# INSTRUCTIONS FOR ASSEMBLING AND ALIGNING RECEIVER 6 TYPE YOKE, FOCUSER, SHIELD, AND TUBE ASSEMBLY

ESB-120

May 11, 1955

## ASSEMBLY

The following instructions cover assembly of the tube shield on the 21-inch Apple tube used in Receiver 6.

1. Using the template dimensions included at the end of this bulletin, cut out the shield for the bulb of the Apple tube from a piece of .003-inch stock of soft aluminum foil. (Anneal if unavailable. )

2. Wrap the foil around the bulb of the tube. Overlap and double-fold the seam, and then cover this seam with a strip of masking tape. Fasten the aluminum to the tube near the tube face in several places, using small pieces of Scotch or masking tape. Then mold the foil to the contour of the tube by gently rubbing or rolling the foil against the tube, using a length of smooth dowel or similar tool. See figure 1.

3. Prepare the mounting ring by attaching a 1-inch strip of felt paper to the inside of the ring. Cut out four 3-inch x 4-inch pieces of foil from .008-inch foil stock; fold these to 1" x 4" and wrap one around the mounting ring at each corner. Avoid shorting the ring to the mounting feet. These foil strips provide contact between the ring and the painted pickup band. See figure 2.

4. Mount the ring on the Apple tube in the usual way, taking care that the mounting feet are symmetrically located at the corners of the tube.

5. Make up a 10-inch piece of RG-59/V cable, and connect the center conductor to the mounting ring at one of the bottom corners. This can be done conveniently by soldering the center conductor to one of the insulated rivets which attaches the mounting foot to the ring. Connect the outer braid to the mounting foot.

6. Ground the ring at the corner diametrically opposite the corner where the pickup connection has been made. This can be done by providing a low-impedance-type soldered bond between the mounting foot and the rivet.

7. The foil-covered cardboard pickup band shield is designed to cover the front edges of the Apple tube. Form the shield by creasing it along the prescored lines; then staple all the joints along the rear (finger) side, using a Neva-Clog Products Co. (Bridgeport, Conn.) Stapler, Model DT-30. See figures 3 and 4. Bend the slotted (finger) edge inward toward the front of the shield.

8. Cut out 12 pieces of corrugated cardboard 3/4" x 2 1/2" x 5/16" thick, and cement to the inside edge of the front of the pickup band shield, spacing them at regular intervals, to maintain an even air gap. See figures 3 and 5.

9. Slide the pickup band shield onto the tube, from the rear, passing the 10-inch pickup band cable through the hole in the band shield. See that the shield fingers are making good

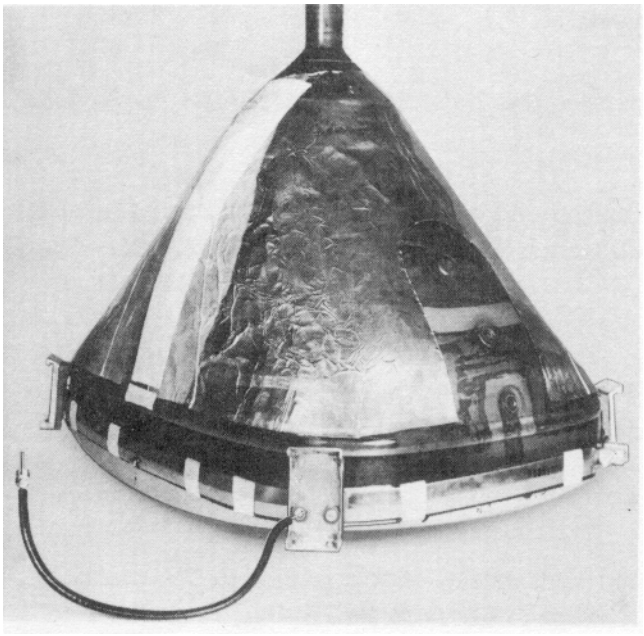


Figure 1. Aluminum Foil Shield, Cut Out from Template, Fastened to Bulb of Apple Tube

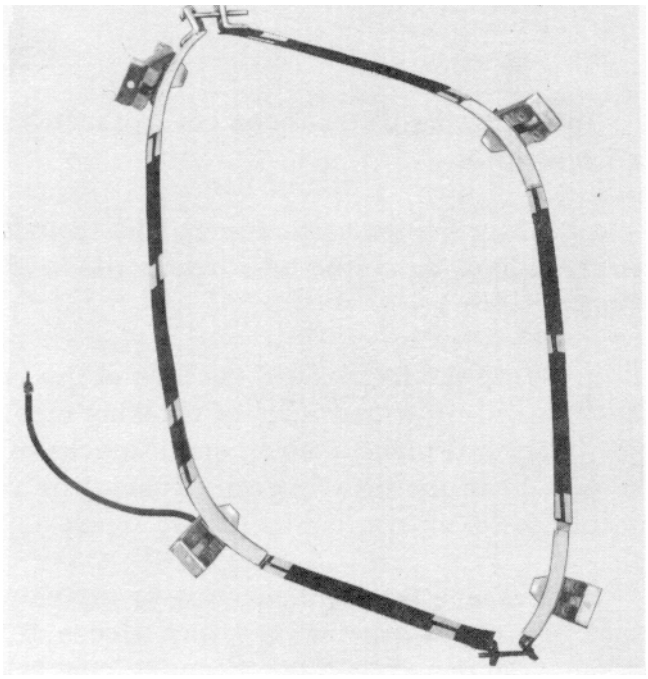


Figure 2. Index Pickup Ring, Showing Foil Straps Attached to Terminal Panel Lug and to Pickup Ring

