LESSON 8

PROJECTION TELEVISION

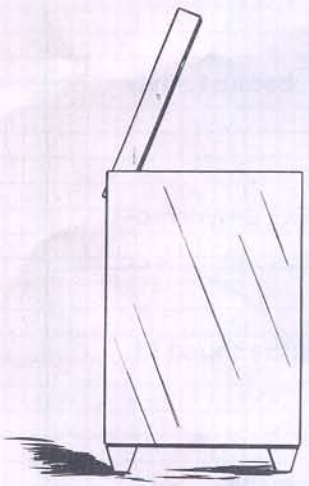
This lesson explains the fundamental principles of a projection system for the television receiver—and the application of these principles in a typical projection receiver.

It is very important that you understand this lesson thoroughly, for you must exercise the greatest care in your work—both in the installation and servicing of projection-television systems.

FUNDAMENTALS OF PROJECTION TELEVISION

The size of the picture tube limits the size of the picture that can be obtained in a direct-view television receiver. A tube 10″ in diameter is required to produce a picture only 6″ x 8″ in size. Because of the requirements of the picture tube, direct-view television becomes impractical, if a picture much larger than 6″ x 8″ in size is to be shown. The desirability of a larger picture is apparent, because such a picture allows more people to view the picture quite comfortably. For this reason, a system of projection television has been developed by Philco. This system uses a small picture tube and an optical system which projects the television picture on a 15″ x 20″ picture screen.

A basic television projection system is shown in figure 96. If you study this figure, you will see that there are three fundamental components in such a system. These components are the picture or primary image to be projected, a lens to collect the light from the primary image, and a screen upon which the lens can focus the image. In a system like the one illustrated, considerable light is lost, unless an extremely large lens is used. The space required for such a system is so great, that it cannot easily be installed in a television cabinet. The Philco Projection Television System overcomes many of the difficulties of the basic television system.



THE PHILCO PROJECTION TELEVISION SYSTEM

THE PRIMARY IMAGE

The primary image in the Philco Projection System is produced by the same basic methods as those employed in the Philco 10-inch, direct-view receiver. This system makes use of magnetic deflection, and the picture signal from the receiver controls the amount of light appearing in any part of the picture.

There are, however, important differences between the direct-view receiver and the projection receiver. In the Philco Model 48-2500 Projection Television Receiver, the picture tube is small (a four-inch diameter, type TP-400A), so that the elements of the optical system may be of reasonable size. Also, an extremely high anode voltage is necessary to produce a brilliant image. This voltage (about 20,000 volts) is developed by a voltage-tripler circuit. Since focusing must be very sharp for projection, the

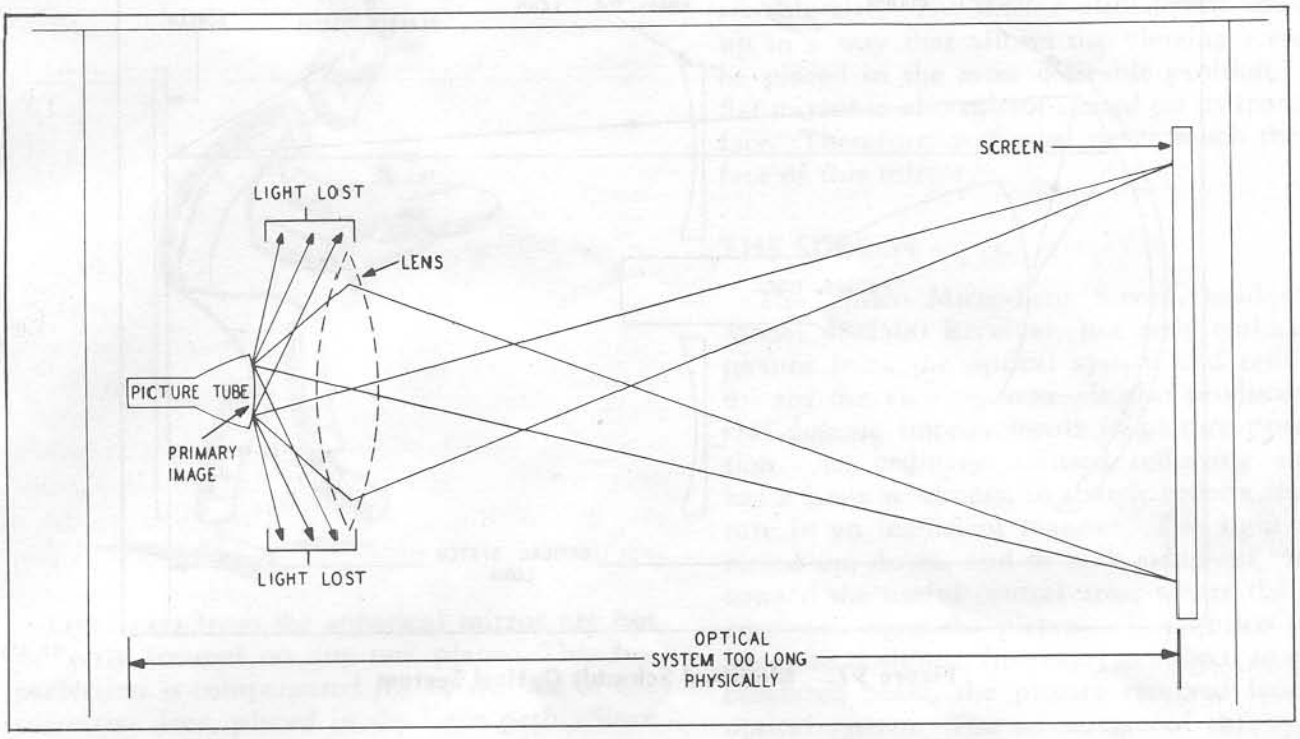


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Figure 96. A Basic Projection System

focus adjustment is naturally quite critical. Therefore, an auxiliary focus control is added, increasing the range of control. Because of the characteristics of the picture tube, the amplitude of the picture signal at the picture-tube grid must be greater in the projection receiver, to obtain good contrast, than that required for a direct-view receiver. An auxiliary BACKGROUND control is provided, to simplify the adjustment of the BACKGROUND and CONTRAST controls.

A good primary image is possible only when the anode voltage, the picture focus, and the amplitude of the picture signal are correct. If the anode voltage decreases for any reason, it affects the color and brilliance of the picture. At approximately 17,500 volts, for example, the picture will become much less brilliant, and it may change in color. Careful adjustment of picture-tube focus is of basic importance in obtaining the best possible primary image, so that subsequent adjustments of the optical system will be possible. Poor contrast in the primary image will result from insufficient picture-signal amplification. Therefore, for the Model 48-2500, the picture signal must be maintained at approximately 140 volts, peak-to-peak, at the picture-tube grid—as compared with 70 volts in a 10-inch set, such as the Philco 48-1000. This larger signal is produced by circuit changes in the video stages, requiring the use of a 7AD7 video output tube.

THE PHILCO OPTICAL SYSTEM

The Modified Schmidt Optical System (figure 97), is employed as the basis of the Philco Optical System. The use of a spherical mirror with a corrective lens results in a high degree of efficiency and excellent focus. In addition, this system can be enclosed easily in a cabinet of reasonable size, and it can be used with a reflecting type of screen.

In the Philco Optical System (figure 98) light from the primary image on the TP-400A picture tube is collected and reflected by the spherical mirror (A), and its focus is corrected by the correction lens (B). The light is then reflected by a flat mirror (C), so that the light path is folded back sharply and directed upon the face of a special type of screen.

