NAVSHIPS 91,707 UNCLASSIFIED

INSTRUCTION BOOK

for

OSCILLOSCOPE

OS-8B/U

Manufactured by

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 Dupont Avenue Cleveland 8, Ohio

for

BUREAU OF SHIPS U. S. NAVY DEPARTMENT

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Contract NObsr-52654
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1 July 1952

LIST OF EFFECTIVE PAGES

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DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

IN REPLY REFER TO
Code 993-100
1 July 1952

From: Chief, Bureau of Ships
To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Oscilloscope OS-8B/U NAVSHIPS 91707

1. This is the instruction book for the subject equipment and is in effect upon receipt.

2. When superseded by a later edition, this publication shall be destroyed.

3. Extracts from this publication may be made to facilitate the preparation of other Department of Defense Publications.

4. All Navy requests for NAVSHIPS Electronics publications should be directed to the nearest District Publications and Printing Office. When changes or revised books are distributed, notice will be included in the Bureau of Ships Journal and in the Index of Bureau of Ships General and Electronics Publications, NAVSHIPS 250-020.

H. N. WALLIN
Chief of Bureau

RECORD OF CORRECTIONS MADE

CHANGE NO.	DATE	SIGNATURE OF OFFICER MAKING CORRECTION

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CONTRACTUAL GUARANTEE

The Contractor guarantees that at the time of delivery thereof the articles provided for under this contract will be free from any defects in material or workmanship and will conform to the requirements of this contract. Notice of any such defect or nonconformance shall be given by the Government to the Contractor within one year of the delivery of the defective or nonconforming article, unless a different period of Guaranty is specified in the schedule. If required by the Government within a reasonable time after such notice, the Contractor shall, with all possible speed, correct or replace the defective or nonconforming article or part thereof. When such correction or replacement requires transportation of the article or part thereof, shipping costs, not exceeding the usual charges, from the delivery point to the Contractor's plant and return, shall be borne by the Contractor; the Government shall bear all other shipping costs. This Guaranty shall then continue as to corrected or replacing articles or, if only parts of such articles are corrected or replaced, to such corrected or replacing parts, until one year after the date of redelivery, unless a different period of Guaranty is specified in the schedule. If the Government does not require a correction or replacement of a defective or nonconforming article, the Contractor, if required by the contracting officer, within a reasonable time after the notice of defect or nonconformance, shall repay such portion of the contract price of the article as is equitable in the circumstances.

INSTALLATION RECORD

Contract Number NObsr-52654	Date of Contract 25 June 1951
Contract Number NObsr-57541	Date of Contract 27 June 1952
Serial Number of Equipment	
Date of Acceptance by the Navy	
Date of Delivery to Contract Destination	
Date of Completion of Installation	
Date Placed in Service	

Blank spaces in this table shall be filled in at time of installation

REPORT OF FAILURE

Report of failure of any part of this equipment, during its entire service life, shall be made to the Bureau of Ships in accordance with current regulations, using form NAVSHIPS NBS 383 (revised). The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 67 of the BUREAU OF SHIPS MANUAL or superseding instructions.

ORDERING PARTS

All requests or requisitions for replacement material should include the following data:

1. Standard Navy stock number or, when ordering from a Marine Corps or Signal Corps supply depot, the Signal Corps stock number.
2. Name and short description of part.

If the appropriate stock number is not available, the following shall be specified:

1. Equipment model or type designation, circuit symbol, and item number.
2. Name of part and complete description
3. Manufacturer's designation.
4. Contractor's drawing and part number
5. JAN or Navy type number.

SAFETY NOTICE

The attention of officers and operating personnel is directed to Chapter 67 of the BUREAU OF SHIPS MANUAL or superseding instructions on the subject of radio-safety precautions to be observed.

The use of this equipment involves voltages which are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working on equipment employing high voltages.

While every practicable safety precaution has been incorporated in ship and shore electronic equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustment inside equipment with high voltage supply on. Under certain conditions, dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties, always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE.

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence of assistance or another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS.

Do not depend upon door switches or interlocks for protection, but always shut down motor generators or other power equipment. Under no circumstances should any access door, gate, or safety interlock switch be removed, short-circuited, or tampered with in any way, by other than authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

RESUSCITATION

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR, OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.

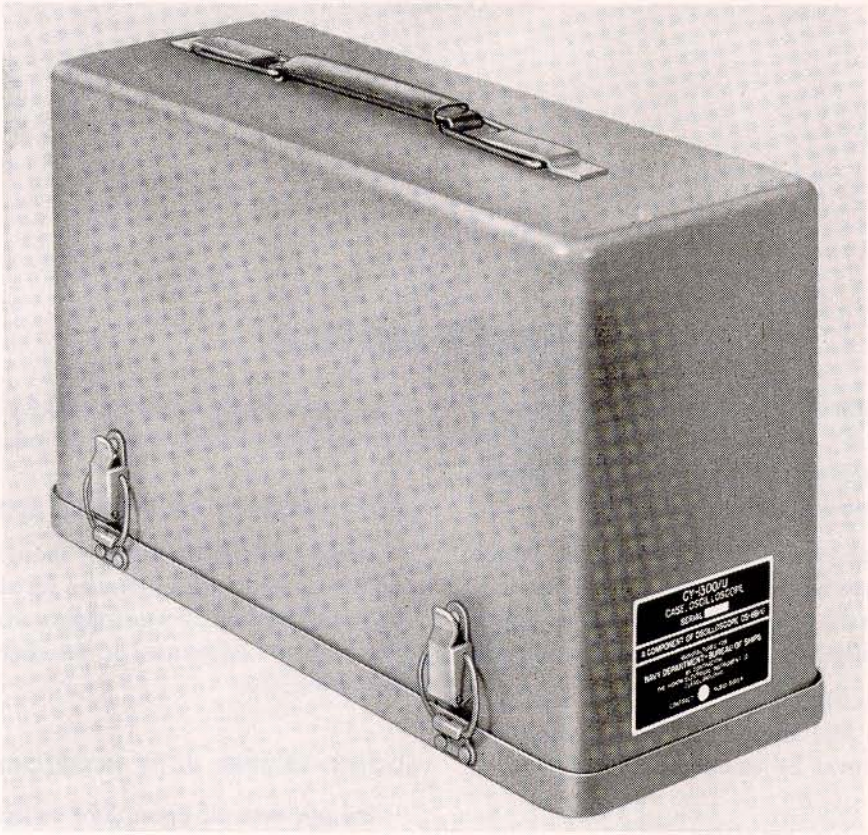


Figure 1-1. Oscilloscope OS-8B/U with Cover in Place

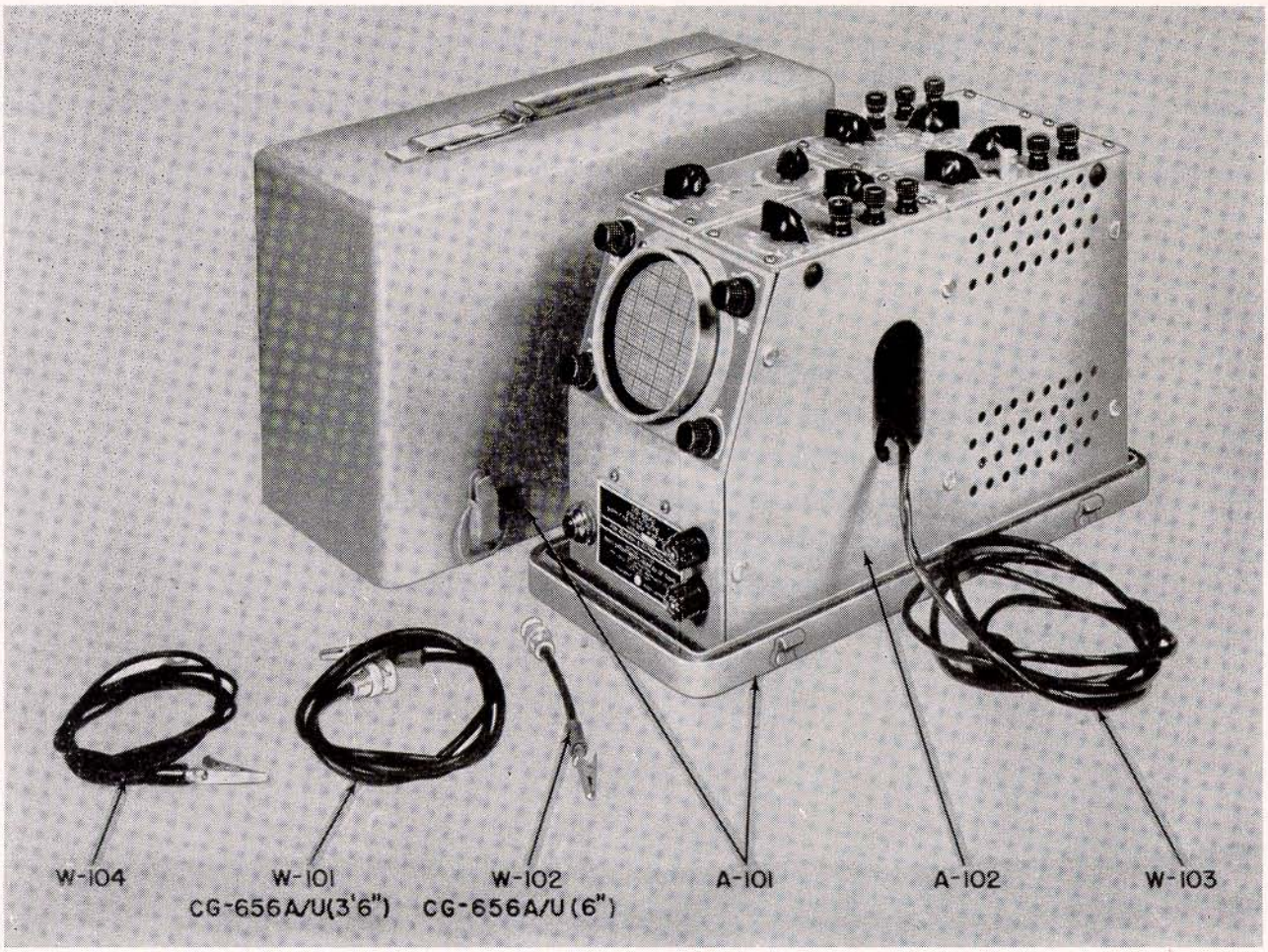


Figure 1-2. Oscilloscope OS-8B/U and Accessories, Cover Removed

SECTION 1
GENERAL DESCRIPTION

1. PURPOSE.

This instruction book describes Oscilloscope OS-8B/U and includes information concerning the operation and maintenance of the equipment.

2. BRIEF DESCRIPTION.

a. GENERAL.—This oscilloscope operates from 115 volts ±10%, 50-1000 cycles a-c, and is designed to be used as a visual testing instrument in all instances where such apparatus can be used to service electronic equipment. It has been designed to be as small and light in weight as possible, consistent with its ability to perform the functions required of it. Some of the characteristics of this oscilloscope which make it a useful instrument are: vertical a-c amplifier operating over a frequency range of 5 cycles to 2 megacycles per second, independent of gain control setting, with a sensitivity of .075 RMS volts per inch; vertical d-c amplifier operating over a frequency range of zero to 2 megacycles per second at full gain control setting; horizontal a-c amplifier operating over a frequency range of one cycle to 500,000 cycles per second, independent of gain control setting, with a sensitivity of .075 RMS volts per inch; horizontal d-c amplifier operating over a frequency range of zero to 500,000 cycles per second at full gain control setting; self-contained sweep circuit oscillator operating through a frequency range of 3 to 50,000 cycles per second with provisions for synchronizing of either positive or negative synchronizing voltages; provisions for beam blanking from either internal or external sources; direct access to both horizontal and vertical deflecting plates; shock mounted within a watertight carrying case; and of unitized construction throughout to allow for versatility and ease of servicing. In regard to this last characteristic, the oscilloscope is made up of seven major assemblies: vertical amplifier, horizontal amplifier, sweep circuit oscillator, sync. circuit, power supply, cathode ray tube assembly, and potentiometer assembly (comprised of vertical positioning, horizontal positioning, intensity and focus controls). Each of these assemblies is interchangeable from one oscilloscope to another, thus allowing for consolidation of working assemblies in case of emergency.

b. APPLICATION.—The portable construction of this oscilloscope makes it convenient to carry to any location where visual servicing is required. This oscilloscope is capable of any number of operations within its ratings, including alignment and testing of electronic and electrical equipment, hum measurements, frequency comparison, observance of complex waveforms, percentage modulation measurements, etc. Operators should familiarize themselves with each control by obtaining a pattern and then rotating the control and noting the effect, except for intensity which should not be allowed to be of extreme brilliance.

3. REFERENCE DATA.

a. Nomenclature: Oscilloscope OS-8B/U, for general electronics use.

b. Contract Number: NObsr-52654. Date: 25 June 1951, Contract Number: NObsr-57541. Date: 27 June 1952.

c. Contractor: The Hickok Electrical Instrument Co.

d. Cognizant Naval Inspector: Inspector of Naval Material, Cleveland, Ohio.

e. Number of Packages Involved per Complete Shipment of Equipment: One.

f. Total Cubical Content: Crated: 3,335 cu. in. Uncrated: 730 cu. in.

g. Total Weight: Crated: 34 lbs. Uncrated: 14½ lbs.

h. Frequency Range:
- (1) Vertical Amplifiers:
  - (a) 0-2,000,000 cycles at full gain control setting.
  - (b) 5-2,000,000 cycles, independent of gain control setting.
- (2) Horizontal Amplifiers:
  - (a) 0-500,000 cycles at full gain control setting.
  - (b) 1-500,000 cycles, independent of gain control setting.
- (3) Sweep Circuit Oscillator: 3 to 50,000 cycles.

i. Characteristics of Power Supply Required for Operation: 105-125 volts, 50-1000 cycles, a-c, single phase.

j. Input Impedance:
- (1) Vertical: AC—1.5 megohm shunted by 25 mmf. DC—2 megohms.
- (2) Horizontal: AC—1.5 megohm shunted by 25 mmf. DC—2 megohms
- (3) Vertical Direct: 9 megohms shunted by 11 mmf.
- (4) Horizontal Direct: 9 megohms shunted by 11 mmf.

k. Deflection Sensitivity:
- (1) Vertical: Amplifier—.075 RMS volts/inch. Direct—approximately 17 RMS volts/inch.
- (2) Horizontal: Amplifier—.075 RMS volts/inch. Direct—approximately 25 RMS volts/inch.

l. Power Consumption: 60 watts at 115 volts.

m. Overall Accuracies:
- (1) Vertical Amplifiers:
  - (a) ±3 DB from zero to 2,000,000 cycles at full gain control setting.
  - (b) ±3 DB from 5 to 2,000,000 cycles, independent of gain control setting.
- (2) Horizontal Amplifiers:
  - (a) ±3 DB from zero to 500,000 cycles at full gain control setting.
  - (b) ±3 DB from one to 500,000 cycles, independent of gain control setting.

4. EQUIPMENT DATA.

TABLE 1-1. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	NOMENCLATURE	OVERALL DIMENSIONS A—CRATED B—UNCRATED HEIGHT — WIDTH — DEPTH	VOLUME A—CRATED B—UNCRATED	WEIGHT A—CRATED B—UNCRATED
1	Oscilloscope	OS-8B/U	A: 20¼"x11⅛"x14¾" B: 9" x 6" x 13½"	A: 3.335 cu. in. B: 730 cu. in.	A: 34 lbs. B: 14½ lbs.
1	Case	CY-1300/U	9" x 6" x 13½"		
1	Test Lead	CG-656A/U	3' 0"		
1	Test Lead	CG-656A/U	6"		
1	Ground Lead	W-104	3' 0"		
1	Cathode Ray Tube Screen	O-104	2⅞" dia.		
1	Instruction Book	Navships 91707	9" x 11½"		

5. TUBE COMPLEMENT.

TABLE 1-2. TUBE COMPLEMENT

TUBE	TYPE	FUNCTION
V101A-V101B	12AT7	Vert. Cathode Follower—Sync. Amplifier
V102A-V102B	12AT7	1st Vert. DC Amplifier
V103	6AH6	2nd Vert. DC Amplifier
V104	6AH6	2nd Vert. DC Amplifier
V105A-V105B	12AT7	Horiz. Cathode Follower—Intensity Modulation Amp.
V106A-V106B	12AT7	1st Horiz. DC Amplifier
V107A-V107B	6J6	2nd Horiz. DC Amplifier
V108A-V108B	6J6	Sweep Circuit Oscillator
V109	3RP1	Cathode Ray Tube
V110	6X4	Intermediate Voltage Rectifier
CR101	Selenium	Low Voltage Rectifier
CR102	Selenium	Low Voltage Rectifier
CR103	Selenium	High Voltage Rectifier

SECTION 2
THEORY OF OPERATION

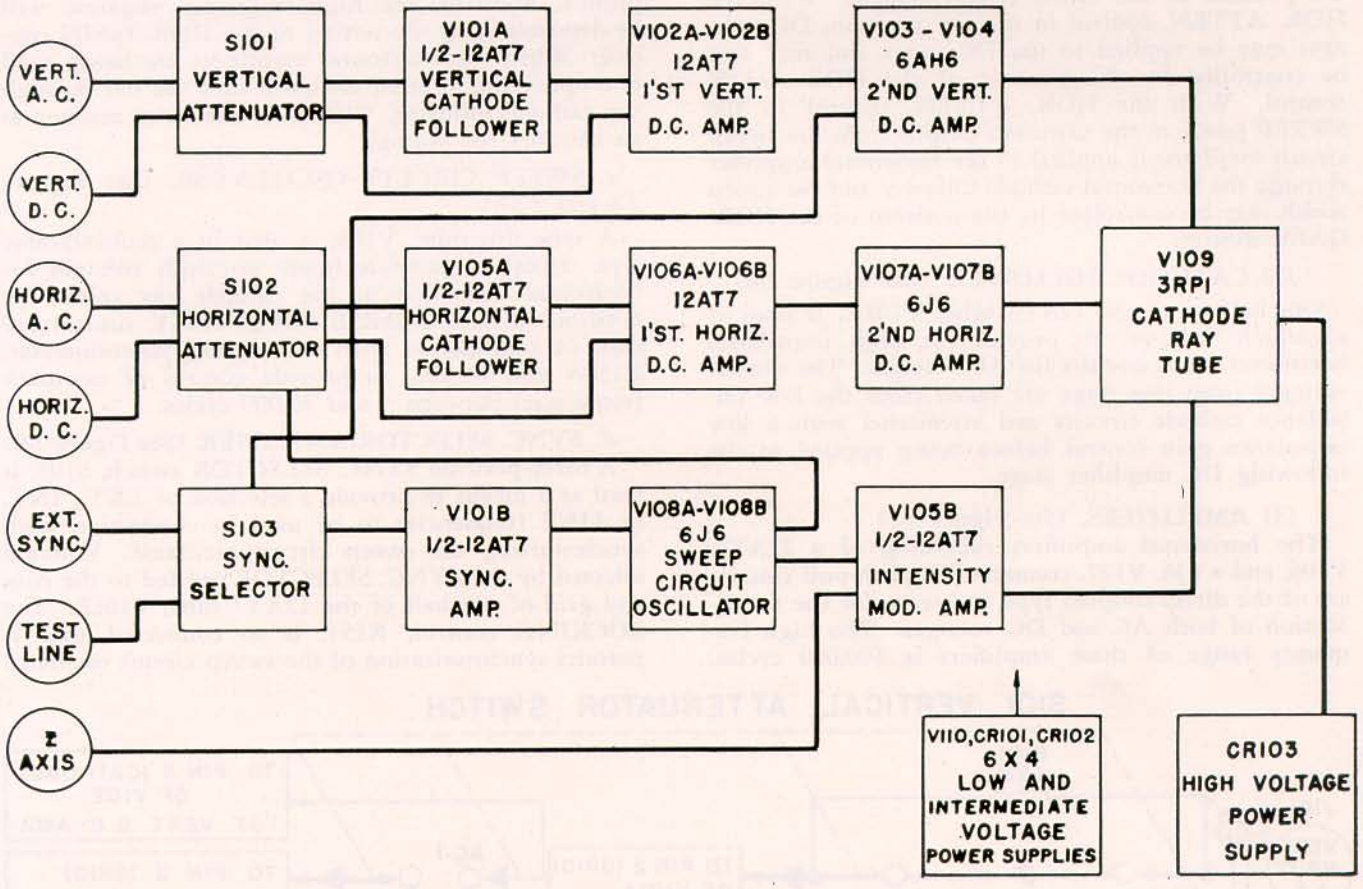


Figure 2-1. Basic Diagram of Operation, Block Form

1. GENERAL.

During the following discussion, reference to the block diagram of the oscilloscope, Figure 2-1, and the schematic wiring diagram, Figure 6-11, will facilitate the understanding of the basic operation of the circuits used in this equipment.

a. VERTICAL.

(1) VERT. ATTEN. AND VERT. GAIN. (See Figure 2-2)

AC voltages applied to the vertical AC input may be attenuated by a factor of 1, 10 or 100 by means of the VERT. ATTEN. control and further controlled by the position of the VERT. GAIN control. With the VERT. ATTEN. in the DC position, DC voltages may be applied to the DC input and may also be controlled by the position of the VERT. GAIN control.

(2) CATHODE FOLLOWER. (See Figure 2-3)

One-half of a type 12AT7 tube, V101A, is used as a cathode follower to provide for high impedance vertical input circuits for AC voltages. The output voltages from this stage are taken from the low impedance cathode circuits and attenuated with a low impedance gain control before being applied to the following DC amplifier stage.

(3) AMPLIFIERS. (See Figure 2-4)

The vertical amplifiers consisting of one 12AT7, V102, and two 6AH6's, V103 and V104, connected in push-pull cascade are of the direct-coupled type and serve for amplification of both AC and DC voltages. The high frequency range of these amplifiers is 2 mc. When amplifying AC voltages, the input is condenser-coupled from the cathode follower, V101A, and gives a low frequency response of 5 cycles. When serving as DC amplifiers, the input is taken directly from the VERT. GAIN control. AC voltages may be applied to the DC input for amplification by the vertical amplifiers; however, the high frequency response will be determined by the setting of the VERT. GAIN control.

b. HORIZONTAL.

(1) HOR. ATTEN. and HOR. GAIN. (See Figure 2-5)

AC voltages applied to the horizontal AC input may be attenuated by a factor of 1, 10 or 100 by means of the HOR. ATTEN. control and further controlled by the position of the HOR. GAIN control. With the HOR. ATTEN. control in the DC position, DC voltages may be applied to the DC input and may also be controlled by the position of the HOR. GAIN control. With the HOR. ATTEN. control in the SWEEP position, the sawtooth output from the sweep circuit oscillator is applied to the horizontal amplifier through the horizontal cathode follower and the sweep width may be controlled by the position of the HOR. GAIN control.

(2) CATHODE FOLLOWER. (See Figure 2-6)

One-half of a type 12AT7 tube, V105A, is used as a cathode follower to provide for high impedance horizontal input circuits for AC voltages. The output voltages from this stage are taken from the low impedance cathode circuits and attenuated with a low impedance gain control before being applied to the following DC amplifier stage.

(3) AMPLIFIERS. (See Figure 2-7)

The horizontal amplifiers consisting of a 12AT7, V106, and a 6J6, V107, connected in push-pull cascade are of the direct-coupled type and serve for the amplification of both AC and DC voltages. The high frequency range of these amplifiers is 500,000 cycles. When amplifying AC voltages, the input is condenser-coupled from the cathode follower, V105A, and gives a low frequency response of one cycle. When serving as DC amplifiers, the input is taken directly from the HOR. GAIN control. AC voltages may be applied to the DC input for amplification by the horizontal amplifiers; however, the high frequency response will be determined by the setting of the HOR. GAIN control. When the horizontal amplifiers are being used to amplify the internal sawtooth they are fed through the cathode follower, V105A, in the same manner as an external AC voltage.

c. SWEEP CIRCUIT OSCILLATOR. (See Figures 2-8 and 2-8A)

A type 6J6 tube, V108, is used in a multivibrator type circuit to generate linear sawtooth voltages for horizontal deflection of the cathode ray tube. Six positions of the COARSE FREQUENCY control are used in conjunction with a two-gang potentiometer, R158A and R158B, to provide control of sawtooth frequencies between 3 and 50,000 cycles.

d. SYNC. SELECTOR-AMPLIFIER. (See Figure 2-9)

A three-position SYNC. SELECTOR switch, S103, is used as a means to provide a selection of EXT., INT. or LINE frequencies to be used in connection with synchronizing the sweep circuit oscillator. Voltages selected by the SYNC. SELECTOR are fed to the control grid of one-half of the 12AT7 tube, V101B. The LOCKING control, R154, is so connected that it permits synchronization of the sweep circuit oscillator

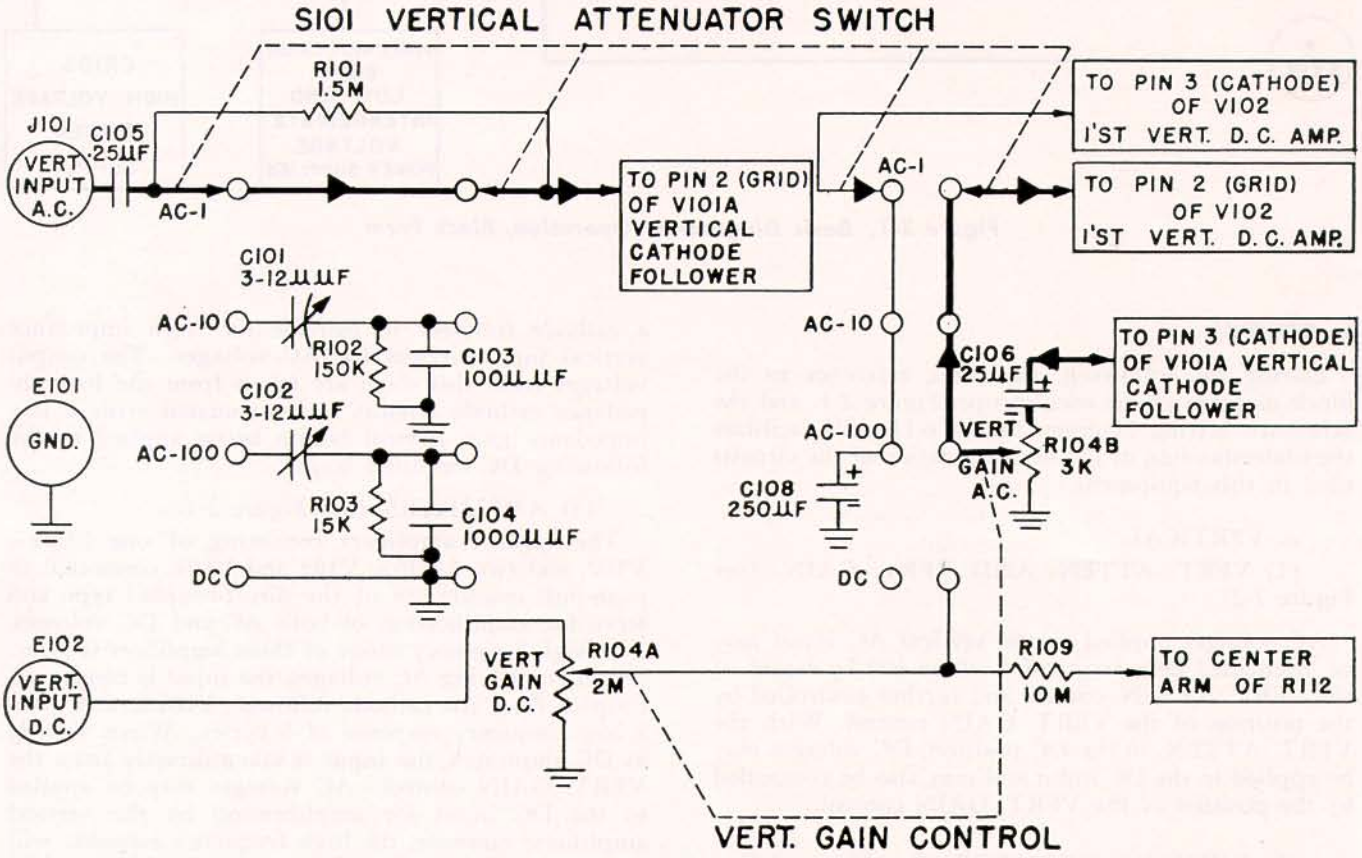


Figure 2-2. Vertical Input Attenuator

on either positive or negative peaks of the selected synchronizing voltage.

e. INTENSITY MODULATION AMPLIFIER. (See Figure 2-10)

One-half of a type 12AT7 tube, V105B, is used as an amplifier whereby external or internal voltages may be amplified to provide for intensity modulation of the beam of the cathode ray tube. By connecting a jumper between BLANKING terminals on terminal board E110, pulses from the sweep circuit oscillator may be used to blank out the return trace when using horizontal sweep.

f. CATHODE RAY TUBE. (See Figure 2-11)

A type 3RP1 electrostatic deflection cathode ray tube, V109, is used as the indicating medium. Deflection voltages for this tube may be applied from internal circuits, or by rearranging the jumpers on terminal board E110 external voltages may be directly applied for deflection.

g. POWER SUPPLY. (See Figure 2-12)

A type 6X4 tube, V110, is connected as a full-wave rectifier and supplies DC voltages for operation of the cathode followers, final amplifier stages and sweep circuit oscillator. A pair of selenium rectifiers, CR101 and CR102, are connected as a full-wave rectifier and supply low DC voltages for the operation of all the other circuits except the cathode ray tube. A selenium rectifier, CR103, is connected as a half-wave rectifier to supply the high voltage for the cathode ray tube. Suitable other windings are on the power transformer, T101, to supply the heater voltages for all tubes in the instrument. The transformer is fused by means of fuses F101 and F102 located on the front panel.

2. CIRCUIT ANALYSIS.

a. VERTICAL.

(1) VERTICAL INPUT ATTENUATOR.