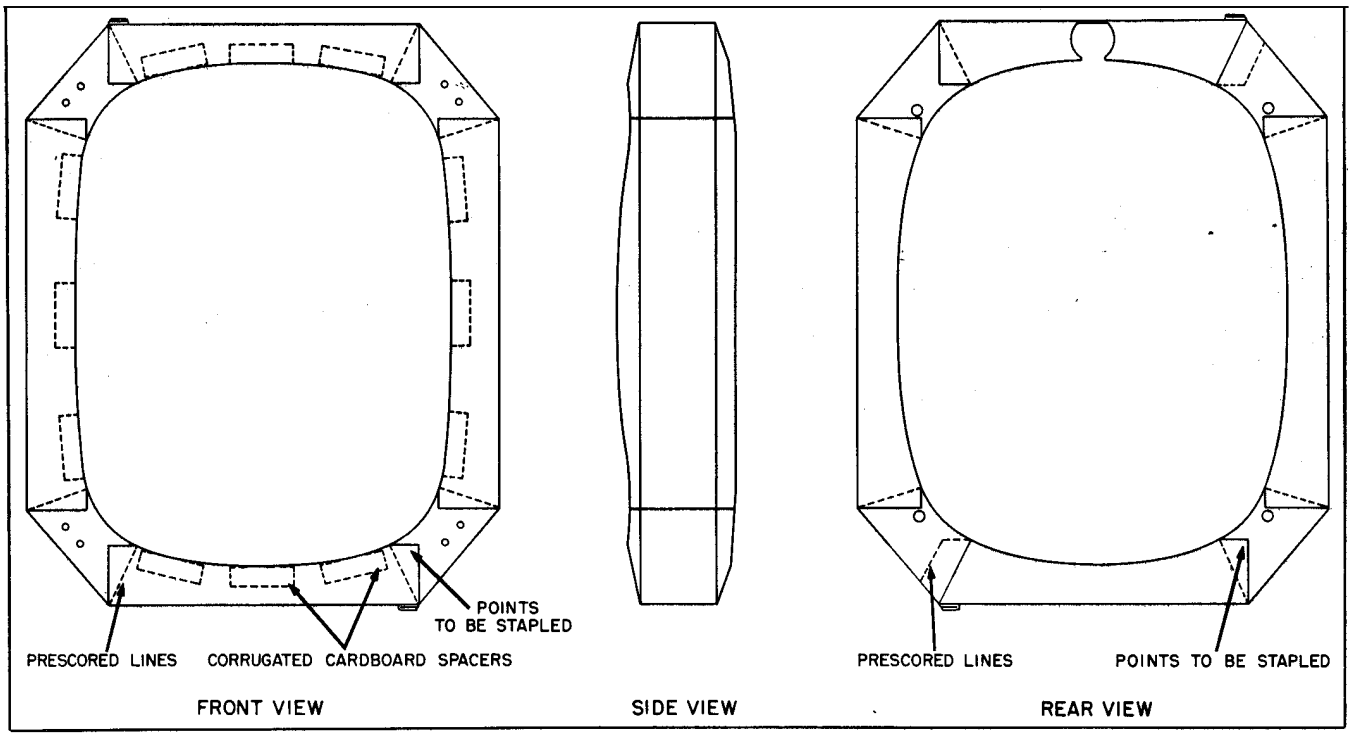



Figure 3. Details of Foil-Covered Cardboard Pickup Band Shield

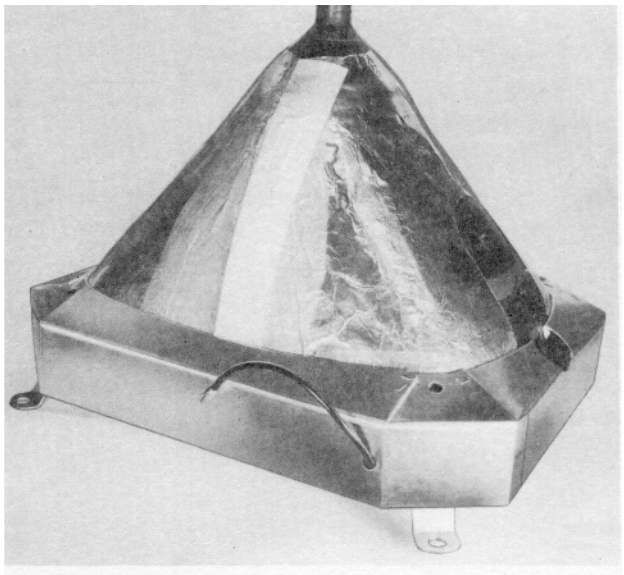


Figure 4. Rear of Apple Tube, Showing Bulb Shield and Rear of Pickup Band Shield

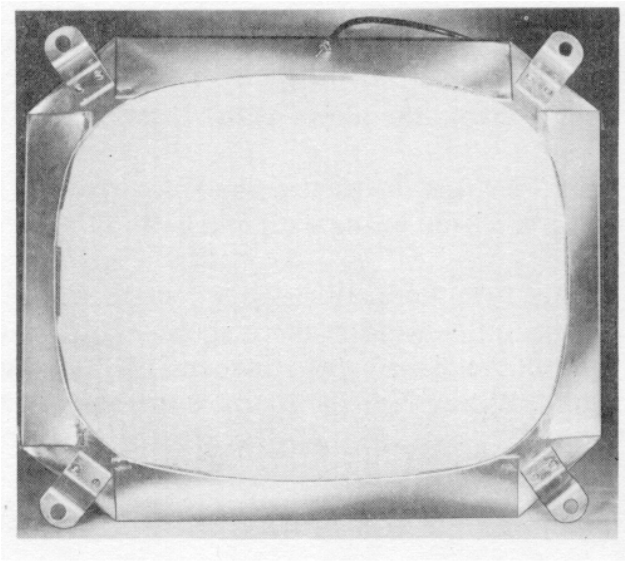


Figure 5. Front of Apple Tube, Showing Front of Pickup Band Shield

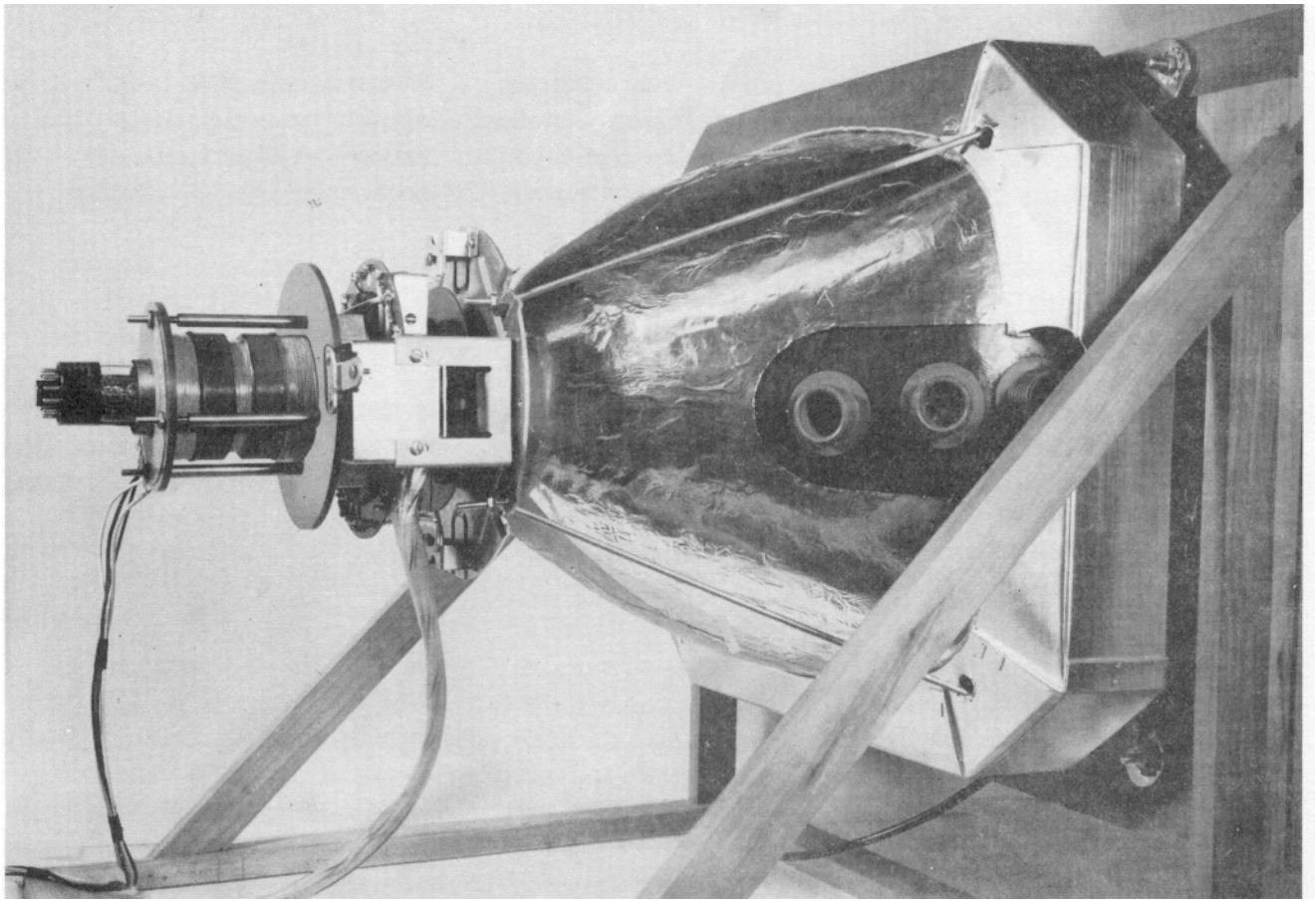


Figure 6. Complete Assembly Using Model 1207ES (Mk IV) Yoke and Focuser Support

mechanical contact with the aluminum foil shield on the bulb of the tube. See figure 4.