The spherical mirror is concave (saucer like) in shape and ruggedly constructed of heavy

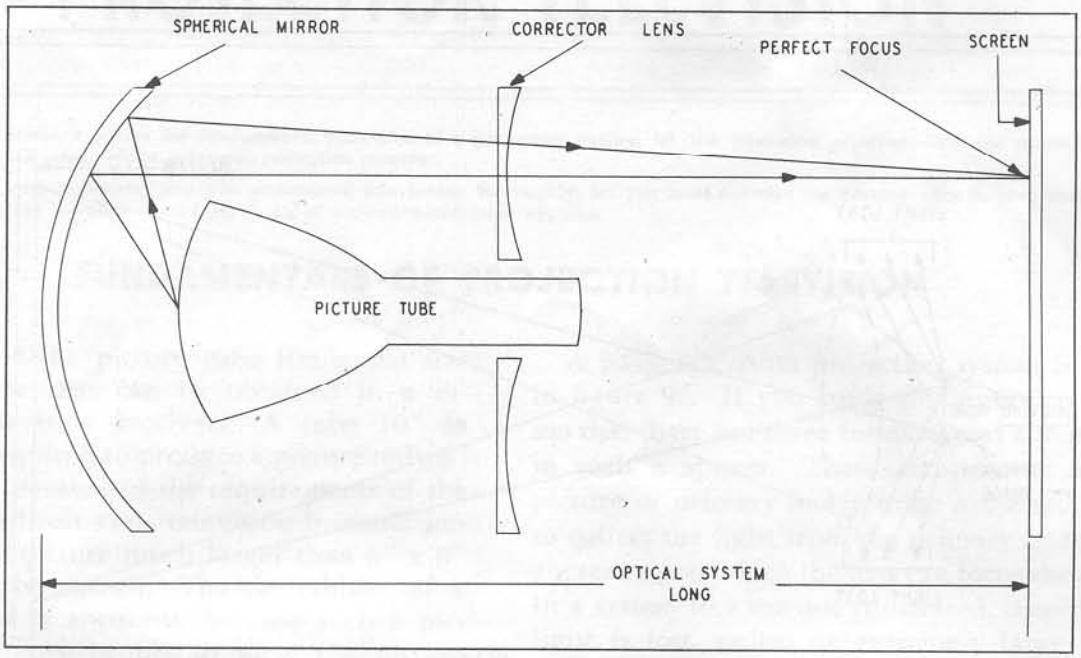


Figure 97. Modified Schmidt Optical System

molded glass. Unlike the surface of a common mirror, the top surface facing the picture tube is mirror-coated. This type of mirror coating prevents stray reflections and the absorption of light, but it leaves the mirror surface exposed. (If a back-surface mirror were used, light would have to pass twice through the thickness of the glass to reach the mirror and be reflected.) If you find it necessary to handle the mirror, you will have to use special precautions. If you touch the mirror surface, the oil and acid normally present on your skin will attack the mirror, even though you clean the surface immediately. The result will be discoloration and corrosion of the surface, with loss of reflection properties—thus ruining the mirror. For this reason, you must never touch the spherical mirror surface—either with your hands or tools. The only safe way of handling this mirror is to grasp it securely by its edges, or by the rear surface, which is uncoated. In the center of the reflecting surface, there is a black, non-reflecting area, as shown in figure 98. This area, which is equal to the area of the picture-tube face, prevents multiple reflections, caused by light that comes from the tube at small angles. (See figure 98.) Such light, reflecting back and forth between the mirror and the tube face, would decrease the contrast of the picture. These refinements in the mirror result in efficient collection and good reproduction of the light from the primary image.

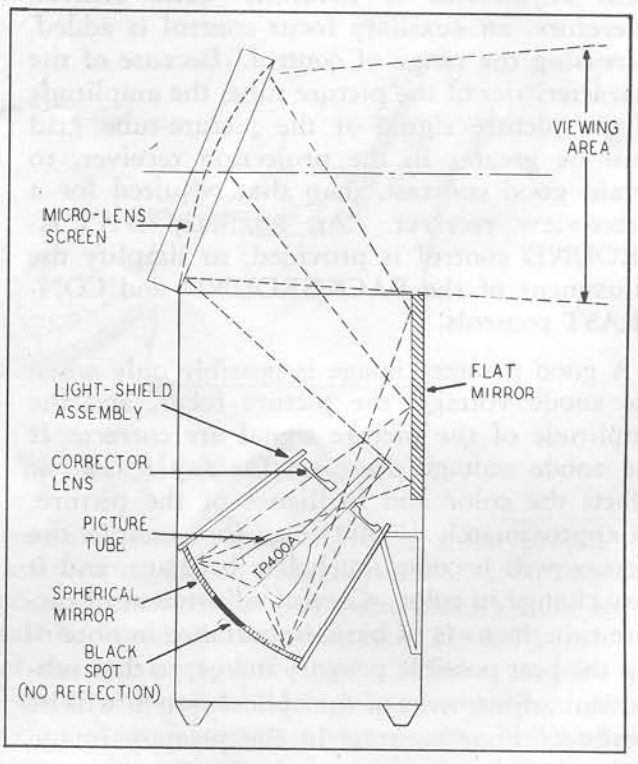
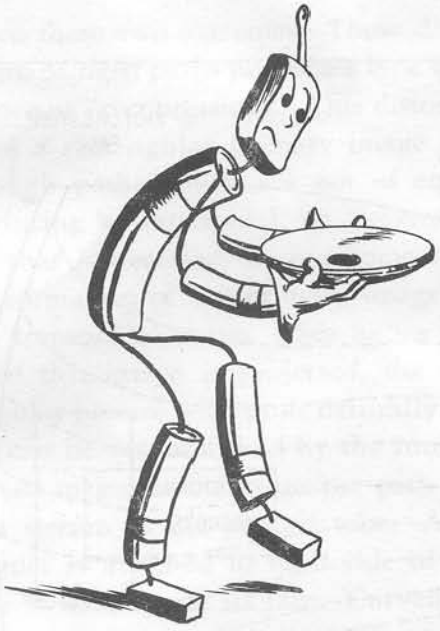


Figure 98. Fundamentals of the Philco Projection System



Light rays from the spherical mirror are not perfectly focused on any one plane. This imperfection is compensated for by the use of the corrective lens, placed in the light path. Since the necessary correction is slight, the corrective lens is of very low power. This lens can be made either of molded plastic or of optically ground glass. (If it is of plastic, the lens can be damaged by scratching—therefore, you must handle it with extreme care.)

A flat mirror is placed in the path of the light rays from the correction lens, reflecting the light upward at an angle. The purpose of this mirror is to fold the light path, so that the entire projection system may be placed in a cabinet of reasonable size. The mirror also directs the light up in a way that allows the viewing screen to be placed in the most desirable position. This flat mirror is also mirror-coated on its front surface. Therefore, you must never touch the surface of this mirror.

THE SCREEN

The Philco Micro-Lens Screen, used in the Model 48-2500 Receiver, not only collects the picture from the optical system and reflects it toward the viewing area—it also produces several definite improvements in picture presentation. An ordinary diffused reflecting surface has a basic weakness, in that it reflects the picture in an inefficient manner. The light is directed up, down, and to both sides—as well as toward the useful central area, where the audience will view the picture. The Philco screen has been designed, however, to reflect, in a concentrated beam, the picture received from the optical system. The advantage of this type of reflection is that the beam provides maximum picture brilliance in the area where the audience will normally be seated. (See figure 102.) In this area, therefore, the picture will appear to be many times brighter than it would be, if an ordinary screen were used. At the same time, the screen acts to prevent annoying reflections from light sources outside the optical system—such as lamps and windows. These advantages are obtained by using a specially curved screen