An AC voltage impressed between the vertical input (AC) and GND is applied through capacitor C105 to the three-stage vertical attenuator network. This network consists of resistors R102 and R103 shunted by C103 and C104 respectively, and resistor R101 shunted by C101 or C102 depending upon the position of the attenuator switch S101. The network is so designed that it is non-frequency discriminating up to square wave frequencies of 100 kc. On position "1" the voltage impressed is applied to grid pin 2 of the vertical cathode follower, V101A. On position "10" this voltage is reduced by a factor of ten, and on position "100" the voltage is reduced by a factor of 100. When the VERT. ATTEN., S101, is operated to the "DC" position and a DC or AC voltage is impressed between vertical input (DC) and GND, the voltage is controlled by potentiometer R104A, the DC VERT. GAIN control, and applied to grid pin 2 of the first vertical DC amplifier, V102A.

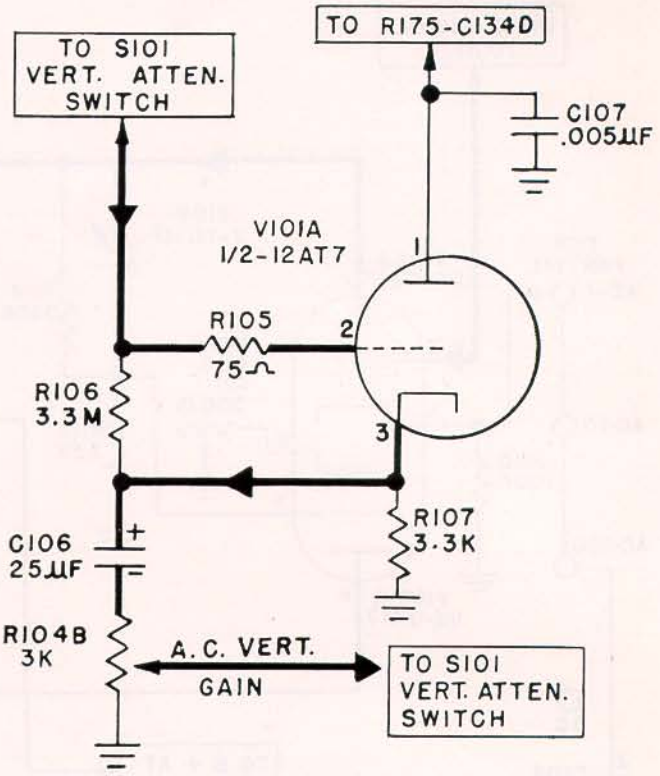


Figure 2-3. Vertical Cathode Follower

(2) CATHODE FOLLOWER.

One-half of a 12AT7 tube, V101A, is connected in a conventional cathode follower circuit with plate bypassed to ground by C134D and C107. Any voltage applied to the grid will, in the same phase, at a slightly lower potential, appear between the cathode and ground. Between the cathode and ground is a network composed of bias resistor R107, paralleled by C106 and AC VERT. GAIN control R104B in series. By virtue of the fact that R104B and C106 are of low impedance, the circuit capacities will be negligible and frequencies of 5 cycles to 2 mc may be controlled by R104B without frequency discrimination. The output voltage from R104B is taken through the VERT. ATTEN. switch, S101, and applied to the grid, pin 2 of the first vertical DC amplifier, V102A.

(3) VERTICAL AMPLIFIERS.

The vertical amplifiers are of the direct-coupled push-pull type. This allows the amplification of DC as well as AC voltages. The fact that the amplifiers are push-pull affords excellent stability with line voltage variations.

When amplifying AC voltages, the signal is applied to grid pin 2 of V102A from the center arm of the low impedance gain control, R104B, through switch S101. The resistance of R104B is low enough so as to afford no frequency discrimination and therefore the position of the gain control has no effect on the band width when in the "A.C." attenuator positions. When amplifying DC voltages, the signal is applied

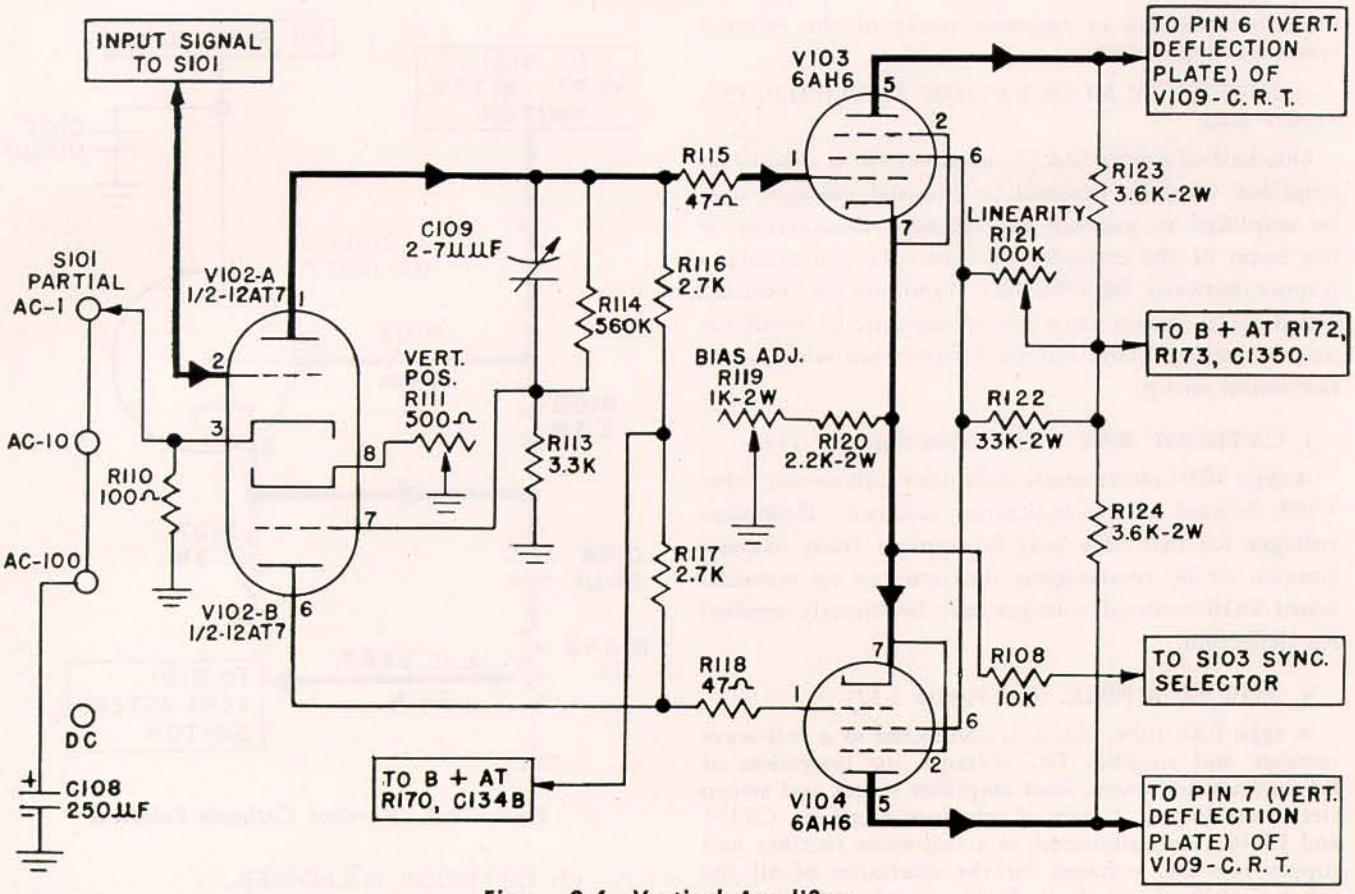


Figure 2-4. Vertical Amplifiers

to grid pin 2 of V102A from the center arm of the high impedance gain control, R104A, through switch S101. The resistance of R104A is high and therefore when the attenuator is in the "D.C." position the gain control acts as a frequency sensitive voltage divider varying the band width as in Table 2-1. When the

TABLE 2-1. Effect of Vertical Gain Control Setting on Bandwidth for Vertical "D.C." Input.

Gain Control Setting	Approximate Band Width
100	2,000,000 cps
75	300,000 cps
50	2,000,000 cps
25	3,000,000 cps

VERT. ATTEN., S101, is on the "DC" position, there is a slight negative contact potential developed on grid pin 2 because of the high impedance in that circuit. This voltage is cancelled out by a B+ voltage applied through R109. The bias for V102A is supplied by cathode resistor R110. When amplifying AC voltages the cathode is bypassed through C108 to eliminate degeneration; however, when amplifying DC voltages this cathode is left unbypassed to eliminate low frequency discrimination. The B+ voltage is supplied to the plate of this amplifier through plate load resistor R116 which is balanced with plate load resistor R117 of the other portion (V102B) of the first push-pull amplifier. Grid pin 7 of V102B is held at a low impedance to ground through R113. This grid carries no signal except at high frequencies as will be explained later. The bias for V102B is supplied by the cathode resistance of the VERT. POS. control, R111.

The output from this first push-pull amplifier is applied between the grids, pins 1 of V103 and V104, which comprise the second push-pull amplifier, through resistors R115 and R118. These resistors act to suppress any tendency for spurious oscillation. The cathodes of V103 and V104 are tied together and biased to ground through resistor R120 and BIAS ADJUST, R119. Since the grids of V103 and V104 are approximately 80 volts above ground, because of the direct connection from the previous stage, the cathode must develop a voltage slightly higher than this to supply sufficient operating bias. The B+ voltage is supplied to the plates, pins 5 of V103 and V104, through plate load resistors R123 and R124. The screen grids, pins 6 of V103 and V104, are tied together and supplied with voltage through a common screen dropping resistor, R122, shunted by LINEARITY control, R121. Since these tubes are operating in push-pull, there is no need for bypass on these screens. The suppressor grids, pins 2 of V103 and V104, are tied to the cathode as in normal pentode connection when the cathode is operated above ground. The signal is directly coupled from the plates, pin 5, of the final push-pull amplifier stage, to the deflection plates of the cathode ray tube through terminal board E110.

Since the circuit is designed in push-pull, any B+ variation caused by fluctuating line voltages has essentially no effect on the centering of the beam of

the cathode ray tube, as a voltage change on one plate is accompanied by an equal voltage change on the other plate. The path of the signal is through one side of the first push-pull amplifier, V102A, and on to the grid, pin 1, of V103. It is then transferred to V104 through the common cathode resistance R120 and BIAS ADJUST R119 in series. The action is as follows. As a positive signal appears on grid pin 1 of V103 this tube draws more current. As the current increases the voltage at cathode pin 7 will rise. This rise is carried to cathode pin 7 of V104 by virtue of the common cathode connection. Since grid pin 1 of V104 is at a stationary potential as far as the signal is concerned, the rising cathode voltage causes this tube to draw less current, accomplishing a push-pull double-ended output between the plates, pins 5, of V103 and V104.

At high frequencies a portion of the signal on the plate of V102A is fed to grid pin 7 of V102B through trimmer condenser C109. This high frequency signal is transferred from the plate of V102B to the grid of V104 and boosts the high frequency output. Trimmer condenser C109 is adjusted to give the amplifier sufficiently high frequency response. Resistors R114 and R113 together form a voltage dividing network that balances both triodes of V102 for proper vertical centering. BIAS ADJUST R119 is provided so that tolerances in resistors and electron tubes may be accounted for in providing the proper bias on the final stage. A LINEARITY adjustment, R121, is incorporated in the circuit to adjust the voltage on the screens of the final push-pull stage (V103 and V104) in order to accomplish maximum linearity with changes in tubes. Normally, these controls will not have to be adjusted unless tubes V102, V103 and V104 are changed, in which case the adjustments will be minor.

b. HORIZONTAL.

(1) HORIZONTAL INPUT ATTENUATOR.

An AC voltage impressed between the horizontal input (AC) and GND is applied through capacitor C110 to the three-stage horizontal attenuator network. This network consists of resistors R126 and R127 shunted by C114 and C115 respectively, and resistor R128 shunted by C111 or C112 depending upon the position of the attenuator switch S102. The network is so designed that it is non-frequency discriminating up to the square wave frequency of 25 kc. On position "1" the voltage impressed is applied directly to grid pin 2 of the horizontal cathode follower, V105A. On position "10" this voltage is reduced by a factor of ten, and on position "100" the voltage is reduced by a factor of 100. When the HOR. ATTEN., S102, is operated to the "DC" position and a DC or AC voltage is impressed between the horizontal input (DC) and GND, the voltage is controlled by potentiometer R129A, the DC HOR. GAIN control, and applied to grid pin 2 of the first horizontal DC amplifier, V106A. When the HOR. ATTEN., S102, is operated to the "SWEEP" position the internal sawtooth voltage is fed to grid pin 2 of the horizontal cathode follower, V105A, shunted by the resistor-capacitor combination R125 and C113.

(2) HORIZONTAL CATHODE FOLLOWER.

One-half of a 12AT7 tube, V105A, is connected in the conventional cathode follower circuit with plate

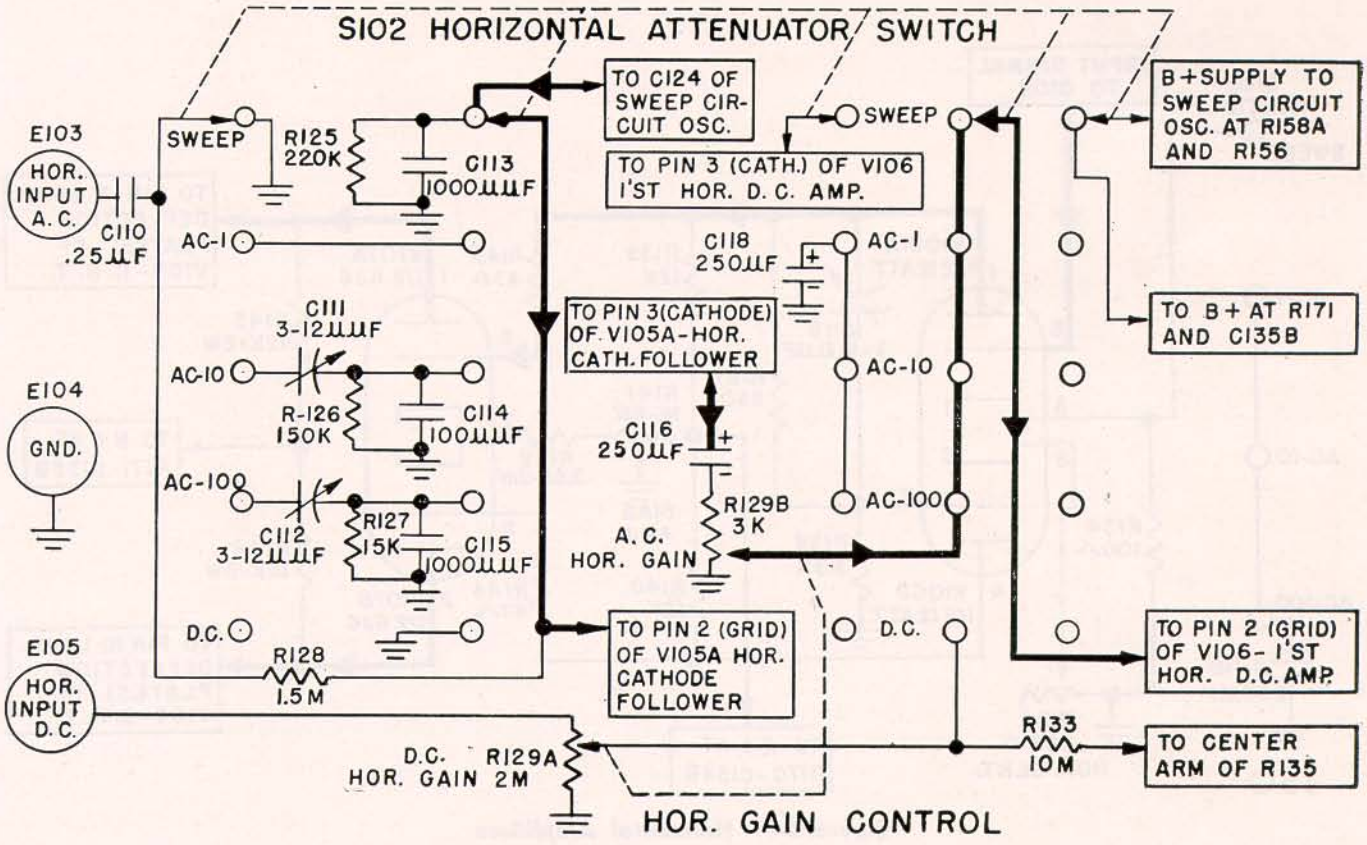


Figure 2-5. Horizontal Input Attenuator

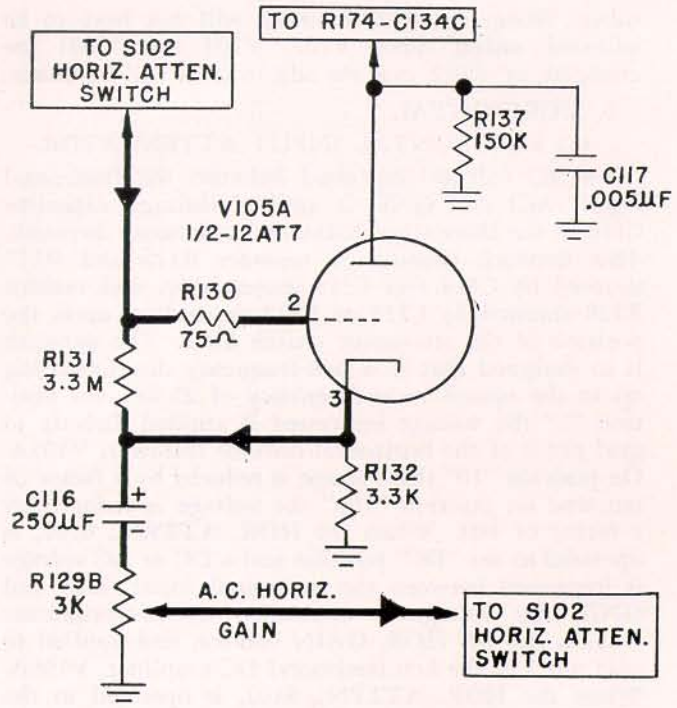


Figure 2-6. Horizontal Cathode Follower

bypassed to ground by C134C and C117. Any voltage applied to the grid will, in the same phase, at a slightly lower potential, appear between the cathode and ground. Between the cathode and ground is a network composed of bias resistor R132, paralleled by C116, and the AC HOR. GAIN control, R129B, in series. By virtue of the fact that R129B and C116 are of low impedance, the circuit capacities will be negligible and frequencies of one cycle to 500 kc may be controlled by R129B without frequency discrimination. The output voltage of R129B is taken through the HOR. ATTEN., S102, and applied to grid pin 2 of the first horizontal DC amplifier, V106A.

(3) HORIZONTAL AMPLIFIERS.

The horizontal amplifiers are of the direct-coupled push-pull type. This allows the amplification of DC as well as AC voltages. The fact that the amplifiers are push-pull affords excellent stability with line voltage variations. When amplifying AC voltages or the internal sawtooth, the signal is applied to grid pin 2 of V106A from the center arm of the low impedance gain control, R129B, through switch S102. When amplifying DC voltages, the signal is applied to grid pin 2 of V106A from the center arm of the high impedance gain control, R129A, through S102. When HOR. ATTEN., S102, is on the "DC" position, there is a slight negative contact potential developed on grid pin 2 of V106A because of the high impedance in that circuit. This voltage is cancelled out by a B+ voltage through R133. The bias for V106A is supplied by cathode resistor R134. When amplifying AC voltages the cathode is bypassed through C118 to eliminate degeneration; however, when amplifying DC voltages this cathode is left unbypassed to eliminate low frequency discrimination. The B+ voltage is supplied to the plate of this amplifier through plate load resistor R139 which is balanced with plate load resistor

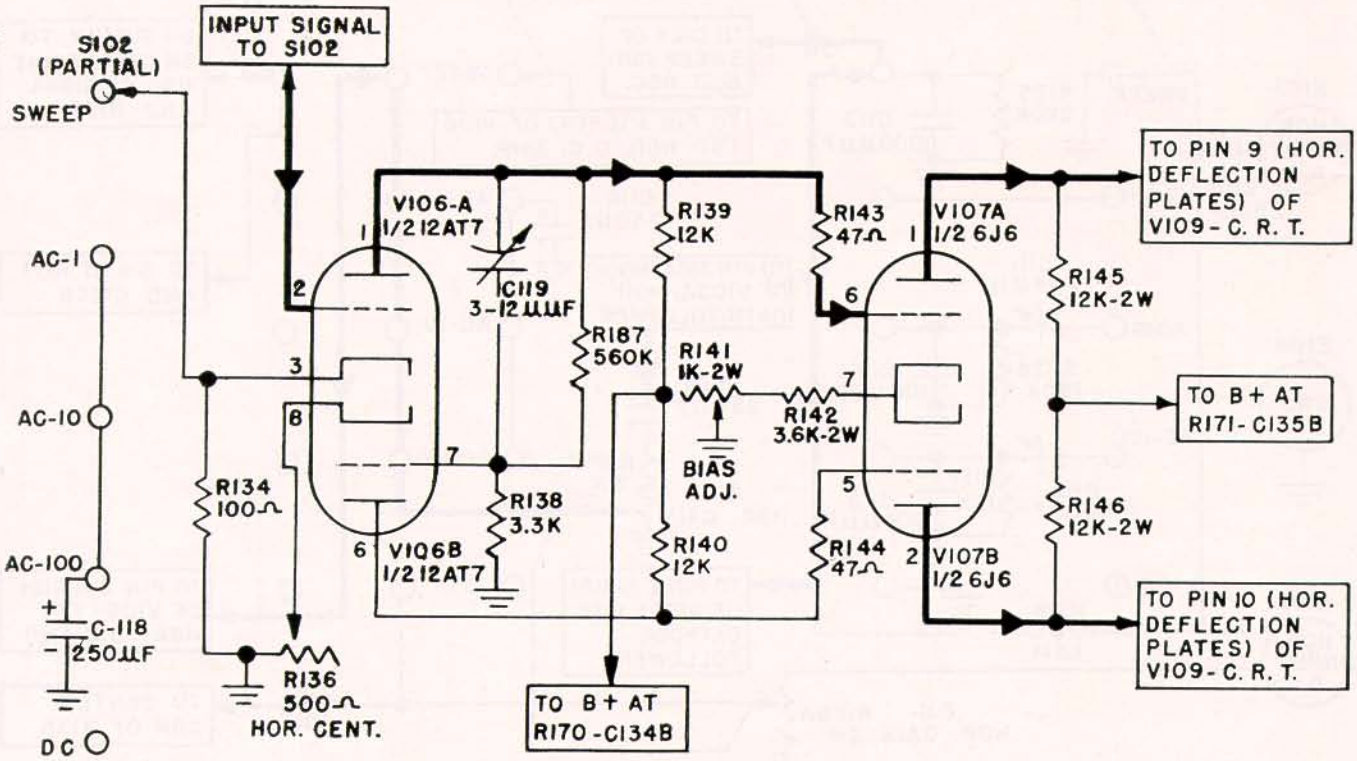


Figure 2-7. Horizontal Amplifiers

R140 of the other portion (V106B) of the first push-pull amplifier. Grid pin 7 of V106B is held at a low impedance to ground through R138. This grid carries no signal except at high frequencies as will be explained later. The bias for V106B is supplied by the cathode resistance of the HOR. POS. control, R136.

The output from this first push-pull amplifier is applied between the grids, pins 5 and 6 of V107, which comprises the second push-pull amplifier, through resistors R143 and R144. These resistors act to suppress any tendency for spurious oscillation. The cathode of V107 is biased to ground through resistor R142 and BIAS ADJUST, R141. Since the grids of V107 are approximately 60 volts above ground, because of the direct connection from the previous stage, the cathode must develop a voltage slightly higher than this to supply sufficient operating bias. The B+ voltage is supplied to the plates, pins 1 and 2 of V107, through plate load resistors R145 and R146. The signal is directly coupled from these to the deflection plates of the cathode ray tube through terminal board E110.

Since the circuit is designed in push-pull, any B+ variation caused by fluctuating line voltage has essentially no effect on the center of the beam of the cathode ray tube, as a voltage change on one plate is accompanied by an equal voltage change on the other plate. The path of the signal is through one side of the first push-pull amplifier, V106A, and on to the grid, pin 6 of V107A. It is then transferred to V107B through the common cathode resistance R142 and BIAS ADJUST R141 in series. The action is as follows: As a positive signal appears on grid pin 6 of V107A this tube draws more current. As the current increases the voltage at cathode pin 7 will rise. Since grid pin 5 of V107B is at a stationary potential as far as the signal is concerned, the rising cathode voltage causes V17B to draw less current, accomplishing a push-pull double-ended output between the plates, pins 1 and 2, of V107.

At high frequencies a portion of the signal on the plate of V106A is fed to grid pin 7 of V106B through trimmer condenser C119. This high frequency signal is transferred from the plate of V106B to the grid of V107B and boosts the high frequency output. Trimmer condenser C119 is adjusted to give the amplifier sufficiently high frequency response. Resistors R187 and R138 together form a voltage dividing network that balances both triodes of V102 for proper horizon-

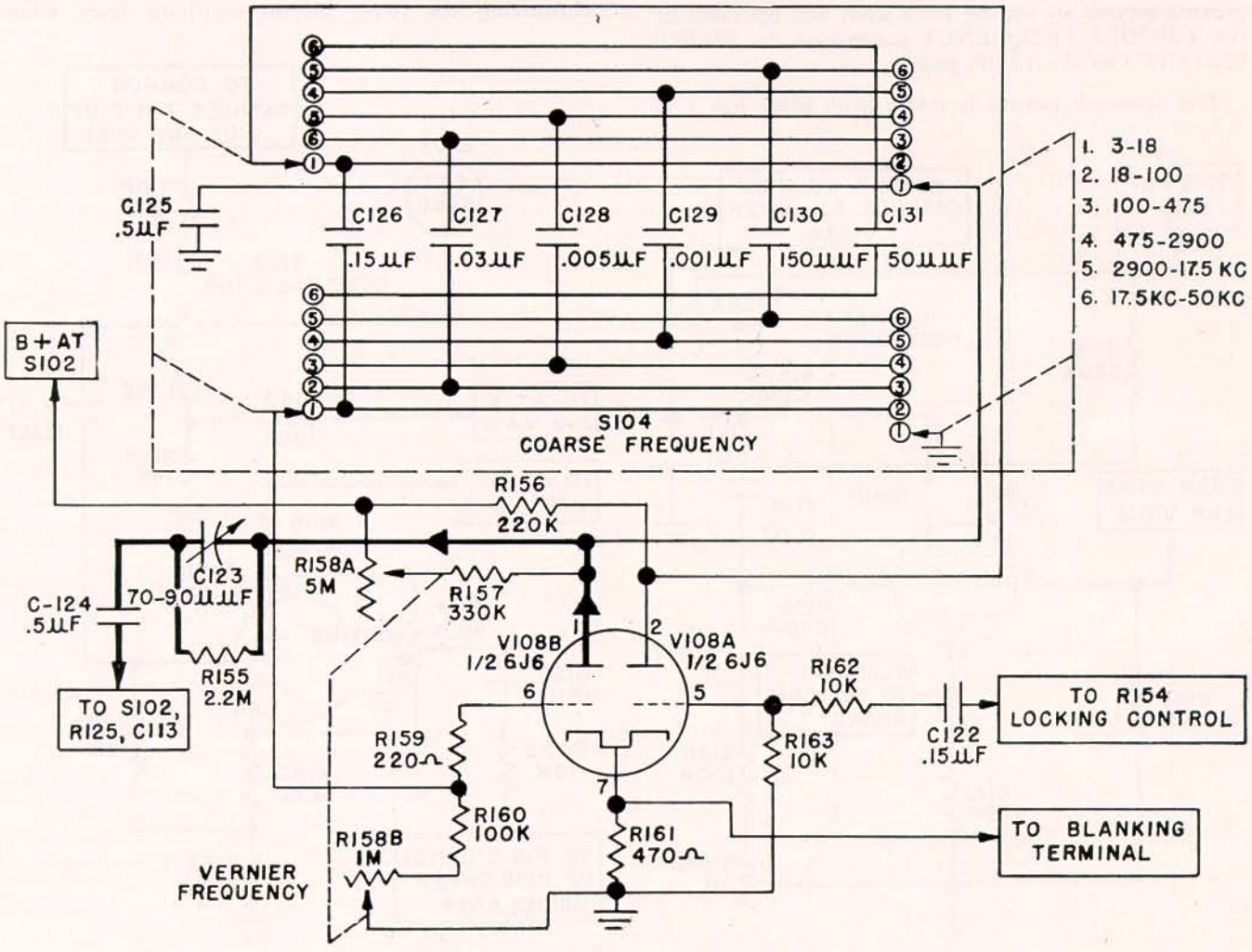


Figure 2-8. Sweep Circuit Oscillator

tal centering. BIAS ADJUST R141 is provided so that tolerances in resistors and electron tubes may be accounted for in providing the proper bias on the final stage. Normally, these controls will not have to be adjusted unless tubes V106 and V107 are changed, in which case the adjustments will be minor.

c. SWEEP CIRCUIT OSCILLATOR.

A cathode coupled multivibrator circuit utilizing a type 6J6 tube, V108, is used as the horizontal sawtooth oscillator and operated over a frequency range from 3 to 50,000 cycles per second. This range of frequencies is controlled by the COARSE FREQUENCY switch, S104, utilizing capacitors C125 through C131. These capacitors act alternately and respectively as sawtooth generating capacitors for the second triode section, V108B, and as coupling capacitors for the first triode section, V108A, to the second triode section of the multivibrator. In the position shown in Figure 2-8, C125 is used as a sawtooth capacitor while C126 is the coupling capacitor.

Fine frequency control is accomplished by means of the dual VERNIER FREQUENCY potentiometer, R158A and R158B, in the plate circuit and in the grid of the second triode section of the multivibrator. Both potentiometers are on the same shaft and operated by the VERNIER FREQUENCY control on the SWEEP CIRCUIT OSCILLATOR panel.

The sawtooth output is taken from plate pin 1 of V108B through the frequency compensated voltage divider consisting of R155 shunted by C123 (Fig. 2-8) and R125 shunted by C113 (Fig. 2-5), and decoupled by capacitor C124. This sawtooth signal is applied to the horizontal cathode follower through HOR. ATTEN. S102 when set to the "SWEEP" position. The high frequency linearity of the sawtooth may be adjusted with capacitor C123 in the frequency compensated dividing network.