10. Staple the joints at the front of the pickup band shield.

11. Fasten the pickup band shield to the tube mounting brackets on the mounting ring, using two 8-32 brass nuts and bolts in each corner. See figure 5.

12. Pass the four support rods through the holes in the pickup band shield; insert the hooked ends into the holes in the ring mounting brackets, and connect the other ends of the rods to the yoke and focuser support assembly. See figure 6. (This photograph shows assembly Model 1257ES (Mark IV); see figure 8 for Model 1285ES universal mount. )

## ALIGNMENT

The ultimate objective of any alignment of yoke, focuser, and electron beam in the electron optical system is to obtain a condition wherein the electron beam travels axially through the center of the focuser and the yoke. If this condition is not obtained, the action of these components on the beam will result in deformation, rotation, defocusing, or other degradation of the spot.

Ideally, the glassware, yoke, focuser, and electron gun would be mechanically and electronically held to such exact tolerances that a mechanical assembly on a jig would produce the required electron-optical results, even to compensating for the earth's field. Since this cannot be economically achieved, certain compromises are necessary.

First, it is assumed that the yoke when seated symmetrically on the bell of the tube neck will be symmetrically located with respect to the axis of the electron beam, and with the center of the tube face. This gives us a point and a line in space through which the electron-optical axis passes. This in turn makes it necessary to adjust the position of the focuser and the direction of the electron beam at its origin, to correct for any angular errors which may exist between the assumed (geometric) electron beam axis and its actual axis. Sv.ch error can arise from a number of causes, including the earth's field. These two corrections will place the axis of the focuser and that of the beam on the axis of the yoke and the center of the tube face.

It is possible to change the direction of the beam at its origin by providing an adjustable "precentering" magnetic field at the location of the gun; the focuser can be physically translated vertically and horizontally. The only remaining requirement is a technique of deter-mining the proper combination of focuser position and precentering magnetic field. A suit-able technique is employed in the alignment procedure described. Figure 12 shows, in block diagram form, the equipment required to utilize this alignment method.

The success of the alignment is based upon initially positioning the yoke accurately with respect to the mechanical axis of the tube. Care taken in this step may materially shorten the over-all alignment procedure. Use of a centering jig, try square, draftman's triangle,

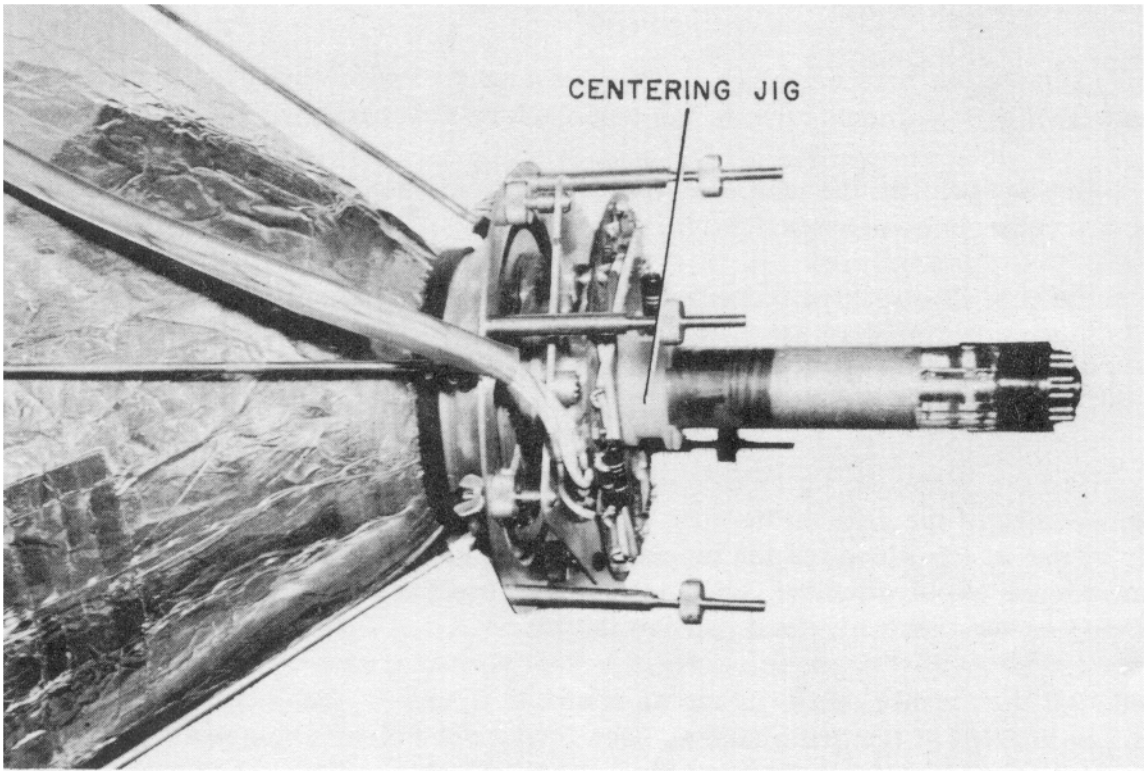



Figure 7. Partial Assembly Using Model 1285ES Support, Showing Centering Jig in Place