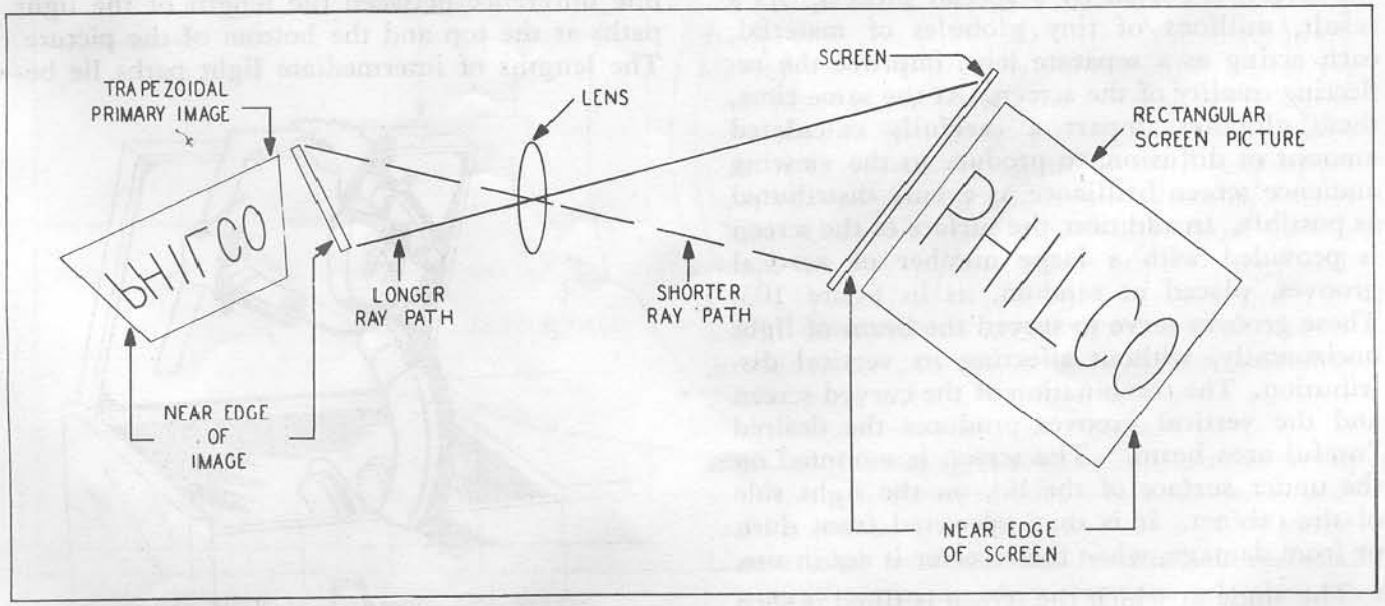


Figure 99. Keystone Projection

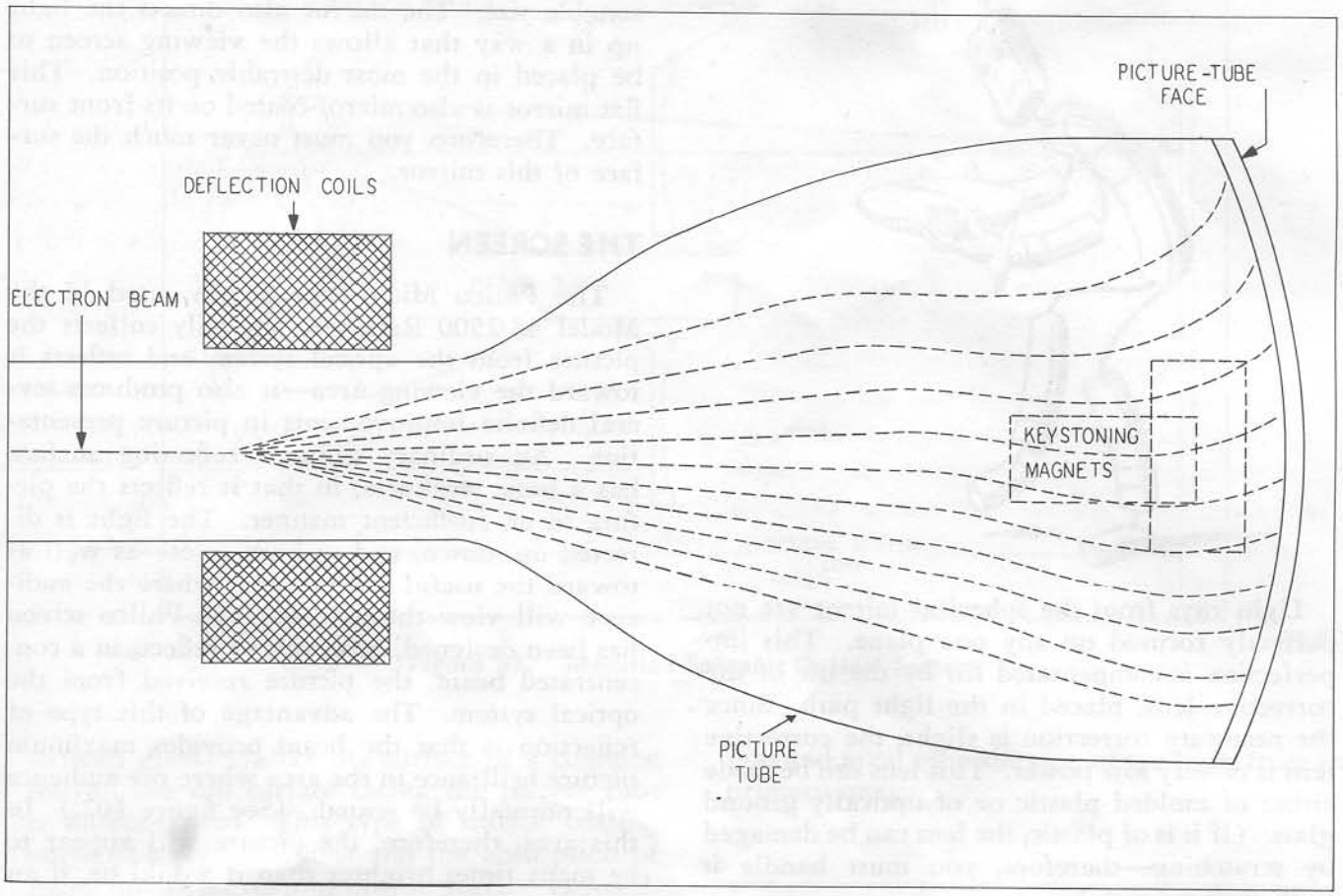


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Figure 100. Action of Fixed Magnetic Field upon Picture-Tube Beam

surface, held at a specific angle. The surface of the screen is coated by a special process. As a result, millions of tiny globules of material, each acting as a separate lens, improve the reflecting quality of the screen. At the same time, these globules impart a carefully calculated amount of diffusion, to produce to the viewing audience screen brilliance as evenly distributed as possible. In addition, the surface of the screen is provided with a large number of vertical grooves, placed at random, as in figure 103. These grooves serve to spread the beam of light horizontally, without affecting its vertical distribution. The combination of the curved screen and the vertical grooves produces the desired "useful area beam." The screen is mounted on the under surface of the lid, on the right side of the cabinet. It is thus protected from dust, or from damage, when the receiver is not in use.

The angle at which the screen is tilted is such that the light rays from the optical system strike the screen at an angle. This angle causes a definite difference between the length of the light paths at the top and the bottom of the picture. The lengths of intermediate light paths lie be-

tween these two extremes. These differences in length of light paths produce a type of distortion known as "compression." This distortion results when a rectangular primary image is projected through paths which are not of equal length, producing a trapezoidal, or "keystone," shape. All that is necessary to overcome this effect is the formation of the primary image in the correct trapezoidal shape. (See figure 99.) Then, when this image is projected, the desired rectangular picture will result naturally. This shaping can be accomplished by the introduction of a fixed magnetic field into the path of the electron stream in the picture tube. A permanent magnet is attached to each side of the picture tube at the edge of its face. Curved pole pieces create a uniform magnetic field across the tube, bending the beam "up" and causing it to travel in a curved path, so that it strikes the face of the tube obliquely, as shown in figure 100. The amount of curvature in the beam will depend upon the proximity of the beam and the magnet. Thus, in the bottom of the picture tube, the beam will travel in a nearly direct path, while, at the top of the picture tube, the beam will travel an elongated path, as shown in figure 100. The greater the distance traveled by the beam, the longer time the deflecting action of the deflection yoke will affect the beam—hence, the greater the amount of deflection. The picture is thus formed into a keystone shape. The action of the magnets in bending the beam upward would move the entire picture toward the top of the tube face, if it were not for the existence of the "return" magnetic field from the outer ends of the magnets. This field acts, however, to push the beam down before it reaches the "up" magnetic field. Figure 101 shows the location of the keystoning magnets and the resulting picture.