Bias for the multivibrator is supplied by cathode resistor R161. The wave form at the cathode consists of sharp pulses of the exact width of the retrace time and in the proper phase. These pulses may be jumpered at terminal board E110 to the input of the intensity modulation amplifier and thus provide return trace elimination when using the sweep circuit oscillator. The synchronizing signal from the LOCKING control, R154, is applied to grid pin 5 of V108A through isolation resistor R162. This causes the frequency of the multivibrator to lock in at the frequency of the synchronizing signal or some submultiple thereof.

d. SYNC. SELECTOR—AMPLIFIER.

The purpose of the SYNC. SELECTOR switch, S103, and amplifier is to provide a means of synchronizing the sweep circuit oscillator from either

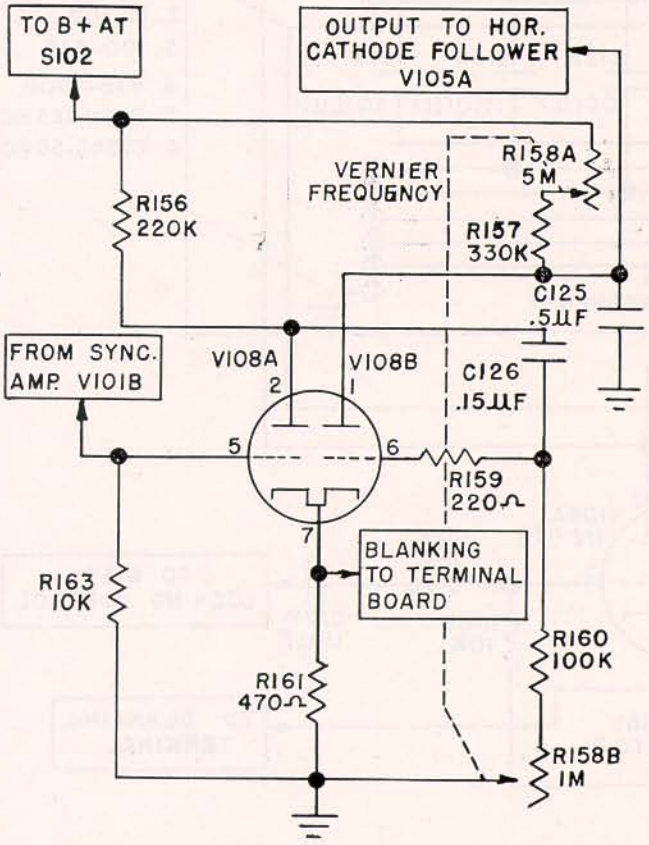


Figure 2-8A. Sweep Circuit Oscillator, Simplified

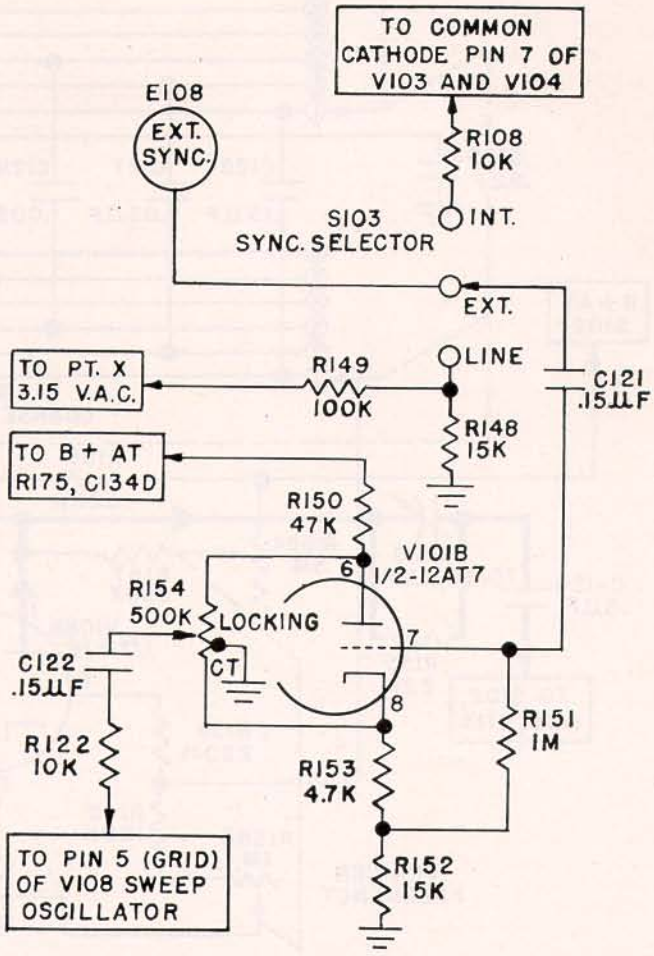


Figure 2-9. Sync. Selector—Amplifier

EXT., INT. or LINE frequency voltages and to permit the synchronization of the sweep circuit oscillator from either positive or negative peaks of the applied synchronizing voltage. The output from the SYNC. SELECTOR is fed through capacitor C121 to grid pin 7 of V101B and selects either:

(1) line frequency voltage supplied from the filament winding through a voltage divider consisting of R149 and R148,

(2) external frequency voltage applied to binding post E108, or

(3) internal frequency voltage supplied from the low impedance cathode of the 2nd vertical d-c amplifier (V103 and V104), through decoupling resistor, R108. The grid of the sync. amplifier, V101B, is returned to the junction of R153 and R152 through resistor R151 to provide sufficient bias for operation of the amplifier.

An analysis of the circuits between the plate of V101A and ground will show that with a signal applied to the control grid, the high end of the LOCKING control, R154, will be electrically receiving signals developed at the plate of this tube; and the low end of the LOCKING control will be receiving signals from the cathode. When this control is at approximately the center of its rotation there is no signal since the center of the control is grounded. If this control is operated toward the plate side of R154 a locking voltage would be obtained which would be out of phase with the signal applied to the grid and consequently, tend to lock the sweep circuit oscillator at a polarity with respect to the negative peaks of the synchronizing signal. If the LOCKING control is advanced toward the cathode side of R154 the locking voltage applied to the sweep circuit oscillator would be in positive phase relation to the synchronizing signal. As a result of this circuit, the sweep circuit oscillator may be locked in with respect to incomings ynchronizing signals, either in phase or out of phase with these voltages.

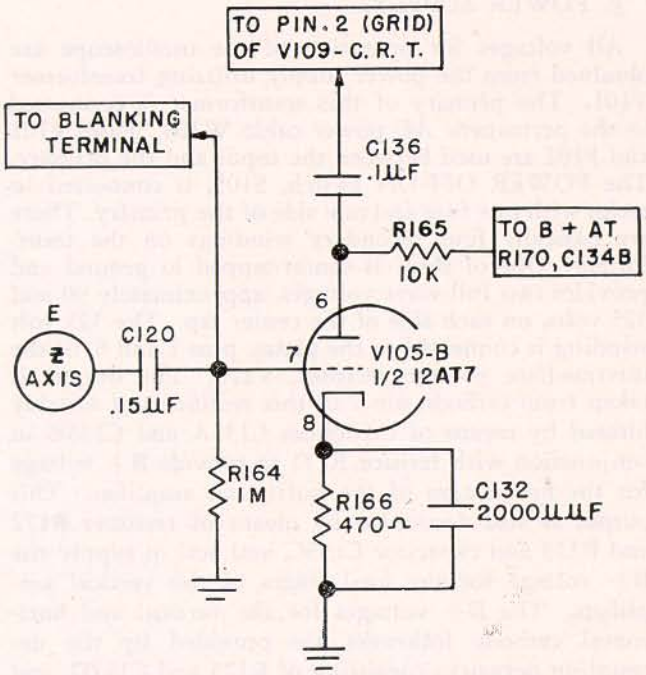


Figure 2-10. Intensity Modulation Amplifier

e. INTENSITY MODULATION AMPLIFIER.

In cathode ray oscilloscope nomenclature a modulation of the intensity of the cathode ray tube beam is known as Z AXIS modulation. Such modulation is often useful to establish a time base for the horizontal deflection of the cathode ray tube beam. As an example, the beam might be modulated by a 1000 cycle source which would cause it to increase in brilliance and decrease each one-thousandth of a second, or each one-thousand microseconds. With this intensity modulation superimposed upon an observed wave form its duration could be calculated.

One-half of a type 12AT7 tube, V105B, is utilized as an amplifier to provide intensity modulation for the cathode ray tube beam. Voltages to actuate this amplifier may be taken from the Z AXIS input, or by means of a jumper on the rear terminal board E110, pulses may be taken from the sweep circuit oscillator to provide beam banking during the return trace when using the sweep circuit oscillator for horizontal deflection. If the voltage is taken from the Z AXIS input it is applied to grid pin 7 of V105B through capacitor C120. However, if the pulses from the sweep circuit oscillator are used for internal beam blanking the signal is directly coupled to the grid from the cathode of the sweep circuit oscillator to eliminate low frequency discrimination. Resistor R164 acts as a grid return to ground. Bias for this amplifier is provided in the cathode circuit by resistor R166 shunted by capacitor C132. This resistor-capacitor combination provides compensation for improving the high frequency response of this amplifier. The B+ is supplied to the plate through resistor R165 and the output is taken from the plate through capacitor C136 and applied directly to the control grid of the cathode ray tube, V109. Positive voltages applied to the Z AXIS input will cause blanking action of the cathode ray tube beam.

f. CATHODE RAY TUBE.

A type 3RP1 cathode ray tube, V109, is used as the indicating medium in the oscilloscope. This tube utilizes electrostatic deflection and has four free deflecting plates. Voltage for the operation of this tube is obtained from the high voltage section of the power supply, the negative side of which is filtered and applied through R179 to the control grid, pin 2 of V109. Intensity (INT.) control, R176, is connected directly from the negative side of the high voltage power supply to R177, the FOCUS control. Cathode pin 3 of V109 is connected to the center arm of INTENSITY control R176 through resistor R180. As the INT. control is operated, it varies the potential difference between the cathode of V109 and the control grid, thereby controlling the intensity of the beam. FOCUS control, R177, is returned to ground through R178 and serves to focus the cathode ray tube beam. Anode #2 and grid #2, pin 8 of V109, are supplied with B+

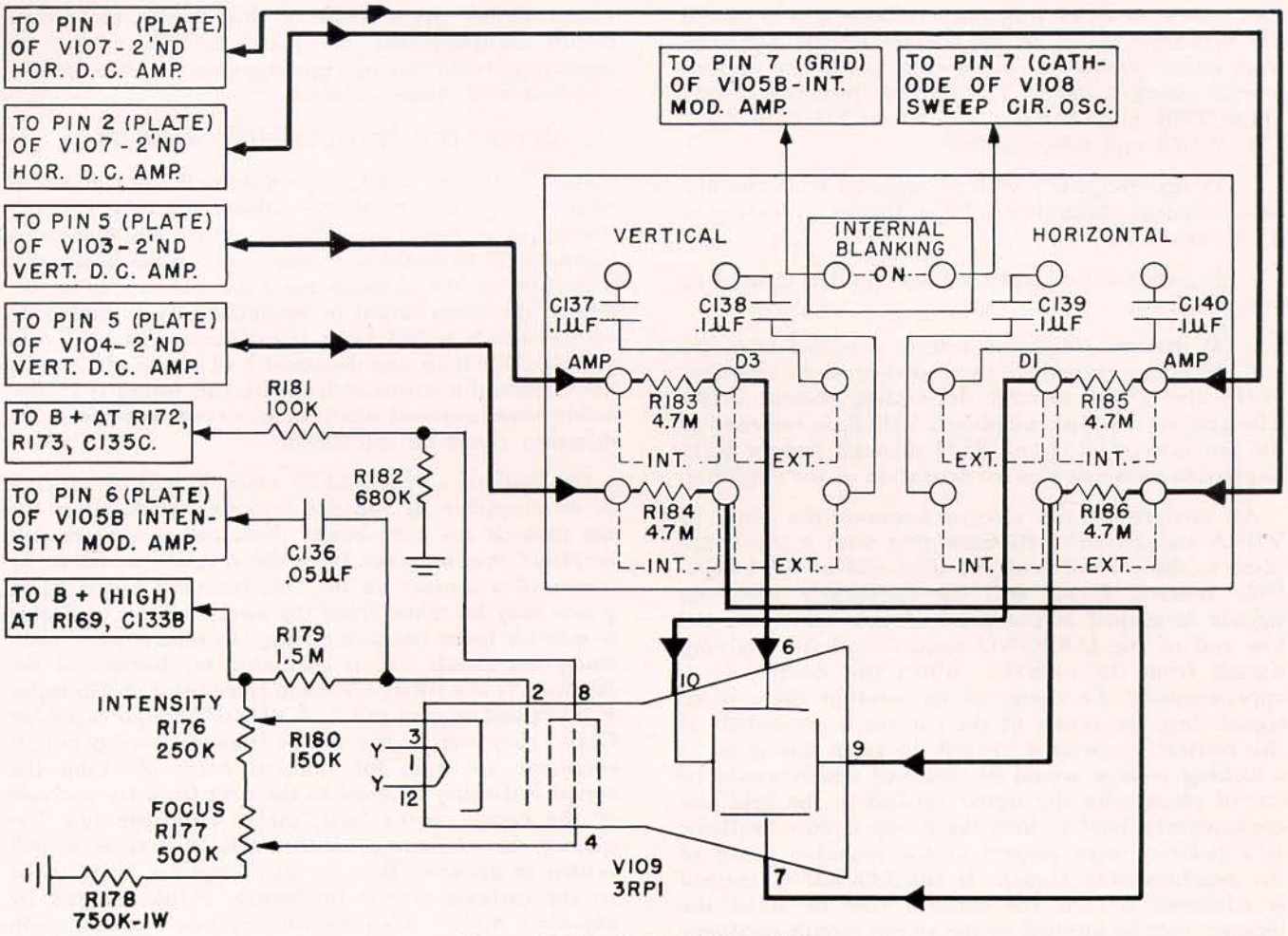


Figure 2-11. Cathode Ray Tube

through the voltage divider consisting of resistors R181 and R182. The voltage at the output of this divider determines the astigmatic focus and is designed to be equal to the nominal DC voltage of the deflection plates, pins 6, 7, 9, and 10 of V109.

The vertical and horizontal deflection plates, pins 6, 7, 9 and 10 respectively, are directly connected to terminal board E110. When the jumpers on this terminal board are arranged for internal connection the output leads from the vertical and horizontal amplifiers are connected directly to the deflection plates. When the jumpers are arranged for external connection, the output leads from the vertical and horizontal amplifiers are connected to the deflection plates through resistors R183 to R186 inclusive. These resistors provide the DC voltage and centering that was present with the internal connection; however, no signal is carried to the deflection plates. With this connection, an external signal may be applied to the deflection plates through capacitors C137 to C140 inclusive by connecting the external signal to the terminals marked EXT. INPUT. If it is desired to use an external capacitor to couple the signal directly to the deflection plates, this capacitor may be connected to the terminals marked D1 through D4 on the terminal board E110.

g. POWER SUPPLY.

All voltages for operation of the oscilloscope are obtained from the power supply utilizing transformer T101. The primary of this transformer is connected to the permanent AC power cable W103. Fuses F101 and F102 are used between the input and the primary. The POWER OFF-ON switch, S105, is connected in series with one fuse and one side of the primary. There are basically four secondary windings on the transformer. One of these is center-tapped to ground and provides two full-wave voltages, approximately 90 and 325 volts, on each side of the center tap. The 325 volt winding is connected to the plates, pins 1 and 6, of the intermediate voltage rectifier, V110. The output is taken from cathode pin 7 of this rectifier and suitably filtered by means of capacitors C135A and C135B in conjunction with resistor R171 to provide B+ voltage for the final stages of the horizontal amplifier. This output is also decoupled by means of resistors R172 and R173 and capacitor C135C, and acts to supply the B+ voltage for the final stages of the vertical amplifiers. The B+ voltages for the vertical and horizontal cathode followers are provided by the decoupling networks consisting of R175 and C134D, and R174 and C134C respectively.

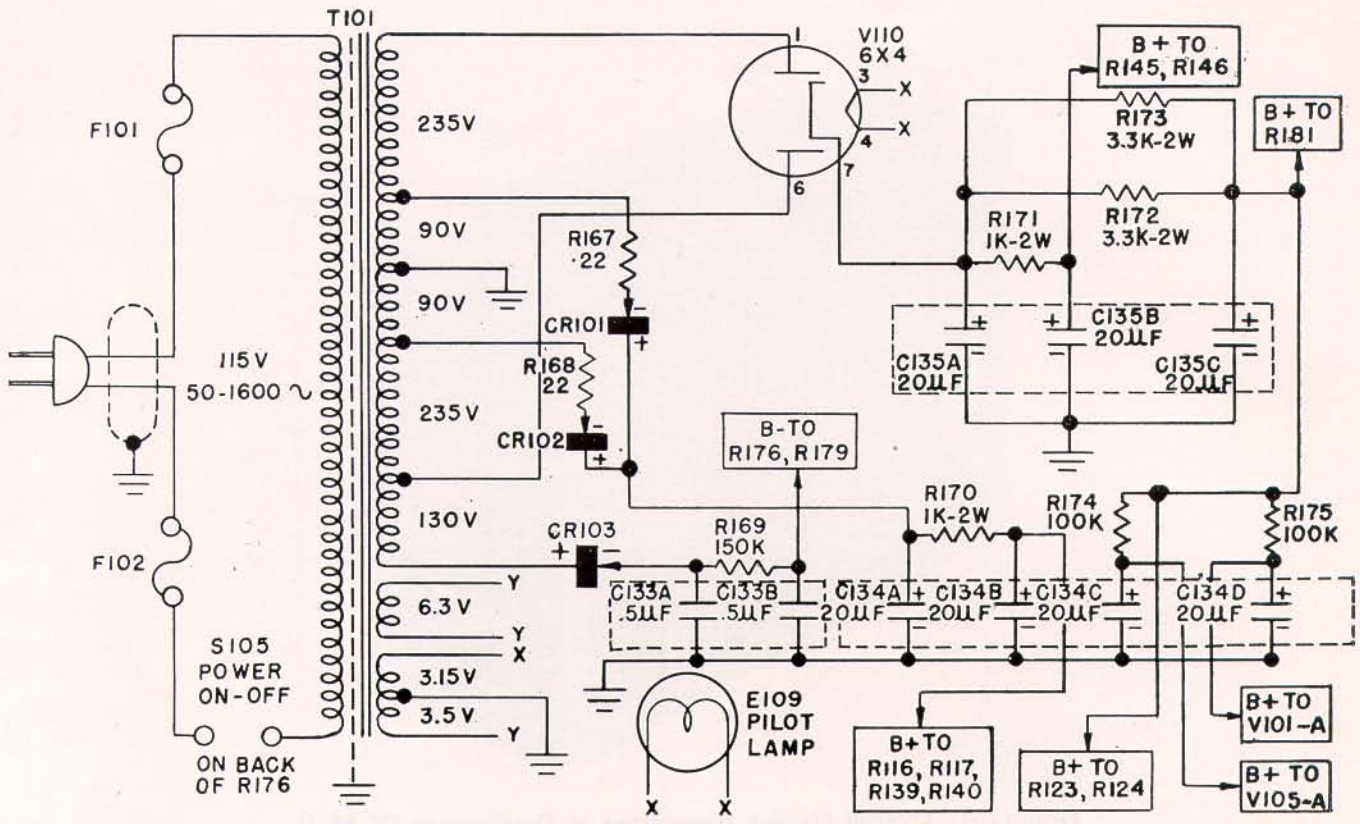


Figure 2-12. Power Supply

The 90 volt winding is connected to the plates of CR101 and CR102 through protective resistors R167 and R168. The output from these selenium rectifiers is filtered by C134A and C134B in conjunction with R170 to provide low voltage B+ supply for the first push-pull horizontal and vertical amplifier stages.

Another secondary winding has its low voltage side tied to one side of the 325 volt winding and its high voltage side tied to the cathode of selenium rectifier CR103. The output from this rectifier is filtered by C133A and C133B in conjunction with R169 and provides a high negative voltage for operation of the cathode ray tube.

A separate 6.3 volt winding is used to supply the heater of the cathode ray tube, V109. Another 6.3 volt winding, center-tapped to ground, is used to supply the heaters of all other tubes in the equipment.

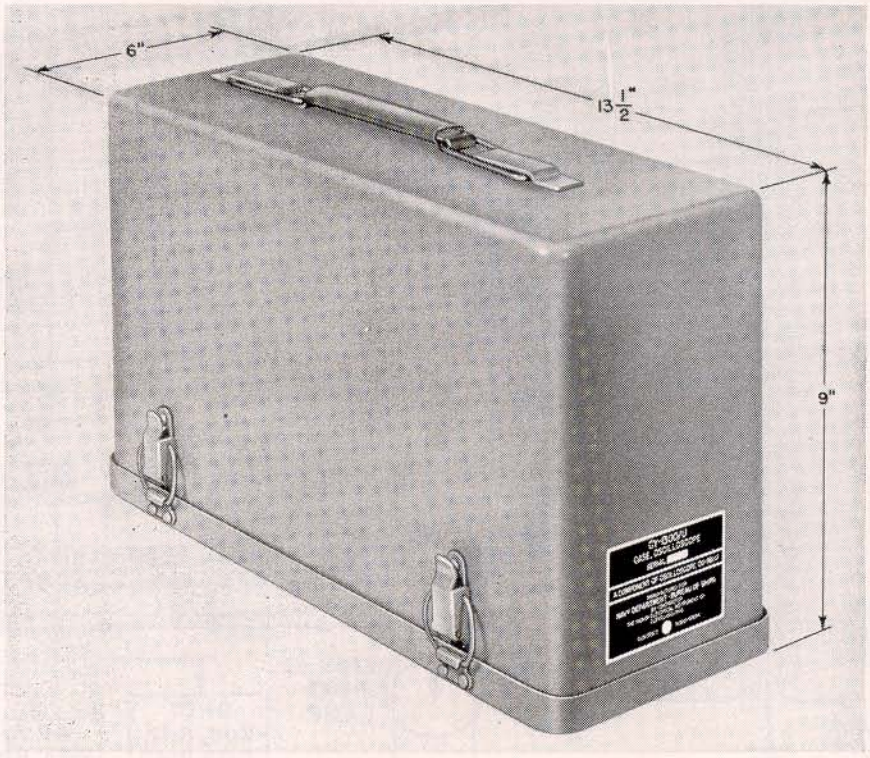


Figure 3-1. Overall Outline Dimensions of Oscilloscope OS-8B/U

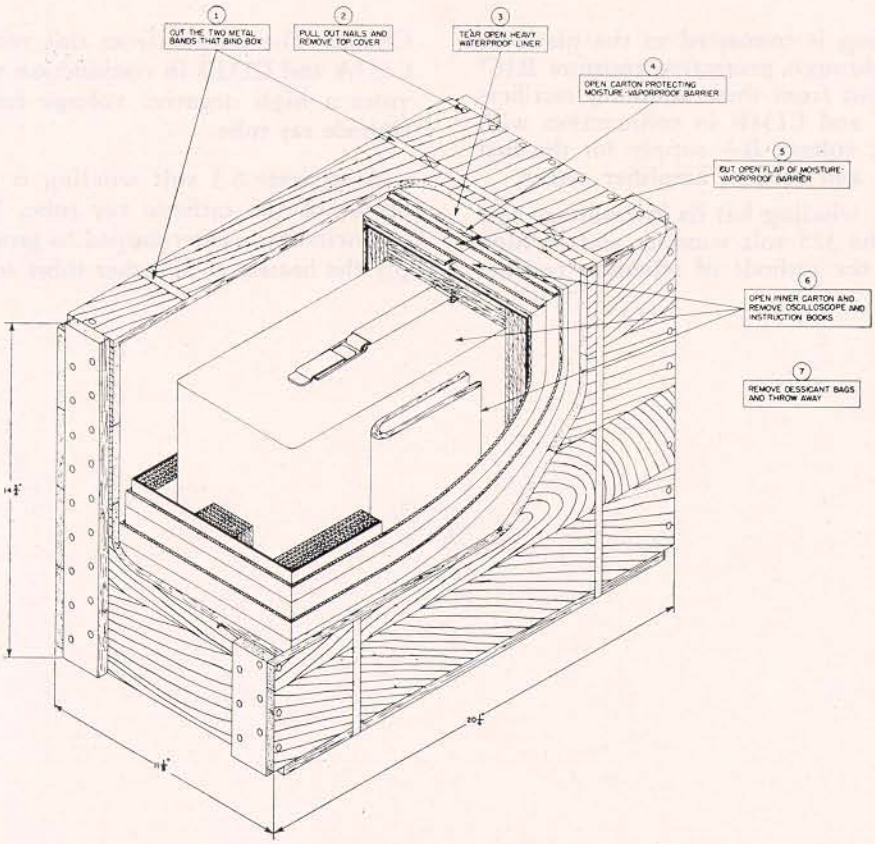


Figure 3-2. Cutaway View of Export Packaging

SECTION 3

INSTALLATION

1. INSTALLATION.

a. HOUSING.—Oscilloscope OS-8B/U, together with all accessories except the instruction book, is housed in a water-tight metal case consisting of a bottom section in which the unit is secured by four shock mounts, and an upper cover which is secured to the lower case by four drawbolts. The upper cover is sealed to the lower case by means of a rubber gasket making the instrument water-tight when the upper cover is in place.

A compartment is provided in the right side panel of the main unit for storing the line cord (See Figure 3-4). The test leads are stored in the front corner of the case.

b. UNPACKING.—As shipped, each equipment is packed in a substantial wooden case which is sufficiently sturdy and affords sufficient protection to the equipment to permit it to remain exposed to the weather for an indefinite time. When opening the packing case and removing the equipment (See Figure 3-2), care should be taken not to dent or otherwise damage the metal housing of the equipment in order to preserve its water-tightness.

c. OPERATING LOCATION.—In general, with very few exceptions, any location where suitable AC input power is available will be a satisfactory operating location for the equipment. However, it should NOT be operated adjacent to or in the vicinity of large electrical generating equipment or in close proximity to other apparatus which might be generating large stray magnetic fields, as this will tend to distort the patterns displayed on the screen of the cathode ray tube.

Note

The equipment has been designed to operate equally well in any convenient operating position.

d. OPERATING CABLES.

(1) AC LINE CORD.—A 5-foot AC line cord (W103) will be found in the accessory compartment on the right side of each equipment. This cord is permanently connected to the oscilloscope on one end and is fitted on the other end with a standard 2-prong male AC line plug. The shield of the power cord is terminated in a lug suitable for retention by an 8-32 roundhead machine screw on the end having the 2-prong male plug.

(2) TEST CABLES.—Supplied as accessories to each equipment are one 36-inch shielded coaxial cable (W101) and one 6-inch shielded coaxial cable (W102) for use in connection with the vertical input circuits. A 3-foot unshielded test lead (W104) is supplied to be used for connection between the chassis of the OS-8B/U oscilloscope and one side of the voltage to be observed.

Figure 3-3. Oscilloscope OS-8B/U, Front Oblique View

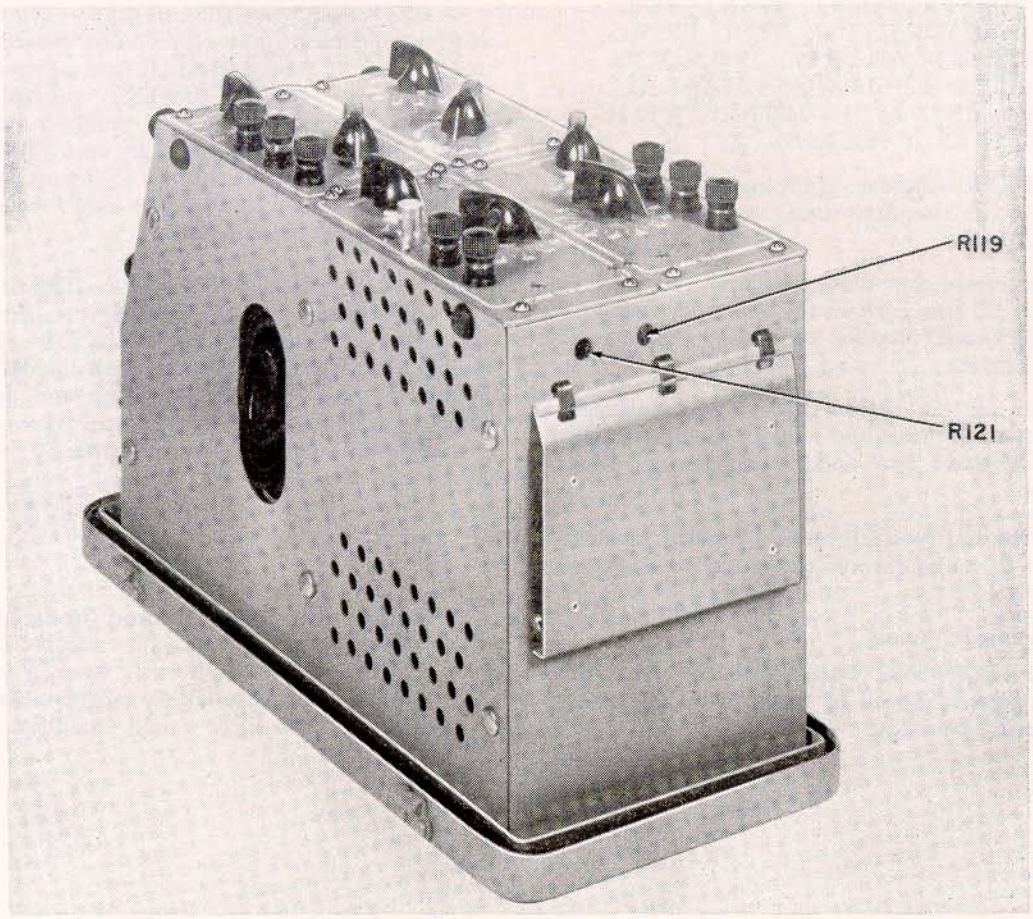


Figure 3-4. Oscilloscope OS8-B/U, Right Cable Compartment and Terminal Board, Rear Oblique View

2. ADJUSTMENT.

WARNING

THE VOLTAGES WHICH ARE UTILIZED IN THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE. BEFORE REMOVING THE EQUIPMENT FROM ITS CASE FOR INSPECTION, THE AC LINE PLUG WHICH FITS INTO THE POWER RECEPTACLE SHOULD BE COMPLETELY REMOVED. SHOULD IT BE NECESSARY TO TAKE VOLTAGE READINGS WITHIN THE INSTRUMENT, MAKE SURE HANDS ARE DRY, USE TEST PRODS INSULATED FOR AT LEAST 2500 VOLTS, AND IN ALL POSSIBLE CASES MAKE ALL READINGS AND ADJUSTMENTS WITH ONE HAND IN A POCKET.

a. INSPECTION.—Before applying AC power to this equipment for the first time, inspect the entire equipment as follows:

(1) Make certain that there are three test leads in addition to the AC line cord in the accessory compartments, and check carefully for mechanical damage to connectors or cables.