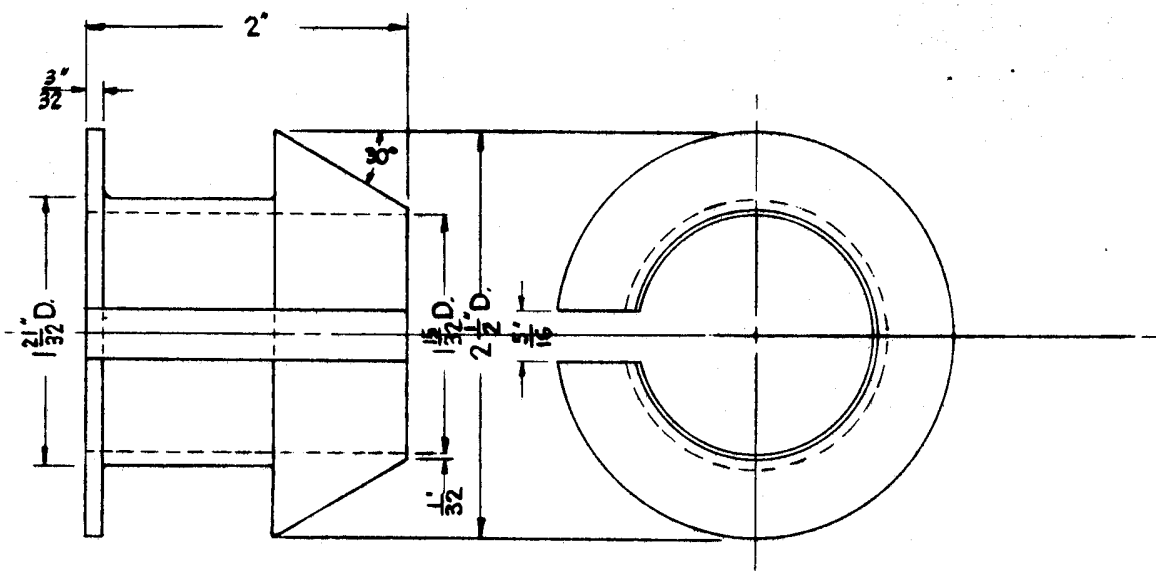



Figure 8. Details of Centering Jig

or other aid is worthwhile.

1. Assemble the yoke mounting plate to the four tie rods, centering the plate on the tube neck and aligning it perpendicular to the tube neck as accurately as possible.

2. Place the yoke on the tube, and center the front opening of the yoke on the tube funnel. Tighten the yoke clamp screws lightly.

> NOTE: If the universal yoke and focuser mount is used, which permits three-axis adjustment of the yoke, the front of the yoke opening may be centered in-dependently of the rear. Otherwise the front of the yoke will center itself ac-cording to the tube contour. This is usually quite satisfactory.

3. Place the centering jig (see figure 7) over the tube neck, and use it as a guide to center the rear opening of the yoke on the tube neck; carefully adjust the yoke position by use of tie rods or by use of tolerances in the mounting brackets. (The centering jig shown is a slit conical sleeve made of polyethylene, such as is shown in figure 8). Tighten the tie-rod nuts and yoke clamp screws securely, and remove the jig.

4. Install the focuser on the mount as shown in figure 9. The center of the focuser should be 3 inches in front of the grid plane as seen through the clear glass near the tube base. Adjust the position of the focuser so that its mechanical axis and that of the tube coincide.

5. The centering magnet (obtained from Quam-Nichols) is next placed on the tube neck and centered approximately 1/2 inch behind the grid plane. The magnet may be placed as far back on the neck as the magnet strength vs. beam centering requirement will permit. The farther back it is located, the less likelihood there is that the magnet will distort the focusing field. The position recommended is usually satisfactory.

6. Locate the geometric center of the tube face, and mark its location.

7. Bias off both grids. Connect a pulsed signal source, adjusted for 2 microsecond duration, 60-cycle repetition rate, to the writing grid.

> CAUTION: The stationary spot can quickly damage the screen if for any reason the average current to the screen should rise above the normal values for this test.

8. Apply normal operating anode and screen voltages to the tube. Adjust the pulse amplitude to obtain a 500-μa. peak pulse of writing current. This will require from 60 to 80 volts of grid drive, approximately, depending upon cutoff of the particular tube. Adjust focuser current for normal focused spot.

9. Move the focuser to position the spot in the center of the tube. This is a preliminary setting of the focuser.

10. Remove the d-c focus current and apply 115 volts, 60 cycles, a.c. to the focuser. (Disconnect focus coil bypass capacitor, if one is used.) Remove the pulse and readjust the d-c bias carefully for a small pattern. A pattern similar to that shown in figure 10A should be seen.

11. Adjust the precentering magnet in position around the gun, and in strength by turning the knob containing the magnet, to obtain the pattern shown in figure 10B.

12. Remove the a-c voltage from the focuser and apply normally connected d-c focus current. Apply a-c bucking pattern to the vertical deflection coils. Adjust the bias if necessary to obtain a small pattern. Adjust the focus current to 50 ma (approximately) and note the tails forming a V or X from the spot. Adjust the yoke voltage for best focus of the tails. These tails provide a clue as to the direction the focuser should be moved. See figure 11.

13. Move the focuser to obtain a symmetrical X. This means that the beam is now centered in the yoke, but not necessarily in the focuser.

14. Reduce the beam current to zero, remove the a-c voltage from the yoke, and repeat steps 10, 11, and 12 until patterns 10B and 11E are obtained. If both cannot be obtained at one setting of the focuser and magnet, pattern 10B should be obtained at the expense of some slight degradation of pattern 11E.

15. Turn, down the beam current, and remove the a-c bucking voltage from the vertical yoke. Apply pulse to the writing grid and adjust the focus for the sharpest spot at the center of the tube.

16. Remove the pulse, and apply approximately 6 volts, a. c. to the vertical yoke (aiding). Adjust the bias to obtain a vertical trace. Simulate dynamic focus by increasing the focus current 15 ma., obtaining the narrowest focus at the top and bottom of the vertical trace.

17. Without disturbing the horizontal or vertical position of the yoke, rotate the yoke to obtain the best coincidence between the trace and a single color Line.

18. Turn off the voltages and restore normal operating connections.

NOTE: The focuser, yoke, and beam are now aligned. If for any reason the yoke or focuser is moved (as for example to effect a compromise for neck shadow), realignment will be necessary.

## FOCUSER FIELD PREDISTORTION TECHNIQUE

It has been found experimentally desirable to predistort the focuser field to obtain a focused spot which has a controllable astigmatism. For example, by distorting the field to produce a center-focused spot whose dimensions are from 2 to 5 times as high as it is wide

