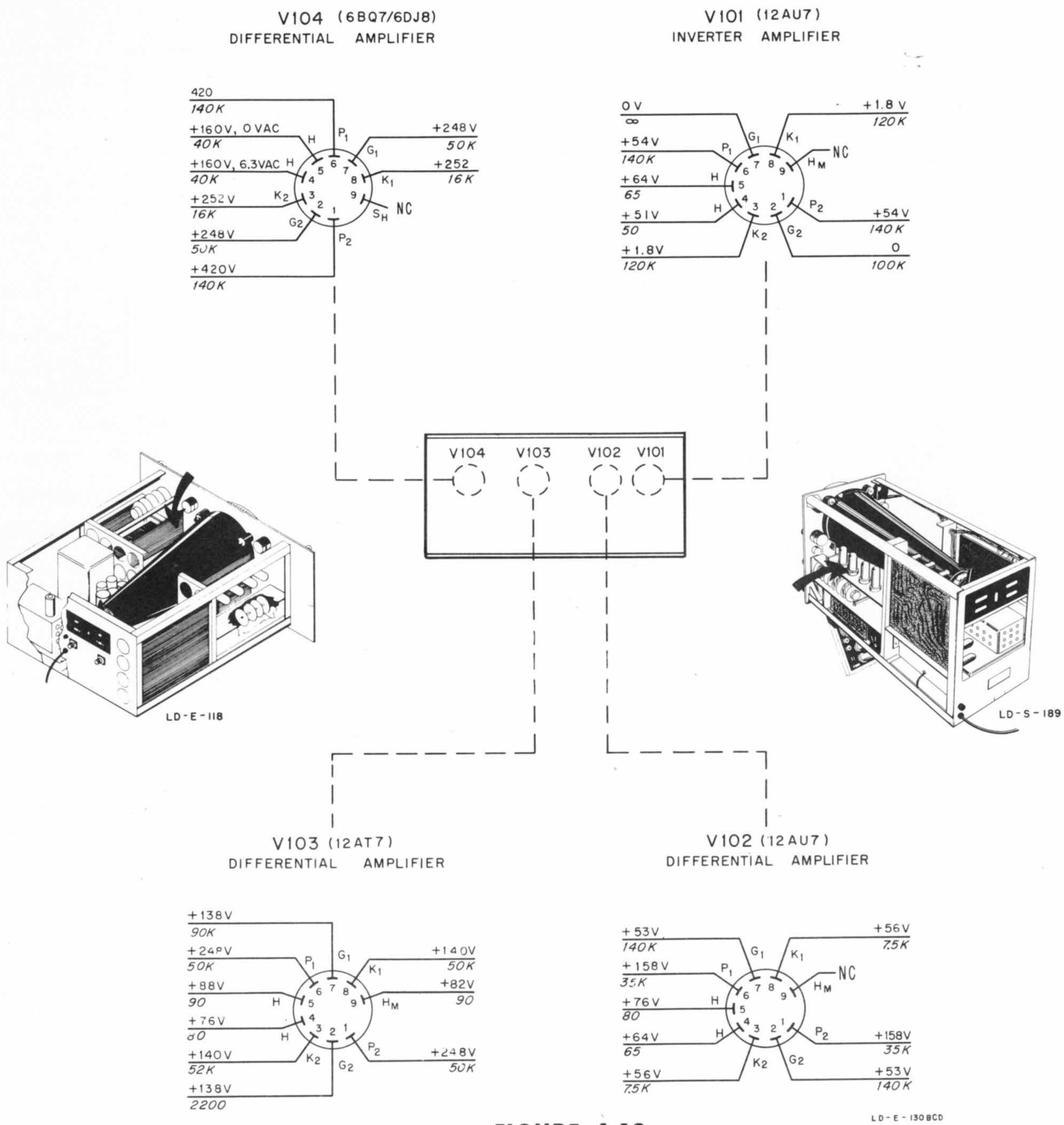


FIGURE 4-10

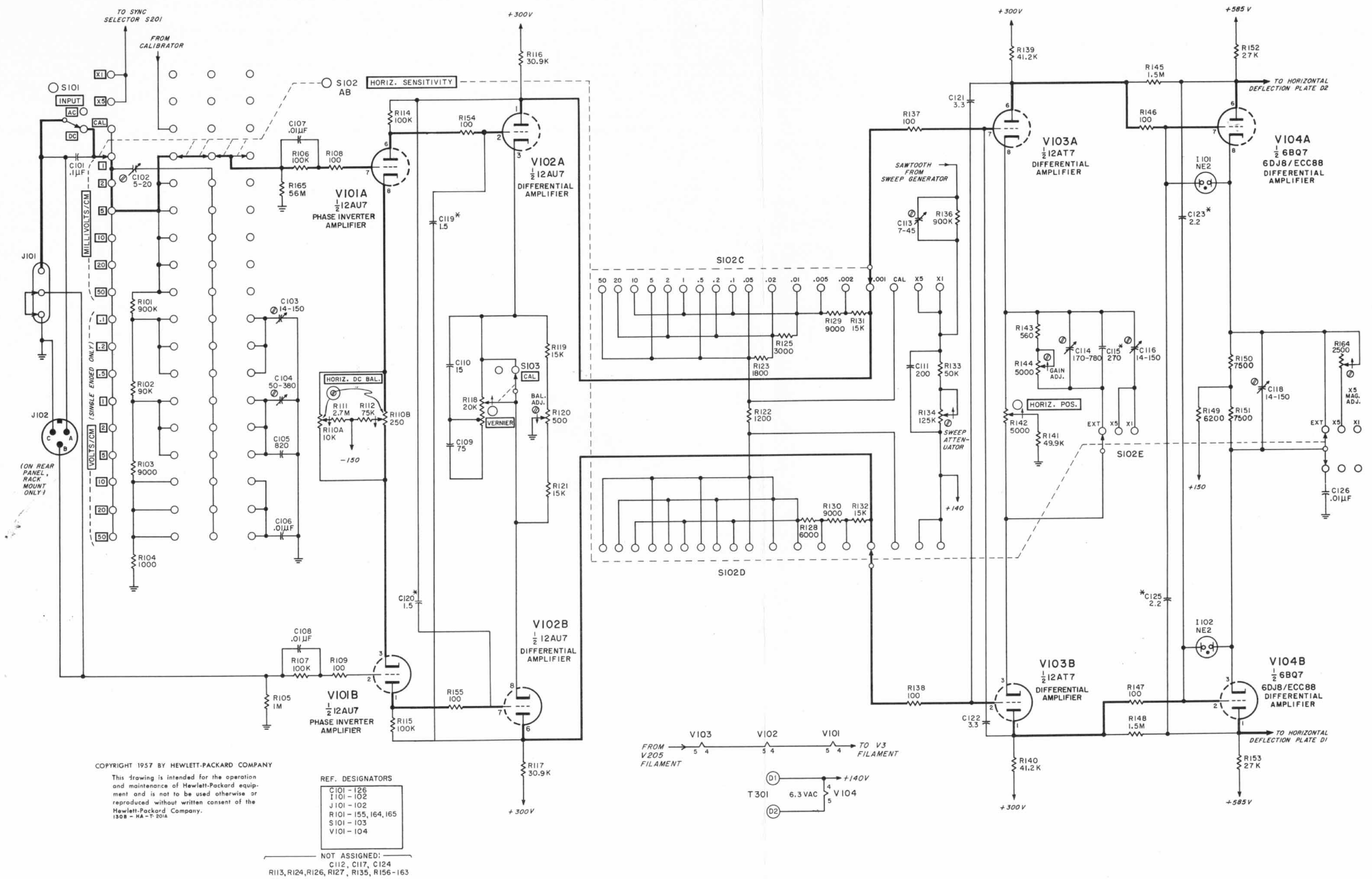


Figure 4-11. Horizontal Amplifier

SWEEP GENERATOR
VOLTAGE - RESISTANCE DIAGRAM
(VIEWED FROM RIGHT SIDE)