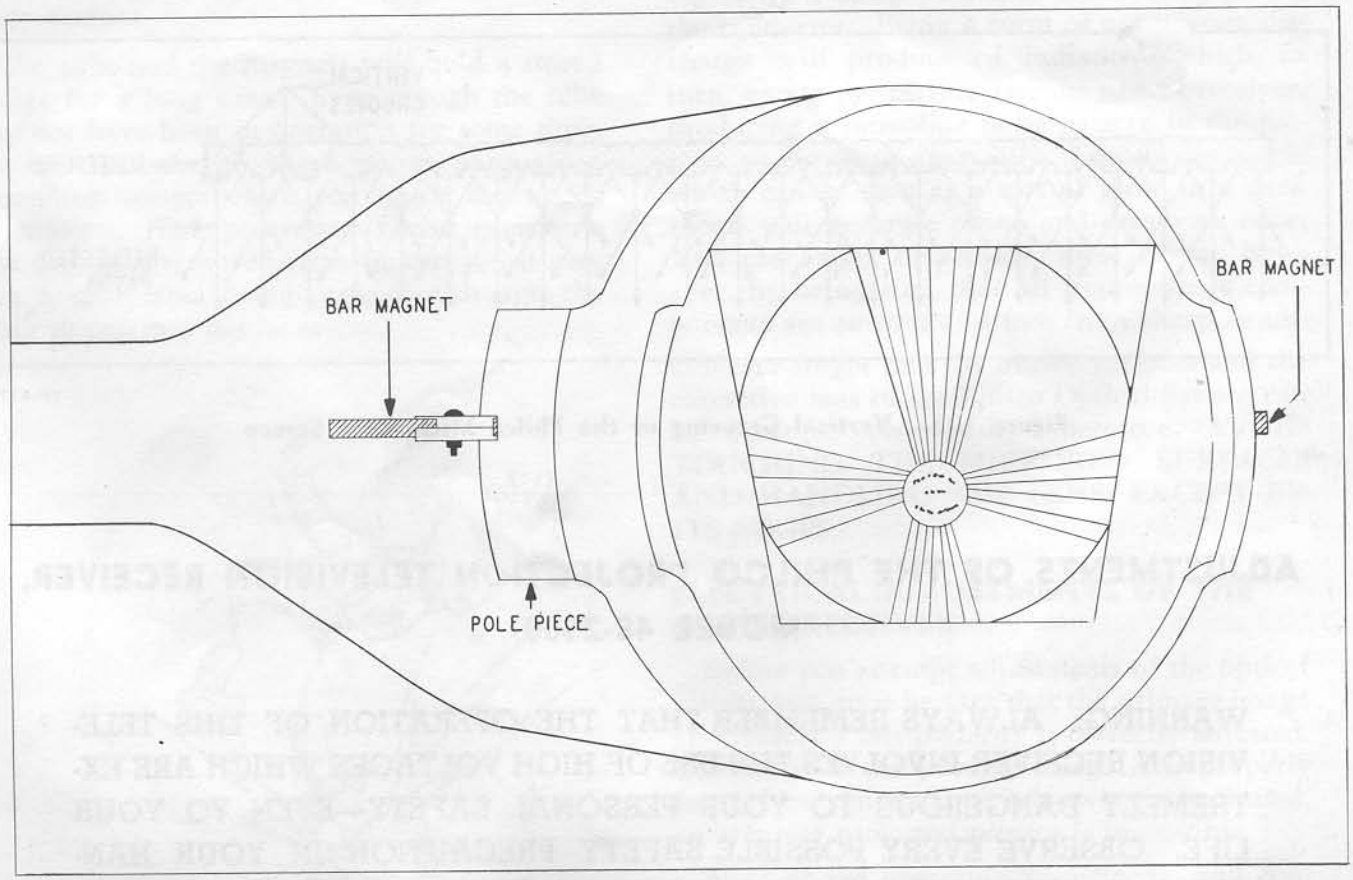

Figure 101. Keystoning Magnets and the Keystoned Picture

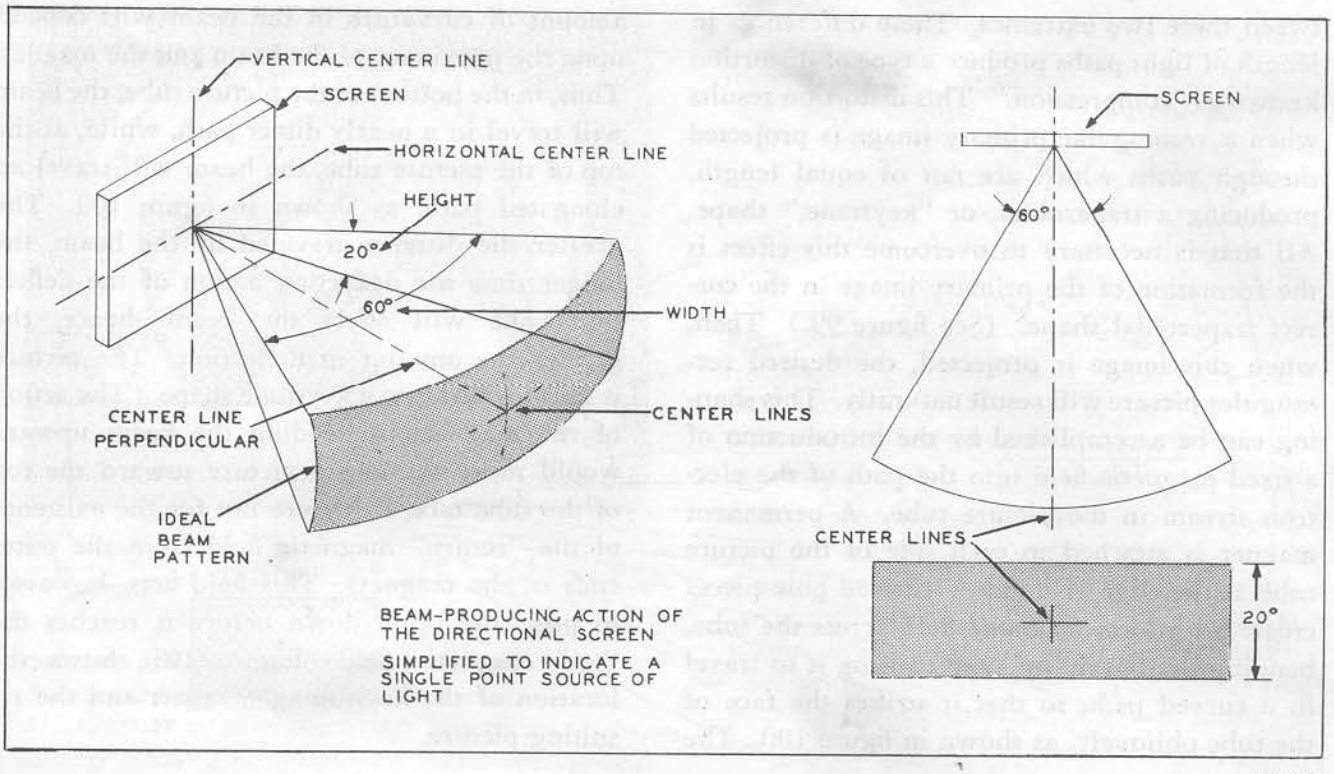

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Figure 102. Beam-Producing Action of the Philco Micro-Lens Screen

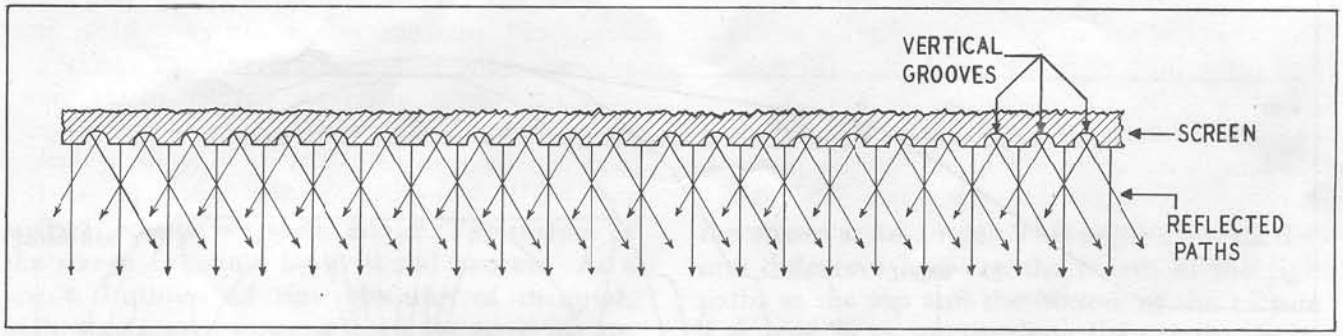

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Figure 103. Vertical Grooving of the Philco Micro-Lens Screen

ADJUSTMENTS OF THE PHILCO PROJECTION TELEVISION RECEIVER, MODEL 48-2500

WARNING: ALWAYS REMEMBER THAT THE OPERATION OF THIS TELEVISION RECEIVER INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE EXTREMELY DANGEROUS TO YOUR PERSONAL SAFETY—EVEN TO YOUR LIFE. OBSERVE EVERY POSSIBLE SAFETY PRECAUTION IN YOUR HANDLING OF THIS RECEIVER. BE POSITIVE TO DISCHARGE THE 20,000-VOLT CIRCUIT BEFORE YOU MAKE ANY REPAIRS.