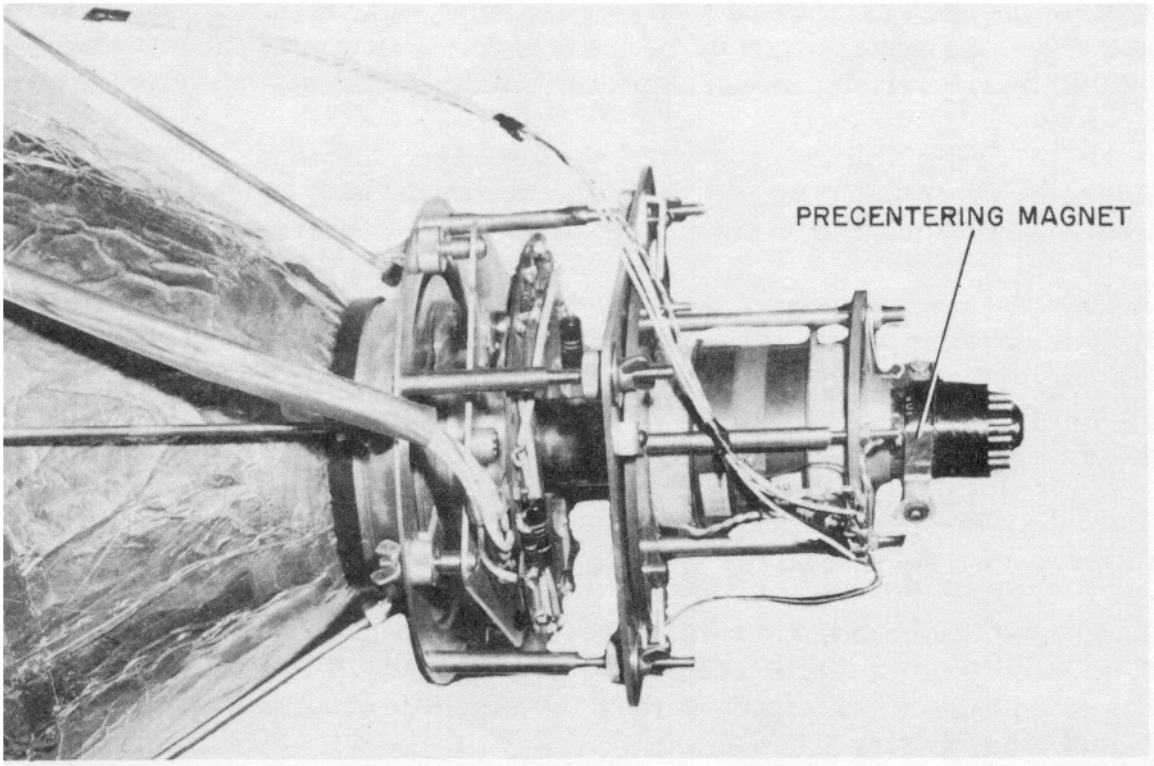



Figure 9. Complete Assembly Using Model 1285ES Support, Showing Precentering Magnet in Place

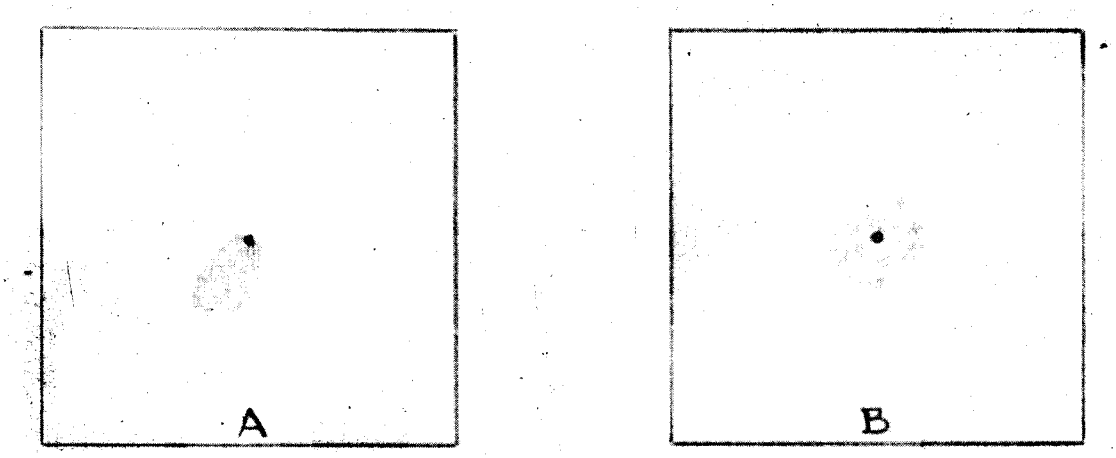



Figure 10. Screen Pattern Before and After Adjustment of Precentering Magnet

| Pattern | A | B | C | D | E |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| Focuser is: | high | low | left | right | correct |

Figure 11. Alignment Patterns

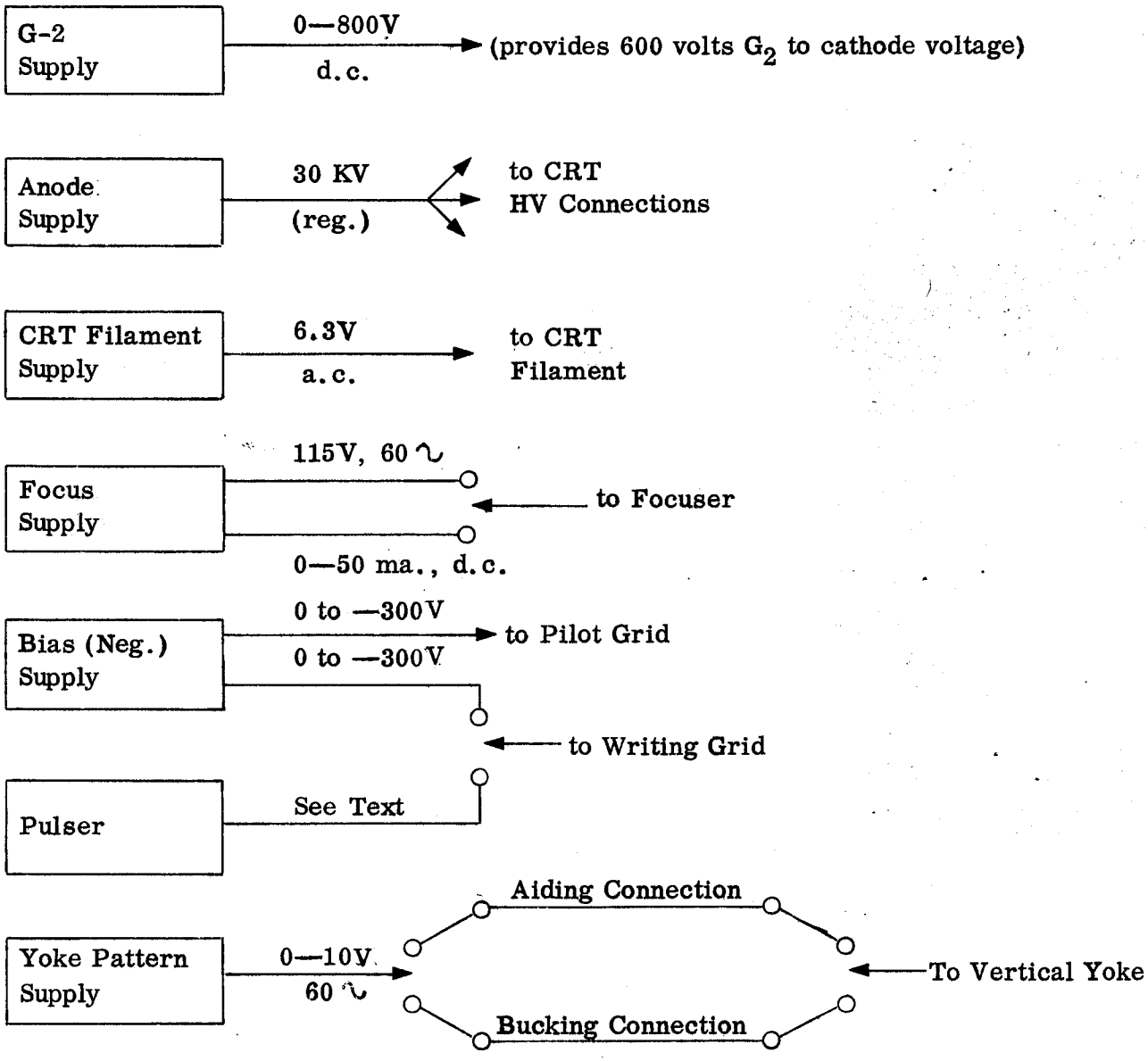



Figure 12. Block Diagram of Test Equipment Requirements

enables the beam to be pulsed to a much higher current, hence greater brightness, for a given saturation.