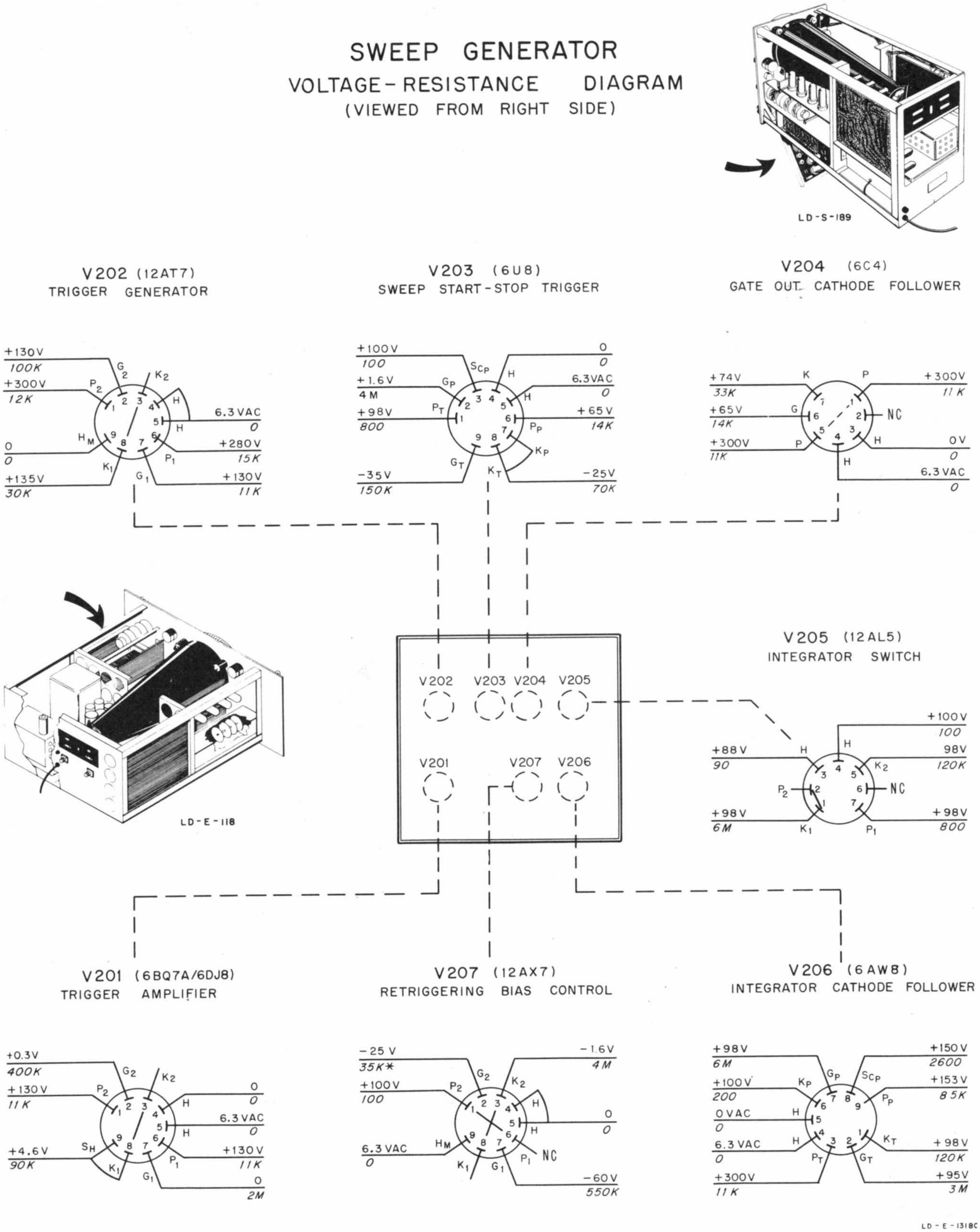


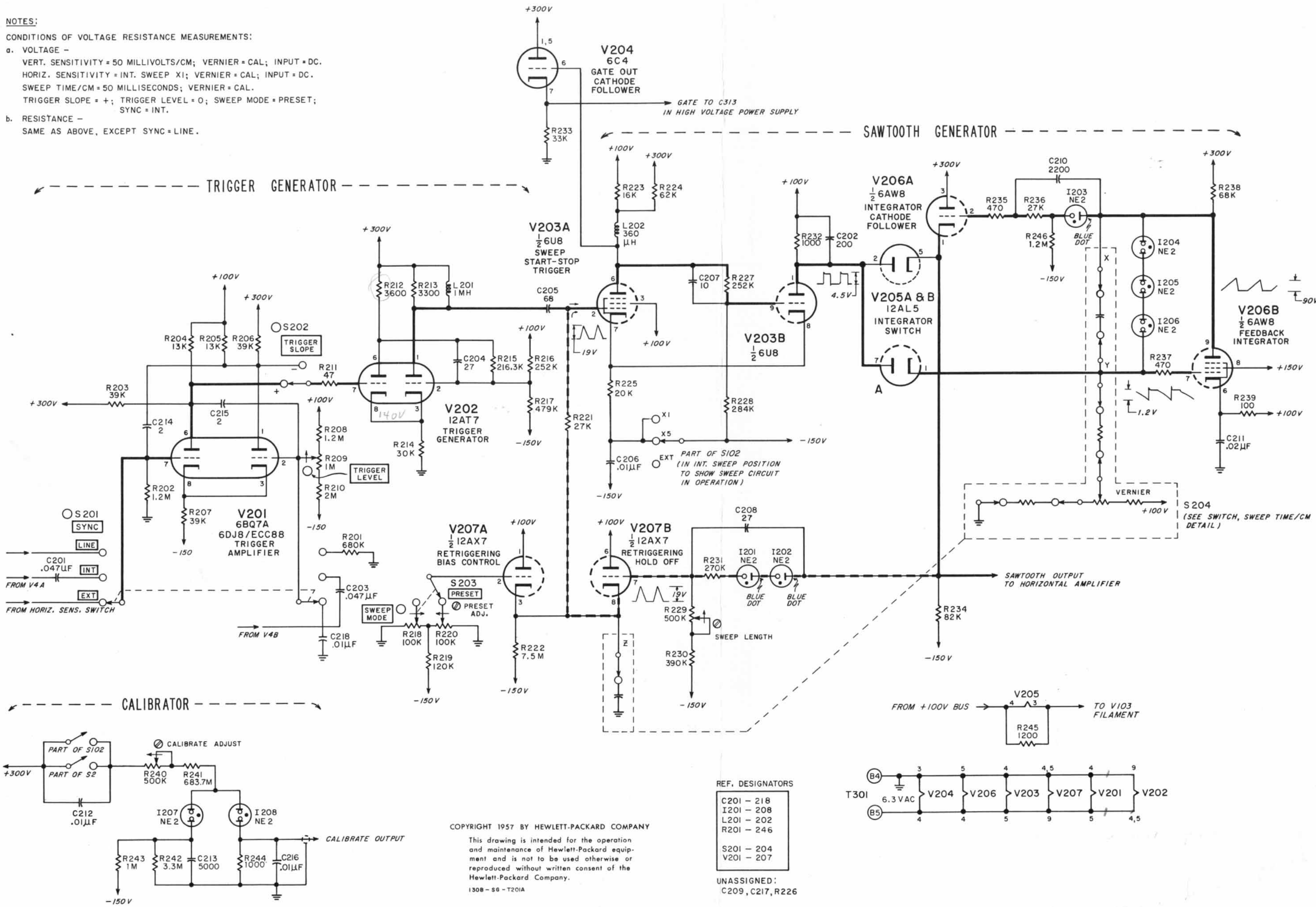
FIGURE 4-12

NOTES:

CONDITIONS OF VOLTAGE RESISTANCE MEASUREMENTS:

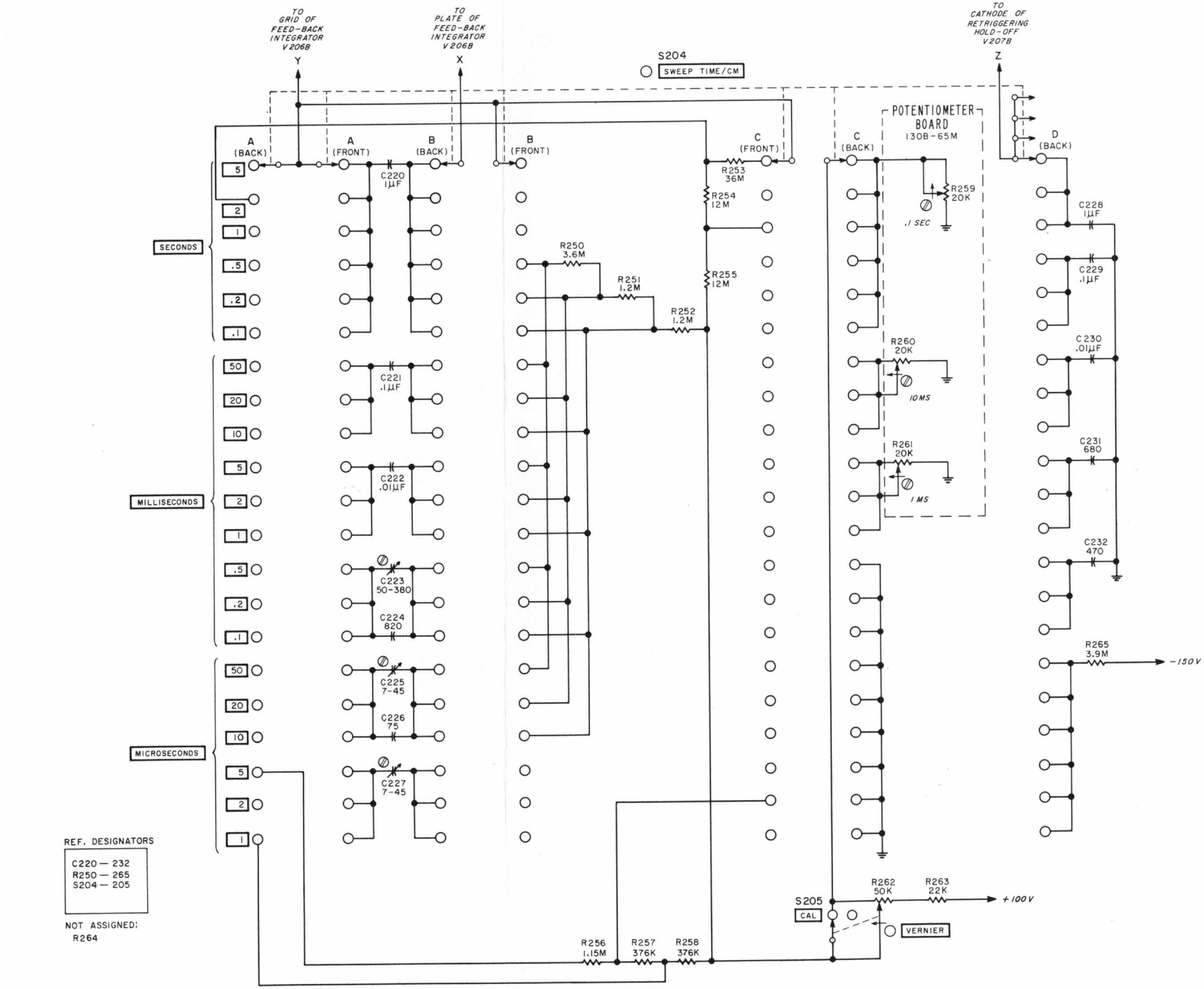
a. VOLTAGE –
   VERT. SENSITIVITY = 50 MILLIVOLTS/CM; VERNIER = CAL; INPUT = DC.
   HORIZ. SENSITIVITY = INT. SWEEP X1; VERNIER = CAL; INPUT = DC.
   SWEEP TIME/CM = 50 MILLISECONDS; VERNIER = CAL.
   TRIGGER SLOPE = +; TRIGGER LEVEL = 0; SWEEP MODE = PRESET; SYNC = INT.

b. RESISTANCE –
   SAME AS ABOVE, EXCEPT SYNC = LINE.



130B – SG – T201A

Figure 4-13. Sweep Generator



130B - ST/CM SWITCH - T946A

POWER SUPPLY REGULATOR
VOLTAGE - RESISTANCE DIAGRAM

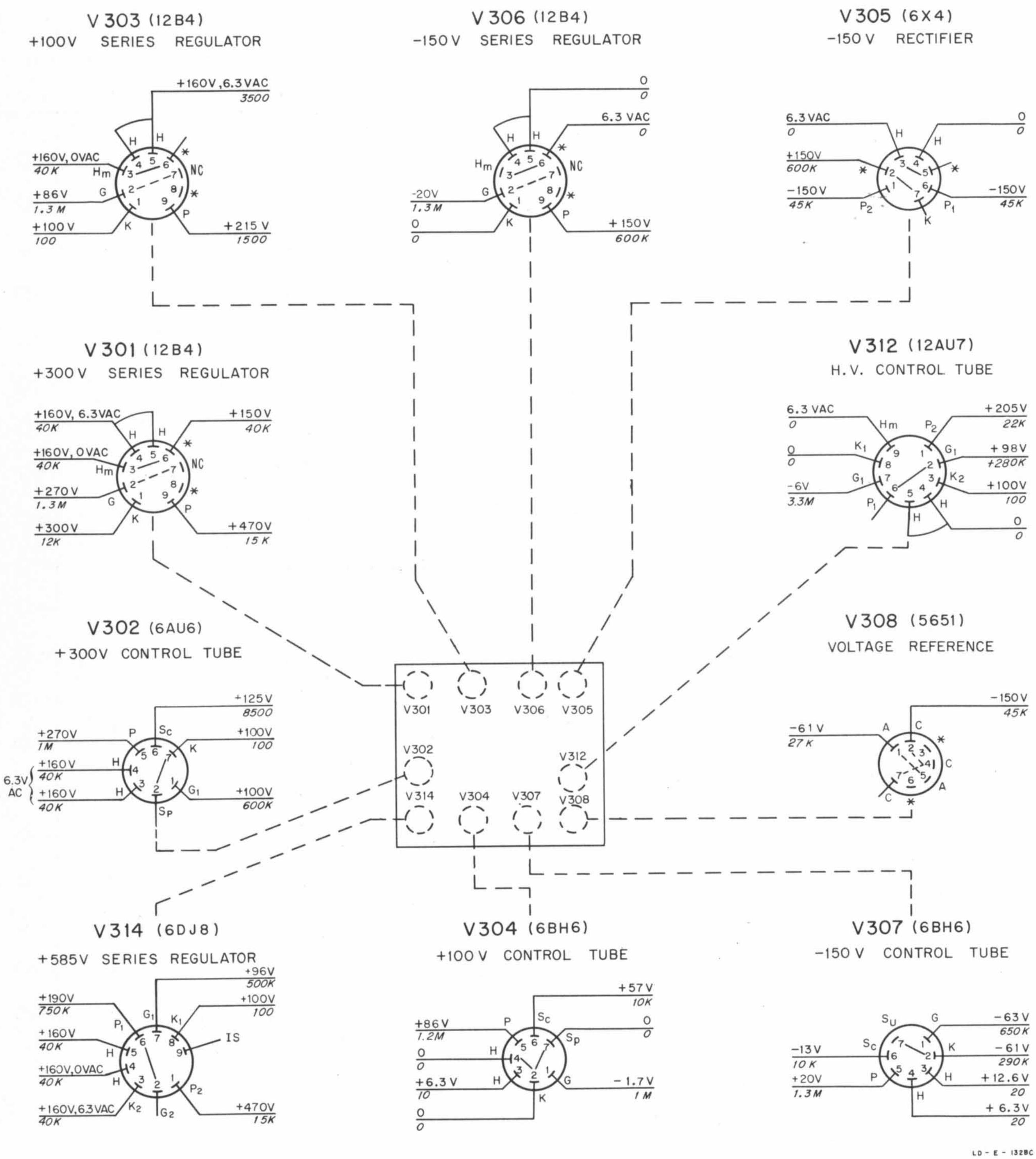


Figure 4-15.