PRECAUTIONS FOR ADJUSTMENTS

The TP-400A picture tube is provided with two separate sprayed-on coatings. The bell-shaped portion of the tube is covered with a sprayed-on coating of material, very high in insulating properties. This coating can be damaged by handling, because of the moisture and oil from your fingers. Leakage currents from the high-voltage anode will become great, and arc-over may result. The coating on the neck of the tube, slightly different in color from the other coating, is of conducting material, and serves to protect the electron stream from stray fields.

Although the keystoning magnets are not connected electrically to the anode, because of leakage current they will collect a charge that is similar to a "static" charge. Therefore, before you touch the magnets, in making any adjustments, you must ground each magnet individually. An effective procedure is to attach a grounding strap to a magnet, to make the adjustment—and then to remove the strap. You must repeat this procedure for each adjustment on every magnet.

The tube and the magnets will hold a stored charge for a long time. Even though the tube may not have been in operation for some time, you must discharge these points through a grounding strap, before you touch the anode or magnets. This procedure is wise, even on a new tube just removed from its carton—it may save a tube from being broken, although the shock to you may not be severe.

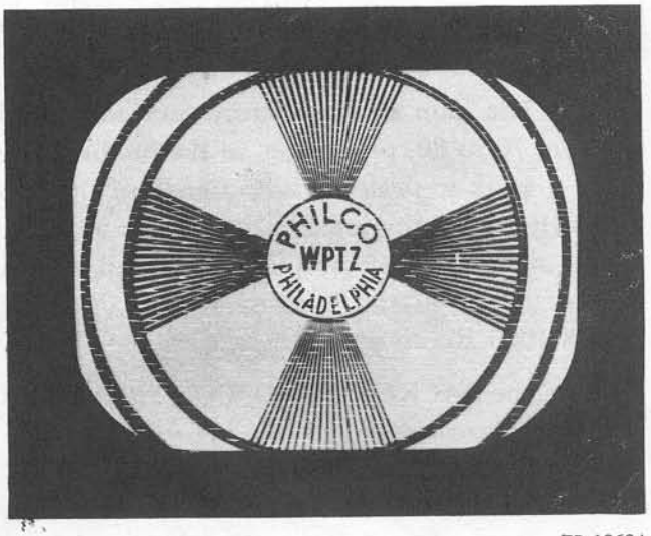

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Figure 104. Test Pattern, Showing Effect of Corona on Picture

The extremely high voltage of the picture-tube anode circuit can also produce various peculiarities in the operation of the receiver. A corona discharge, involving ionization of the air, may occur near a high-voltage conductor—especially if sharp points, or bends, occur along the conductor. Being a form of arc, corona discharge will produce r-f radiation, which, in turn, enters the picture circuits of the receiver, producing a snow-like noise pattern in the picture, as shown in figure 104. Corona discharge, which can be seen as a sort of glow in a dark room, will generate ozone and create an odor. You can avoid, or remedy, these effects, however, by being sure that all high-voltage components are smooth and free from sharp bends.

Never forget that the mirror surfaces and the corrective lens of the Philco Optical System can be damaged very easily—therefore, AVOID TOUCHING THE MIRRORED SURFACES AND HANDLING THE LENS, EXCEPT BY ITS EDGES.

ELECTRICAL ADJUSTMENTS OF THE 48-2500 RECEIVER

Before you attempt adjustments of the optical system, you must be sure that the primary image (preferably a test pattern) is correctly adjusted. Obviously, if the primary image is improperly focused or centered, or otherwise misadjusted, an accurate projected picture is impossible.

Most of the operating adjustments and controls of the Philco 48-2500 Receiver are similar to those in the Philco 48-1000 Receiver. Be

sure, however, to note the following differences very carefully:

1. The gain of the Picture Section should be from 70 to 80, producing, at the picture-tube grid, a peak-to-peak picture signal of 140 to 160 volts, with the a.g.c. adjusted for a 2-volt signal at the detector output—compared with a gain of 35 to 40 and a 70 to 80-volt signal of the 48-1000 Receiver.

2. The BACKGROUND, CONTRAST, and FOCUS controls interact—so, before these controls can be adjusted, the AUX. BACKGROUND and AUX. FOCUS controls must be preset. Proceed as follows, in adjusting these five controls:

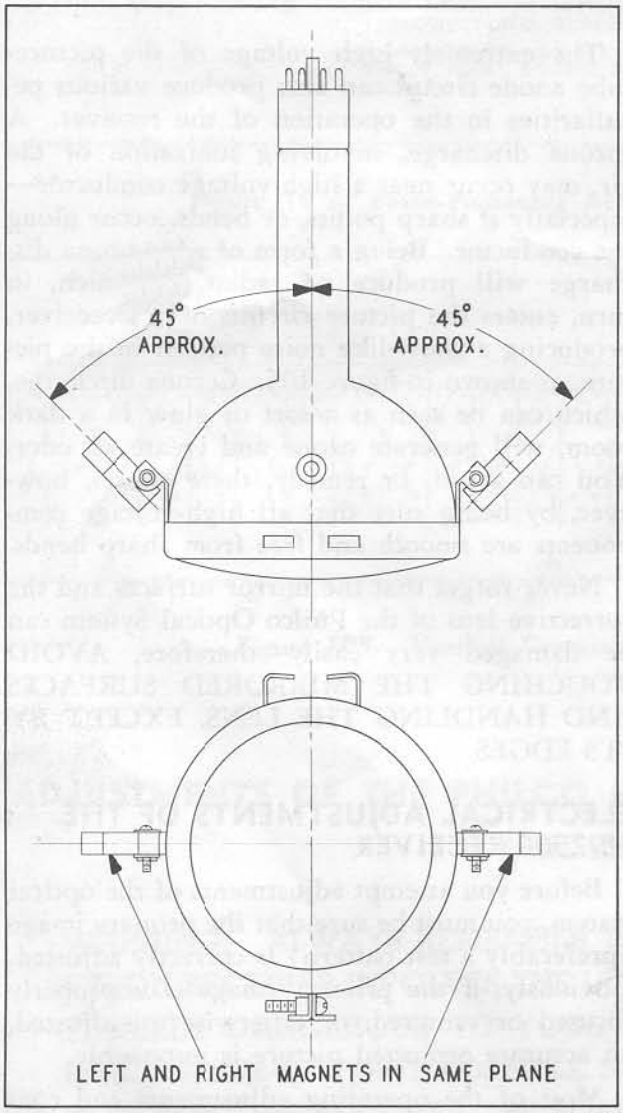

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Figure 105. Position of Keystone Magnets