(2) Loosen the six captive screws securing each side panel to the main unit and inspect chassis to make certain that all tubes are undamaged and in their proper sockets.

(3) Give the entire equipment a careful mechanical inspection to make certain there are no damaged components.

(4) Replace side panels.

b. TESTS PRECEDING OPERATION.—The following measurements should be made prior to placing the equipment in operation:

(1) With a continuity tester, check the test cables for open or short circuits.

(2) With the AC line cord disconnected from the power supply, but with the INT. control rotated a sufficient distance to place the AC line switch in the "ON" position, check with an ohmmeter the DC resistance between the two prongs of the male AC line plug. This resistance should be about 8 ohms. If it should vary substantially from this value, or show no continuity at all, inspect fuses, AC line switch on the INT. control, and all wiring, for cause of trouble.

c. INITIATING OPERATION.—With the AC line cord inserted into any convenient source of 115 volts $\pm 10\%$, 50 to 1000 cycles AC, the equipment is set in operation by rotating the INT. control in a clockwise direction away from the position marked "OFF". Operation will be indicated by the glow of the pilot light E109 near the bottom of the front panel. Within approximately one minute, the beam should appear on the cathode ray tube screen.

d. CHECKING OPERATION.—Check operation of the positioning (POS.), FOCUS and intensity (INT.) controls. By turning the COARSE FREQUENCY switch through all positions, with the HOR. ATTEN. switch in the "SWEEP" position and advancing the HOR. GAIN control, proper operation of the sweep circuit oscillator will be indicated by horizontal deflection of the beam.

Note

In order to prevent burning the screen of the cathode ray tube, always set the INT. control at the point which will give a trace no brighter than that which can be conveniently seen with the light shield extended.

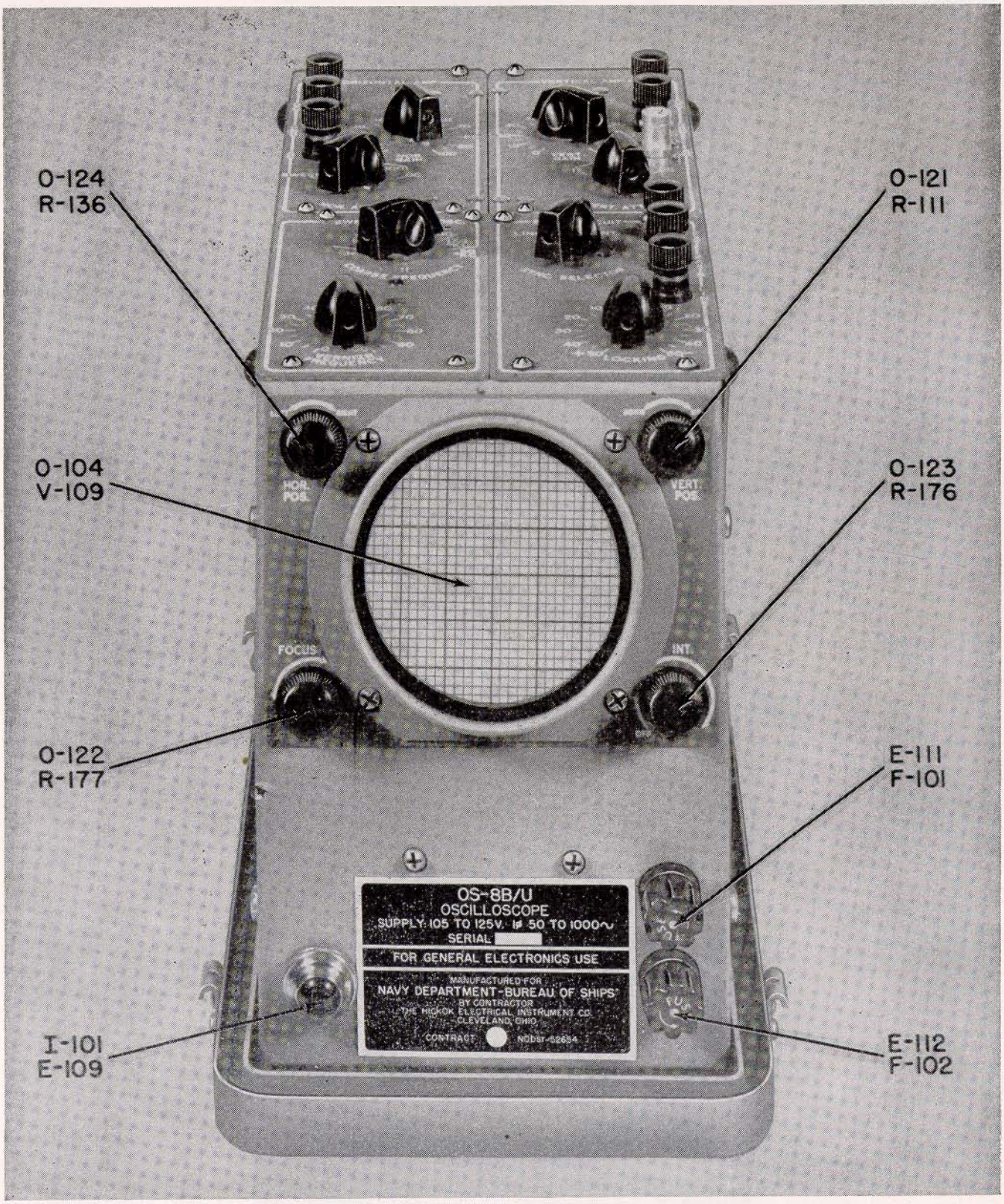


Figure 4-1. Panel Connectors and Controls, Front View

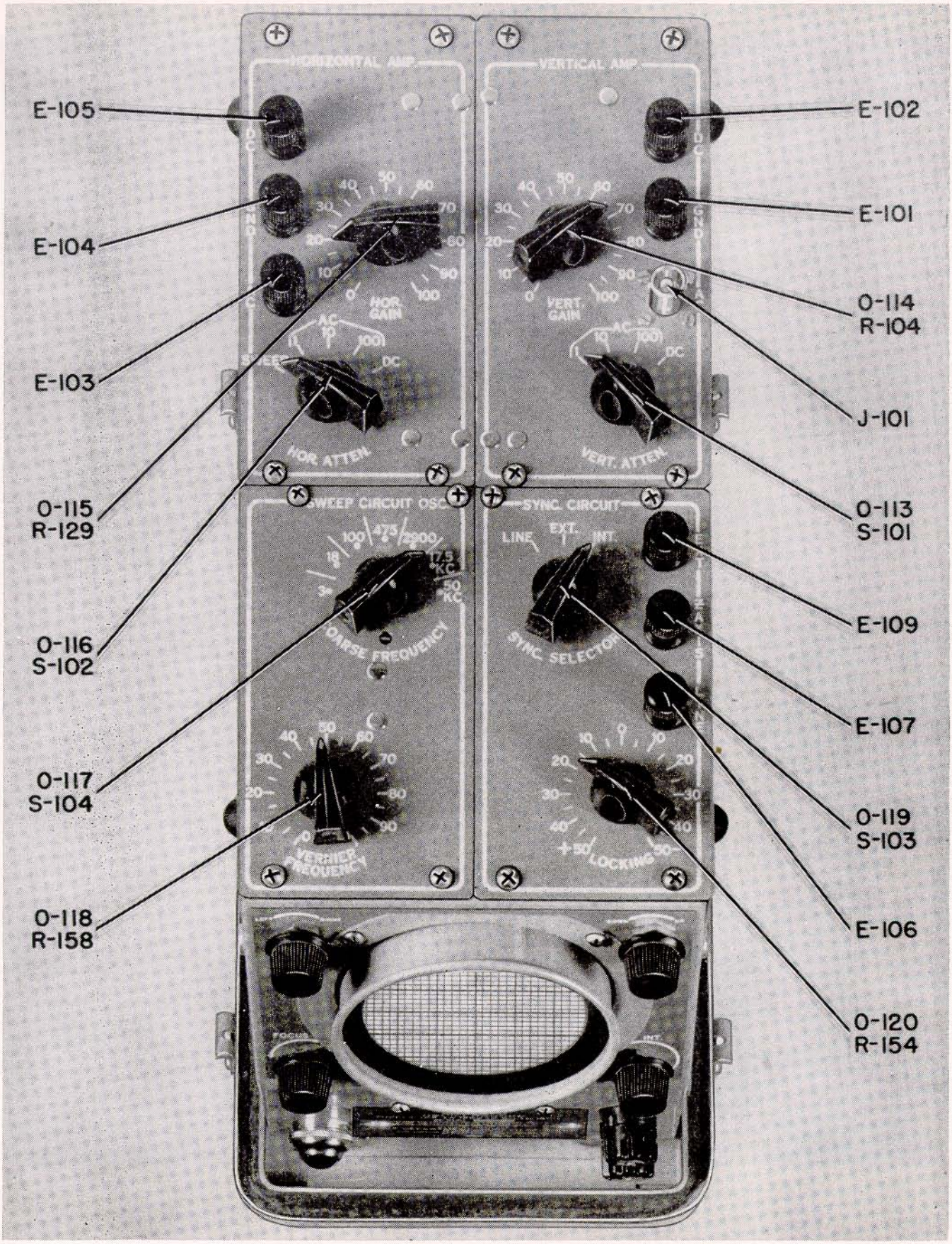


Figure 4-2. Panel Connectors and Controls, Top View

SECTION 4
OPERATION

1. FUNCTION OF EQUIPMENT.

Since Oscilloscope OS-8B/U is operated in a conventional manner, only a basic knowledge of cathode ray oscilloscopes is required for its application and operation. Therefore, this section will be concerned with the specific controls of the equipment and their functions.

2. CONTROLS AND THEIR FUNCTIONS.

The front panel views illustrated in Figures 4-1 and 4-2 show the location of all operating controls.

a. INT.-OFF (R176, S105).—Operating the intensity control clockwise turns the power on to the instrument and the pilot light E109 will indicate that the instrument is on. As this control is operated further clockwise, it controls the intensity of the pattern on the cathode ray tube. When moved to full clockwise position, the pattern is at maximum brilliancy.

b. FOCUS (R177).—This control adjusts the focus, or sharpness, of the trace on the cathode ray tube.

c. POS. (LEFT-RIGHT (R136), DOWN-UP (R111)).—The purpose of the positioning controls is to adjust the position of the trace on the screen, either horizontally or vertically.

d. VERT. ATTEN. (S101).

Important Note

Always operate the VERT. ATTEN. switch to the highest attenuator position in which suitable vertical deflection can be obtained. If this is not done, overloading of the cathode follower will generally result. Overloading can be detected by a clipping or squashing of the pattern.

This control attenuates the signal fed in at the vertical input (AC) connector by a factor of 1, 10 or 100. When turned to the "DC" position, it permits the DC voltages fed in between the DC input and GND to be amplified by the vertical amplifier. Positive DC voltages will cause the beam to move up on the screen.

e. VERT. GAIN (R104).—This control is used as a vernier in connection with the VERT. ATTEN. to control the height of the pattern on the screen in the case of AC voltages; and in the case of DC voltages, the extent of deflection, either up or down, of the beam. The position of the gain control has no effect on band width when the attenuator is in the "AC" positions; however, in the "DC" position the gain control affects the band width as indicated in Table 2-1.

f. HOR. ATTEN. (S102).

Important Note

Always operate the HOR. ATTEN. switch to the highest attenuator position in which suitable horizontal deflection can be obtained. If this is not done, overloading of the cathode follower will generally result. Overloading can be detected by a clipping or squashing of the pattern.

This control attenuates the signal fed in at the horizontal input (AC) connector by a factor of 1, 10 and 100. When turned to the "DC" position, it permits the DC voltages fed in between the DC input and GND to be amplified by the horizontal amplifier. Positive DC voltages will cause the beam to move to the right on the screen. This control, when turned to the "SWEEP" position, permits the sawtooth from the sweep circuit oscillator to be amplified by the horizontal amplifier, thus providing horizontal deflection.

g. HOR. GAIN (R129).—This control is used as a vernier in connection with the HOR. ATTEN. to control the width of the pattern on the screen in the case of external AC voltages; and in the case of DC voltages, the extent of deflection, either left or right, of the beam. When the HOR. ATTEN. is in the "SWEEP" position, the HOR. GAIN controls the width of the sweep.

h. COARSE FREQUENCY (S104).—This control selects the range of frequencies of the internal sweep circuit oscillator which may operate between the limits of 3 and 50,000 cycles. Although the frequency ranges are marked on the panel for convenience of the operator, these frequencies are only approximate and, in general, the actual frequency range will be much greater so that two consecutive frequency ranges will exhibit a sizeable overlap.

i. VERNIER-FREQUENCY (R158).—This control serves as a vernier on the frequency being generated by the sweep circuit oscillator in any one of the six positions of the COARSE FREQUENCY control.

j. SYNC. SELECTOR (S103).—This control selects synchronizing voltage for application to the sweep circuit oscillator. These synchronizing voltages may be selected either from an external source, internal source which is the voltages being applied to the vertical amplifiers, or from an internal source of line frequency voltage.

k. LOCKING (R154).—This control permits selection of either positive or negative peaks of synchronizing voltages and, in addition, controls the extent of locking voltage applied to the sweep circuit oscillator.

l. TERMINALS.

VERTICAL INPUT (AC) (J101).—Input for AC voltages deflecting the beam vertically on the cathode ray tube screen.

VERTICAL INPUT (DC) (E102).—Input for DC voltages applied to the vertical amplifiers.

HORIZONTAL INPUT (AC) (E103).—Input for AC voltages deflecting the beam horizontally on the cathode ray tube screen.

HORIZONTAL INPUT (DC) (E105).—Input for DC voltages applied to the horizontal amplifiers.

GND (2) (E101, E104).—Direct connection to chassis of equipment and to one side of all other externally applied voltages.

EXT. (E108).—Input for external synchronizing voltages to be used in synchronizing the sweep circuit oscillator.

LINE (E106).—A source of line supply frequency to be used either in causing deflection for horizontal or vertical inputs, or as a source of line frequency for any other use to which it might be put.

Z AXIS (E107).—Connection for an external voltage to be used in intensity modulating the cathode ray tube beam.

TERMINAL BOARD (E110).—Permits direct connection to either horizontal or vertical deflection plates and provides means of beam blanking from internal sweep circuit oscillator.

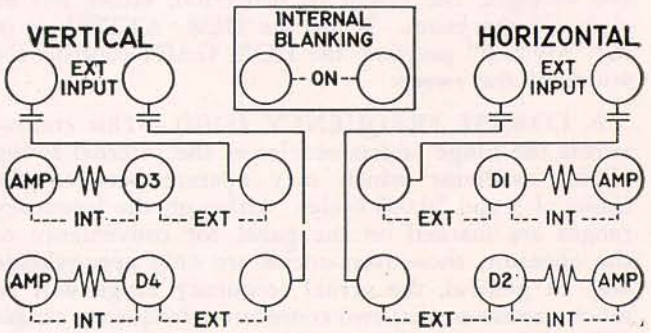


Figure 4-3. Rear Terminal Board E110

3. OPERATION.

a. OBSERVING WAVE FORMS USING INTERNAL SWEEP AND SYNC.

Connect the source of alternating voltage to be observed to the vertical input (AC) and GND connections. Set the COARSE FREQUENCY control, S104, to the slowest sweep frequency, position "3-18". The SYNC. SELECTOR, S103, should be turned to "INT", while the LOCKING control, R154, is turned to the zero position. Adjust VERT. GAIN R104 and VERT. ATTEN. S101 for suitable vertical deflection. Adjust HOR. GAIN R129 until the pattern is of the desired width. When the pattern first appears it will usually show many cycles as the picture of the sine wave under observation in Figure 4-4. Slowly rotate the VERNIER-FREQUENCY, R158, until the number of cycles decreases to the desired number. If the number is still greater than convenient, then COARSE FREQUENCY S104 should be rotated to the next clockwise position and fewer cycles will appear as shown in Figure 4-5. When the desired number of cycles are obtained, the trace can be locked in by rotating the LOCKING control, R154, either clockwise or counter-clockwise, depending upon whether it is desired to lock in positive or negative synchronizing pulses.

b. OBSERVING WAVE FORMS USING INTERNAL SWEEP AND EXT. SYNC.

Follow all steps outlined in paragraph 3(a) with the following exception:

SYNC. SELECTOR S103 is turned to "EXT" rather than "INT", and the source of synchronizing voltage is applied between the EXT. binding post and GND.

c. OBSERVING WAVE FORMS USING INTERNAL SWEEP WITH LINE FREQUENCY SYNCHRONIZING VOLTAGES.

Follow all steps outlined in paragraph 3(a) with the following exception:

When the sweep circuit is to be locked in at line frequency, SYNC. SELECTOR S103 is turned to "LINE".

d. OBSERVING WAVE FORMS USING INTERNAL SINE WAVE LINE FREQUENCY SWEEP.

Connect the source of alternating voltage to be observed between the vertical input (AC) and GND. Set the HOR. ATTEN., S102, to the AC divided by 10 position. Make an electrical connection between the LINE binding post and the horizontal input (AC) binding post. Operate the HOR. GAIN and VERT. GAIN controls to give the desired size of pattern. LOCKING, VERNIER-FREQUENCY and SYNC. SELECTOR controls have no effect upon the operation.

e. OBSERVING PATTERNS WITH SINE WAVE VOLTAGES IN BOTH HORIZONTAL AND VERTICAL INPUTS.

Connect the two voltages for comparison to the oscilloscope, one on the horizontal input (AC) and one on the vertical input (AC). Adjust the HOR. ATTEN., S102, and VERT. ATTEN., S101, to the highest attenuation position that will give suitable deflection in both directions. Adjust the HOR. GAIN and VERT. GAIN controls until the pattern is of the desired size. With the above controls so adjusted, as the two frequencies become exact ratios of one another definite patterns, as illustrated in Figures 4-6 and 4-7, will appear on the screen.

The rule for determining ratios is to count the number of times the pattern touches one axis and then the number of times it touches the other. The ratio between the two is the ratio of the two frequencies. If the beam touches the horizontal axis more often than the vertical axis, then the beam must be moving more slowly in the horizontal direction than it is in the vertical direction. This being the case, the slowest frequency is being fed into the horizontal amplifier.

f. VERTICAL DEFLECTION WITH DC INPUT.

Operate the VERT. ATTEN., S101, to the "DC" position. Apply DC voltage to the (DC) vertical input connection, E102, and adjust VERT. GAIN R104 to give the desired deflection sensitivity.

g. HORIZONTAL DEFLECTION WITH DC INPUT.

Operate HOR. ATTEN. S102 to the "DC" position. Apply DC voltages to the (DC) horizontal input con-

nection, E105, and adjust HOR. GAIN R129 to give the desired deflection sensitivity.

h. APPLYING VOLTAGE DIRECTLY TO DEFLECTION PLATES. (See Figure 4-3)

WARNING

The voltages that appear on the bottom two rows of terminals on TERMINAL BOARD E110 are by necessity high and dangerous to human life. Before changing any jumper connections on these terminals, de-energize the oscilloscope.

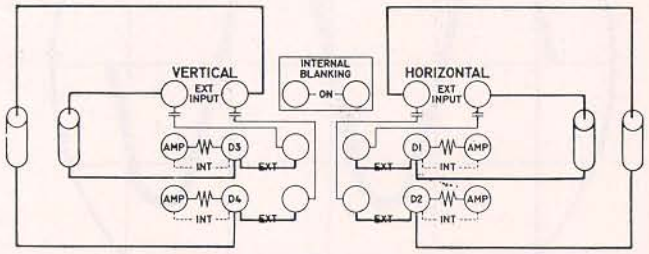


Figure 4-3A—Rear Terminal Board E-110, showing the addition of larger external capacitors.

(1) VERTICAL PLATES.—To apply voltages directly to the vertical deflection plates, change the jumpers on the vertical side of the board from "INT" to "EXT" connection as indicated by the dotted lines on the diagram appearing on the cover of TERMINAL BOARD E110. The deflecting voltages may then be applied to the two terminals marked "EXT. INPUT". These terminals are isolated from the voltage on the deflection plates through capacitors C137 and C138. In observing very low frequency wave forms, the time constant of this input circuit may become objectionable. In this case, larger external capacitors may be connected between the terminals marked "EXT. INPUT" and the terminals marked D3 and D4 (See Figure 4-3A).

(2) HORIZONTAL PLATES.—To apply voltages directly to the horizontal deflection plates, change the jumpers on the horizontal side of the board from "INT" to "EXT" connection as indicated by the dotted lines on the diagram appearing on the cover of TERMINAL BOARD E110. The deflecting voltages may then be applied to the two terminals marked "EXT. INPUT". These terminals are isolated from the voltage on the deflection plates through capacitors C139 and C140. In observing very low frequency wave forms, the time constant of this input circuit may become objectionable. In this case larger external capacitors may be connected between the terminals marked "EXT. INPUT" and the terminals marked D1 and D2 (See Figure 4-3A).

i. RETURN TRACE ELIMINATION. (See Figure 4-3)

When using the sweep circuit oscillator for horizontal deflection, should it be desired to blank the beam out on the return trace, a jumper should be installed between the two INTERNAL BLANKING terminals on the TERMINAL BOARD E110. With these terminals connected together voltage should not be fed in at the Z AXIS binding post, E107, on the main panel to avoid distorting the saw tooth output of the sweep circuit oscillator.

j. OTHER APPLICATIONS OF THE OSCILLOSCOPE.

In addition to using the OS-8B/U for observation of wave forms as outlined in paragraphs 3(a) through 3(i), the oscilloscope may find use in many other applications such as:

(1) Alignment of tuned R.F. and I.F. stages and video circuits,

(2) Alignment of F.M. discriminator stages,

(3) Observation of irregular wave shapes, pulses, etc.,

(4) Approximate measurements of percent distortion,

(5) Detection and identification of hum in power supplies, and

(6) Determination of percent modulation in transmitters.

(7) Due to the wide frequency response of the vertical amplifiers, being from zero cycles on DC to 2 mc AC, the instrument will find extremely wide uses in connection with measurements and observation of wave forms from very low frequencies on up into the high frequency ranges.

(8) If suitable calibrating potentials are available it may be used as an electronic voltmeter. As an example, if it is desired to determine the voltage of an unknown signal being applied, the VERT. GAIN controls may be adjusted to give a deflection such as 15 small squares, or one and one-half inches. By substituting for the unknown voltage a known voltage of given magnitude, the ratio of the number of divisions of deflection of the unknown voltage would be proportional to that voltage as the number of divisions of deflection of the unknown voltage is to that unknown voltage. As a concrete example, if, with a given setting of the gain controls, the unknown voltage produced 15 divisions and a known voltage of 5 volts produced 5 divisions, the unknown voltage is to 15 as the known voltage (5) is to 5 divisions, or unknown voltage equals 15 volts.

If either of the VERT. GAIN controls are changed, recalibration should be effected unless notations of the exact control settings have been made and recorded for future use. Such recorded calibrations should be accurate for relatively long periods of time as they would be affected only by the operator's ability to reset accurately and the potential loss of mutual conductance with age of the vertical amplifier tubes.

(9) If using the DC vertical amplifier section with unshielded leads, caution should be taken as these unshielded leads might pick up stray fields and distort the wave shape being observed. Such precautions consist of using as short leads as possible and orienting the leads so that they do not come close to a source of AC fields such as transformers or alternating-current-carrying wires.

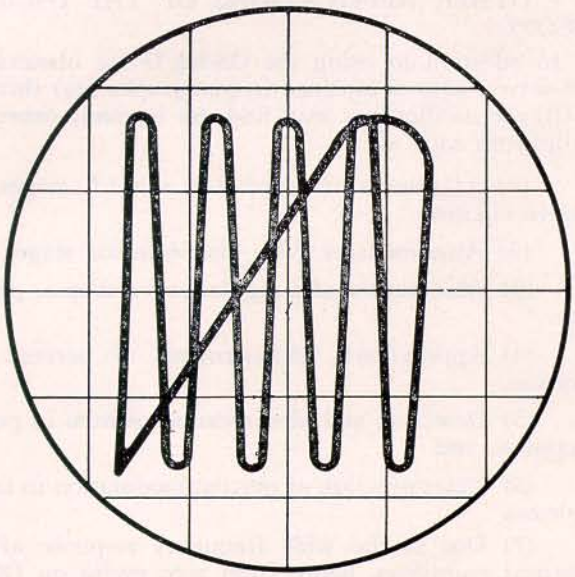


Figure 4-4

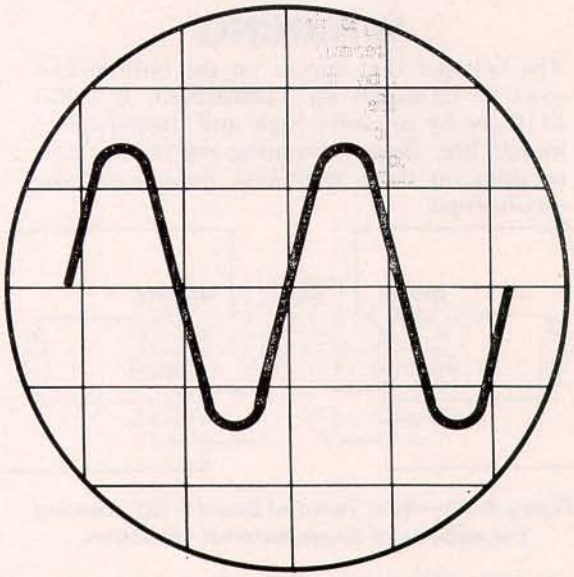


Figure 4-5

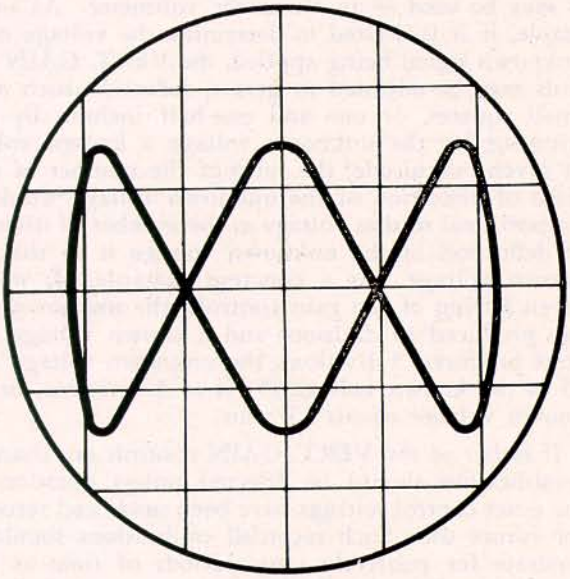


Figure 4-6

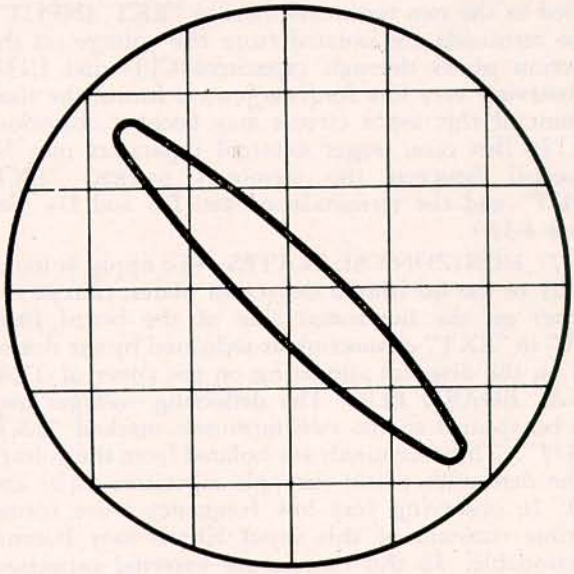


Figure 4-7

Wave Forms

SECTION 5

PREVENTIVE MAINTENANCE

1. GENERAL.

Preventive maintenance is the removing of possible trouble which might later cause the equipment to become inoperative. Primarily, this includes periodic inspection, checking, cleaning and tightening of contacts and components. Certain suggestions can be made for such a program, but local conditions will largely determine the exact details.

The guide to the program will be found in Table 5-1, ROUTINE MAINTENANCE CHART. By carefully following this chart, troubles can be detected and remedied before causing actual breakdown of the equipment.

2. LUBRICATION.

No lubrication is required.

3. CLEANING.

WARNING

Disconnect power cord.

a. GENERAL.—The chassis is best blown out with dry compressed air or cleaned with a dry cloth and a soft dry paint brush of suitable size. It may be necessary to use dry cleaning solvent, MIL-S-16067 (SNSN G51-S-4718-10 for a 5 gallon can), on a cloth to clean ceramic high voltage insulators. On chassis surfaces, however, this solvent should not be used as there is danger of softening the tropicalizing paint which covers them. Dust should be cleaned off thoroughly, both inside and outside the case.

Inspection should be combined with cleaning, since every part of the equipment can be observed at that time, and cleaning may inadvertently break or loosen a connection.

All exposed lug and screw connections, plug and socket connections, and electron tube pins should be checked for tightness. Cable ends should be properly dressed to prevent short circuits or strain on wires and lugs.

Caution

Faulty electrical contacts can cause equipment failure at a critical time. Evidences of heating or breakdown such as carbonized surfaces, overheated resistors with discolored surfaces, and discolored metal parts should be noted. Though there may be no damage, potential trouble is indicated.

TABLE 5-1. ROUTINE MAINTENANCE CHART

ATTENTION OF MAINTENANCE PERSONNEL IS INVITED TO REQUIREMENTS OF CHAPTER 67 OF THE "BUREAU OF SHIPS MANUAL" OF THE LATEST ISSUE.