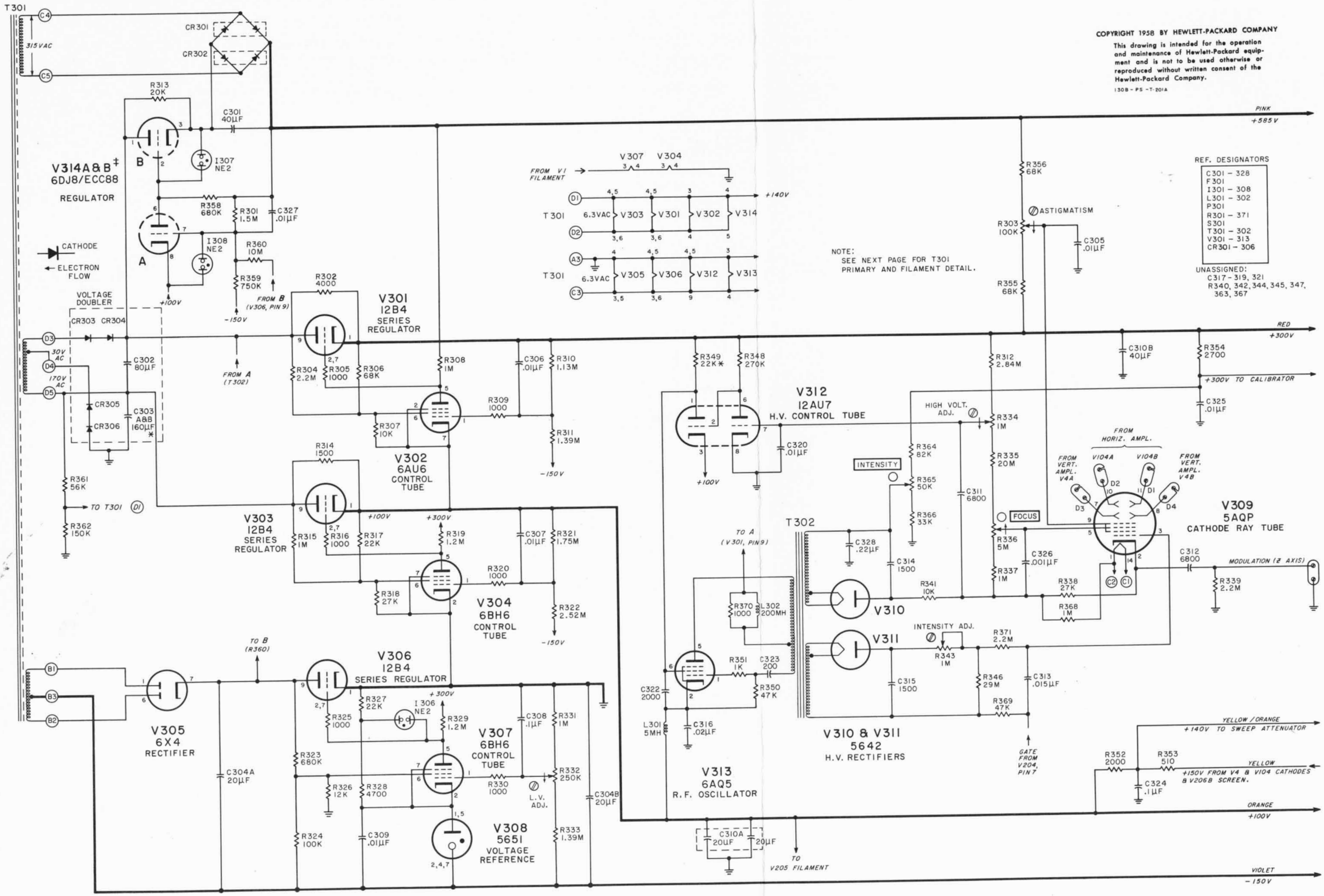
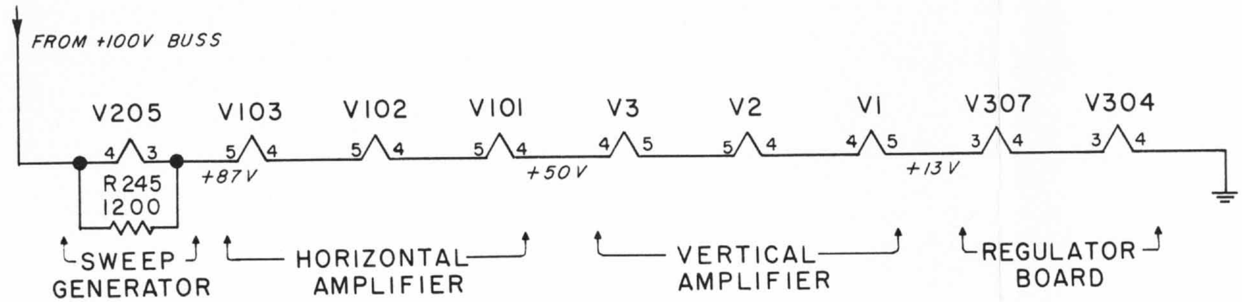
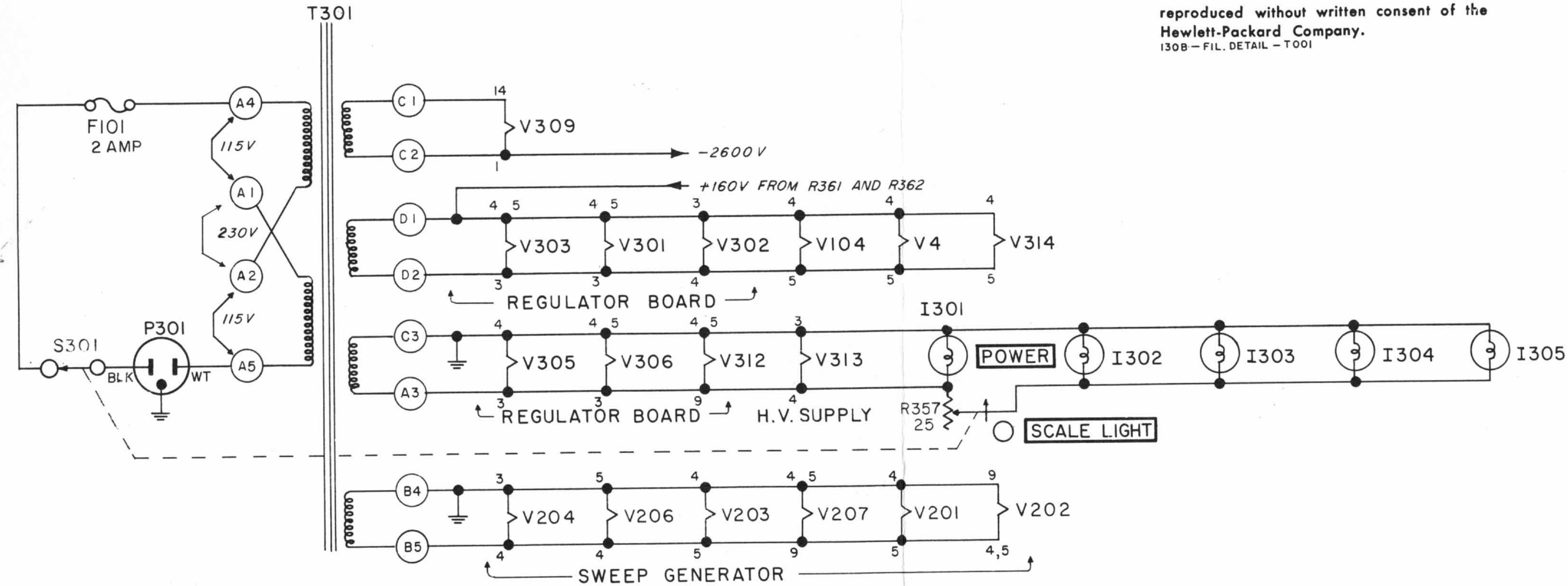