This gain is not entirely without a price at the present time. Various other effects, such as corner rotation of this elongated spot, can cause considerable desaturation as the spot is deflected. Other forms of distortion have also been observed. However, it is felt that this is a technique which offers considerable potential in improved brightness and saturation. For this reason, the following preliminary procedure is suggested as a means of becoming familiar with the technique.

1. Apply a pulsed spot of approximately 500 μa. of writing beam current to a normally connected and focused tube.

2. Observe the spot, preferably under a microscope, noting the nature of the astigmatism.

3. Place two small, round soft-iron "buttons" on each of the permanent magnet rings of the focuser, locating them as shown in figure 13.

4. While the spot is under observation, adjust the location of the iron buttons to obtain a vertical astigmatism of approximately 3:1 in the focused spot, maintaining the spot vertical by positioning the buttons. Each pair of buttons must be kept 180° from each other, as indicated in figure 13.

An alternative procedure, which is sometimes faster, is to apply the two buttons to the front magnet first and adjust them for vertical astigmatism, and then apply the two rear buttons and adjust them for vertical astigmatism. The focus current should be adjusted during this procedure to maintain the narrowest vertical spot.

NOTE: In their final position the buttons should not be near the horizontal plane. Such a position will introduce undesirable astigmatic conditions.

5. Deflect the spot to the right and left edges of the tube, and observe the deformation of the spot. If the spot deforms drastically in such a manner as to make it probable that edge saturation will be very adversely affected, readjust the button positions for somewhat less center astigmatism, and recheck. Experimental results indicate that some tube-yoke-focuser combinations can be used with greater center astigmatism than others.

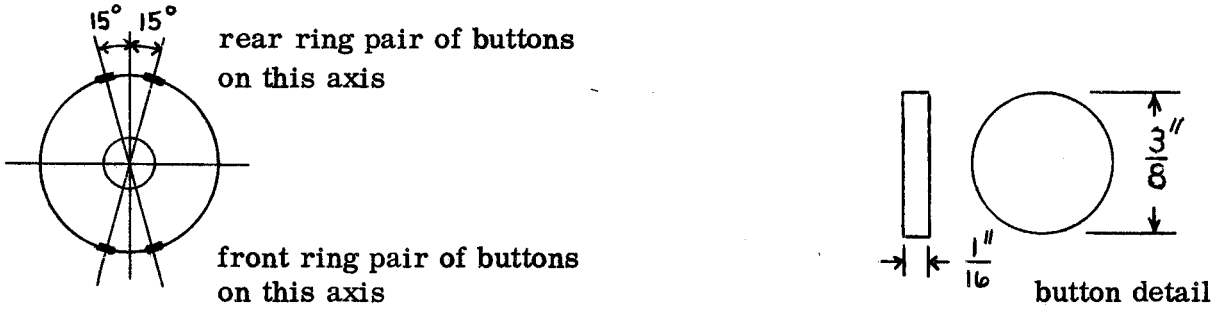
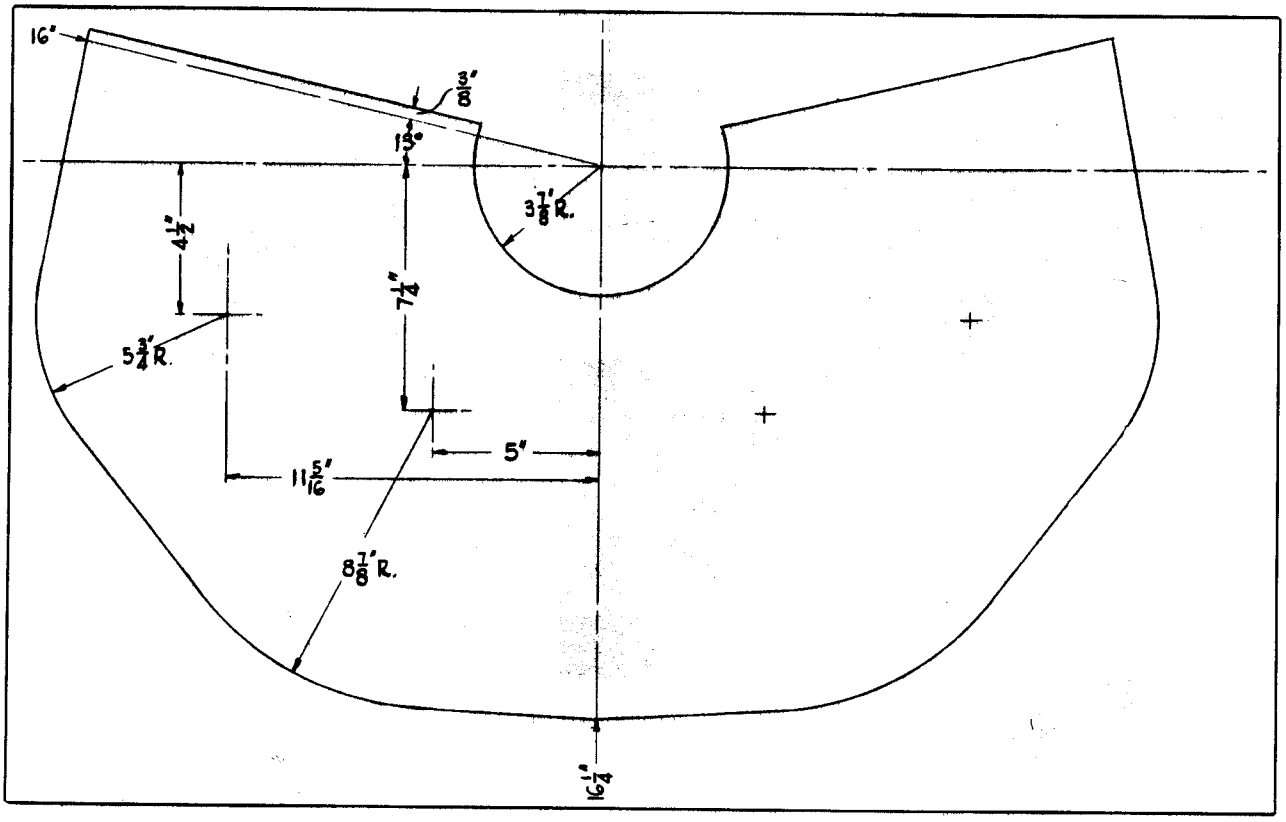



Figure 13. Initial Button Position, Front View




TEMPLATE DIMENSIONS

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## ADDENDUM TO ESB-120

## A PORTABLE ALIGNMENT UNIT FOR APPLE ELECTRON-OPTICS SYSTEMS

A unit providing a convenient arrangement of the circuits necessary for alignment of the Apple electron-optics system has been developed and constructed by the Engineering Department. Figures A-1, A-2, and A-3 provide the detailed information necessary for the construction of this unit, which can be housed in a portable-type case. The lid of the case should be of sufficient depth to provide stowage space for the necessary accessories, including cables and the dummy load yoke.

In addition to providing for the functions specified in the block diagram, figure 12 of ESB-120, a sweep is incorporated in the unit. This minimizes the danger of screen damage which is caused by a stationary spot. A phasing control enables the operator to time the pulse to coincide with the zero-deflection position of the spot and the optimum focus current. With this condition established, the alignment procedure is carried out as directed below; this procedure replaces steps 7 through 18, pages 6 and 7, of ESB-120.