The following Table is given as a basis for a routine maintenance schedule.

WARNING

Before removing the case, remove the power cable. After removal of the case, discharge any capacitors in the power supply.

MONTHLY

a. Remove fuses one at a time. Clean and burnish ends and clips as needed.

b. Check tube pins and socket contacts for corrosion. Clean as needed.

c. Check all tubes in a tube tester. Replace weak tubes.

d. Replace any tubes missing from tested emergency spares after first testing in proper socket.

e. Check operation of all panel controls.

f. Blow out dust with dry compressed air.

g. Check for rust and corrosion. Clean and touch up with paint as needed.

All knobs should be checked for looseness and tightened if necessary. Occasionally knobs become loose and fail to rotate their controls; thus, a loose knob may give the impression of fault in a variable circuit.

Rough handling of the oscilloscope will sometimes jar parts or wires out of position or abrade them; such damage should be repaired. Rust or corrosion on painted surfaces should be cleaned and sanded smooth, and the spot covered with touchup paint. Unpainted surfaces will not ordinarily corrode unless exposed to salt water or some other corrosive agent. Should corrosion occur, it should be cleaned off thoroughly, taking care not to let the scrapings fall into the unit, and the spot touched up with clear varnish or tropicalizing paint. Paint or varnish should not be used too close to switch or tube socket contacts.

b. TUBES.

Compressed air or a brush will usually suffice to remove dust from the tubes. Be careful to clean tubes that operate at a high temperature, as a layer of dust would interfere with heat radiation and raise the operating temperature. After cleaning, make sure that all tubes are properly seated in their sockets, and all tube clamps locked.

Tubes should be removed from their sockets periodically and the pins inspected. Any dirt and corrosion found should be removed from the pins with crocus cloth and from socket contacts with the round blade of a burnishing tool.

The plate connectors used on high voltage rectifier tubes may lose their spring tension as a result of overheating. The tension should be increased when necessary.

c. FUSES.

Fuses should be removed and checked for corrosion and looseness, either of which can cause eventual trouble. A clean cloth moistened with dry cleaning solvent, MIL-S-16067 (SNSN G51-S-4718-10 for a 5 gallon can), will usually suffice for cleaning the fuses and clips, but in some cases it may be necessary to use crocus cloth or fine sandpaper. When replacing, make sure that the fuses are tight in their clips.

d. HIGH-VOLTAGE INSULATORS.

Ceramic and other insulators for voltages under 600 volts are usually tropicalized. They should be kept clean, but care should be taken not to remove the special paint. The use of solvents is not recommended.

Ceramic insulators for voltages greater than 600 volts are not tropicalized. They should be kept clean to prevent the possibility of arc-overs. It may be necessary to use a cloth moistened with dry cleaning solvent, MIL-S-16067 (SNSN G51-S-4718-10 for a 5 gallon can), or some other solvent.

FAILURE REPORTS

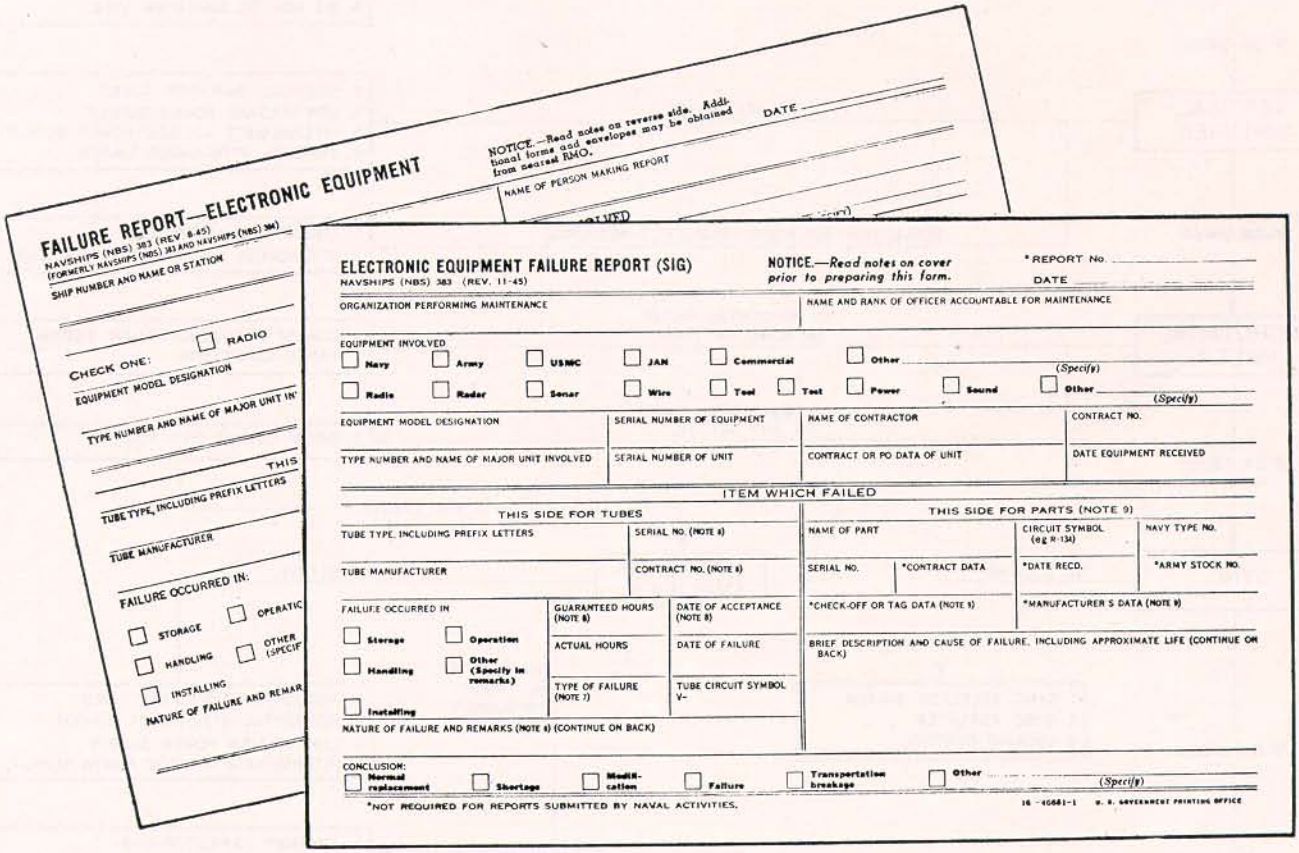
A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form NBS-383, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS in the franked envelope which is provided. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example, under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from the nearest district printing and publications office.



FAILURE REPORT—ELECTRONIC EQUIPMENT
NAVSHIPS (NBS) 383 (REV. 8-45)
(FORMERLY NAVSHIPS (NBS) 383 AND NAVSHIPS (NBS) 384)
SHIP NUMBER AND NAME OR STATION
CHECK ONE: RADIO
EQUIPMENT MODEL DESIGNATION
TYPE NUMBER AND NAME OF MAJOR UNIT IN
THIS
TUBE TYPE, INCLUDING PREFIX LETTERS
TUBE MANUFACTURER
FAILURE OCCURRED IN:
STORAGE
OPERATIC
HANDLING
OTHER (SPECIF
INSTALLING
NATURE OF FAILURE AND REMAR
NOTICE.—Read notes on reverse side. Additional forms and envelopes may be obtained from nearest RMO.
DATE
NAME OF PERSON MAKING REPORT

ELECTRONIC EQUIPMENT FAILURE REPORT (SIG)
NAVSHIPS (NBS) 383 (REV. 11-45)
NOTICE.—*Read notes on cover prior to preparing this form.*
*REPORT No.
DATE
ORGANIZATION PERFORMING MAINTENANCE
NAME AND RANK OF OFFICER ACCOUNTABLE FOR MAINTENANCE
EQUIPMENT INVOLVED
Navy Army USMC JAN Commercial Other (Specify)
Radio Radar Sonar Wire Tool Test Power Sound Other (Specify)
EQUIPMENT MODEL DESIGNATION
SERIAL NUMBER OF EQUIPMENT
NAME OF CONTRACTOR
CONTRACT NO.
TYPE NUMBER AND NAME OF MAJOR UNIT INVOLVED
SERIAL NUMBER OF UNIT
CONTRACT OR PO DATA OF UNIT
DATE EQUIPMENT RECEIVED
ITEM WHICH FAILED
THIS SIDE FOR TUBES
TUBE TYPE, INCLUDING PREFIX LETTERS
SERIAL NO. (NOTE 6)
TUBE MANUFACTURER
CONTRACT NO. (NOTE 6)
FAILURE OCCURRED IN
Storage Operation
Handling Other (Specify in remarks)
Installing
GUARANTEED HOURS (NOTE 8)
DATE OF ACCEPTANCE (NOTE 8)
ACTUAL HOURS
DATE OF FAILURE
TYPE OF FAILURE (NOTE 7)
TUBE CIRCUIT SYMBOL V-
NATURE OF FAILURE AND REMARKS (NOTE 6) (CONTINUE ON BACK)
THIS SIDE FOR PARTS (NOTE 9)
NAME OF PART
CIRCUIT SYMBOL (eg R-134)
NAVY TYPE NO.
SERIAL NO.
*CONTRACT DATA
*DATE RECD.
*ARMY STOCK NO.
*CHECK-OFF OR TAG DATA (NOTE 9)
*MANUFACTURER S DATA (NOTE 9)
BRIEF DESCRIPTION AND CAUSE OF FAILURE, INCLUDING APPROXIMATE LIFE (CONTINUE ON BACK)
CONCLUSION:
Normal replacement Shortage Modification Failure Transportation breakage Other (Specify)
*NOT REQUIRED FOR REPORTS SUBMITTED BY NAVAL ACTIVITIES.
16-40681-1 U. S. GOVERNMENT PRINTING OFFICE

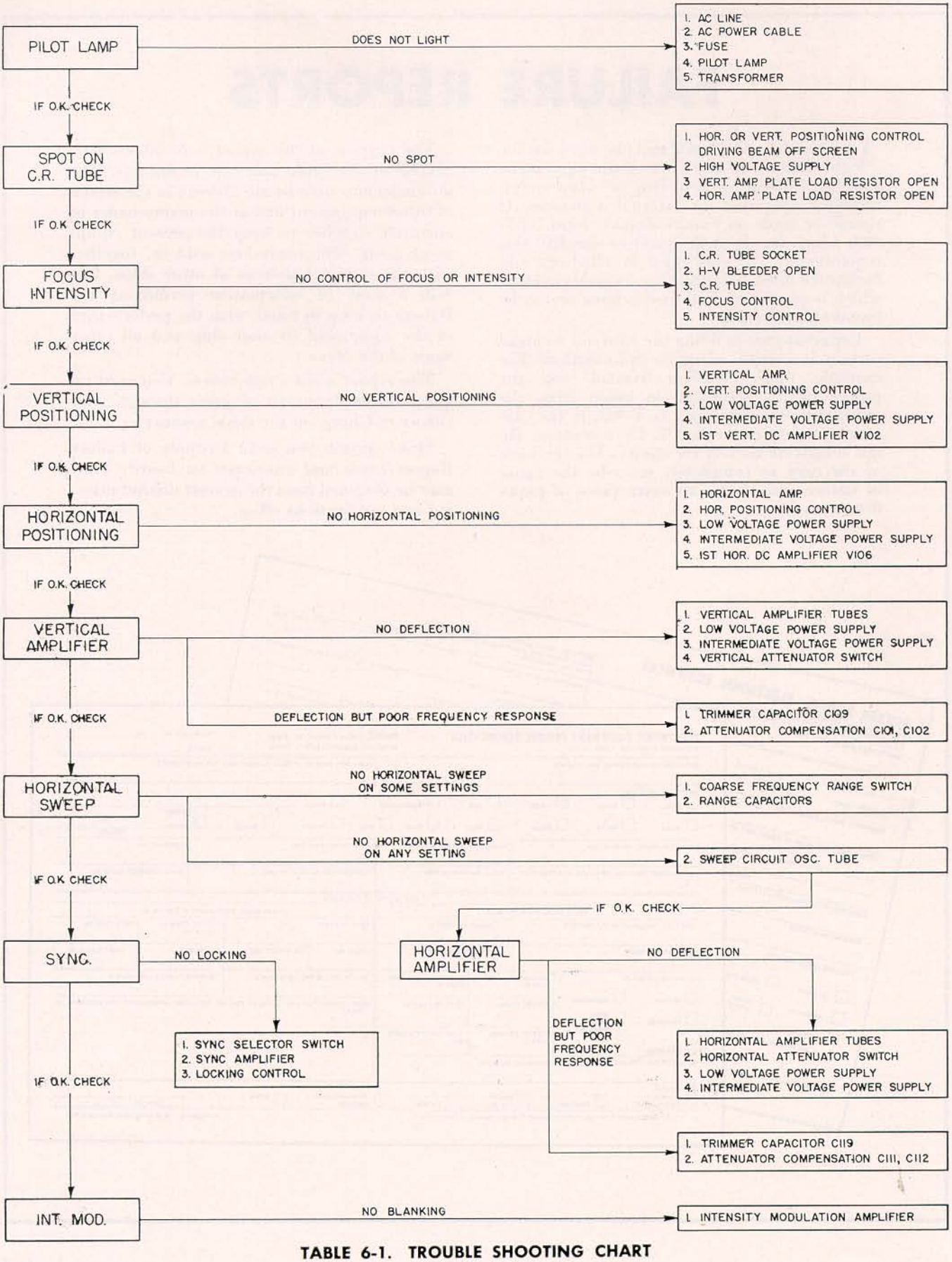


TABLE 6-1. TROUBLE SHOOTING CHART

SECTION 6
MAINTENANCE

1. GENERAL.

Components in oscilloscope OS-8B/U can, in general, be replaced with equivalent components without the necessity of any further adjustment except where specifically mentioned. Most of the components may be replaced in the scope generally serviced by merely removing the side panels, six captive screws per panel; however, it will be found much more convenient when attempting any major repair to remove the sub-assembly involved as indicated below.

a. REMOVING SUB-ASSEMBLIES

(1) VERTICAL AMPLIFIER.

(a) Remove the right side panel.

(b) Unsolder the two leads from the vertical amplifier assembly at terminal board E110 in the rear of the scope.

(c) Remove the four screws holding the vertical amplifier assembly to the top of the chassis.

(d) Remove the assembly from the chassis by giving it a slight counter-clockwise turn and pulling straight out.

(e) The vertical amplifier assembly may then be swung down and laid on the bench next to the oscilloscope, and the two leads from the amplifiers reconnected to the terminal board with short jumpers. The oscilloscope may now be operated in its normal manner with this circuit completely exposed.

(2) HORIZONTAL AMPLIFIER.

(a) Remove the left side panel.

(b) Unsolder the two leads from the horizontal amplifier assembly at terminal board E110 in the rear of the scope.

(c) Remove the four screws holding the horizontal amplifier panel to the top of the chassis.

(d) Remove the assembly from the chassis by giving it a slight clockwise turn and pulling straight out.

(e) The horizontal amplifier assembly may then be swung down and laid on the bench next to the oscilloscope, and the two leads from the amplifiers reconnected to the terminal board with short jumpers. The oscilloscope may now be operated in its normal manner with this circuit completely exposed.

(3) SWEEP CIRCUIT OSCILLATOR.

(a) Remove the left side panel.

(b) Remove the four screws holding the sweep circuit oscillator panel to the top of the chassis.

(c) Remove the assembly from the chassis by pulling straight out.

(d) The sweep circuit oscillator may then be swung down and laid on the bench beside the oscilloscope and the scope operated in the normal manner with this circuit completely exposed.

(4) SYNC. CIRCUIT.

(a) Remove the right side panel.

(b) Remove the four screws holding the sync. circuit panel to the top of the chassis.

(c) Remove the assembly from the chassis by applying a slight clockwise twist and pulling straight out.

(d) The sync. circuit assembly may then be swung down and laid on the bench next to the scope and the scope operated in the normal manner with this circuit completely exposed.

(5) POWER SUPPLY.

(a) Disengage the bottom pan from the chassis by removing the four water-tight screws from the shock mounts.

(b) Remove both side panels.

(c) Unsolder the two gray wires at the pilot light assembly and the two wires coded white with blue tracers. One of these wires is terminated at the upper fuse post and the other on the AC switch located on the back of the INTENSITY control.

(d) Unsolder the shield of the power cord from its lug on the power supply assembly.

(e) Remove the four screws holding the power supply assembly to the chassis. Two of these screws are located on the front of the chassis and the other two on the bottom.

(f) The assembly may then be removed by pulling it through the opening on the right side of the chassis and turning it slightly counter-clockwise. There is sufficient slack in the cabling to permit this removal.

(g) After reconnecting the two wires coded white with blue tracers, and the two gray wires from the pilot light assembly by means of jumpers, the oscilloscope may be operated in the normal manner with this assembly completely exposed.

Important Note

IN CASE OF EMERGENCY, WHEN REPLACEMENT PARTS ARE NOT AVAILABLE, THESE ASSEMBLIES MAY BE COMPLETELY DETACHED FROM THE OSCILLOSCOPE BY UNSOLDERING THE CABLES FROM DISTRIBUTION BOARD AND A CONSOLIDATION OF WORKABLE ASSEMBLIES MAY BE ACCOMPLISHED SINCE EACH ASSEMBLY IS INTERCHANGEABLE FROM ONE OSCILLOSCOPE TO ANOTHER.

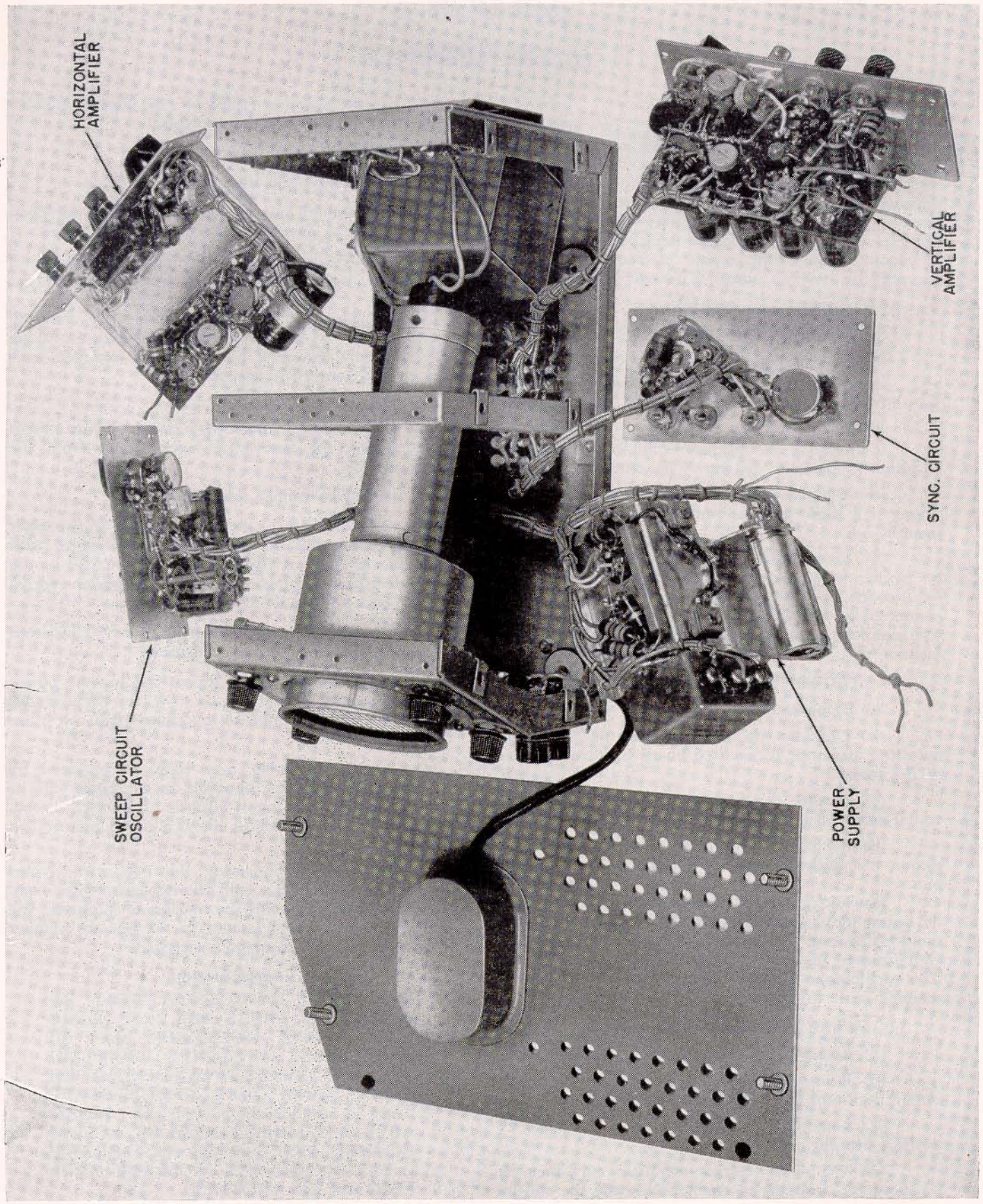


Figure 6-1. Oscilloscope OS8-B/U, Sub-Assemblies Removed

b. REPLACING CATHODE RAY TUBE.

Caution

HANDLE WITH CARE. Breakage of this tube, which contains a high vocuum, may result in injury from flying glass. Do not strike or scratch the tube. Never subject to more than moderate pressure when installing in or removing from equipment.

Should it be necessary to replace the cathode ray tube, the following procedure should be followed:

(1) Remove the right side panel.

(2) Loosen the cathode ray tube clamp (See Figure 6-2).

(3) The cathode ray tube may then be removed by disengaging the socket and pulling forward and out with the tube visor.

c. REPLACING THE TRANSFORMER (See Figure 6-3).

Should it become necessary to replace transformer T101, the following procedure should be followed:

(1) Disengage the bottom pan from the chassis by removing the four water-tight screws from the shock mounts.

(2) Remove both side panels.

(3) Unsolder all leads from the transformer terminals, being sure to identify them so that they can be correctly replaced.

(4) Remove the cathode ray tube as outlined above.

(5) Remove the four screws securing the transformer to the main chassis. These screws are located on the bottom of the chassis.

(6) The transformer may then be removed through the right side of the chassis and the replacement made.

d. ALIGNMENT OF DC AMPLIFIERS (HORIZONTAL AND VERTICAL.

The amplifiers used in the vertical and horizontal deflection circuits are of the direct-coupled type which depend upon proper adjustment for best operation. Although these adjustments are made in the factory, it is possible that after replacement of major components, readjustment may be required for optimum performance. Some of the symptoms of maladjustment and the methods for correcting them are listed below, as well as in Table 6-2.

(1) LACK OF SENSITIVITY, INSUFFICIENT POSITIONING, CROWDING, OR POOR FOCUS (ASTIGMATIC CONDITION)—If any one or more of these conditions exist in the vertical or horizontal amplifiers, readjustment of BIAS controls R119 and R141 respectively would be advisable. For the vertical amplifier, adjust BIAS ADJ. R119 (See Figure 3-4) until the voltage drop across plate load resistor R123 or R124 (See Figure 6-7) is 45 volts with the beam vertically centered on the cathode ray tube. For the horizontal amplifier, BIAS ADJ. R141 (See Figure 6-3) should be adjusted until the voltage drop across plate load resistor R145 or R146 (See Figure 6-7) is 90 volts when the beam is horizontally centered on the cathode ray tube.

If, after the bias adjustment indicated above, the vertical amplifier still exhibits excessive crowding, readjustment of LINEARITY control R121 would be advisable. Crowding is the term used for non-linearity of the pattern height with changes in positioning. For example, a one-half inch pattern obtained in the center of the screen may be appreciably less than one-half inch when positioned to the top or bottom of the screen. To readjust LINEARITY control R121, feed a test signal into the vertical amplifier and adjust the trace until it is approximately one-half inch high and positioned to the top or bottom of the cathode ray tube. Adjust R121 (See Figure 3-4) for maximum deflection.

(2) SHIFTING OF THE BEAM WITH GAIN CONTROL SETTINGS ON DC ATTENUATOR POSITION—When the vertical or horizontal attenuators are in the DC position and no signal is being fed into the DC input, the beam should not shift appreciably when the GAIN control is rotated. If the beam shifts vertically or horizontally it would be advisable to readjust potentiometers R112 (See Figure 6-2) or R135 (See Figure 6-3) respectively. The easiest way to accomplish this is to center the beam with the POSITIONING control while the GAIN control is in its extreme counter-clockwise position, with no signal applied to the amplifier, and with the intensity reduced so as not to burn a hole in the cathode ray tube screen. Then, turn the GAIN control to its extreme clockwise position and re-center the beam with potentiometer R112 (vertical) or R135 (horizontal), depending upon whether the beam moves vertically or horizontally. This process may have to be repeated more than once.

(3) POSITIONING CONTROLS INCAPABLE OF SWINGING THE BEAM OFF SCREEN IN ONE DIRECTION—If replacement tubes used in the horizontal or vertical DC amplifiers are badly unbalanced, a condition might result in which the POSITIONING control is not capable of positioning the beam off screen in one direction. If this condition arises, the unbalanced tube should be replaced. In an emergency resistors R114 (See Figure 6-7) (vertical) or R187 (See Figure 6-7) (horizontal) may be changed in value until the beam will swing off screen in both directions. These resistors are 560K, 10%, ½ watt, carbon as originally supplied in the oscilloscope and any replacement should be the same type (carbon) but could range in value anywhere from 330K to 4.7 megohm.

(4) LACK OF FREQUENCY RESPONSE, SQUARE WAVE ROUNDING, OR EXCESSIVE SQUARE WAVE OVERSHOOT (See Figures 6-4, 6-5 and 6-6)—In making any adjustments of the frequency characteristics of the amplifiers or the compensation of the attenuators, it is important that a good quality square wave generator be used in order to insure good pulse response.

With a 100 kc square wave on the vertical amplifier, and the attenuator in the AC divide by 1 (AC-1) position, the trace should exhibit a fast rise time and about

TABLE 6-2—Alignment Chart for Major Component Replacement.

COMPONENT REPLACED	SYMPTOMS SHOWING NEED FOR ALIGNMENT	PART TO BE ALIGNED	ALIGNMENT PROCEDURE
V102, V103 or V104	Lack of Sensitivity, Insufficient Positioning, Crowding, or Poor Focus (Astigmatic Condition) on Vertical Amplifier.	Bias. Adj. R119	Adjust R119 until drop across plate load resistor R123 or R124 is 45 volts with the beam vertically centered on the cathode ray tube.
	Crowding after the bias adjustment indicated above.	Linearity Control R121	Feed a test signal into the vertical amplifier and adjust the trace until it is approximately one-half inch high and positioned to the top or bottom of the cathode ray tube. Adjust R121 for maximum deflection.
V106 or V107	Lack of Sensitivity, Insufficient Positioning, Crowding, or Poor Focus (Astigmatic Condition) on Horizontal Amplifier.	Bias Adj. R141	Adjust R141 until drop across plate load resistor R145 or R146 is 90 volts when the beam is horizontally centered on the cathode ray tube.
V102 or V106	Shifting of the Beam with Gain Control Settings on DC Attenuator Position.	R112 (Vertical) R135 (Horizontal)	With the gain control counter-clockwise, center the beam wth positioning control. Then run the gain control clockwise and re-center the beam with R112 (Vertical) or R135 (Horizontal).
V102, V106 or V107	Positioning Controls Incapable of Swinging Beam off Screen in One Direction.		Replace unbalanced tube or in case of emergency change resistors R114 (Vertical) or R187 (Horizontal).
V102, V103, V104, V106 or V107	Lack of Frequency response, square wave rounding, or excessive square wave overshoot in the AC divide by 1 (AC-1) attenuator position.	C109 (Vertical) or C119 (Horizontal)	With 100KC square wave, adjust C109 (Vertical) for 3% overshoot. With 25KC 3 square wave, adjust C119 (Horizontal) for 3% overshoot.
Any Attenuator Components	Square wave rounding or excessive square wave overshoot in the (AC-10) or (AC-100) attenuator positions.	C101 (Vertical AC-10) C102 (Vertical AC-100) C111 (Horizontal AC-10) C112 (Horizontal AC-100)	With square wave, adjust attenuator trimmer condensers until the trace appears normal.