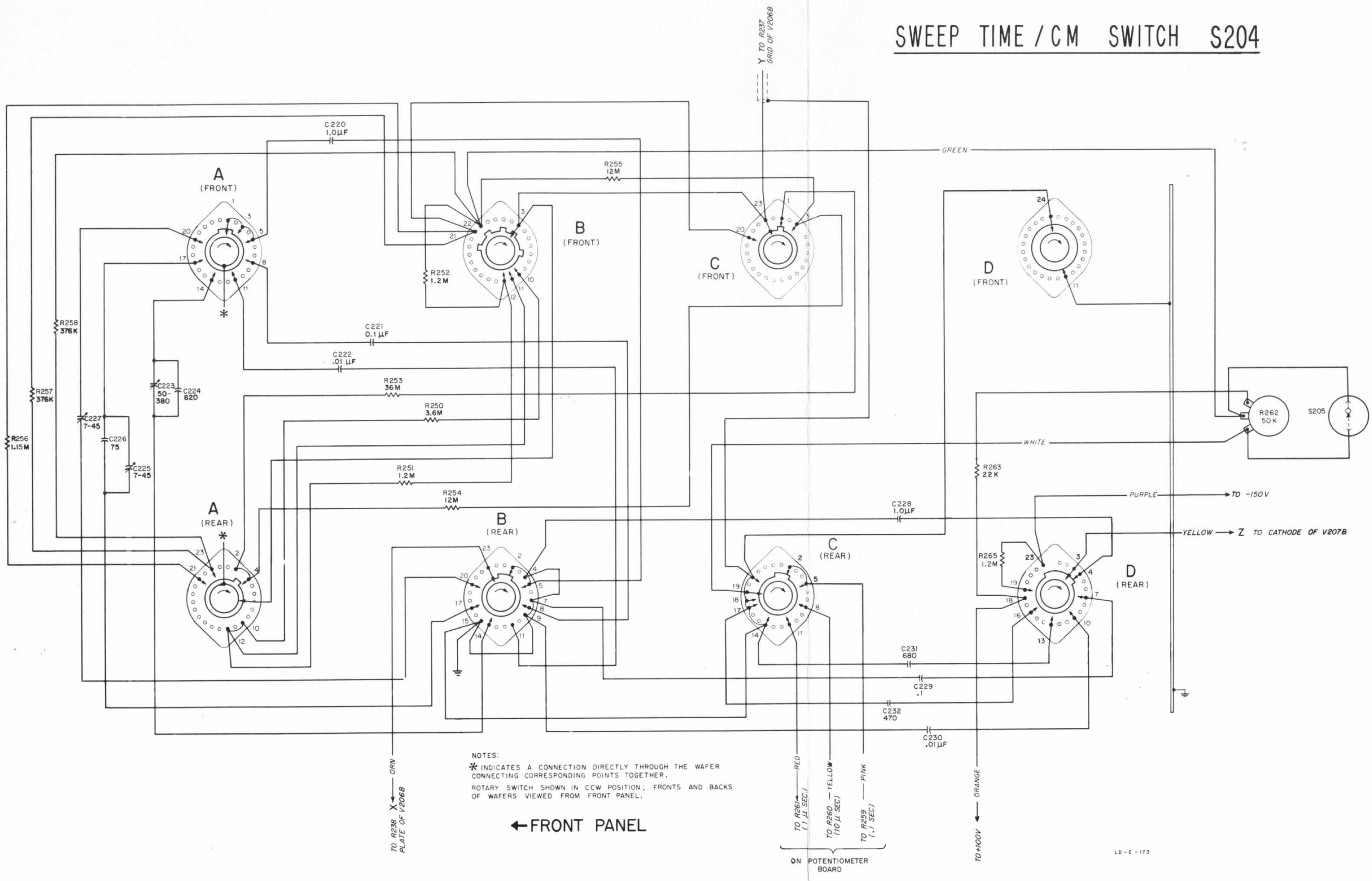
Figure 4-16. Power Supply



130B—FIL. DETAIL—T001



SWEEP TIME / CM SWITCH S204



NOTES:
* INDICATES A CONNECTION DIRECTLY THROUGH THE WAFER CONNECTING CORRESPONDING POINTS TOGETHER.
ROTARY SWITCH SHOWN IN CCW POSITION; FRONTS AND BACKS OF WAFERS VIEWED FROM FRONT PANEL.

← FRONT PANEL

LD-E-173

Table 5-1. Reference Designation Index

Circuit Reference	ⓗ Stock No.	Description	Note
C1	0170-0022	fxd, my, 0.1 μf ±20%, 600 vdcw	
C2	0130-0006	var, cer, 5-20 pf, 500 vdcw	
C3	0131-0004	var, mica, 14-50 pf, 500 vdcw	
C4	0131-0001	var, mica, 50-380 pf, 175 vdcw	
C5	0140-0091	fxd, silver mica, 820 pf ±5%, 500 vdcw	
C6	0140-0009	fxd, mica, 0.01 μf ±5%, 500 vdcw	
C7, 8	0150-0012	fxd, cer, 0.01 μf ±20%, 1000 vdcw	
C9	0140-0040	fxd, mica, 75 pf ±5%, 500 vdcw	
C10	0140-0004	fxd, mica, 15 pf ±10%, 500 vdcw	
C11		Not Assigned	
C12	0131-0003	var, mica, 170-780 pf, 175 vdcw	
C13	0140-0044	fxd, mica, 560 pf ±10%, 500 vdcw. Optimum value selected at factory. Average value shown.	
C14		Not Assigned	
C15, 16	0150-0031	fxd, TiO_2, 2 pf ±5%, 500 vdcw. Optimum value selected at factory. Average value shown.	
C17, 18	0150-0022	fxd, TiO_2, 3.3 pf ±10%, 500 vdcw	
C19	0150-0031	fxd, TiO_2, 2 pf ±5%, 500 vdcw. Optimum value selected at factory. Average value shown.	
C20		Not Assigned	
C21	0150-0031	fxd, TiO_2, 2 pf ±5%, 500 vdcw. Optimum value selected at factory. Average value shown.	
C22	0150-0012	fxd, cer, 0.01 μf ±20%, 1000 vdcw	
C23 thru C100		Not Assigned	
C101	0170-0022	fxd, my, 0.1 μf ±20%, 600 vdcw	
C102	0130-0006	var, cer, 5-20 pf, 500 vdcw	
C103	0131-0004	var, mica, 14-50 pf, 500 vdcw	
C104	0131-0001	var, mica, 50-380 pf, 175 vdcw	
C105	0140-0091	fxd, silver mica, 820 pf ±5%, 500 vdcw	
C106	0140-0009	fxd, mica, 0.01 μf ±5%, 500 vdcw	
C107, 108	0150-0012	fxd, cer, 0.01 μf ±20%, 1000 vdcw	
C109	0140-0040	fxd, mica, 75 pf ±5%, 500 vdcw	
C110	0140-0004	fxd, mica, 15 pf ±10%, 500 vdcw	
C111	0140-0056	fxd, mica, 200 pf ±10%, 500 vdcw	
C112		Not Assigned	
C113	0130-0001	var, cer, 7-45 pf, 500 vdcw	
C114	0131-0003	var, mica, 170-780 pf, 175 vdcw	
C115	0140-0015	fxd, mica, 270 pf ±10%, 500 vdcw	
C116	0131-0004	var, mica, 14-50 pf, 500 vdcw	