1. Connect portable alignment unit, dummy load yoke, and receiver as shown in figure A-2. Set both bias controls for maximum bias (zero beam current). Disconnect focus by-pass capacitor if one is used.

2. With receiver turned off, turn on portable alignment unit. Set PULSE 60–120 CYCLES to 120 CYCLES, PULSE OFF-ON to OFF, VSA to HI, FOCUS AC to OFF, and YOKE BUCK AC to OFF.

> NOTE: The receiver should always be turned on last and turned off first, to minimize the possibility of screen damage. The receiver a. c. is fed through the alignment unit as a precaution against turning off of the unit while the receiver remains on, which would remove the bias from the tube and allow the screen to be destroyed.

3. Turn on receiver and allow a reasonable warm-up time.

4. Adjust BIAS G1A well below cutoff (approximately – 250 volts). Note bias reading.

5. Turn pulse on, and adjust pulse amplitude for a barely visible spot. Readjust BIAS G1A if necessary, to achieve this condition.

6. Reset BIAS G1A to obtain a beam current of approximately 500 μa. The required bias value can be determined from the $I_b - E_g$ curve for the CCRT being used, or it may be approximated as follows: if the tube is a low-cutoff tube (less than 110 volts, approx.), set the bias to obtain a pulse of 60 volts above cutoff; if the tube is a high-cutoff tube (over 140 volts, approx.), set the bias to obtain a pulse of 70 volts above cutoff.

7. Adjust focuser current (receiver focus control) for best focus of spot, and adjust phase to obtain a single spot.

8. Adjust receiver focus for maximum focus current, turn YOKE BUCK AC to ON and adjust YOKE BUCK I to obtain clear pattern of arms on spot with minimum bucking current. See figure 11. The direction of the arms provides an indication of the focuser position error.

9. Move focuser to obtain a symmetrical X. The beam is now centered in the yoke, but not necessarily in the focuser.

10. Turn BUCK AC to OFF, turn FOCUS AC to ON, adjust receiver focus for a sharp spot, and note resultant pattern. (See figure 10A).

11. Adjust precentering magnet to obtain pattern shown in figure 10B.

12. Repeat procedure of steps 8, 9, 10, and 11 until patterns 10B and 11E are obtained. If both cannot be obtained at the same setting of the focuser and magnet, pattern 10B should be obtained at the expense of some slight degradation of pattern 11E.

13. Turn BUCK AC to OFF, FOCUS AC to OFF, and VSA to LOW. This should result in a single vertical color line on the face of the tube. It will be necessary to increase the focus current (simulating dynamic focus). The yoke is now rotated, if necessary, to obtain a single color in this vertical line.

CAUTION: Do not disturb the horizontal or vertical position of the yoke.

14. Turn off receiver, wait several minutes, then turn off portable alignment unit. (This waiting time can be shortened by discharging the receiver high-voltage supply). The focuser yoke and beam are now aligned. If for any reason the yoke or focuser is moved (as for example to effect a compromise for neck shadow), realignment will be necessary.