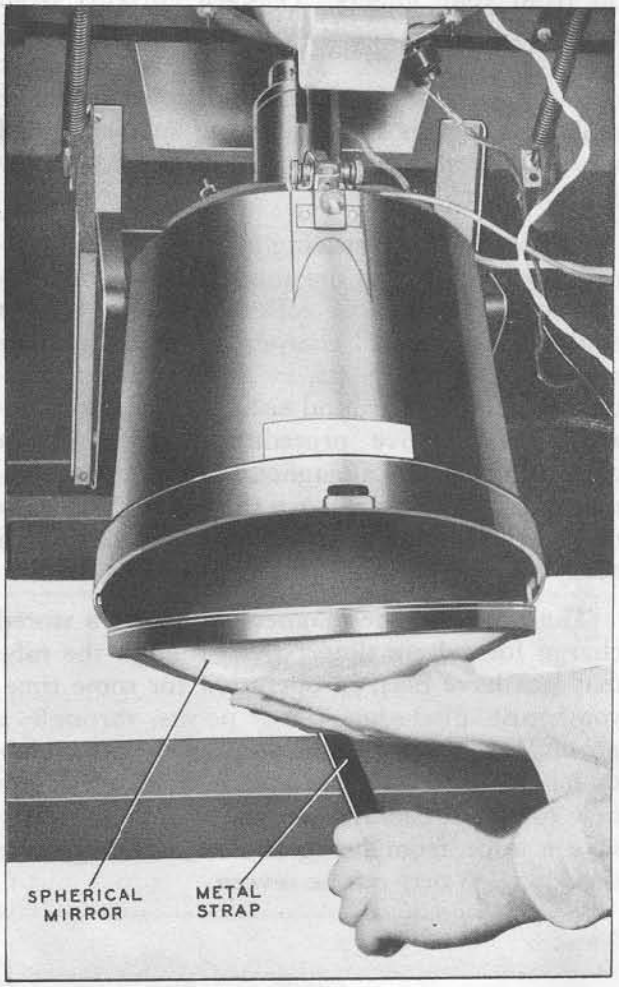

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Figure 106. Inserting Spherical Mirror

(a) Set the BACKGROUND, CONTRAST, and FOCUS controls to ¾ of their maximum clockwise positions.

(b) Connect a 0 to 100-microampere meter into the cathode circuit of the picture tube, and set the AUX. BACKGROUND control for a beam current of 70 to 80 microamperes. Do not adjust the AUX. BACKGROUND control again. This setting of beam current will pre-

vent overloading of the picture tube, and will thereby reduce the interaction of the BACKGROUND, CONTRAST, and FOCUS controls, thus making adjustments more simple. Another result will be the best picture consistent with long life of the picture tube.

(c) After you remove the spherical mirror, use a small mirror to observe the face of the picture tube, and adjust the AUX. FOCUS control to obtain sharp, clear sweep lines in the picture. Do not adjust this control hereafter.

(d) Adjust the CONTRAST control for the desired range of gray shades, with pure blacks and whites in the picture. Then set the BACKGROUND control for best clarity and focus in the picture.

(e) The settings of BACKGROUND, CONTRAST, and FOCUS controls should now result in a picture of excellent quality on the picture tube. If the picture is not of good quality, make slight readjustments—first, the CONTRAST control for picture shading; then, the BACKGROUND control for sharpness of picture detail.

OPTICAL-SYSTEM ADJUSTMENTS OF THE 48-2500 RECEIVER

After you have adjusted the primary image properly on the picture tube, you must make the necessary adjustments in the optical system. Before you begin these adjustments, however, there are two checks that you must make. First, be sure to position the keystoning magnets on the tube, as shown in figure 105. Second, be sure that the spherical mirror is replaced in the light-shield assembly, as illustrated in figure 106.

Now you are ready to begin the various adjustments in the optical system, as they are shown in figure 107:

1. Picture-Tube Rotational Adjustment

You must rotate the picture tube, with respect to the deflection yoke, if the top and bottom of the picture are not parallel. This adjustment is merely a convenient way of positioning the keystoning magnets, with respect to the deflected beam of the picture tube. If the field from the keystoning magnets is not aligned horizontally, the bending of the beam will not be uniform across the tube, and the top and bottom edges will therefore not be parallel. To align these magnets properly, loosen the picture-tube clamp screw and turn the tube until the top and

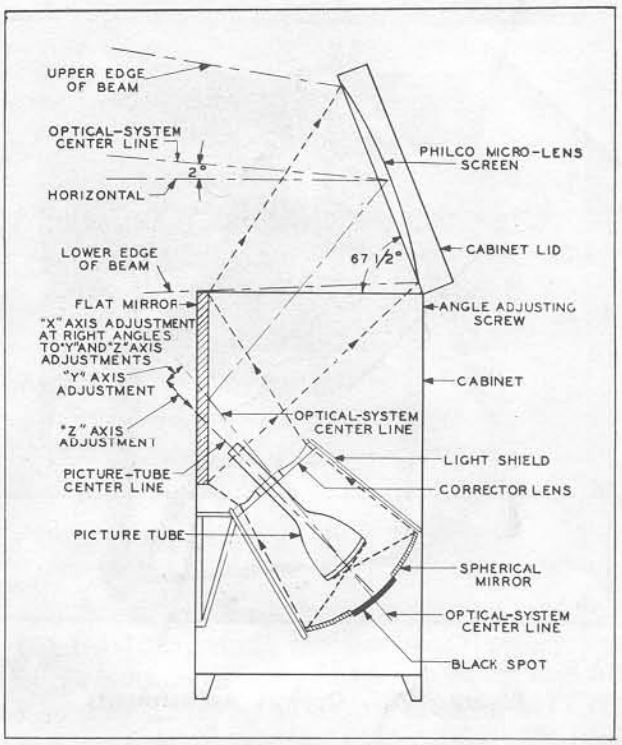

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Figure 107. Details of the Philco Projection System

bottom edges of the picture are parallel. Then tighten the clamp screw. (See figure 108.)

2. Deflection-Yoke Adjustment

You must also adjust the deflection yoke, if the top and bottom of the picture are not parallel with the top and bottom edges of the screen. To adjust the yoke, loosen thumb nuts A and B (figure 108), and rotate the yoke assembly until you obtain the parallel condition. (Note that the tube turns with the yoke in this adjustment.) Then tighten the thumb nuts.

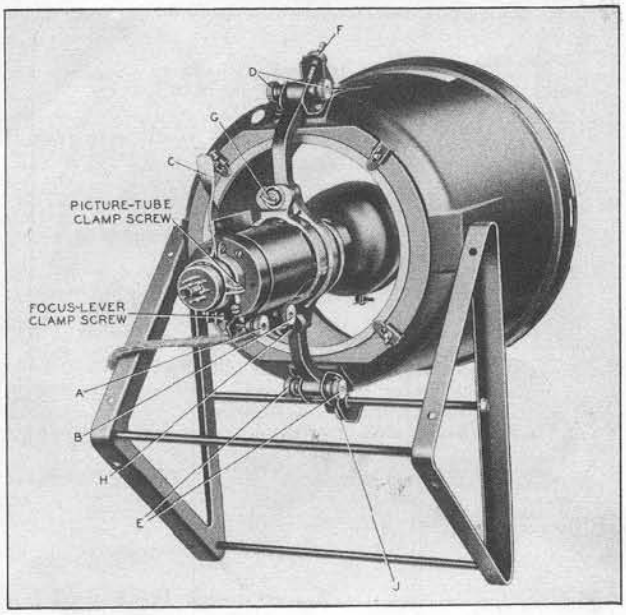

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Figure 108. Optical Adjustments

3. Keystone-Magnet Adjustment.

The sides of the picture should be parallel, both with each other and with the sides of the screen. If the sides are not parallel, the keystone magnets are set improperly, with respect to the longitudinal (Z) axis of the picture tube. This condition means that the primary image is either over-keystoned or under-keystoned. If this condition exists, you must adjust the angle of the magnets, with respect to the axis of the tube. If you inspect the picture, you will see whether the fault is with the right magnet, the left magnet—or both magnets—as shown in figures 109 and 110. You will also find whether the primary image is over-keystoned or under-keystoned. After you have determined which magnet is at fault, remove the spherical mirror and connect a ground strap to the magnet, or magnets, to be adjusted. Change the magnet position according to the correction required, as shown in figure 111. Remove the ground strap and replace the mirror. Then observe the effect of the correction, and repeat the process until the sides of the picture are parallel —with each other and with the sides of the screen.

4. Micro-Lens Screen Adjustment

Use a protractor to set the angle of the cabinet lid, so that the stop will hold the lid at exactly 67.5 degrees above horizontal, in the fully raised position. The angle-adjusting screw is located at the back of the cabinet lid. (See figure 107.)

5. Focus Adjustment of the Optical System

Focusing the optical system entails adjustment of the picture-tube position. The focus lever (figure 108) adjusts the position of the tube along the Z axis (figure 107), moving it either toward the spherical mirror, or away from it—thereby adjusting the length of the optical path equally, in all parts of the picture.