See introduction to this section

Table 5-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗⓟ Stock No.	Description	Note
C228	0170-0018	fxd, my, 1.0 μf ±5%, 200 vdcw	
C229	0160-0013	fxd, paper, 0.1 μf ±10%, 400 vdcw	
C230	0160-0002	fxd, paper, 0.01 μf ±10%, 600 vdcw	
C231	0140-0007	fxd, mica, 680 pf ±10%, 500 vdcw	
C232	0140-0027	fxd, mica, 470 pf ±10%, 500 vdcw	
C233 thru C300		Not Assigned	
C301	0180-0012	fxd, elect, 2 sect, 20 μf/sect, 450 vdcw	
C302	0180-0044	fxd, elect, 80 μf, 300 vdcw	
C303	0180-0030	fxd, elect, 2 sect, 120 x 40 μf, 450 vdcw. Optimum value selected at factory. Average value shown.	
C304A, B	0180-0012	fxd, elect, 2 sect, 20 μf/sect, 450 vdcw	
C305	0160-0040	fxd, paper, 0.1 μf ±10%, 1000 vdcw	
C306, 307	0160-0054	fxd, tubular, 0.01 μf ±20%, 400 vdcw	
C308	0160-0013	fxd, paper, 0.1 μf ±10%, 400 vdcw	
C309	0160-0054	fxd, tubular, 0.01 μf ±20%, 400 vdcw	
C310A, B	0180-0025	fxd, elect, 4 sect, 20 μf/sect, 450 vdcw	
C311, 312	0160-0045	fxd, paper, 6800 pf ±10%, 5000 vdcw	
C313	0160-0062	fxd, paper, 0.015 μf ±10%, 3000 vdcw	
C314, 315	0160-0061	fxd, paper, 1500 pf ±20%, 5000 vdcw	
C316	0150-0024	fxd, cer, 0.02 μf ±10%, 600 vdcw	
C317 thru C319		Not Assigned	
C320	0160-0054	fxd, tubular, 0.01 μf ±20%, 400 vdcw	
C321		Not Assigned	
C322	0150-0023	fxd, cer, 2000 pf ±20%, 1000 vdcw	
C323	0140-0056	fxd, mica, 200 pf ±10%, 500 vdcw	
C324	0160-0013	fxd, paper, 0.1 μf ±10%, 400 vdcw	
C325	0160-0054	fxd, tubular, 0.01 μf ±20%, 400 vdcw	
C326	0160-0006	fxd, paper, 0.001 μf ±10%, 600 vdcw	
C327	0150-0012	fxd, cer, 0.01 μf ±20%, 1000 vdcw	
C328	0160-0018	fxd, paper, 0.22 μf, 400 vdcw	
CR301, 302	1883-0005	Diode, se	
CR303 thru CR306	1901-0007	Diode, Si: 500 ma, 400 PIV	
F301	2110-0006 2110-0007	Fuse, cartridge: 2 amp, s-b for 115 V operation Fuse, cartridge: 1 amp, s-b for 230 V operation	
I1, 2	2140-0008	Lamp, neon: 1/25 W, 90 vdcw, 65 VAC, NE2	
I3 thru I100		Not Assigned	
I101, 102	2140-0008	Lamp, neon: 1/25 W, 90 vdcw, 65 VAC, NE2	
I103 thru I200		Not Assigned	

See introduction to this section

Table 5-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗ Stock No.	# Description	Note
R22	0727-0105	fxd, dep c, 1200 ohms ±1%, 1/2 W	
R23	0727-0112	fxd, dep c, 1800 ohms ±1%, 1/2 W	
R24		Not Assigned	
R25	0727-0124	fxd, dep c, 3K ohms ±1%, 1/2 W	
R26, 27		Not Assigned	
R28	0727-0140	fxd, dep c, 6K ohms ±1%, 1/2 W	
R29, 30	0727-0152	fxd, dep c, 9K ohms ±1%, 1/2 W	
R31, 32	0727-0168	fxd, dep c, 15K ohms ±1%, 1/2 W	
R33, 34	0687-1011	fxd, comp, 100 ohms ±10%, 1/2 W	
R35, 36	0757-0023	fxd, mfg, 41,200 ohms ±1%, 1 W	
R37	0757-0024	fxd, mfg, 49,900 ohms ±1%, 1 W	
R38	2100-0006	var, ww, 5K ohms ±10%, 2 W	
R39	0687-5611	fxd, comp, 560 ohms ±10%, 1/2 W	
R40	2100-0091	var, comp, 5K ohms ±30%, 1/3 W, lin	
R41	0757-0025	fxd, mfg, 806K ohms ±1%, 1 W	
R42, 43	0687-1011	fxd, comp, 100 ohms ±10%, 1/2 W	
R44	0757-0025	fxd, mfg, 806K ohms ±1%, 1 W	
R45	0689-5125	fxd, comp, 5100 ohms ±5%, 1 W	
R46	0693-2231	fxd, comp, 22K ohms ±10%, 2 W	
R47	0693-1031	fxd, comp, 10K ohms ±10%, 2 W	
R48	0693-2231	fxd, comp, 22K ohms ±10%, 2 W	
R49	0689-5125	fxd, comp, 5100 ohms ±5%, 1 W	
R50, 51	0687-1011	fxd, comp, 100 ohms ±10%, 1/2 W	
R52 thru R100		Not Assigned	
R101	0730-0103	fxd, dep c, 900K ohms ±1%, 1 W	
R102	0727-0203	fxd, dep c, 90K ohms ±1%, 1/2 W	
R103	0727-0152	fxd, dep c, 9K ohms ±1%, 1/2 W	
R104	0727-0100	fxd, dep c, 1K ohms ±1%, 1/2 W	
R105	0727-0274	fxd, dep c, 1 M ±1%, 1/2 W	
R106, 107	0687-1041	fxd, comp, 100K ohms ±10%, 1/2 W	
R108, 109	0687-1011	fxd, comp, 100 ohms ±10%, 1/2 W	
R110A, B	2100-0147	var, dual concentric, lin, rear sect: 250 ohms ±10% front sect: 10K ohms ±10%, 2 W	
R111	0687-2751	fxd, comp, 2.7 M ±10%, 1/2 W	
R112	0730-0058	fxd, dep c, 75K ohms ±1%, 1 W	
R113		Not Assigned	
R114, 115	0757-0012	fxd, mfg, 100K ohms ±1%, 1/2 W	
R116, 117	0757-0022	fxd, mfg, 30,900 ohms ±1%, 1 W	

See introduction to this section

Table 5-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗⓟ Stock No.	# Description	Note
R206, 207	0692-3935	fxd, comp, 39K ohms ±5%, 2 W	
R208	0687-1251	fxd, comp, 1.2 M ±10%, 1/2 W	
R209		nsr; Part of S202	
R210	0727-0287	fxd, dep c, 2 M ±1%, 1/2 W	
R211	0687-4701	fxd, comp, 47 ohms ±10%, 1/2 W	
R212	0686-3625	fxd, comp, 3600 ohms ±5%, 1/2 W	
R213	0687-3321	fxd, comp, 3300 ohms ±10%, 1/2 W	
R214	0692-3035	fxd, comp, 30K ohms ±5%, 2 W	
R215	0727-0223	fxd, dep c, 216,300 ohms ±1%, 1/2 W	
R216	0727-0228	fxd, dep c, 252K ohms ±1%, 1/2 W	
R217	0730-0091	fxd, dep c, 479K ohms ±1%, 1 W	
R218		nsr; Part of S203	
R219	0687-1241	fxd, comp, 120K ohms ±10%, 1/2 W	
R220	2100-0095	var, comp, lin, 100K ohms ±30%, 1/4 W	
R221	0687-2731	fxd, comp, 27K ohms ±10%, 1/2 W	
R222	0686-7555	fxd, comp, 7.5 M ±5%, 1/2 W	
R223	0689-1635	fxd, comp, 16K ohms ±5%, 1 W	
R224	0692-6235	fxd, comp, 62K ohms ±5%, 2 W	
R225	0771-0004	fxd, mfg, 20K ohms ±10%, 4 W	
R226		Not Assigned	
R227	0727-0228	fxd, dep c, 252K ohms ±1%, 1/2 W	
R228	0727-0230	fxd, dep c, 284K ohms ±1%, 1/2 W	
R229	2100-0102	var, comp, lin, 500K ohms ±30%, 1/4 W	
R230	0687-3941	fxd, comp, 390K ohms ±10%, 1/2 W	
R231	0687-2741	fxd, comp, 270K ohms ±10%, 1/2 W	
R232	0686-1025	fxd, comp, 1K ohms ±5%, 1/2 W	
R233	0690-3331	fxd, comp, 33K ohms ±10%, 1 W	
R234	0693-8231	fxd, comp, 82K ohms ±10%, 2 W	
R235	0687-4711	fxd, comp, 470 ohms ±10%, 1/2 W	
R236	0687-2731	fxd, comp, 27K ohms ±10%, 1/2 W	
R237	0687-4711	fxd, comp, 470 ohms ±10%, 1/2 W	
R238	0693-6831	fxd, comp, 68K ohms ±10%, 2 W	
R239	0687-1011	fxd, comp, 100 ohms ±10%, 1/2 W	
R240	2100-0102	var, comp, lin, 500K ohms ±30%, 1/4 W	
R241	0730-0096	fxd, dep c, 683.7K ohms ±1%, 1 W	
R242	0687-3351	fxd, comp, 3.3 M ±10%, 1/2 W	
R243	0687-1051	fxd, comp, 1 M ±10%, 1/2 W	