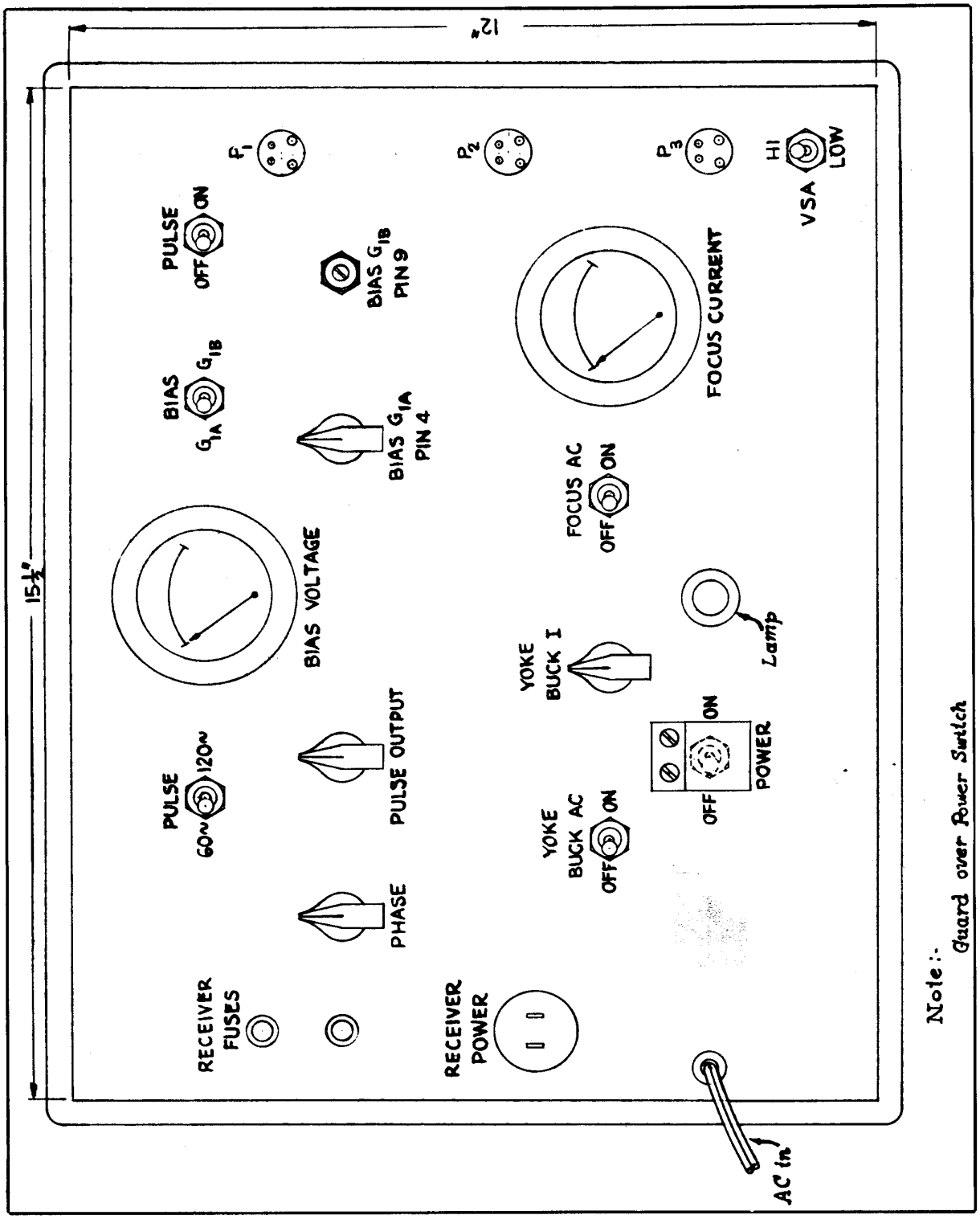


Figure A-1. Portable Alignment Unit, Front Panel View

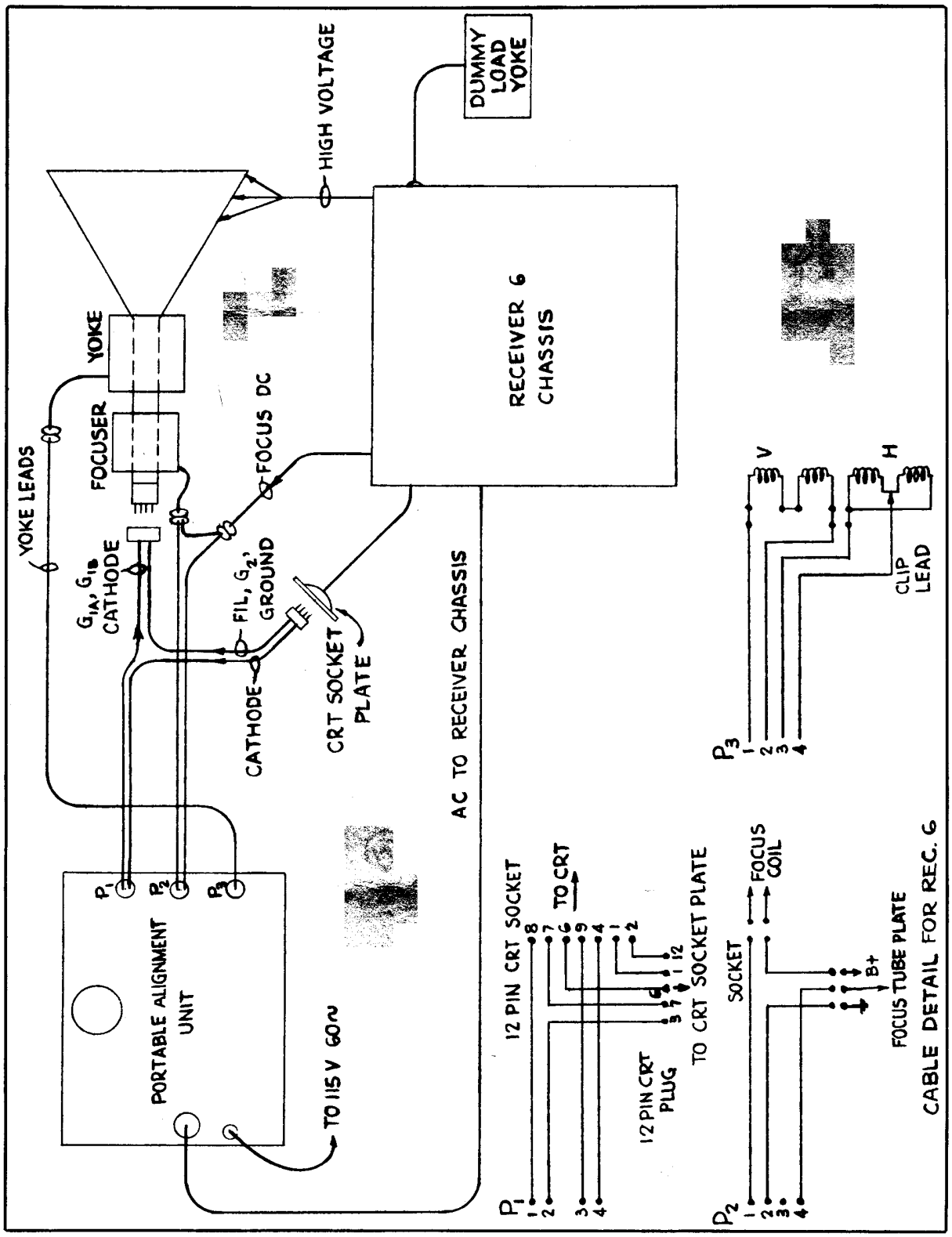


**Figure A-2. Diagram Showing Interconnections for Use of Portable Alignment Unit**

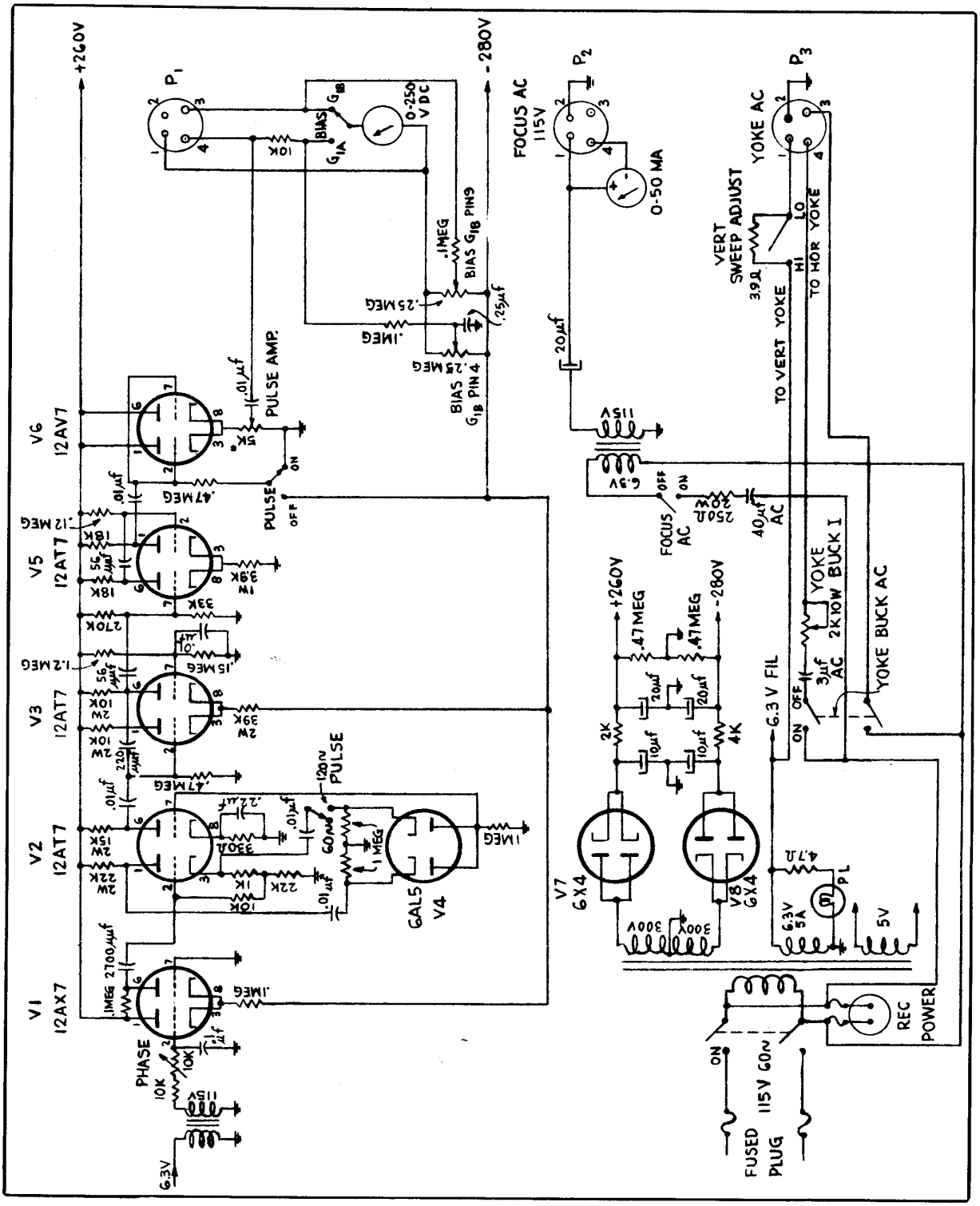


Figure A-3. Portable Alignment Unit, Schematic Diagram