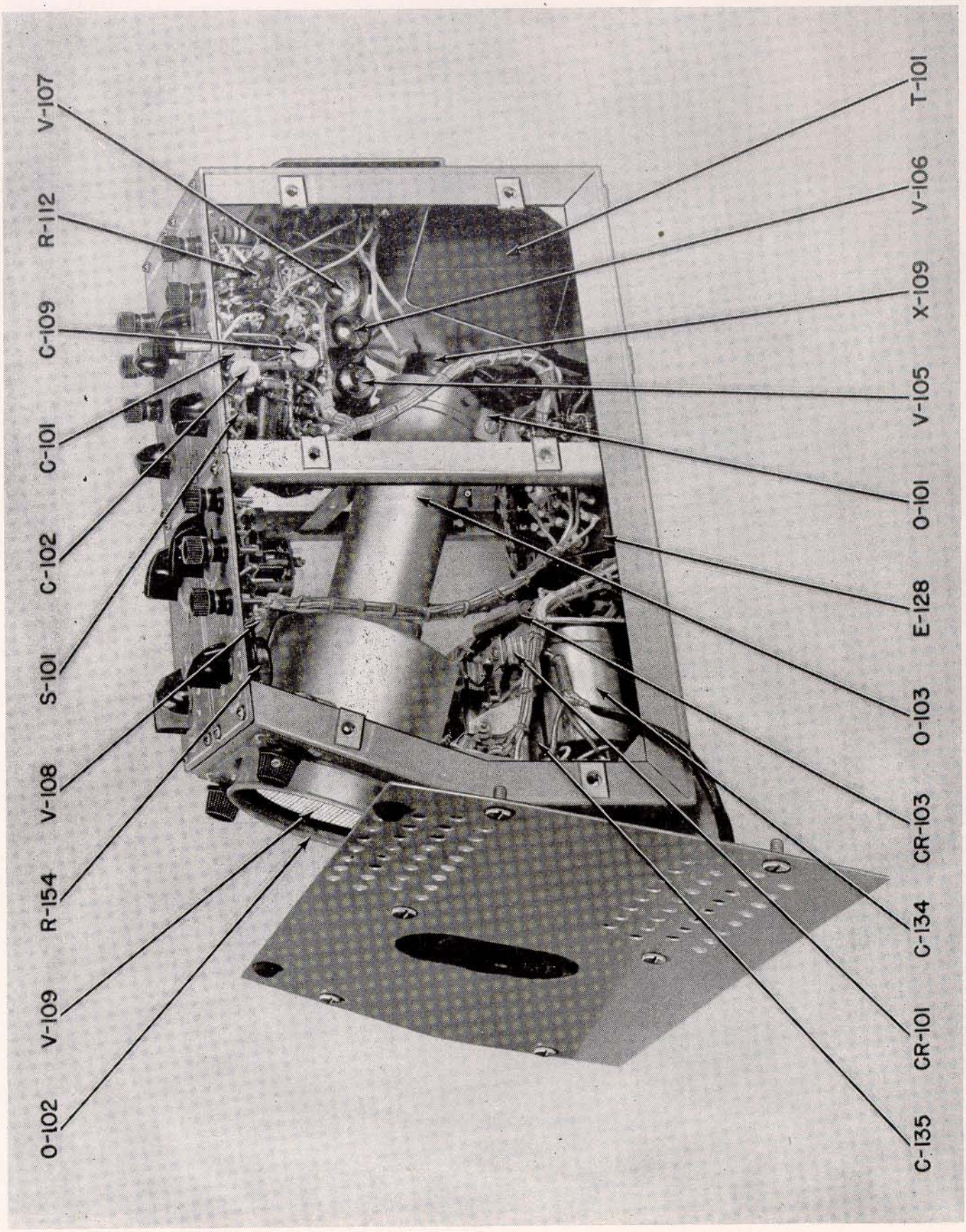


Figure 6-2. OS-8B/U, Right Side View, Cover and Side Panel Removed

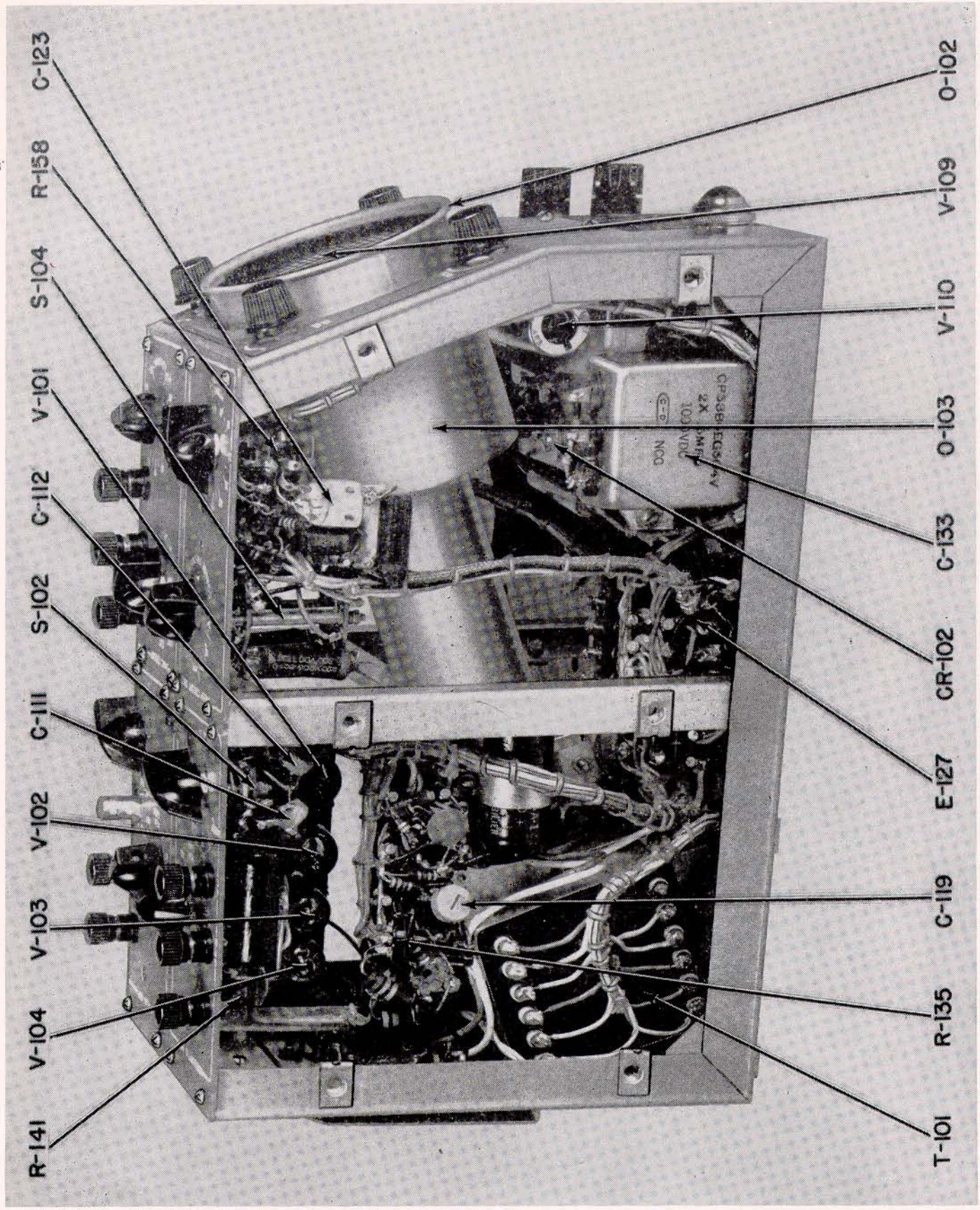


Figure 6-3. OS-8B/U, Left Side View, Cover and Side Panel Removed

3% overshoot as indicated in Figure 6-6. If the trace exhibits rounding as in Figure 6-4, or excessive overshoot as in Figure 6-5, readjustment of trimmer condenser C109 (See Figure 6-2) would be advisable. If, after the adjustment indicated above, the square wave trace appears distorted on the AC divide by 10 (AC-10) position, adjust trimmer condenser C101 (See Figure 6-2) until the trace appears normal as in Figure 6-6. If the distortion appears on the AC divide by 100 (AC-100) position, adjust C102 (See Figure 6-2) as above.

With the vertical amplifier driven by a sawtooth from an external source to provide a vertical sweep, the horizontal attenuator in the AC divide by 1 (AC-1) position, and a 25 kc square wave on the horizontal amplifier, the trace should exhibit a fast rise time and about 3% overshoot as indicated in Figure 6-6. If the trace exhibits rounding as in Figure 6-4, or excessive overshoot as in Figure 6-5, readjustment of trimmer condenser C119 (See Figure 6-3) would be advisable. If, after the adjustment indicated above, the square wave trace appears distorted on the AC divide by 10 (AC-10) position, adjust trimmer condenser C111 (See Figure 6-3) until the trace looks normal as in Figure 6-6. If the distortion appears on the AC divide by 100 (AC-100) position, adjust trimmer C112 (See Figure 6-3) as above.

e. MAKING REPLACEMENTS WITH COMPONENT PARTS OTHER THAN THOSE CALLED FOR IN THE PARTS LIST.

(1) E101 may be made from Standard Navy Stock Number N17-P-69135-8011 by cutting off the excessive stud length.

(2) X101 and X103 may be made from Standard Navy Stock numbers N16-S-64063-6717 and N16-S-62063-6693 respectively by cutting off the ground ears and removing the center shield.

(3) When replacing X109 socket, check the color coding on replacement socket and make any necessary notes as to changes before removing the old socket.

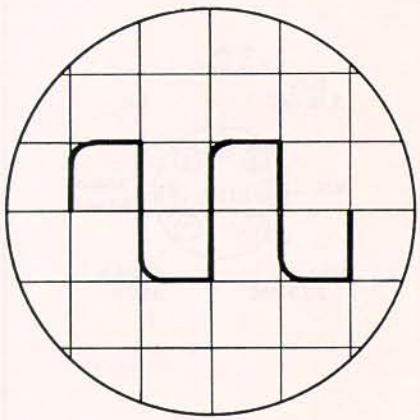


Figure 6-4

Square wave exhibiting excessive rounding. UNDER-COMPENSATED

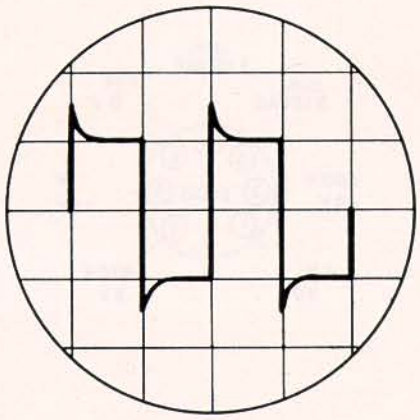


Figure 6-5

Square wave exhibiting excessive overshoot. OVER-COMPENSATED

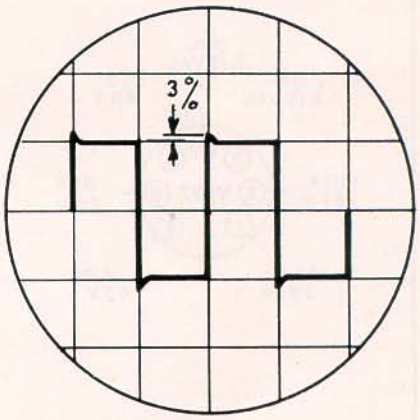
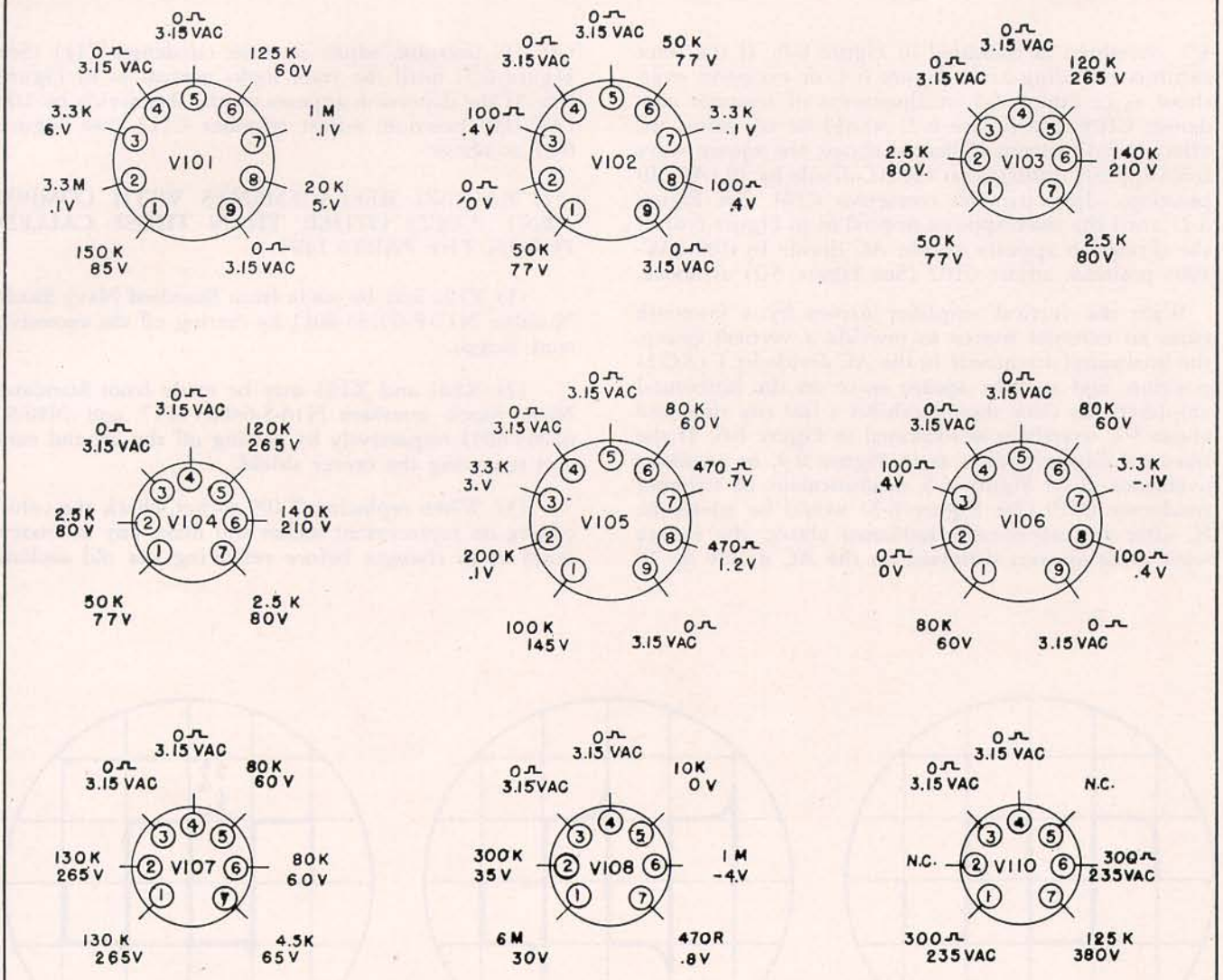


Figure 6-6

Square wave exhibiting 3% overshoot. CORRECT ADJUSTMENT

Figure 6-7. Pictorial Wiring Diagram.
Large drawing found in envelope in back of book.



* VOLTAGE MEASUREMENTS TAKEN WITH CONTROLS IN FOLLOWING POSITIONS:-

——VERT. AMP.——

GAIN SET AT 0, ATTENUATOR SET AT AC X 1.

——HOR. AMP.——

GAIN SET AT 0, ATTENUATOR SET AT SWEEP.

——SYNC. CIRCUIT——

SELECTOR SET AT INTENSITY, LOCKING SET AT +50.

—SWEEP CIRCUIT OSC.—

COARSE FREQUENCY SET AT 100-475, VERNIER FREQUENCY SET AT 0.

D.C.V. READINGS WERE TAKEN WITH A 20,000Ω PER VOLT METER.

A.C.V. READINGS WERE TAKEN WITH A 1,000Ω PER VOLT METER.

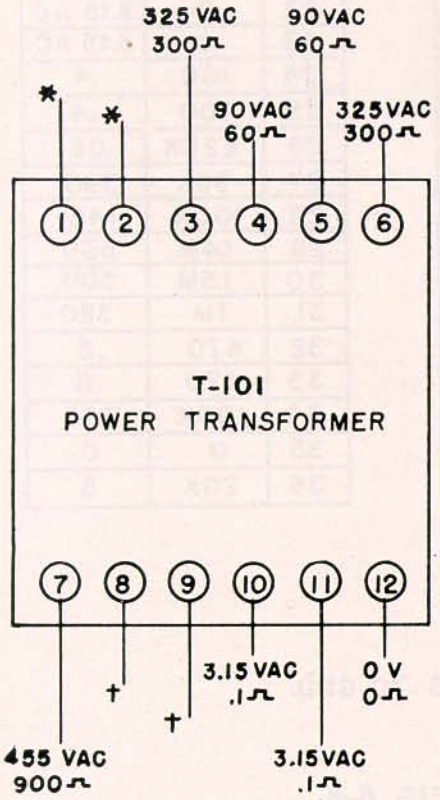
ALL TEST LEADS DISCONNECTED.

RESISTANCE MEASUREMENTS TAKEN WITH CONTROLS IN POSITION FOR VOLTAGE MEASUREMENTS BUT WITH LINE POWER CORD REMOVED.

*VOLTAGES BETWEEN THESE POINTS ARE 6.3 VAC.

ALL OTHER VOLTAGES AND RESISTANCE READINGS MADE TO GROUND.

Figure 6-8. Tube Socket Voltage and Resistance Measurements



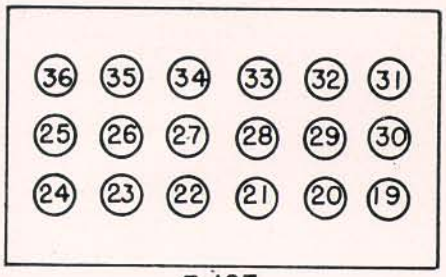
*BETWEEN PINS 1+2 115 VAC, 7Ω

†BETWEEN PINS 8+9 6.3 VAC, .6Ω

READING ON ALL OTHER TEMINALS TO GND.

ACV READ WITH 1000Ω PER VOLT METER, LINE VOLTAGE 115 V., CONTROLS SET AS IN FIG. 6-8.

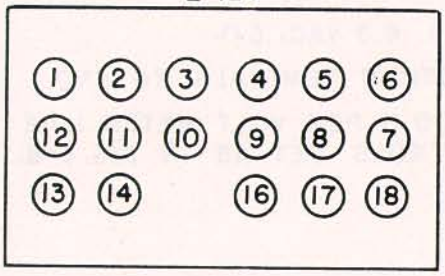
Figure 6-9. Power Transformer Voltage and Resistance Measurements



E-127

DISTRIBUTION BOARDS

E-128



	NO.	Ω	V.
	1	100	.4
	2	0	3.15 AC
	3	0	3.15 AC
	4	50K	87
	5	1.5M	520
	6	3M	480
†	7	—	—
	8	80K	310
†	9	—	—
	10	150K	85
	11	150K	210
	12	1M	.1
	13	20K	5
	14	125K	60
	16	470	.8
	17	0	0
	18	175K	265

NO.	Ω	V.
19	80K	60
20	1.5M	520
21	50K	87
22	0	3.15 AC
23	0	3.15 AC
24	100	.4
25	100	.4
26	220K	.06
27	90K	360
28	100K	145
29	1.4M	535
30	1.5M	500
31	1M	320
32	470	.8
33	470	.8
34	100K	360
35	0	0
36	20K	5

†BETWEEN PINS 7+9 6.3 VAC., .8Ω.

ALL OTHER VOLTAGES AND RESISTANCES TO GND.

ACV READ WITH 1000 Ω PER VOLT METER,
DCV READ WITH 20,000 Ω PER VOLT METER,
LINE VOLTAGE 115 V., CONTROLS SET AS IN FIG. 6-8.

Figure 6-10. Distribution Board Voltage and Resistance Measurements

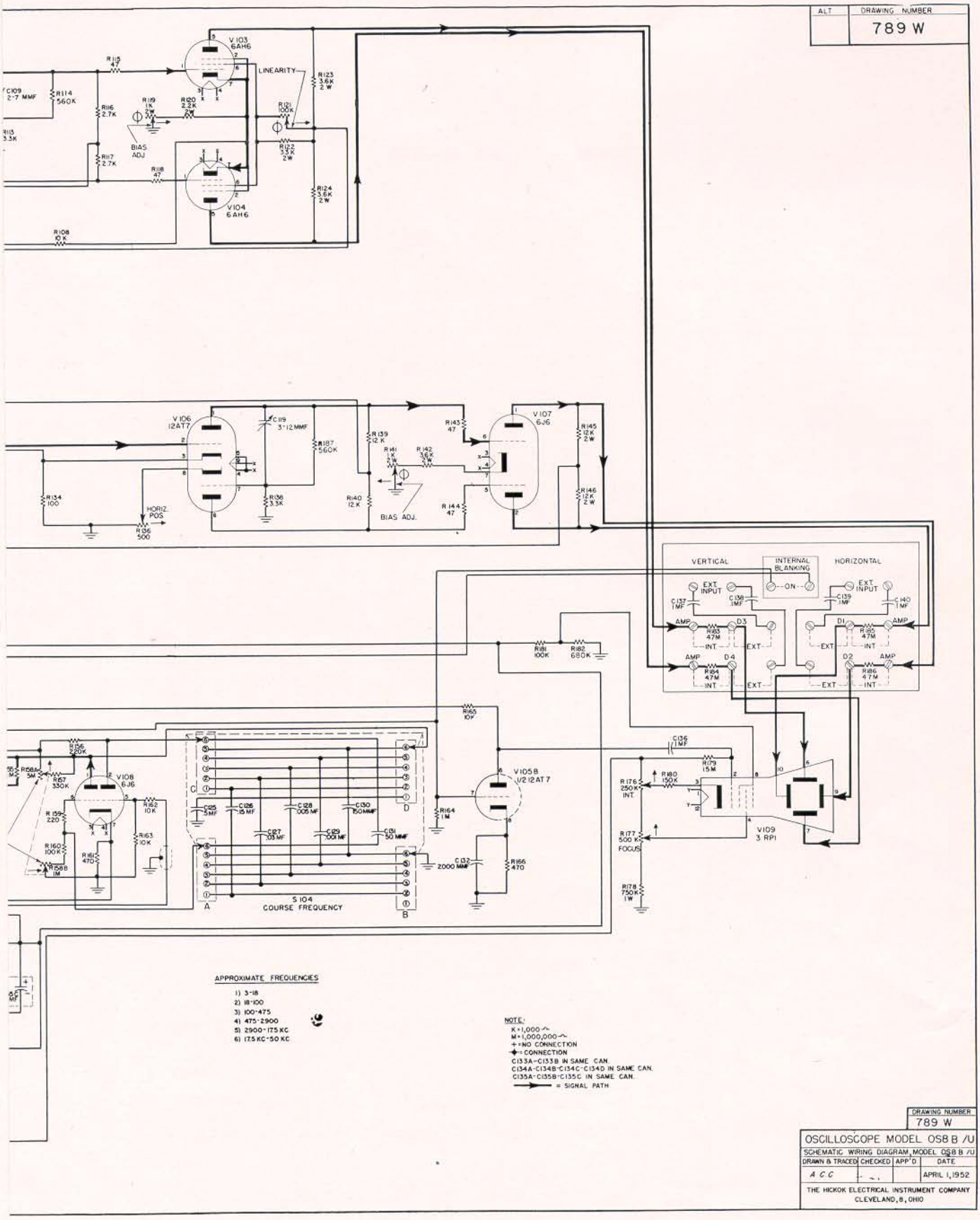
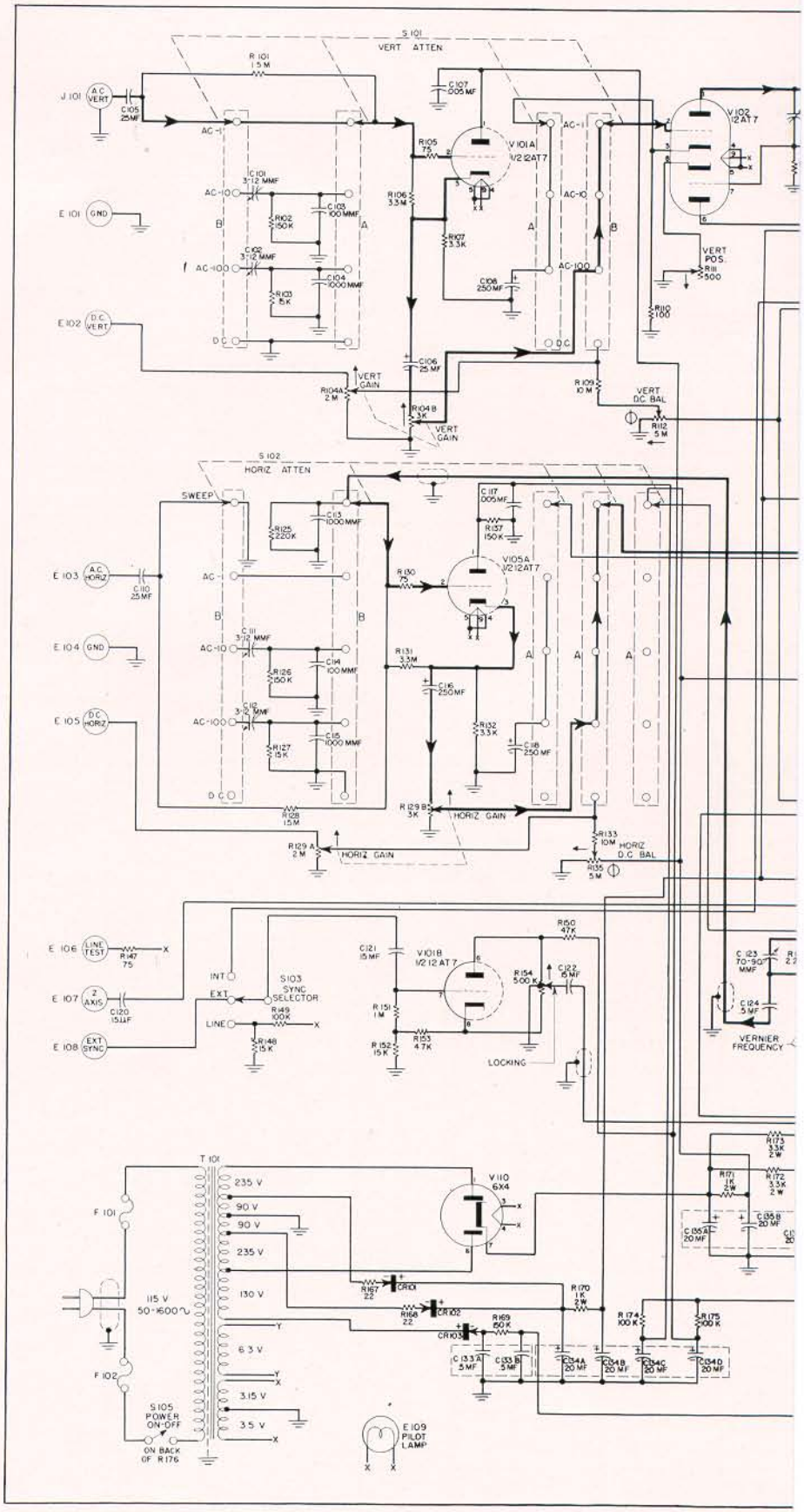


Figure 6-11. Oscilloscope OS-8B/U, Schematic Wiring Diagram


S 101
VERT ATTEN
R 101
1.5 M
J 101
A C VERT
C105
25MF
E 101
GND
E 102
D C VERT
C107
005 MF
V 102
12 AT 7
V 101A
1/2 12AT7
R105
75
R106
3.3M
R107
3.3K
C108
250MF
VERT
POS.
R111
500
R110
100
C106
25 MF
VERT
GAIN
R104A
2 M
R104B
3K
VERT
GAIN
R109
10 M
VERT
D.C. BAL
R112
5 M
S 102
HORIZ ATTEN
SWEEP
E 103
A C HORIZ
C110
25MF
E 104
GND
E 105
D C HORIZ
C117
005MF
R157
150K
R125
220K
C113
1000MMF
V105A
1/2 12AT7
R130
75
R131
3.3M
C116
250MF
R132
3.3K
C118
250 MF
R128
1.5M
R129B
5K
HORIZ GAIN
R129A
2 M
HORIZ GAIN
R133
10M
HORIZ
D.C. BAL
R135
5M
E 106
LINE TEST
R147
75
E 107
Z AXIS
C120
.15MF
E 108
EXT SYNC
INT
EXT
LINE
S103
SYNC
SELECTOR
R149
100K
R148
15K
C121
.15MF
V101B
1/2 12 AT 7
R154
500 K
C122
.15 MF
R151
1M
R153
4.7K
R152
15K
R150
47K
LOCKING
C123
70-90
MMF
C124
.5MF
VERNIER
FREQUENCY
T 101
F 101
115 V
50-1600~
F 102
S105
POWER
ON-OFF
ON BACK
OF R176
235 V
90 V
90 V
235 V
130 V
6.3 V
3.15 V
3.5 V
V 110
6X4
R167
22
R168
22
CR101
CR102
CR103
R169
150 K
R170
1K
2W
R174
100 K
R175
100 K
R171
1K
2W
R172
3.5K
2W
R173
3.5K
2W
C135A
20 MF
C135B
20 MF
C133A
.5 MF
C133B
.5 MF
C134A
20 MF
C134B
20 MF
C134C
20 MF
C134D
20 MF
E 109
PILOT
LAMP

SECTION 7

PARTS LIST

TABLE 7-1. LIST OF MAJOR UNITS

SYMBOL GROUP	QUANTITY	NAME OF MAJOR UNIT	DESIGNATION
100	1	Oscilloscope	OS-8B/U

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
A-101	CASE: portable; water-tight enclosure for OS-8B/U Oscilloscope; aluminum, gray enamel finish; 6″ wd x 9″ high x 13½″ deep; one folding handle on top; four latch fasteners to secure cover to bottom; water seal between cover and bottom. Consists of A-101A, A-101B, A-101C, A-101D.	Protective carrying case for unit when not in use		*		Part No. 3145-273	A-101	1
A-101A	COVER—Part of A-101			*				1
A-101B	BOTTOM—Part of A-101			*				1
A-101C	LATCH, FASTENER—Part of A-101			#	Neilson Mfg. Co. HC-202 Latch			2
A-101D	CATCH, FASTENER—Part of A-101			#	Neilson Mfg. Co. HC-202 Catch			2
A-102	CABINET: housing for OS-8 B/U Oscilloscope; aluminum, gray enamel finish; empty; 5¼″ wide x 7⅜″ high x 11 15/16″ deep o/a; upper section of front slopes 20° for cathode ray tube; single compartment; mtg holes for components of equipment; removable side panels secured by captive screws.	Structural housing and chassis for all assemblies and components in the oscilloscope		*		Part No. 3145-272	A-102	1
A-103	MOUNTING: rubber, molded in steel plate; attaches to equipment by four .141″ mtg holes spaced 1″ C to C, attaches to supporting base by one 8-32 screw; for 4.5 lb. load.	Rear shock cushion between case and structural housing		N17-M-74978-7591	Lord # J-5695-1	Part No. 19200-3	A-103, A-104	2
A-104	Same as A-103	Same as A-103						
A-105	MOUNTING: rubber, molded in steel plate; attaches to equipment by four mtg holes .141″ diam, attaches to supporting base by one 8-32 screw; for 2 lb. load.	Front shock cushion between case and structural housing		N17-M-74937-9501	Lord # J-5695-2	Part No. 19200-4	A-105, A-106	2
A-106	Same as A-105	Same as A-105						

C-101	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: rotary type, single section 3-12 mmf capacity; 500 vdcw; .531 in. diam., .218 in. thick; two solder lug terminals on bottom; unit mtg. by means of solder lugs; screw driver adjustment.	Adjustable frequency compensating capacitor for AC-10 position of vertical attenuator	N16-C-63934-8109	Centralab Type DA-827-000	Part No. X-3115-10	C-101, C-102, C-111, C-112, C-119	5
C-102	Same as C-101	Adjustable frequency compensating capacitor for AC-100 position of vertical attenuator					
C-103	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100 mmf p/m 10%; 500 vdcw; zero temp. coef.; insulated; approx. dimensions .885″ lg. x .255″ diam.; two radial wire leads.	Fixed frequency compensating capacitor for AC-10 position of vertical attenuator	N16-C-17082-4829	Centralab Type TC-32A	Part No. X-3110-31	C-103, C-114	2
C-104	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1000 mmf p/m 20%; insulated; dimensions .530″ lg. x .260″ diam. approx; two radial wire leads.	Fixed frequency compensating capacitor for AC-100 position of vertical attenuator	N16-C-18659-7736	Centralab Type BC-20A	Part No. X-3110-28	C-104, C-113, C-115, C-129	4
C-105	CAPACITOR, FIXED, PAPER DIELECTRIC: 250,000 mmf —10%+20%; 600 vdcw; paper case; 1⅛″ lg. x ⅝″ diam; two axial wire leads; mineral wax impregnated.	Blocking capacitor for vertical input		Aerovox Type P82	Part No. X-3105-161	C-105, C-110	2
C-106	CAPACITOR, FIXED, ELECTROLYTIC: 25 mfd; 25 vdcw; 1¼″ lg. x 7/16″ diam; two axial wire leads both insulated from case; tubular metal case with vinyl sleeve.	Blocking capacitor from vertical cathode follower to first vertical D.C. amplifier	N16-C-19781-4701	Sprague Type D17032	Part No. X-3085-59	C-106	1
C-107	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 5000 mmf guaranteed minimum capacity; 500 vdcw; disc type 19/32″ diam. x 5/32″ thk. approx.; two radial wire leads; phenolic insulation.	High frequency bypass capacitor for plate of vertical cathode follower		Centralab Type DA-048-001A	X-3110-7	C-107, C-117	2

*NOTE: Not furnished as a maintenance part. If failure occurs, do not request replacement unless the item can not be repaired or fabricated.
#NOTE: Listed for reference only.