The adjustment of the Y axis (figure 107) regulates the angle at which the tube is placed, with respect to the vertical axis of the optical system. Changing this angle lengthens the

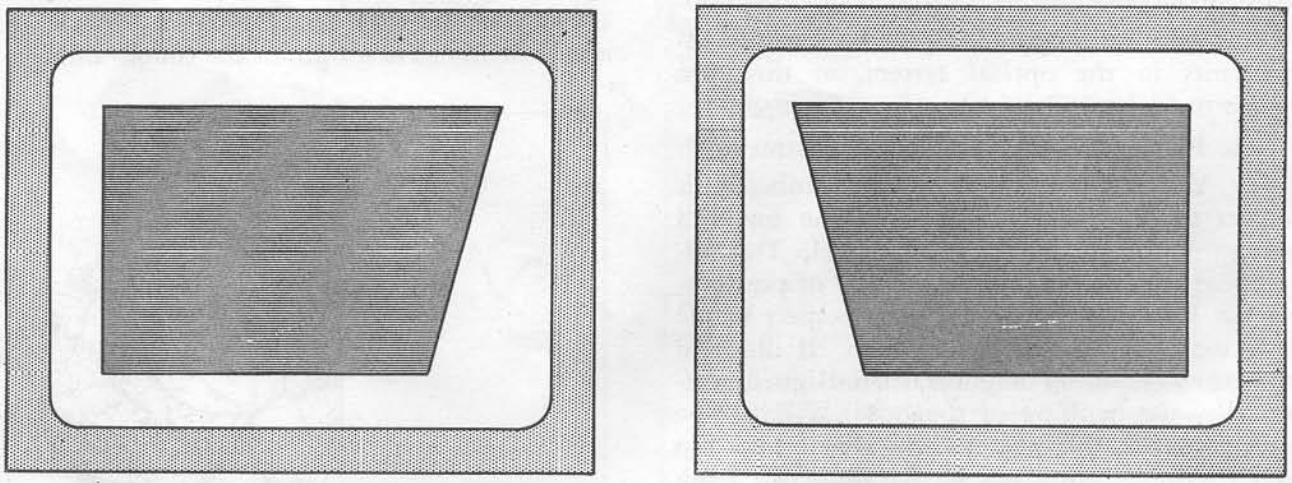

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Figure 109. Effects of Under-Keystoning

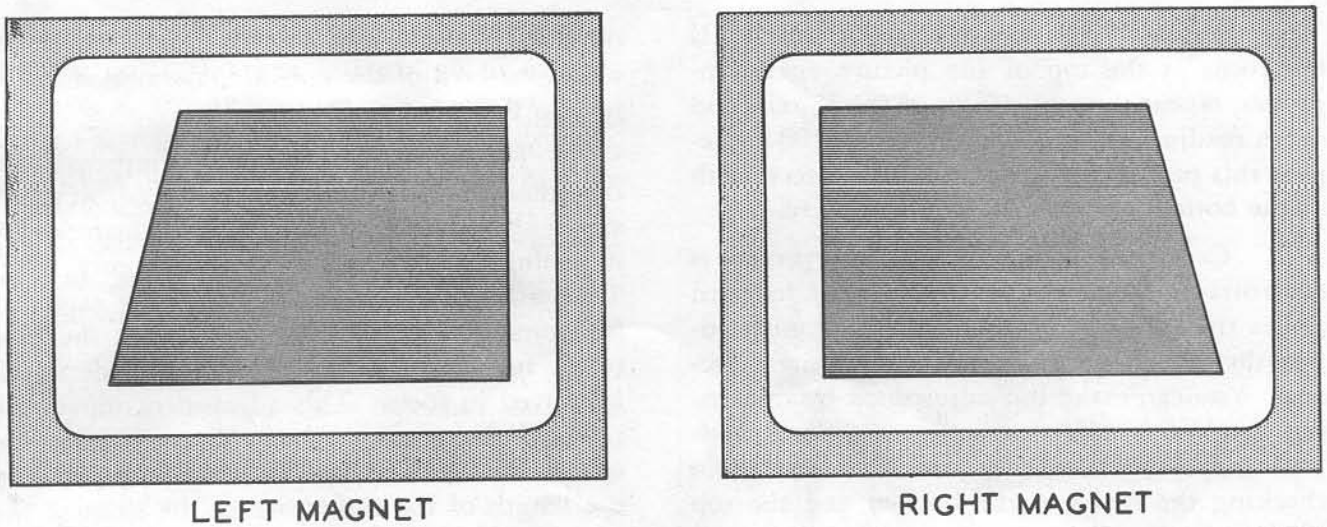


Figure 110. Effects of Over-Keystoning

light path between the bottom of the tube face and the top of the screen. At the same time, it shortens the path between the top of the tube face and the bottom of the screen—or vice versa, depending on the way the adjusting nut is turned.

The X-axis adjustment (figure 107) regulates the horizontal angle of the tube, with respect to the horizontal axis of the optical system. This adjustment enables focus at the sides of the screen to be made equally sharp.

It is important that you loosen the locking nuts only enough to allow you to make the required adjustment. If you have loosened these nuts excessively, the adjustments will be inaccurate when the locking nuts are tightened.

Proceed as follows, in adjusting the focus of the optical system (figure 107):

A. Loosen the deflection-yoke clamps A and B, and move the focus lever back and forth (figure 108), until the horizontal-sweep lines in the bottom of the picture are sharp and fine. You may desire to misadjust the HEIGHT control temporarily, to spread the lines. This misadjustment will aid you in determining the correct optical-focus point.

B. Tilt the screen forward slowly, and notice whether the focus in the top of the picture improves. If it does improve, the indication is that the bottom of the picture tube is too far from the spherical mirror, and therefore you must adjust the Y axis of the picture tube. Then loosen the Y-axis locking nuts D and E, and back off the Y-axis adjusting nut F one turn. The neck of the picture tube will move down very slightly, tilting the bottom of the picture tube toward the spherical mirror. Then readjust the focus lever (figure 108).

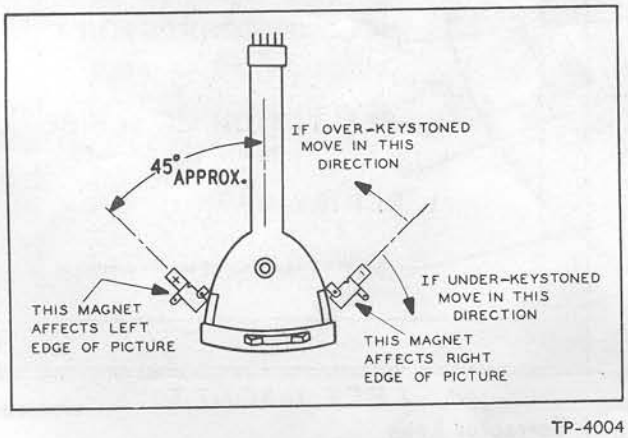
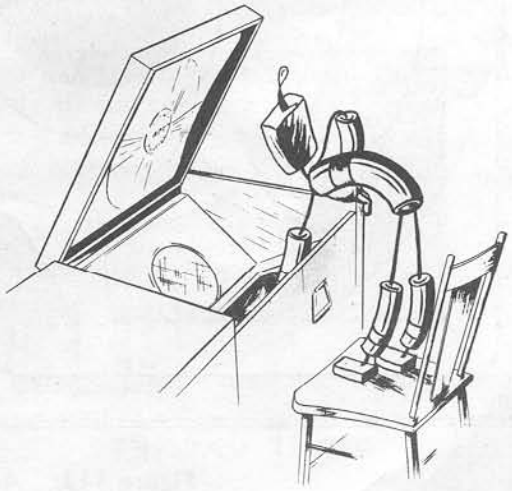


Figure 111. Adjustment of Keystone Magnet



Again tilt the screen forward slowly. If the focus at the top of the picture again improves, repeat the adjustment of the Y axis, and again readjust the focus lever (figure 108). Repeat this process until the focus is correct, both in the bottom and the top of the picture.

C. If the focus at the top of the picture is not correct, and yet tilting the screen forward causes the focus to become worse, you must adjust the picture-tube tilt in the opposite direction. You can make this adjustment by tightening the Y-axis adjusting screw one turn, readjusting the focus lever (figure 108) and again checking the focus in the bottom and the top of the picture. Repeat these adjustments until the focus is correct, both at the bottom and the top. Then tighten the locking screws A, B, D, and E (figure 108).