See introduction to this section

Table 5-1. Reference Designation Index (Cont')

Circuit Reference	ⓗ Stock No.	# Description	Note
R324	0690-1041	fxd, comp, 100K ohms ±10%, 1 W	
R325	0687-1021	fxd, comp, 1K ohms ±10%, 1/2 W	
R326	0690-1231	fxd, comp, 12K ohms ±10%, 1 W	
R327	0687-2231	fxd, comp, 22K ohms ±10%, 1/2 W	
R328	0687-4721	fxd, comp, 4700 ohms ±10%, 1/2 W	
R329	0690-1251	fxd, comp, 1.2 M ±10%, 1 W	
R330	0687-1021	fxd, comp, 1K ohms ±10%, 1/2 W	
R331	0727-0276	fxd, dep c, 1 M ±1%, 1/2 W	
R332	2100-0144	var, comp, lin, 250K ohms ±30%, 1/4 W	
R333	0727-0281	fxd, dep c, 1.39 M ±1%, 1/2 W	
R334	2100-0096	var, comp, lin, 1 M ±30%, 1/4 W	
R335	0836-0002	fxd, dep c, 20 M ±10%, 1 W	
R336	2100-0112	var, comp, lin, 5 M ±30%, 1/2 W	
R337	0727-0274	fxd, dep c, 1 M ±1%, 1/2 W	
R338	0687-2731	fxd, comp, 27K ohms ±10%, 1/2 W	
R339	0690-2251	fxd, comp, 2.2 M ±10%, 1 W	
R340		Not Assigned	
R341	0687-1031	fxd, comp, 10K ohms ±10%, 1/2 W	
R342		Not Assigned	
R343	2100-0080	var, comp, lin, 1 M, ±30%, 1/4 W	
R344, 345		Not Assigned	
R346	0836-0003	fxd, dep c, 29 M ±10%, 1 W	
R347		Not Assigned	
R348	0690-2741	fxd, comp, 270K ohms ±10%, 1 W	
R349	0693-2231	fxd, comp, 22K ohms ±10%, 2 W	
R350	0687-4731	fxd, comp, 47K ohms ±10%, 1/2 W	
R351	0687-1021	fxd, comp, 1K ohms ±10%, 1/2 W	
R352	0692-2025	fxd, comp, 2K ohms ±5%, 2 W	
R353	0689-5115	fxd, comp, 510 ohms ±5%, 1 W	
R354	0687-2721	fxd, comp, 2700 ohms ±10%, 1/2 W	
R355, 356	0687-6831	fxd, comp, 68K ohms ±10%, 1/2 W	
R357	2100-0140	var, ww, lin, 25 ohms ±10%, 2 W, includes S301	
R358	0690-6841	fxd, comp, 680K ohms ±10%, 1 W	
R359	0727-0253	fxd, dep c, 750K ohms ±1%, 1/2 W	
R360	0687-1061	fxd, comp, 10 M ±10%, 1/2 W	
R361	0690-5631	fxd, comp, 56K ohms ±10%, 1 W	
R362	0690-1541	fxd, comp, 150K ohms ±10%, 1 W	
R363		Not Assigned	

See introduction to this section

Table 5-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗⓟ Stock No.	# Description	Note
V202	1932-0027	Tube, elect: 12AT7	
V203	1933-0004	Tube, elect: 6U8	
V204	1921-0005	Tube, elect: 6C4	
V205	1930-0019	Tube, elect: 12AL5	
V206	1933-0002	Tube, elect: 6AW8A	
V207	1932-0030	Tube, elect: 12AX7	
V208 thru V300		Not Assigned	
V301	1921-0010	Tube, elect: 12B4A	
V302	1923-0021	Tube, elect: 6AU6	
V303	1921-0010	Tube, elect: 12B4A	
V304	1923-0027	Tube, elect: 6BH6	
V305	1930-0016	Tube, elect: 6X4	
V306	1921-0010	Tube, elect: 12B4A	
V307	1923-0027	Tube, elect: 6BH6	
V308	1940-0001	Tube, elect: 5651	
V309	2090-0007	Tube, elect, cathode-ray type (Normally supplied with P1 phosphor. Also available are P2, P5 and P7.)	
V310, 311	1920-0001	Tube, elect: 5642	
V312	1932-0029	Tube, elect: 12AU7	
V313	1923-0018	Tube, elect: 6AQ5	
V314	1932-0022	Tube, elect: 6DJ8	
		MISCELLANEOUS	
	120A-20A	CRT bezel	
	120A-83A	Filter, light: amber	
	120A-83B	Filter, light: blue	
	120A-83G	Filter, light: green	
	1400-0084	Fuseholder	
	130B-11B	High voltage oscillator and rectifier assy	
	1400-0056	Holder, rectifier	
	1450-0020	Jewel, for pilot lamp	
	G-74D	Knob: FOCUS, INTENSITY, SCALE LIGHT	
	G-74G	Knob: VERT. POS., HORIZ. POS	
	G-74L	Knob: TRIGGER LEVEL	
	G-74Q	Knob: VERT SENSITIVITY, HORIZ SENSITIVITY, SYNC TIME SWEEP TIME	
	G-74AT	Knob: TRIGGER SLOPE	
	G-74AU	Knob: VERNIER, VERT. SENSITIVITY, HORIZ SENSITIVITY, SYNC TIME, SWEEP TIME	
	G-74BJ	Knob: VERT. and HORIZ DC BAL	
	1450-0022	Socket assy, pilot lamp	

See introduction to this section

Table 5-2. Replaceable Parts (Cont'd)