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
C-108	CAPACITOR, FIXED, ELECTROLYTIC: 250 mfd; 6 vdcw; tubular metal case with insulating sleeve; 1 1/16" lg x 5/8" diam; two axial wire leads; negative lead grounded to case; metal mtg. strap with one 5/32" diam. mtg. hole.	Cathode bypass capacitor for first vertical D.C. amplifier		N16-C20303-1201	Cornell-Dubilier Type BRV -6025-1	Part No. X-3085-58	C-108, C-118	2
C-109	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: single section; rotary type 2-7 mmf capacity; 500 vdcw; .531 in diam., .218 in. thick; two solder lug terminals on bottom; unit mtg. by means of solder lugs; screw driver adjustment.	Adjustable frequency compensating capacitor for first vertical D.C. amplifier			Centralab Type DA 827	X-3115-12	C-109	1
C-110	Same as C-105	Blocking capacitor for horizontal input						
C-111	Same as C-101	Adjustable frequency compensating capacitor for AC-10 position of horizontal attenuator						
C-112	Same as C-101	Adjustable frequency compensating capacitor for AC-100 position of horizontal attenuator						
C-113	Same as C-104	Fixed frequency compensating capacitor for sweep circuit oscillator decoupling network						
C-114	Same as C-103	Fixed frequency compensating capacitor for AC-10 position of horizontal attenuator						
C-115	Same as C-104	Fixed frequency compensating capacitor for AC-100 position of horizontal attenuator						

C-116	CAPACITOR, FIXED, ELECTROLYTIC: 250 mfd; 25 vdcw; tubular metal case with insulating sleeve; 2″ lg. x 7/8″ diam; two axial wire leads; negative lead connected to case; metal mtg. strap with one 5/32″ diam. mtg. hole.	Blocking capacitor from horizontal cathode follower to first horizontal D.C. amplifier		N16-C-20506-6081	Cornell-Dubilier Type BRV -2525 A-1	Part No. X-3085-57	C-116	1
C-117	Same as C-107	High frequency bypass capacitor for plate of horizontal cathode follower						
C-118	Same as C-103	Cathode bypass capacitor for first horizontal D.C. amplifier						
C-119	Same as C-101	Adjustable frequency compensating capacitor for first horizontal D.C. amplifier						
C-120	CAPACITOR, FIXED, PAPER DIELECTRIC: 150,000 mmf p/m 10%; 200 vdcw; tubular paper case; 5/8″ lg. x 15/32″ diam.; mineral wax impregnated; 2 axial wire leads.	Blocking capacitor for Z axis input			Aerovox Type P-82	Part No. X-3105-113 Dwg. No. X-3105-103	C-120, C-121 C-122	3
C-121	Same as C-120	Blocking capacitor for sync. amplifier input						
C-122	Same as C-120	Blocking capacitor from locking control to synchronization grid of sweep circuit oscillator						
C-123	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: rotary type single section; 70-90 mmf capacity; 500 vdcw; .835 lg. x .610 wd. x .137 thk. approx; two solder lug terminals on back; two .120″ diam. mtg. holes 3/8″ c to c; screw driver slot adjustment.	Adjustable frequency compensating capacitor for sweep circuit oscillator decoupling network			Centralab Type 820G	Part No. X-3115-11	C-123	1
C-124	CAPACITOR, FIXED, PAPER DIELECTRIC: 500,000 mmf p/m 10%; 200 vdcw; tubular paper case; 1 1/8″ lg. x 15/32″ diam.; mineral wax impregnated; two axial wire leads.	Blocking capacitor from sweep circuit oscillator to horizontal cathode follower		♦	Aerovox Type P-82	Part No. X-3105-112 Dwg. No. X-3105-103	C-124, C-125	2

♦ NOTE: For replacement, specify maximum allowable dimensions of 15/32″ diam. x 1 1/8″ lg.

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
C-125	Same as C-124	Sweep circuit oscillator plate discharge capacitor on 3-18 range						
C-126	CAPACITOR, FIXED, PAPER DIELECTRIC: .15 mfd, 200v. ±20%; .400 x 1⅜" lg; hermetically sealed metal case; 2 axial wire leads.	Sweep circuit oscillator plate discharge capacitor on 18-100 range and grid coupling capacitor on 3-18 range			Astron type AQF	X-3105-162	C-126	1
C-127	CAPACITOR, FIXED, PAPER DIELECTRIC: 300,000 mmf p/m 20%; 200V; .312 dia. x ⅞" lg; hermetically sealed metal case; 2 axial wire leads.	Sweep circuit oscillator plate discharge capacitor on 100-475 range and grid coupling capacitor on 18-100 range			Astron type AQF	X-3105-163	C-127	1
C-128	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 5000 mmf p/m 20%; 500 vdcw; phenolic coating; 1.200" lg. x .330" diam.; two radial wire leads; high K ceramic dielectric.	Sweep circuit oscillator plate discharge capacitor on 475-2900 range and grid coupling capacitor on 100-475 range		N16-C-19011-7855	Centralab Type BC-35A	Part No. X-3110-32	C-128	1
C-129	Same as C-104	Sweep circuit oscillator plate discharge capacitor on 2900-17, 5KC range and grid coupling capacitor on 475-2900 range						
C-130	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 150 mmf p/m 10%; 500 vdcw; zero temp. coef; phenolic coating; 1.180" lg., .310 diam; two radial wire leads.	Sweep circuit oscillator plate discharge capacitor on 17.5-50 KC range and grid coupling capacitor on 2900-17.5 range		N16-C-17402-6004	Centralab Type TC-35A-NPO	Part No. X-3110-30	C-130	1
C-131	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 50 mmf p/m 10%; 500 vdcw; zero temp. coef; phenolic coating; .750" lg. x .230 diam.; two radial wire leads.	Sweep circuit oscillator grid coupling capacitor on 17.5-50KC range		N16-C-16570-4284	Centralab Type TC-25A -NPO	Part No. X-3110-27	C-131	1

C-132	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 2000 mmf p/m 20%; 500 vdcw; phenolic coating; .810″ lg. x .260″ diam.; two radial wire leads; high K ceramic dielectric.	Z axis amplifier cathode bypass for high frequency compensation		N16-C-18883-8854	Centralab Type BC-25A	Part No. X-3110-29	C-132	1
C-133	CAPACITOR, FIXED, PAPER DIELECTRIC: 2 sections; 500,000 mmf plus 20 minus 10% each section; 1000 vdcw; hermetically sealed metal case; 2″ lg. x 2″ wd. x 1⅛″ high; oil impregnated and filled; three solder lug terminals ¾″ high on side of case, 17/32″ c to c on insulated bases; no internal ground connection; two mtg. holes 3/16″ diam. 2⅜″ c to c; Spec. JAN-C-25; consists of C-133A and C-133B.	Two section filter capacitor for high voltage rectifier	CP53B4-EG504V	N16-C-53697-7565	Cornell-Dubilier Type CD-CP53-B4EG-504V	Part No. X-3105-124	C-133, C-133A C-133B	1
C-133A	Part of C-133			#				
C-133B	Part of C-133			#				
C-134	CAPACITOR, FIXED, ELECTROLYTIC: 4 section 20 mfd per section; 150 vdcw for all sections; tubular metal case; 2 1/16″ lg. x 1⅜″ diam; 4 solder lug terminals on bottom of case; negative terminal connected to case internally; twist lug mtg. Consists of C-134A, C-134B, C-134C, C-134D.				P. R. Mallory Type FP	Part No. X-3085-55	C-134, C-134A C-134B, C-134C C-134D	1
C-134A	Part of C-134	Filter capacitor for low voltage power supply		#				
C-134B	Part of C-134	Filter capacitor for low voltage power supply		#				
C-134C	Part of C-134	Decoupling capacitor for horizontal cathode follower		#				
C-134D	Part of C-134	Decoupling capacitor for vertical cathode follower		#				

NOTE: Listed for reference only.

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
C-135	CAPACITOR, FIXED, ELECTROLYTIC: 3 sections; 20 mfd per section; 450 vdcw all sections; tubular metal case $2\frac{9}{16}$" lg. x $1\frac{3}{8}$" diam.; 3 soldering terminals connected to case internally; twist lug mounting. Consists of C-135A, C-135B, and C-135C.	Multiple filter capacitor for intermediate power supply			P. R. Mallory Type FP	Part No. X-3085-56	C-135, C-135A C-135B, C-135C	1
C-135A	Part of C-135			#				
C-135B	Part of C-135			#				
C-135C	Part of C-135			#				
C-136	CAPACITOR, FIXED, CERAMIC DIELECTRIC: .1 mfd, 600v. G.M.V.; $1\frac{9}{32}$" x $\frac{27}{32}$" x $\frac{1}{8}$" thick; two wire leads; durez coating.	Blocking capacitor for cathode ray tube grid pin Z of V109			Centralab flat plate Hi Kap type DF-104	X-3110-33	C-136	1
C-137	CAPACITOR, FIXED, PAPER DIELECTRIC: 100,000 mmf p/m 20%; 400 vdcw; tubular paper case; $1\frac{1}{8}$" lg. x $\frac{15}{32}$" diam.; mineral wax impregnated; two axial wire leads.	Decoupling capacitor for external connection to deflection plate D-3 Pin 6 of cathode ray tube V109		♦N16-C-45805-4321	Aerovox Type P-82	Part No. X-3105-135	C-137, C-138, C-139, C-140	4
C-138	Same as C-137	Decoupling capacitor for external connection to deflection plate D-4 Pin 7 of cathode ray tube V109						
C-139	Same as C-137	Decoupling capacitor for external connection to deflection plate D-2 Pin 11 of cathode ray tube V109						
C-140	Same as C-137	Decoupling capacitor for external connection to deflection plate D-1 Pin 10 of cathode ray tube V109						

CR-101	RECTIFIER, METALLIC: selenium; single phase half wave; input 130 volts ac RMS max.; output 125 volts dc at 20 ma max.; ½″ x ½″ x 9/16″ thk.; center mtg. hole for 6-32 screw; 2 solder lug terminals.	Low Voltage Rectifier		N17-R-51401-8431	Selectron Type 8Y1	Part No. X-18150-18	CR-101, CR-102	2
CR-102	Same as CR-101	Low Voltage Rectifier						
CR-103	RECTIFIER, METALLIC: selenium; single phase half wave; input 1650 volts max. inverse peak at frequencies up to 15,000 cycles; output 800 volts dc at 1.5 ma max. current; two axial wire leads.	High Voltage Rectifier		N17-R-51557-1075	Conant Laboratories No. SE1H45-TUA	Part No. X-18150-22	CR-103	1
E-101	POST, BINDING: screw type no engraving; knob ½″ diam. x 7/16″ high, base 7/32″ diam. x ¼″ thk.; overall height fully extended from mtg. surface ⅞″, 6-32 x 5/16″ lg. threaded stud; knob and base molded of black phenolic; 3/16″ neck with 3/32″ diam. wire hole; flatted boss on .300″ across flats x 11/32″ lg. x 1/32″ thk.; flats on boss parallel with wire hole in neck; non-removable knob.	Vertical amplifier ground connection			EBY #38 Ensign except for stud length	Part No. X-2360-56	E-101, E-102, E-103, E-104, E-105, E-106, E-107, E-108	8
E-102	Same as E-101	Vertical amplifier D.C. input connection						
E-103	Same as E-101	Horizontal amplifier A.C. input connection						
E-104	Same as E-101	Horizontal amplifier ground connection						
E-105	Same as E-101	Horizontal amplifier D.C. input connection						
E-106	Same as E-101	Line test output connection						
E-107	Same as E-101	Z axis input connection						
E-108	Same as E-101	External sync. connection						

♦ NOTE: For replacement, specify maximum allowable dimensions of 15/32″ diam. x 1⅛″ lg.
NOTE: Listed for reference only.

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
E-109	LAMP INCANDESCENT: 6 to 8 volts @ .15 amp; bulb T-3¼ clear; 1⅛″ long; miniature bayonet base; C-2 filament; burn any position; brown bead.	Pilot light		N17-L-6297 2Z5952	General Electric Type #47	Part No. 12270-12	E-109	1
E-110	BOARD, TERMINAL: asasembly; phenolic board; 18 terminals, screw type, 4½″ lg, 3″ wide, 3/32″ thk. excluding terminals.	To provide external connection to cathode ray tube deflection plates		*		Part/Dwg. #2420-175	E-110	1
E-111	HOLDER FUSE: extractor post type; rated 15 amp. @ 250 V; accommodates one cartridge type fuse 1¼″ lg. x ¼″ diam; molded black phenolic body; 141/64″ lg. x 11/16″ diam; beryllium copper contacts; two solder lug terminals; mounts in single ½″ diam. hole.	Holder for F-101			Littlefuse Type A-342003	Part No. X-8825-51	E-111, E-112	2
E-112	Same as E-111	Holder for F-102						
E-113	TERMINAL, STUD: insulated solder connection; brass, silver plated; 13/16″ lg o/a, 5/16″ hex base; mounts by 6-32 threaded shank ¼″ lg; ceramic insulation.	Insulated terminal for mounting CR-103		N17-T-28218	Cambridge Thermionic X-1581B	Part No. 20340-16	E-113, E-114	2
E-114	Same as E-113	Insulated terminal for mounting CR-103						
E-115 through E-122	TERMINAL, STUD: insulated solder connection; brass tin dipped; .16″ lg. o/a; .156″ hex base; mounts by 2-56 threaded shank .218″ lg; phenolic insulation.	Insulated terminal for junction of components		N17-T-28224-4101	Garde Mfg. Company	Part No. X-20340-32	E-115, thru E-122, E-125	9
E-123	SHIELD, ELECTRON TUBE: brass, nickel plated; cylindrical; 1¾″ lg x .810 in I.D.; bayonet mtg; includes tension spring; Spec. JAN-S-28A.	Shield for V-108	JAN NO. TS102U02	N16-S34557-8351	American Phenolic No. 5-402	Part No. X-19155-137	E-123	1

E-124	SHIELD, ELECTRON TUBE: brass, nickel plated; cylindrical; 2¼″ lg x .810 in I.D.; bayonet mounting; includes tension spring; Spec. JAN-S-28A.	Shield for V-110	JAN NO. TS102U03	N16-S31607-6039	American Phenolic No. 5-403	Part No. X-19155-138	E-124	1
E-125	Same as E-115	Insulated terminal for junction of components						
E-126	BOARD, TERMINAL: molded phenolic board; 8 rivet type terminals; 4 17/32″ lg. x 1⅜″ wide x ⅛″ thick.	Tube and component mounting board for horizontal amplifier				Part/Dwg. #2420-179	E-126	1
E-127	BOARD, TERMINAL: phenolic board, 18 terminals, 9 double type, 9 single type; 3″ lg, 1½″ wide, 3/32″ thick excluding terminals; left section.	Distribution board—leftside				Part/Dwg. #2420-171	E-127	1
E-128	BOARD, TERMINAL: phenolic board; 17 terminals, 6 single type, 11 double type; 3″ lg, 1½″ wide, 3/32″ thick excluding terminals; right section.	Distribution board—right side				Part/Dwg. #2420-170	E-128	1
E-129	BOARD, TERMINAL: molded phenolic board, 5 rivet type terminals; 4 17/32″ lg., 1⅜″ wide, ⅛″ thick excluding terminals.	Tube and component mounting board for vertical amplifier				Part/Dwg. #2420-177	E-129	1
F-101	FUSE, CARTRIDGE: ¾ Amp @ 250 volts; time delay 135% rated load for 1 hour, 200% for 60 seconds maximum 5 seconds minimum; ferrule type terminals ¼″ diam x ¼″ lg. enclosed glass body; 1¼″ lg x ¼″ diam o/a; one time operation.	Overload protection		N17-F14310-370	Little fuse No. 313. 750	Part No. X-6900-6	F-101, F-102 and 2 spares	4
F-102	Same as F-101	Overload protection						
F-103	Same as F-101	Spare fuse						
F-104	Same as F-101	Spare fuse						
H-101	RETAINER, ELECTRON, TUBE: .035″ diam. stainless steel wire; secures 7 or 9 pin miniature tubes in socket, mtd. by one ⅛″ diam. mtg. hole.	Retainer for V-101				Part/Dwg. #3275-149	H-101 through H-107 inclusive	7
H-102	Same as H-101	Retainer for V-102						
H-103	Same as H-101	Retainer for V-103						
H-104	Same as H-101	Retainer for V-104						

*NOTE: Not furnished as a maintenance part. If failure occurs, do not request replacement unless the item cannot be repaired or fabricated.

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
H-105	Same as H-101	Retainer for V-105						
H-103	Same as H-101	Retainer for V-106						
H-107	Same as H-101	Retainer for V-107						
I-101	LIGHT, INDICATOR: with lens; ½″ diam. red jewel frosted on back only; for miniature bayonet base T 3¼ lamp; open frame, brass nickel plated; 2 5/32″ lg. x 15/16″ diam. o/a; 11/16″ mtg. hole; max. panel thickness ¼″; horizontal mtg. lamp removable from front; slotted jewel holder; two solder lug terminals; polarized disk; consists of I-101A and I-101B.	Indicates power on		N-17-L-76854-4021 2Z5991-144	Drake Type 80	Part No. X-19350-83	I-101	1
I-101A	Socket—part of I-101					X-19350-1C0		
I-101B	Lens—part of I-101					X-19350-161		
J-101	CONNECTOR, RECEPTACLE: one round female contact JAN type UG-290/U.	Vertical amplifier input connection	JAN UG-290/U	N17-C-73108-1267 2Z7390-290	American Phenolic No. 31-003	Part No. X-18075-30	J-101	1
O-101	CLAMP: for CR tube; steel, cadmium plated; one screw type fastener; 1¾″ inside diam. x 5/8″ wide; three radial holes 5/32″ diam to mount rubber bumpers.	Tension clamp for cathode ray tube		*		Part No. 3275-145	O-101	1
O-102	VISOR: for CR tube; aluminum .031″ thick; gray enamel finish; cylindrical; 3⅜″ lg. x 3.415″ approx. o/a; mounts in cathode ray tube shield.	Improve visibility for cathode ray tube V-109		*N16-V-300202-236		Part No. 22400-9	O-102	1
O-103	SHIELD, CATHODE RAY TUBE: aluminum with MU metal insert sleeve; gray enamel finish; 4⅛″ diam x 8.035″ lg approx o/a; four 5/32″ diam mtg holes in flange located on 1.937″ radius 90° apart. Consists of O-103A and O-103B.	Shielded housing for Cathode ray tube		*		Part No. 19155-192	O-103 O-103A O-103B	1

O-103A	SHIELD, CATHODE RAY TUBE: Aluminum housing. Part of O-103.	Machined mounting for O-103B, O-102, and cathode ray tube V-109		*		Part No. 19155-184		
O-103B	SHIELD, CATHODE RAY TUBE: MU metal insert sleeve. Part of O-103.	Isolate cathode ray tube V-109 from stray magnetic fields				Part No. 19155-180		
O-104	SCREEN, CATHODE RAY TUBE: round celluloid 2⅞″ diam x .020″ thk; imprinted with vertical and horizontal lines spaced 10 divisions to the inch; three radial mtg tabs spaced 120° apart to slip between CR tube and visor.	Aid in evaluation of deflection and waveform		N16-S-11701-273 2Z8076-122		Part No. 19020-10	O-104	1
O-105	Not assigned							
O-106	BUMPER: rubber; flat top mushroom type; head ⅜″ diam x 5/32″ thick, shank 3/16″ diam x ⅜″ lg.	Bumper for gripping cathode ray tube V-109 to keep from turning		N17-B-775001-160 2Z1320-25	Continental Rubber No. 5085	Part. No. X-2790-1	O-106, O-107, O-108	3
O-107	Same as O-106	"						
O-108	Same as O-106	"						
O-109	BUMPER- rubber; mushroom type; head ½″ diam x 3/16″ thk; shank 5/16″ diam x ¼″ lg, grooved for 1/16″ panel.	Protection for side panel when mounting cover			Continental Rubber No. R-2084	Part No. X-2790-2	O-109, O-110 O-111, O-112	4
O-110	Same as O-109	"						
O-111	Same as O-109	"						
O-112	Same as O-109	"						
O-113	KNOB: pointer type; black phenolic; for ¼″ diam shaft; single 8-32 set screw; brass insert; white indicator line; 1¼″ lg x ¾″ wd x ⅝″ high o/a.	Vertical attenuator switch knob			Patent Button Works Type S-67	Part No. 11505-53	O-113, O-114, O-115, O-116, O-117, O-118, O-119, O-120	8
O-114	Same as O-113	Vertical gain control knob						
O-115	Same as O-113	Horizontal gain control knob						
O-116	Same as O-113	Horizontal attenuator switch knob						
O-117	Same as O-113	Coarse frequency control knob						

*NOTE: Not furnished as a maintenance part. If failure occurs, do not request replacement unless the item cannot be repaired or fabricated.

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
O-118	Same as O-113	Vernier frequency control knob						
O-119	Same as O-113	Sync. selector control knob						
O-120	Same as O-113	Locking control knob						
O-121	KNOB: round; black phenolic; for ¼″ shaft; single 8-32 set screw; brass insert; no marking.	Vertical positioning control knob		N16-K-700277-348 2Z5822-322	Kurz Kasch No. 230-64	Part No. 11505-11	O-121, O-122, O-123, O-124	4
O-122	Same as O-121	Focus control knob						
O-123	Same as O-121	Intensity control knob						
O-124	Same as O-121	Horizontal positioning control knob						
O-125	CLIP: alligator type; steel cad. plated; 2¼″ lg x ⅜″ wd x ½″ h o/a; red plastic insulated handle; solder loop connection; ⅜″ max. jaw opening.	Replacement part for W-101		N17-C-802584-311 3Z1087-8	Mueller Electric No. 60HS Red	Part No. 3300-9	O-125, O-126	2
O-126	Same as O-125	Replacement part for W-102						
O-127	CLIP: alligator type; steel cad. plated; 2¼″ lg x ⅜″ wd x ½″ h o/a; black plastic insulated handle; solder loop connection; ⅜″ max jaw opening.	Replacement part for W-104		N17-C-802584-284 3Z1087-8.1	Mueller Electric No. 60HS Black	Part No. 3300-10	O-127	1
P-101	CONNECTOR PLUG: one round male contact JAN type UG-88/U.	Replacement Part for W-101	JAN NO. UG-88/U	N17-C-71408-5333 2Z7390-88	American Phenolic No. 31-002	Part No. 16525-91	P-101 P-102	2
P-102	Same as P-101	Replacement Part for W-102						
R-101	RESISTOR, FIXED, COMPOSITION: 1.5 meg; p/m 5%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of voltage dividing network for input of vertical cathode follower	RC20BF-155J	N-16-R-51019-431	Allen Bradley #EB-1555	Part No. #X-18415-151	R-110, R-128	2
R-102	RESISTOR, FIXED, COMPOSITION: 150,000 ohms; p/m 5%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of voltage dividing network for input of vertical cathode follower	RC20BF-154J	N16-R-50677-431	Allen Bradley #EB-1545	Part No. #X-18414-151	R-102, R-126	2

R-103	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; p/m 5%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of voltage dividing network for input of vertical cathode follower	RC20BF-153J	N16-R-50335-431 3RC20BF153J	Allen Bradley #EB-1535	Part No. #X-18413-151	R-103, R-127	2
R-104	RESISTOR, VARIABLE: composition; front section 2 meg p/m 20%, rear section 3000 ohms p/m 20%; ½ watt each section; three solder lug terminals per section; phenolic base, metal cover; 15/16″ diam. 1″ deep, enclosed; round metal shaft ¼″ diam. x ⅝″ lg; linear taper; insulated contact arm, no off position; normal torque; mtg. bushing ⅜″-32 x ¼″ lg; consists of R-104A and R-104B.	Vertical gain control			Mallory	Part No. #X-16925-163	R-104, R-129	2
R-104A	RESISTOR, VARIABLE: 2 meg p/m 20%, Part of R-104.	Vertical gain control for D.C. signals		#				
R-104B	RESISTOR, VARIABLE: 3000 ohms p/m 20%, Part of R-104.	Vertical gain control for A.C. signals		#				
R-105	RESISTOR, FIXED, COMPOSITION: 75 ohms p/m 5%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Parasitic suppression resistor pin 2 of V-101-A	RC20BF-750J	N16-R-49516-431 3RC20BF750J	Allen Bradley #EB-7505	Part No. #X-18410-751	R-105, R-130, R-147	3
R-106	RESISTOR, FIXED, COMPOSITION: 3.3 meg; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Grid return pin 2 of V-101-A	RC20BF-335K	N16-R-51110-811	Allen Bradley #EB-3355	Part #X-18415-332	R-106, R-131	2
R-107	RESISTOR, FIXED, COMPOSITION: 3300 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Cathode load resistor pin 3 of V-101-A	RC20BF-332K	N16-R-50066-811 3RC20BF332K	Allen Bradley #EB-3321	Part #X-18412-332	R-107, R-113, R-132, R-138	4
R-108	RESISTOR, FIXED, COMPOSITION: 10,000 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Isolation resistor for internal sync signal	RC20BF-103K		Allen Bradley #EB-1031	Part #X-18413-102	R-108, R-162, R-163, R-165	4
R-109	RESISTOR, FIXED, COMPOSITION: 10 meg; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Isolation and voltage dropping resistor for cancellation of contact potential at R-104-A	RC20BF-106K	N16-R-50282-811	Allen Bradley #EB-1061	Part #X-18416-102	R-109, R-133	2
R-110	RESISTOR, FIXED, COMPOSITION: 100 ohms; p/m 5%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Cathode bias resistor pin 3 of V-102	RC20BF-101J		Allen Bradley #EB-1015	Part #X-18411-101	R-110, R-134	2

NOTE: Listed for reference only.