D. Tilt the lid slowly forward and note whether the focus at both sides of the screen is affected equally. If the sides do appear to be affected to an equal degree, the X-axis adjustment is correct. You may then check the overall adjustment of the optical system, as directed in step F.

If one side of the picture improves and the other side is impaired, you must adjust the X axis (figure 107). Begin this adjustment by loosening locking nuts G and H (figure 108). Then slide the picture-tube-and-yoke assembly horizontally a small distance, so that the base of the tube is moved away from the side which improved in focus. This adjustment moves the sides of the picture tube, either closer to the spherical mirror or farther from it, equalizing the length of the light path to the sides of the screen. Check the result of the adjustment by tilting the screen again—and repeat the adjustment until the focus on both sides of the screen is affected equally by tilting the screen. Then tighten the locking nuts G and H (figure 108).

E. Recheck the focus in all parts of the picture, and readjust the Y axis and the Z axis, if necessary. This procedure will be necessary

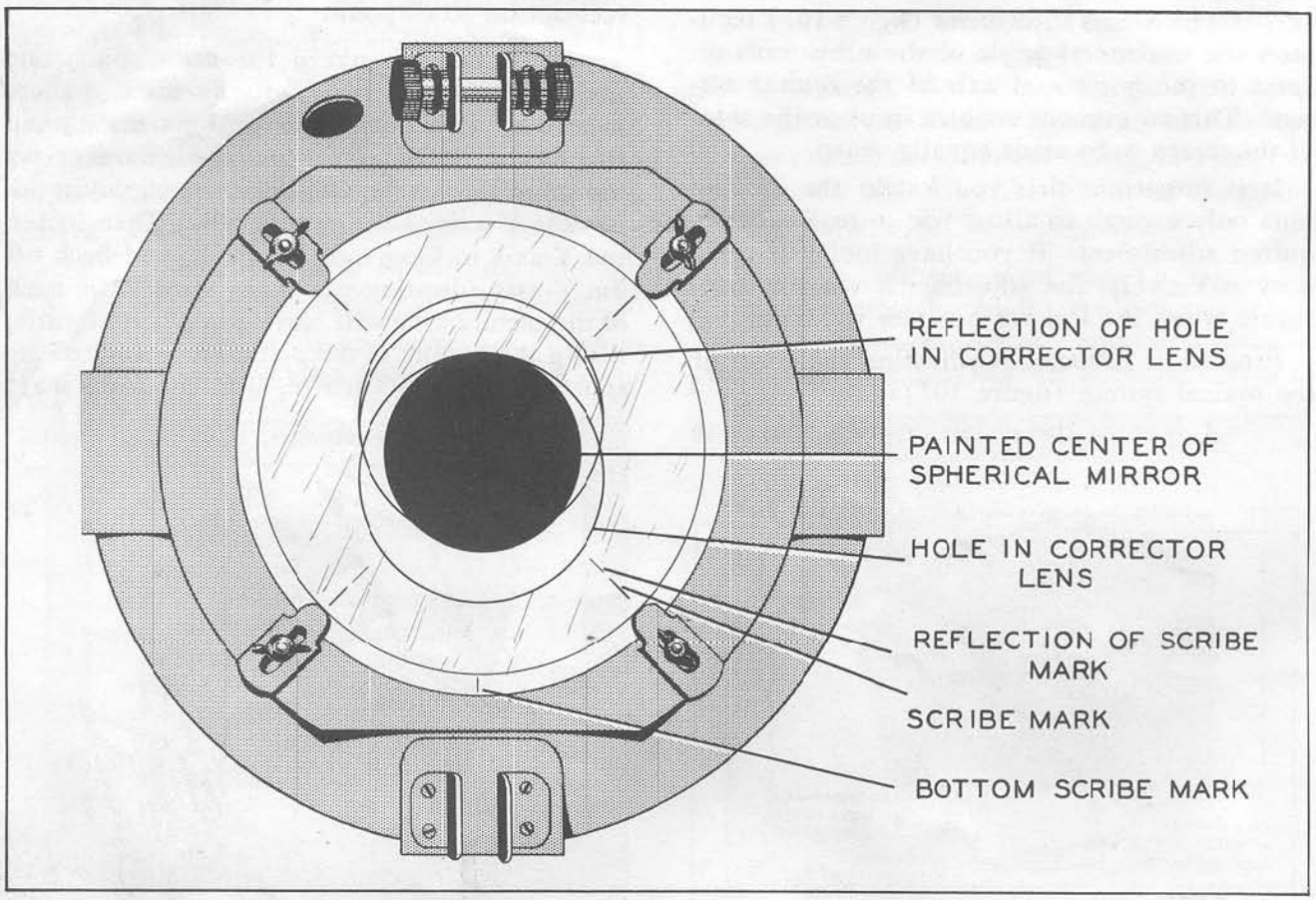


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Figure 112. Adjustment of Corrector Lens

only if the X-axis adjustment has disturbed these other adjustments.

F. You may now make a final over-all check for optical-system adjustments. Move your hand about the dust-cover opening, to shade different portions of the screen. If you notice no improvement in detail near the moving shadow on any part of the screen, the optical adjustments are correct.

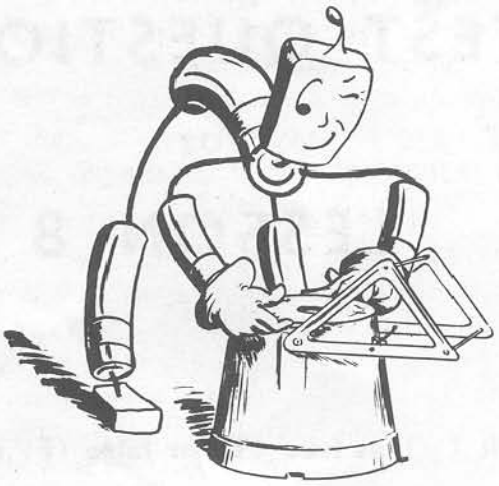
6. Corrector-Lens Adjustment

If the corrector lens has been damaged, or if, for any other reason, it must be removed or replaced, you will find it necessary to complete the following procedure:

To remove the corrector lens, you must first remove the optical-housing assembly from the cabinet. Then remove the spherical mirror, the picture tube, the deflection yoke, and the picture-tube mounting assembly from the optical-housing assembly. Loosen the four wing nuts which hold the corrector lens, and turn the clips so that they are free of the lens. Then remove the corrector lens itself—be sure to hold this lens by its edges, to avoid scratching or marring it.

When you replace the corrector lens, first replace the spherical mirror and clean the lens with a soft cloth and a cleansing agent, such as Philco Optical Surface Cleaner. Since this plastic lens is soft, you will have to be extremely careful to avoid scratching its surface. Hold the lens by its edges and place the flat side toward the spherical mirror. Since the hole is not in the center of the lens, align the lens so that the hole will be located near the bottom edge of the assembly. Center the outside scribe mark at the bottom of the assembly, using the eccentric adjustment as a centering guide. Figure 112 illustrates the proper alignment of the lens and the results of its correct adjustment.

Place yourself with your eyes about one foot from the lens, directly over the black



painted center of the spherical mirror. Adjust the lens until you have spaced this center evenly between the lower edge of the hole in the lens and the upper edge of the reflected hole. Then shift the lens until the scribe marks on the lens and their reflections in the mirror coincide, thus forming four single scribe marks instead of eight. (Figure 112 shows the scribe marks as separated, for clarity of illustration.) At this time, the outside scribe mark will also be centered at the bottom of the housing. When you first attempt this adjustment, you may experience some difficulty in centering your eye properly—and also in distinguishing the reflections from the actual image. If you do encounter this trouble, you would be wise to repeat the adjustment a few times, until you are positive that it has been made properly.

After you have aligned the scribe marks, hold the lens carefully in place and tighten the four wing nuts. Remove the spherical mirror; replace the deflection yoke, the picture-tube mounting assembly, the picture tube, and the mirror; and then replace the optical-housing assembly in the cabinet. Finally, check the keystoning adjustment and all of the optical adjustments, resetting them, if it seems necessary.