ℎ Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS		
0693-2731	fxd, comp, 27K ohms ±10%, 2 W	01121	HB2731	2	1		
0693-6831	fxd, comp, 68K ohms ±10%, 2 W	01121	HB6831	1	1		
0693-8231	fxd, comp, 82K ohms ±10%, 2 W	01121	HB8231	1	1		
0727-0100	fxd, dep c, 1K ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	2	1		
0727-0105	fxd, dep c, 1200 ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	2	1		
0727-0112	fxd, dep c, 1800 ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	2	1		
0727-0124	fxd, dep c, 3K ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	2	1		
0727-0140	fxd, dep c, 6K ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	2	1		
0727-0152	fxd, dep c, 9K ohms ±1%, 1/2 W	19701	DC1/2BR5 obd#	6	2		
0727-0168	fxd, dep c, 15K ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	8	2		
0727-0195	fxd, dep c, 50K ohms ±1%, 1/2 W	19701	DC1/2BR5 obd#	1	1		
0727-0203	fxd, dep c, 90K ohms ±1%, 1/2 W	19701	DC1/2BR5 obd#	2	1		
0727-0223	fxd, dep c, 216,300 ohms ±1%, 1/2 W	19701	DC1/2BR5 obd#	1	1		
0727-0228	fxd, dep c, 252K ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	2	1		
0727-0230	fxd, dep c, 284K ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	1	1		
0727-0237	fxd, dep c, 376K ohms ±1%, 1/2 W	19701	DC1/2CR5 obd#	2	1		
0727-0253	fxd, dep c, 750K ohms ±1%, 1/2 W	19701	DC1/2AR5 obd#	1	1		
0727-0259	fxd, dep c, 900K ohms ±1%, 1/2 W	19701	DC1/2AR5 obd#	1	1		
0727-0274	fxd, dep c, 1M ±1%, 1/2 W	19701	DC1/2AR5 obd#	3	1		
0727-0276	fxd, dep c, 1M ±1%, 1/2 W	19701	DC1/2CR5 obd#	1	1		
0727-0278	fxd, dep c, 1.13M ±1%, 1/2 W	19701	DC1/2CR5 obd#	1	1		
0727-0279	fxd, dep c, 1.15M ±1%, 1/2 W	19701	DC1/2CR5 obd#	1	1		
0727-0280	fxd, dep c, 1.2M ±1%, 1/2 W	19701	DC1/2AR5 obd#	2	1		
0727-0281	fxd, dep c, 1.39M ±1%, 1/2 W	19701	DC1/2AR5 obd#	2	1		
0727-0284	fxd, dep c, 1.75M ±1%, 1/2 W	19701	DC1/2AR5 obd#	1	1		
0727-0287	fxd, dep c, 2M ±1%, 1/2 W	19701	DC1/2CR5 obd#	1	1		
0727-0289	fxd, dep c, 2.52M ±1%, 1/2 W	19701	DC1/2AR5 obd#	1	1		
0727-0294	fxd, dep c, 3.6M ±1%, 1/2 W	19701	DC1/2BR5 obd#	1	1		
0730-0058	fxd, dep c, 75K ohms ±1%, 1 W	19701	DC1R5 obd#	2	1		
0730-0091	fxd, dep c, 479K ohms ±1%, 1 W	19701	DC1R5 obd#	1	1		
0730-0096	fxd, dep c, 683.7K ohms ±1%, 1 W	19701	DC1R5 obd#	1	1		
0730-0103	fxd, dep c, 900K ohms ±1%, 1 W	19701	DC1R5 obd#	2	1		
0730-0116	fxd, dep c, 2.84M ±1%, 1W	19701	DC1R5 obd#	1	1		
0730-0145	fxd, dep c, 12M ±1%, 1 W	19701	DC1R5 obd#	2	1		
0733-0009	fxd, dep c, 36M ±1%, 2 W	19701	DC2R5 obd#	1	1		
0757-0012	fxd, mfg, 100K ohms ±1%, 1/2 W	15909	obd#	4	1		
0757-0022	fxd, mfg, 30,900 ohms ±1%, 1 W	07115	NI25 obd#	4	1		

See introduction to this section

Table 5-2. **Replaceable Parts** (Cont'd)

ⓗ Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS		
2100-0095	var, comp, lin, 100K ohms ±30%, 1/4 W	11237	UPE70 Special obd#	2	1		
2100-0096	var, comp, lin, 1M ±30%, 1/4 W	11237	UPE70 Special obd#	1	1		
2100-0102	var, comp, lin, 500K ohms ±30%, 1/4 W	11237	UPE70 Special obd#	2	1		
2100-0107	var, comp, lin, 50K ohms ±30%, 1/3 W	11237	RGC-45	1	1		
2100-0112	var, comp, lin, 5M ±30%, 1/2 W	12697	37, HV insulator	1	1		
2100-0140	var, ww, lin, 25 ohms ±10%, 2 W includes S301	11237	GC-252	1	1		
2100-0144	var, comp, lin, 250K ohms ±30%, 1/4 W	11237	UPE70 obd#	1	1		
2100-0145	var, comp, 20K ohms ±20%, 1/3 W, includes S3	11237	RGC47	2	1		
2100-0147	var, dual concentric, lin, Rear sect: 250 ohms ±10% Front sect: 10K ohms ±10%, 2 W	11237	C252-HT252	2	1		
2100-0151	var, comp, lin, 500 ohms ±20%, 2/10 W	11237	UPE70 obd#	2	1		
2110-0006	Fuse, cartridge: 2 amp, s-b, for 115V operation	71400	MDL2	1	10		
2110-0007	Fuse, cartridge: 1 amp, s-b, for 230V operation	71400	MDL1	1	0		
2140-0008	Lamp, neon: 1/25 W, 90 vdcw, 65 VAC, NE2	24455	NE2	6	6		
2140-0009	Lamp, incd: 6-8V, 0.15 amp, #47	24455	#47	4	4		
2140-0012	Lamp, incd: 6-8V, 2 pin base, #12	24455	#12	1	1		
3100-0243	Switch, rot: 5 sect, 16 pos	76854	189138-L6	1	1		
3101-0001	Switch, tog: SPST, Vertical AC-DC Switch	04009	80994-H	1	1		
8120-0050	Cord, power	71700	obd#	1	1		
9100-0091	Transformer, power	28480	obd#	1	1		
9140-0019	Coil, r.f.: 200 μh	99848	1200-15-201	1	1		
9140-0037	Coil, r.f.: 5 mh	99848	35000-15-502	1	1		
9140-0038	Inductor: 360 μh	99848	Special obd#	1	1		
9140-0053	Inductor: 1 μh	99848	31000-15-102	1	1		
	MISCELLANEOUS						
G-74D	Knob: FOCUS, INTENSITY, SCALE LIGHT	28480	G-74D	3	0		
G-74G	Knob: VERT. POS., HORIZ. POS.	28480	G-74G	1	0		
G-74L	Knob: TRIGGER LEVEL	28480	G-74L	1	0		
G-74Q	Knob: VERT. SENSITIVITY, HORIZ. SENSITIVITY, SYNC TIME, SWEEP TIME	28480	G-74Q	4	0		
G-74AT	Knob: TRIGGER SLOPE	28480	G-74AT	1	0		
G-74AU	Knob: VERNIER, VERT. SENSITIVITY, HORIZ. SENSITIVITY, SYNC TIME, SWEEP TIME	28480	G-74AU	4	0		
G-74BJ	Knob: VERT. and HORIZ. DC BAL	28480	G-74BJ	2	0		
120A-20A	CRT bezel	28480	120A-20A	1	0		
120A-83A	Filter, light: amber	28480	120A-83A	1	0		
120A-83B	Filter, light: blue	28480	120A-83B	1	0		
120A-83G	Filter, light: green	28480	120A-83G	1	0		
130B-11B	High voltage oscillator and rectifier assy	28480	130B-11B	1	0		

See introduction to this section

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

CODE NO.	MANUFACTURER	ADDRESS
00334	Humidial Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Division	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04870	P M Motor Co.	Chicago, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05729	Metropolitan Telecommunications Corp., Metro Cap. Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc.	Lowell, Mass.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronics, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C. A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C. P. Clare & Co.	Chicago, Ill.
71528	Standard-Thomson Corp., Clifford Mfg. Co. Div.	Waltham, Mass.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J. H. Winns, and Sons	Winchester, Mass.

From: F.S.C. Handbook Supplements
H4-1 Dated October 1961
H4-2 Dated November 1961

00015-19
Revised: 6 December 1961

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

CODE NO.	MANUFACTURER	ADDRESS
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E. F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littelfuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C. W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J. W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Chicago, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78283	Signal Indicator Corp.	New York, N.Y.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W. L. Maxson Corp.	Wallingford, Conn.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs., Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc., Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85474	R. M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91921	Minneapolis-Honeywell Regulator Co., Micro-Switch Division	Freeport, Ill.
92196	Universal Metal Products, Inc.	Bassett Puente, Calif.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98734	Palo Alto Engineering Co., Inc.	Palo Alto, Calif.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000I	Telefunken (c/o American Elite)	New York, N.Y.
0000L	Winchester Electronics, Inc.	Santa Monica, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000DD	General Transistor	Los Angeles, Calif.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000FF	Carmichael Corrugated Specialties	Richmond, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.

From: F.S.C. Handbook Supplements
H4-1 Dated October 1961
H4-2 Dated November 1961

00015-19
Revised: 6 December 1961