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
R-111	RESISTOR, VARIABLE: composition; 500 ohms p/m 20%; ½ watt; three solder lug terminals; phenolic base, metal cover; 15/16″ diam x 15/32″ d; enclosed; round metal shaft ¼″ diam x ⅝″ lg from mtg surface; linear taper; insulated contact arm; no off position; normal torque; mtg. bushing ⅜″-32 x ¼″ lg.	Adjustable cathode bias resistor pin 8 of V-102. Vertical centering control			Chicago Telephone Supply Corp. Type 45	Part #X-16925-167	R-111, R-136	2
R-112	RESISTOR, VARIABLE: composition; 5 megohms p/m 20%; 1/10 watt; 3 solder lug terminals; phenolic body; ⅝″ dia. x .170 max. deep; enclosed; round screw driver slotted shaft 5/32″ dia; normal torque, insulated contact arm, no off position, mtd by own solder lugs.	Adjustable calibration potentiometer for cancellation of contact potential at R-104-A			Centralab type 1	Part/dwg #X-16925-169	R-112, R-135	2
R-113	RESISTOR, FIXED, COMPOSITION: Same as R-107	Grid return pin 7 of V-102						
R-114	RESISTOR, FIXED, COMPOSITION: 560,000 ohms, ± 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Voltage divider with R-113	RC20BF564K		Allen Bradley #EB-5641	Part #X-18414-562	R-114, R187	2
R-115	RESISTOR, FIXED, COMPOSITION: 2700 ohms; p/m 5%; ½ watt; insulated; axial wire leads; Spec. JAN-R-11.	Parasitic suppression resistor pin 1 of V-103	3RC20BF470K	N16-R-49427-811 3RC20BF470K	Allen Bradley #EB-4701	Part #X-18410-472	R-115, R-118, R-143, R-144	4
R-116	RESISTOR, FIXED, COMPOSITION: 2700 ohms; p/m 5%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Plate load resistor pin 1 of V-102	RC20BF272J	N16-R-50038-431	Allen Bradley #EB-2725	Part #X-18412-271	R-116, R-117	2
R-117	RESISTOR, FIXED, COMPOSITION: Same as R-116.	Plate load resistor pin 6 of V-102						
R-118	RESISTOR, FIXED, COMPOSITION: Same as R-115.	Parasitic suppression resistor pin 1 of V-104						

R-119	RESISTOR, VARIABLE: Wire wound; 1000 ohms p/m 20%; 2 watts; linear taper; two solder lug terminals; metal case, open type; 1 3/32" diam. x 7/16" d; round metal shaft 1/4" diam x 3/8" lg FMS, screw driver slot; contact arm grounded to case; no off position; normal torque; mtg. bushing 3/8"-32 x 1/4 lg.	Adjustable cathode bias resistor of V-103 & V-104. In series with R-120		N16-R-90764-9340	P. R. Mallory Type C	Part #X-16925-158	R-119, R-141	2
R-120	RESISTOR, FIXED, COMPOSITION: 2200 ohms; p/m 10%; 2 watt; insulated; axial wire leads; Spec JAN-R-11.	Fixed cathode bias resistor of V-103 and V-104. In series with R-119	RC42BF-222K	N16-R-50013-461	Allen Bradley #HB-2221	Part #X-18432-222	R-120	1
R-121	RESISTOR, VARIABLE: composition; 100,000 ohms p/m 20%; 1/2 watt; linear taper; three solder lug terminals; phenolic base, enclosed metal case 15/16" diam x 17/32" deep; round metal shaft 1/4" diam. x 3/8" lg FMS, screw driver slot; normal torque; insulated contact arm, no off position; mtg. bushing 3/8"-32 x 1/4" lg.	Screen grid voltage adjustment pin 6 of V-103 & V-104 for amplifier linearity			Mallory	Part #X-16925-168	R-121	1
R-122	RESISTOR, FIXED, COMPOSITION: 33,000 ohms; p/m 10%; 2 watt; insulated; axial wire leads; Spec JAN-R-11.	In parallel with R-121 as part of screen dropping resistor	RC42BF-333K		Allen Bradley #HB-3331	Part #X-18433-332	R-122	1
R-123	RESISTOR, FIXED, COMPOSITION: 3600 ohms; p/m 5%; 2 watt; insulated; axial wire leads; Spec JAN-R-11.	Plate load resistor pin 5 of V-103	RC42BF-362J		Allen Bradley #HB-3625	Part #X-18432-361	R-123, R-124 R-142	3
R-124	RESISTOR, FIXED, COMPOSITION: Same as R-123.	Plate load resistor pin 5 of V-103						
R-125	RESISTOR, FIXED, COMPOSITION: 220,000 ohms; p/m 10%; 1/2 watt; insulated; axial wire leads; Spec JAN-R-11.	Part of sweep circuit oscillator decoupling network	RC20BF-224K	N16-R-50714-811	Allen Bradley #EB-2241	Part #X-18414-222	R-125, R156	2
R-126	RESISTOR, FIXED, COMPOSITION: Same as R-102.	Part of voltage dividing network for input of vertical cathode follower						
R-127	RESISTOR, FIXED, COMPOSITION: Same as R-103.	Part of voltage dividing network for input of vertical cathode follower						

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
R-128	RESISTOR, FIXED, COMPOSITION: Same as R-101.	Part of voltage dividing network for input of vertical cathode follower						
R-129	RESISTOR, VARIABLE: Same as R-104; consists of R-129A and R-129B.	Horizontal gain control						
R-129A	RESISTOR, VARIABLE: 2 meg p/m 20%, part of R-129.	Horizontal gain control for DC signals		#				
R-129B	RESISTOR, VARIABLE: 3000 ohms p/m 20%, part of R-129.	Horizontal gain control for AC signals		#				
R-130	RESISTOR, FIXED, COMPOSITION: Same as R-105.	Parsitic suppression resistor pin 2 of V-105A						
R-131	RESISTOR, FIXED, COMPOSITION: Same as R-106.	Grid return pin 2 of V-105A						
R-132	RESISTOR, FIXED, COMPOSITION: Same as R-107.	Cathode load resistor pin 3 of V-105A						
R-133	RESISTOR, FIXED, COMPOSITION: Same as R-109.	Isolation and voltage dropping resistor for cancellation of contact potential at R-129A						
R-134	RESISTOR, FIXED, COMPOSITION: Same as R-110.	Cathode bias pin 3 of V-106						
R-135	RESISTOR, FIXED, COMPOSITION: Same as R-112.	Adjustable calibration potentiometer for cancellation of contact potential at R-129A						
R-136	RESISTOR, VARIABLE: Same as R-111.	Adjustable cathode bias resistor pin 8 of V-106 Horizontal centering control						

R-137	RESISTOR, FIXED, COMPOSITION: 150,000 ohms, p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Bleeder resistor for Horizontal cathode follower decoupling network	RC20BF-154K	N16-R-50678-811 3RC20BF154K	Allen Bradley #EB-1541	Part #X-18414-152	R-137, R-169, R-180	3
R-138	RESISTOR, FIXED, COM: POSITION: Same as R-107.	Grid return pin 7 of V-106						
R-139	RESISTOR, FIXED, COMPOSITION: 12,000 ohms p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Plate load resistor pin 1 of V-106	RC20BF-123K	N16-R-50309-811	Allen Bradley #EB-1231	Part #X-18413-122	R-139, R-140	2
R-140	RESISTOR, FIXED, COMPOSITION: Same as R-139.	Plate load resistor pin 6 of V-106						
R-141	RESISTOR, VARIABLE: Same as R-119.	Adjustable cathode bias resistor of V-107. In series with R-142						
R-142	RESISTOR, FIXED, COMPOSITION: Same as R-123.	Fixed cathode bias resistor of V-107. In series with R-141						
R-143	RESISTOR, FIXED, COMPOSITION: Same as R-115.	Parasitic suppression resistor pin 6 of V-107						
R-144	RESISTOR, FIXED, COMPOSITION: Same as R-115.	Parasitic suppression resistor pin 5 of V-107						
R-145	RESISTOR, FIXED, COMPOSITION: 12,000 ohms p/m 5%; 2 watt; insulated; axial wire leads; Spec JAN-R-11.	Plate load resistor pin 1 of V-107	RC42BF-123J	N16-R-50308-940	Allen Bradley #HB-1235	Part #X-18433-121	R-145, R-146	2
R-146	RESISTOR, FIXED, COMPOSITION: Same as R-145.	Plate load resistor pin 2 of V-107						
R-147	RESISTOR, FIXED, COMPOSITION: Same as R-105.	Series load resistor for line test voltage						
R-148	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of AC voltage dividing network to provide line cync.	RC20BF-153K	N16-R-50336-811	Allen Bradley #EB-1531	Part #X-18413-152	R-148, R-152	2
R-149	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of AC voltage dividing network to provide line sync.	RC20BF-104K	N16-R-50633-811	Allen Bradley #EB-1041	Part #X-18414-102	R-149, R-160, R-174, R-175, R-181	5
R-150	RESISTOR, FIXED, COMPOSITION: 47,000 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Plate load pin 6 of V-101 B	RC20BF-473K	N16-R-50480-811, 3RC20BF473K	Allen Bradley #EB-4731	Part #X-18413-472	R-150	1

NOTE: Listed for reference only.

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
R-151	RESISTOR, FIXED, COMPOSITION: 1 megohm, p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Grid return pin 7 of V-101B	RC20BF-105K	N16-R-50775-811 3RC20BF105K	Allen Bradley #EB-1051	Part #X-18415-102	R-151, R-164	2
R-152	RESISTOR, FIXED, COMPOSITION: Same as R-148.	Part of cathode load resistor of V-101B in series with R-153						
R-153	RESISTOR, FIXED, COMPOSITION: 4700 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of cathode load resistor of V-101B. In series with R-152	RC20BF-472K	N16-R-50129-811	Allen Bradley #EB-4721	Part #X-18412-472	R-153	1
R-154	RESISTOR, VARIABLE: composition; 500,000 ohms p/m 20%; ½ watt; linear taper; tap at 250,000 ohms; four solder lug terminals; enclosed metal body 15/16″ diam. x 17/32″ d. FMS; insulated contact arm, no off position; mtg. bushing 3/8″-32 x ¼″ lg.	Sync. amplifier locking control			Mallory	Part/dwg #X-16925-166	R-154	1
R-155	RESISTOR, FIXED, COMPOSITION: 2.2 meg; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of sweep circuit oscillator decoupling network	RC20BF-225K	N16-R-51065-811	Allen Bradley #EB-2251	Part #X-18415-222	R-155	1
R-156	RESISTOR, FIXED, COMPOSITION: Same as R-125.	Plate load resistor pin 2 of V-108						
R-157	RESISTOR, FIXED, COMPOSITION: 330,000 ohms; p/m 10%; ½ watt; insulated; axial leads; Spec JAN-R-11.	Part of plate load resistor pin 1 of V-108 In series with R-158A	RC20BF-334K	N16-R-50759-811 3RC20BF334K	Allen Bradley #EB-3341	Part #X-18414-332	R-157	1
R-158	RESISTOR, VARIABLE: composition; front section 1 meg p/m 20%, rear section 5 meg p/m 20%; ½ watt each section; 3 solder lug terminals per section; phenolic base, metal cover; 15/16″ diam. x 1″ deep; enclosed; round metal shaft ¼″ diam x 5/8″ lg; linear taper; insulated contact arm, no off position; normal torque; mtg bushing 3/8″-32 x ¼″ lg.	Vernier frequency control. 5 meg. section in series with R-157 as part of plate load resistor pin 1 of V-108 1 meg. section in series with R-160 as part of grid return pin 6 of V-108			Mallory	Part/dwg #X-16925-162	R-158	1

R-158A	RESISTOR, VARIABLE: 1 meg p/m 20%.	Part of R-158		#				
R-158B	RESISTOR, VARIABLE: 5 meg p/m 20%.	Part of R-158		#				
R-159	RESISTOR, FIXED, COMPOSITION: 220 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of grid return pin 6 of V-108. In series with R-160	RC20BF-221K	N16-R-49661-811	Allen Bradley #EB-2211	Part #X-18411-222	R-159	1
R-160	RESISTOR, FIXED, COMPOSITION: Same as R-149.	Part of grid return pin 6 of V-108. In series with R-159 and R-158A						
R-161	RESISTOR, FIXED, COMPOSITION: 470 ohms; p/m 10%; ½ watt; insulated; axial wire leads Spec JAN-R-11.	Cathode bias resistor pin 7 of V-108	RC20BF-471K	N16 R-49769-811	Allen Bradley #EB-4711	Part #X-18411-472	R-161, R-166	2
R-162	RESISTOR, FIXED, COMPOSITION: Same as R-108.	Isolation resistor for sync. grid pin 6 of V-108 sweep circuit oscillator						
R-163	RESISTOR, FIXED, COMPOSITION: Same as R-108.	Grid return pin 6 of V-108						
R-164	RESISTOR, FIXED, COMPOSITION: Same as R-151.	Grid return pin 7 of V-105B						
R-165	RESISTOR, FIXED, COMPOSITION: Same as R-108.	Plate load resistor pin 6 of V-105B						
R-166	RESISTOR, FIXED, COMPOSITION: Same as R-161.	Cathode bias resistor pin 8 of V-105B						
R-167	RESISTOR, FIXED, COMPOSITION: 22 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Surge suppression on input to CR-101	RC20BF-220K	N16-R-49319-811	Allen Bradley #EB-2201	Part #X-18410-222	R-167, R-168	2
R-168	RESISTOR, FIXED, COMPOSITION: Same as R-167.	Surge suppression on input of CR-102						
R-169	RESISTOR, FIXED, COMPOSITION: Same as R-137	Filter resistor for high voltage power supply						
R-170	RESISTOR, FIXED, COMPOSITION: 1000 ohms ;p/m 10%; 2 watt; insulated; axial wire leads; Spec JAN-R-11.	Filter resistor for low voltage power supply	RC42BF-102K	N16-R-49923-531	Allen Bradley #HB-1021	Part #X-18432-102	R-170, R-171	2
R-171	RESISTOR, FIXED, COMPOSITION: Same as R-170.	Filter resistor for intermediate voltage power supply. Horizontal amplifier						

NOTE: Listed for reference only.

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
R-172	RESISTOR, FIXED, COMPOSITION: 3300 ohms; p/m 10%; 2 watt; insulated; axial wire leads; Spec JAN-R-11.	Part of filter resistor for intermediate voltage power supply. Vertical amplifier. In parallel with R-173	RC42BF-332K		Allen Bradley #HB-3321	Part #X-18432-332	R-172, R-173	2
R-173	RESISTOR, FIXED, COMPOSITION: Same as R-172.	Part of filter resistor for intermediate voltage power supply. Vertical amplifier. In parallel with R-172						
R-174	RESISTOR, FIXED, COMPOSITION: Same as R-149.	Decoupling resistor for horizontal cathode follower						
R-175	RESISTOR, FIXED, COMPOSITION: Same as R-149.	Decoupling resistor for vertical cathode follower						
R-176	RESISTOR, VARIABLE: composition; 250,000 ohms p/m 20%; ½ watt; linear taper; 3 solder lug terminals; phenolic base with enclosed metal cover 15/16" diam.; round metal shaft ¼" diam x 7/8" lg. FMS; insulated contact arm, off position extreme counter clockwise; normal torque; mtg. bushing 3/8"-32 x ¼" lg; SPST switch normally open, closes at start of clockwise rotation, 3 amps at 125v ac; consists of S-105.	Intensity control. Part of high voltage network			Mallory	Part/dwg #X-16925-165	R-176	1
R-177	RESISTOR, VARIABLE: composition; 500,000 ohms p/m 20%; ½ watt; linear taper; three solder lug terminals; phenolic base with enclosed metal cover, 15/16" diam. 17/32" deep; insulated contact arm, no off position; normal torque; round metal shaft ¼" diam x 7/8" lg. FMS; 3/8"-32 bushing ¼" lg.	Focus control. Part of high voltage network			Mallory	Part/dwg #X-16925-164	R-177	1

R-178	RESISTOR, FIXED, COMPOSITION: 750,000 ohms; p/m 5%; 1 watt; insulated; axial wire leads; Spec JAN-R-11.	Part of high voltage dividing network	RC30BF-754J	N16-R-50911-751	Allen Bradley #GB-7545	Part #X-18424-751	R-178	1
R-179	RESISTOR, FIXED, COMPOSITION: 1.5 meg; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Intensity grid return to high voltage B. Pin 2 of V-109	RC20BF-155K	N16-R-51020-811	Allen Bradley #EB-1555	Part #X-18415-152	R-179	1
R-180	RESISTOR, FIXED, COMPOSITION: Same as R-137.	Current limiting cathode resistor pin 3 of V-109						
R-181	RESISTOR, FIXED, COMPOSITION: Same as R-149.	Part of astigmatic voltage dividing network						
R-182	RESISTOR, FIXED, COMPOSITION: 680,000 ohms; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Part of astigmatic voltage dividing network	RC20BF-684K	N16-R-50894-811	Allen Bradley #EB-6841	Part #X-18414-682	R-182	1
R-183	RESISTOR, FIXED, COMPOSITION: 4.7 meg; p/m 10%; ½ watt; insulated; axial wire leads; Spec JAN-R-11.	Return path for deflection plate D3 pin 6 of V-109	RC20BF-475K	N16-R-51173-811	Allen Bradley #EB-4751	Part #X-18415-472	R-183, R-184, R-185, R-186	4
R-184	RESISTOR, FIXED, COMPOSITION: Same as R-183.	Return path for deflection plate D4 pin 7 of V-109						
R-185	RESISTOR, FIXED, COMPOSITION: Same as R-183.	Return path for deflection plate D1 pin 10 of V-109						
R-186	RESISTOR, FIXED, COMPOSITION: Same as R-183.	Return path for deflection plate D2 pin 9 of V-109						
R-187	RESISTOR, FIXED, COMPOSITION: Same as R-114.	Voltage divider with R-138						
S-101	SWITCH, ROTARY: one section; 4 positions, 4 poles; silver plated brass contacts; phenolic insulation; 5/8" lg x 1 13/32" wd x 1 17/32" high; 3/8"-32 mtg bushing 1/4" lg; round shaft 1/4" diam x 5/8" lg from mtg surface; solder lug terminals; non shorting contacts.	Vertical attenuator switch			Oak Mfg. Co. #51294-J1	Part/Dwg. #X-19912-239	S-101	1

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
S-102	SWITCH, ROTARY: one section; 5 positions, 5 positions; silver plated brass contacts; phenolic insulation; 5/8" lg x 1 13/32" wd x 1 17/32" high; 3/8"-32 mtg bushing 1/4" lg; round shaft 1/4" diam x 5/8" lg from mtg surface; solder lug terminals; non shorting contacts.	Horizontal attenuator switch			Oak Mfg. Co. #51293-J1	Part/Dwg. #X-19912-238	S-102	1
S-103	SWITCH, ROTARY: one section; one pole, 3 positions; silver plated brass contacts; phenolic insulation; 5/8" lg x 1 13/32" diam. 1 17/32" high; 3/8"-32 mtg bushing; round shaft 1/4" diam x 5/8" lg from mtg surface; solder lug terminals; non shorting contacts.	Sync. selector switch			Oak Type N	Part/Dwg #19912-240	S-103	1
S-104	SWITCH, ROTARY: two sections; 4 poles, 6 positions; silver plated brass contacts; phenolic insulation; 2 1/4" lg x 1 1/4" wd x 1 5/16" high; 3/8"-32 mtg bushing 1/4" lg; round shaft 1/4" diam x 5/8" lg from mtg surface; solder lug terminals; non shorting contacts.	Sweep circuit oscillator coarse frequency switch			Oak Mfg. Co. Type F	Part/Dwg #X-19912-237	S-104	1
S-105	SWITCH, ROTARY: SPST; mounted on and actuated by R-176.	Power switch						
T-101	TRANSFORMER, POWER, STEP-UP and STEP-DOWN: hermetically sealed metal case; input 115 volts ac, 50 to 1000 cycles, single phase; 6 output windings, #1 secondary 235 volts @ 50 ma #2 secondary 180 volts @ 65 ma C/T #3 secondary 235 volts @ 50 ma #4 secondary 130 volts @ 1/2 ma	Power transformer			RCA Mfg.	Part/Dwg. #20800-120	T-101	1

	#5 secondary 6.3 volts @3.75 amp. C/T #6 secondary 6.3 volts @.6 amp 2000 volt insulation; oil filled; dimensions excluding terminals and mtg. brackets 3″ lg. x $2\frac{15}{32}$″ wd. x $2\frac{27}{32}$″ h; 11 insulated solder lug terminals on end of case; four 6-32 mtg. bushings on $3\frac{1}{4}$″ x $2\frac{3}{8}$″ mtg. centers; electrostatic shield between primary and secondaries; special mtg. brackets welded to case incline axis of core 20°.							
V-101	ELECTRON TUBE: duo triode Type 12AT7	Vertical cathode follower and sync. amplifier	JAN-12AT7	N16-T-58240-10 2J12AT7	General Electric only	Part No. X-20874-100	V-101, V-102, V-105, V-106	4
V-102	Same as V-101	1st vertical DC amplifier						
V-103	ELECTRON TUBE: pentode Type 6AH6.	Part of second vertical DC amplifier	JAN 6AH6	N16-T-56185		Part No. X-20874-92	V-103, V-104	2
V-104	Same as V-103	Part of second vertical DC amplifier						
V-105	Same as V-101	Horizontal cathode follower and Z axis amplifier						
V-106	Same as V-101	1st Horizontal DC amplifier						
V-107	ELECTRON TUBE: duo triode Type 6J6	2nd Horizontal DC amplifier	JAN 6J6	N16-T-56360 2J6J6		Part No. X-20874-71	V-107, V-108	2
V-108	Same as V-107	Sweep circuit oscillator tube						
V-109	ELECTRON TUBE: cathode ray Type 3RP1	Cathode ray tube	JAN 3RP1	N16-T-53860 2J3RP1		Part No. X-20874-79	V-109	1
V-110	ELECTRON TUBE: rectifier full wave Type 6X4.	Intermediate voltage rectifier	JAN 6X4	N16-T-56840 2J6X4		Part No. X-20874-68	V-110	1
W-101	LEAD, TEST: JAN Type RG-58A/U cable; 36″ lg. including termination; JAN Type UG-88/U plug on one end, Mueller type 60 H red alligator clip on other end.	Connector for vertical amplifier		*		Part/Dwg. X-3030-64	W-101	1

*NOTE: Not furnished as a maintenance part. If failure occurs, do not request replacement unless the item cannot be repaired or fabricated.

TABLE 7-3 (Cont.) CROSS REFERENCE PARTS LIST

PARTS								
SYMBOL DESIG.	NAME OF PARTS AND DESCRIPTION	FUNCTION	AWS, JAN OR NAVY TYPE DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS AIR MATERIAL COMMAND AVIATION SUPPLY OFFICE	MFR AND MFR'S DESIG.	CONTRACTOR'S DWG. AND PART NO.	ALL SYMBOL DESIGNATIONS INVOLVED	TOTAL NO. PER EQUIP.
W-102	LEAD, TEST: JAN Type RG-58A/U cable, 6″ lg. including termination; JAN Type UG-88/U plug on one end. Mueller type 60H red alligator clip on other end.	Connector for vertical amplifier		*		Part/Dwg. X-3030-65	W-102	1
W-103	CABLE ASSEMBLY, POWER: type RG-108/U shielded cable; 5 ft. 6 in. lg. including male appliance plug molded on one end; other end stripped and tinned for connection to OS-8B/U equipment.	Power cable		*		Part/Dwg. X-3030-69	W-103	1
W-104	LEAD, TEST: on #18AWG stranded copper conductor; black rubber insulation; 36″ lg; Mueller Electric No. 60HS black alligator clip on one end; No. 10 open tongue terminal on other end.	Ground lead		* N17-L-63295-5531		Part/Dwg. No. 12450-232	W-104	1
W-105	CABLE, RF: JAN Type RG-58A/U Spec JAN-C-17A.	Replacement lead material for W-101 and W-102	JAN RG-58A/U			Part No. 3025-272	W-105	42″
W-106	WIRE, ELECTRICAL: insulated .140 nominal OD; one #18 AWG tinned copper conductor; stranded 65 strands #36 AWG; cotton wrap; black rubber insulation .043″ thk; rated 5000 volts.	Replacement lead wire for W-104		N15-W-2195-5100 1B818.175	Belden No. 8899 Black	Part No. 23900-288	W-106	36″
X-101	SOCKET, ELECTRON TUBE: 9 contacts, phos. bronze silver plated; noval; no shock shield; no center shield; round mica filled phenolic body; o/a dimensions excluding terminals $1\frac{13}{32}$″ lg. x $\frac{15}{16}$″ wd. x $\frac{11}{32}$″ high; one piece saddle, bottom mtg. in $\frac{3}{4}$″ diam. chassis hole, two .125″ diam. mtg. holes spaced $1\frac{1}{8}$″ c to c.	Socket for V-101		✪ N16-S-6406"-3233	Elco #277PHSPTD	Part/Dwg. X-19350-154	X-101, X-102 X-105, X-106	4

X-102	Same as X-101	Socket for V-102						
X-103	SOCKET, ELECTRON TUBE: 7 contacts, phos. bronze silver plated; 7 pin miniature; no shock shield; no center shield; round mica filled phenolic body; o/a dimensions excluding terminals 1 3/32" lg., 51/64" wide x 11/32"; one piece saddle, bottom mtg. in 5/8" diam. chassis holes spaced .875" c to c.	Socket for V-103		• N16-S-62603-6907	Elco #116PHSPTD	Part/Dwg. X-19350-155	X-103, X-104 X-107	3
X-104	Same as X-103	Socket for V-104						
X-105	Same as X-101	Socket for V-105						
X-106	Same as X-101	Socket for V-106						
X-107	SOCKET, ELECTRON TUBE: Same as X-103	Socket for V-107						
X-108	SOCKET, ELECTRON TUBE: 7 contacts, beryllium copper silver plated; miniature 7 pin; includes metal shock shield; center shield .180 O.D.; round low loss phenolic body; one piece saddle above chassis mtg. in 5/8" diam chassis hole, two mtg holes .125" diam. spaced 7/8" c to c; Spec JAN-S-28A; Type TS102P01.	Socket for V-108	JAN TS102P01	N16-S-62603-6699	American Phenolic No. 147-916	Part No. X-19350-120	X-108, X-110	2
X-109	SOCKET, ELECTRON TUBE: 12 pin; spring brass contacts, solder dipped; No. 5 and No. 11 contacts omitted; miniature duodecal; round molded phenolic body; o/a dimen. excluding leads 1 11/32" diam x 1/2" thk.; connects directly to base of C R tube, no other mounting required; insulated terminal leads.	Socket for V-109			Alden Products No. 212 MINC	Part/Dwg. X-19350-153	X-109	1
X-110	SOCKET, ELECTRON TUBE: Same as X-108	Socket for V-110						

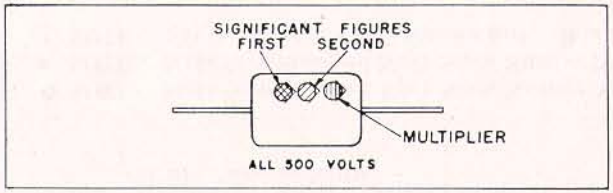
✪ NOTE: Make from Standard Navy Stock Number N16-S-64063-6717.

• NOTE: Make from Standard Navy Stock Number N16-S-62603-6693.

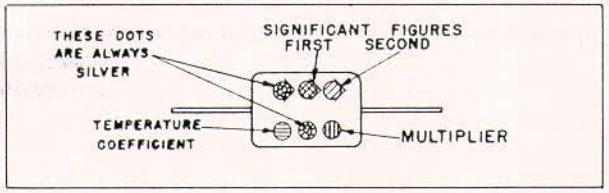
* NOTE: Not furnished as a maintenance part. If failure occurs, do not request replacement unless the item cannot be repaired or fabricated.

CAPACITOR COLOR CODES

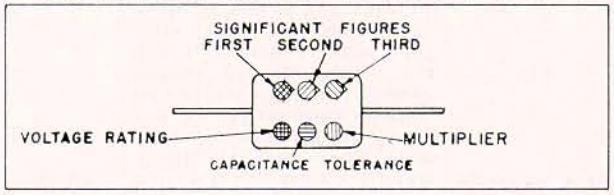
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



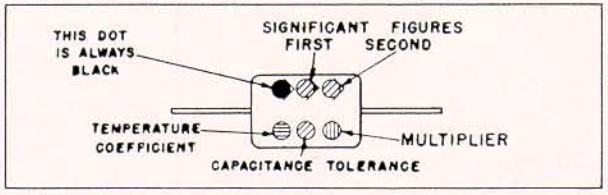
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



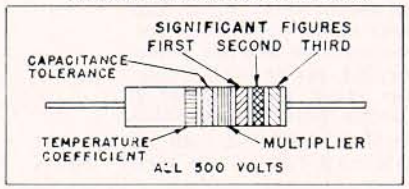
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

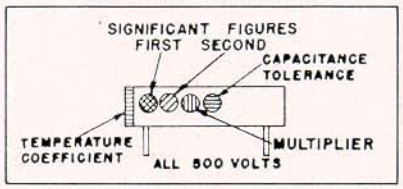


RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS

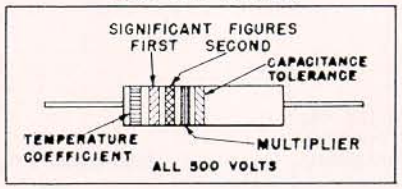


JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

RADIAL TYPE NON-INSULATED



AXIAL TYPE INSULATED



RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

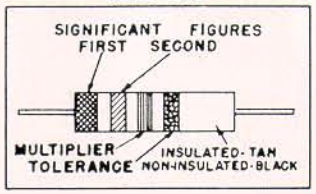
RESISTORS				CAPACITORS				
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1000	1000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

TABLE 7-3. APPLICABLE COLOR CODES – RESISTORS AND CAPACITORS

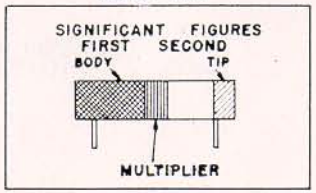
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE

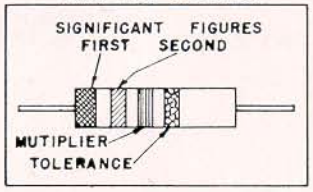


RADIAL TYPE



JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED

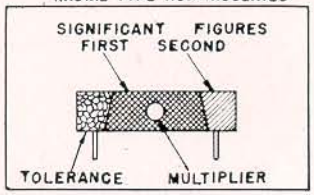


TABLE 7-4. LIST OF MANUFACTURERS

MFR'S PREFIX	NAME	ADDRESS
CHK	The Hickok Electrical Instrument Co.	10514 Dupont Ave., Cleveland, Ohio
CAW	Aerovox Corporation	742 Belleville Ave., New Bedford, Mass.
CPH	American Phenolic Corp.	1830 S. 54th Ave., Chicago, Ill.
CBZ	Allen-Bradley Co.	118 W. Greenfield Ave., Milwaukee, Wis.
CYA	Alden Products Co.	117 N. Main Street, Brocton, Mass.
CQG	Belden Mfg. Co.	P.O. Box 5070A, Chicago, Ill.
CBN	Centralab Division, Globe-Union	900 E. Keefe Ave., Milwaukee, Wis.
CD	Cornell-Dubilier Corp.	1000 Hamilton Blvd., So. Plainfield, N. J.
CAZO	Conant Electrical Labs.	6500 "O" Street, Lincoln, Nebraska
CAMQ	Cambridge Thermionic Corp.	Cambridge, Mass.
CTC	Chicago Telephone Supply Corp.	Elkhart, Indiana
CAYS	Drake Mfg. Co.	1713 W. Hubbard St., Chicago, Ill.
CG	General Electric Co.	1 River Road, Schenectady, N. Y.
CEB	Hugh H. Eby	4700 Stenton Ave., Philadelphia, Pa.
CAUP	Kurz-Kasch Inc.	1421 So. Broadway, Dayton, Ohio
CAXP	Lord Mfg. Co.	1639 W. 12th St., Erie, Pa.
CLF	Littlefuse, Inc.	4765 Ravenswood Ave., Chicago, Ill.
CMA	P. R. Mallory Co., Inc.	1941 Thomas St., Indianapolis, Ind.
CBIT	Mueller Electric Co.	1597 E. 31st St., Cleveland, Ohio
COC	Oak Mfg. Co.	1200 N. Clybourne Ave., Chicago, Ill.
CAFQ	Radio Receptor Co., Inc.	251 W. 19th St., New York, N. Y.
CSF	Sprague Specialties Co.	North Adams, Mass.
	Astron Corporation	255 Grant Ave., East Newark, N. J.
	Continental Rubber Works	Erie, Pennsylvania
	Elco Mfg. Co.	Philadelphia, Pa.
	Garde Mfg. Co.	588 Eddy Street, Providence, R. I.
	Patent Button Works	Knoxville, Tenn.

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