INSTALLING A COLOR PICTURE TUBE

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Fig. 1. Slipping a purity coil assembly over the neck of a 15-inch color tube. The yoke and Mumetal picture tube shield are already on the picture tube.

You may not install a color picture tube tomorrow, but you will need to know these facts when you do.

NOW that some manufacturers have started to ship the first color TV receivers to their dealers, information on installation problems is becoming available. The majority of these early TV receivers use the shadow-mask type color tube and this is usually shipped in a separate carton. Assuming that all circuits have been adjusted properly at the factory, the main job is to mount the color picture tube and adjust the various components and controls for proper pictures.

This article presents a detailed setup procedure for both the 15GP22 (*RCA*) and the 15HP22 (*CBS-Hytron*), as well as the new 19-inch tubes, based on manufacturers' instructions and the personal experience of the author. It might be mentioned here that a full day was spent for the first setup, but it took less than an hour the third time to produce acceptable color pictures. Installation procedures are presented here in hopes that they will save service technicians from many errors they might commit when they come in contact with color sets.

Before unpacking the picture tube, the color receiver should be air-tested for sound reception. Also check the "B+" and heater voltages. Next, check off the following items which go on the picture tube:

1. *Mumetal* shield.
2. Deflection yoke.
3. Purity-coil assembly.
4. Convergence-coil assembly and blue magnet for 19-inch tubes.
5. Field-neutralizing coil (omitted in some models).

The major test equipment required is a dot generator or a bar generator. If neither is available, a monochrome or color station signal can be used. For final testing, both monochrome and color signals should be used, although a lot can be accomplished with monochrome only. In addition to a conventional multimeter, a high-voltage probe or meter having a range up to 30 kv. should be available. A mirror will greatly help in some adjustments.

Since the high-voltage supply furnishes up to 27 kv. at 1 ma., the ordinary safety precautions should be increased. Wearing rubber soles and heels, plenty of space to move in, and some privacy, are a great help to the technician in his first encounter with the new color TV monster.

Preliminary Adjustment

Remove the color picture tube from the carton and place it face down on a padded spot. Figs. 1 and 2 show the location of the various items mounted on the 15-inch color picture tube. The *Mumetal* shield does not fit directly on the tube envelope, but contains foam rubber pads which cushion and center it. A plastic insulating ring, similar to the ones used on metal-envelope tubes, fits over the metal flange which connects internally to the 2nd anode or "ultor." Fig. 3 shows the components on the 19-inch color tube. The major differences between it and the 15-inch tubes are described in the section on convergence.

After mounting all parts, install the entire assembly on the receiver chassis. The blue gun should be on top, as shown in the socket end view in Fig. 2. Line the inner tube mask up with the cabinet escutcheon. Before connecting power to the receiver, be sure all plugs are in their respective sockets.

Turn the set on, allow for warm-up time, and tune in a monochrome or color telecast. Check fine tuning, contrast, brightness, and sync for best reception. In most color TV receivers, the high voltage is regulated, and this regulation as well as the actual voltage should be checked. The voltage at the kinescope "ultor" terminal—the metal flange near the face of the tube—should remain at 20 kv. (27 kv. for the 19-inch tube), with either a bright or dark raster. Check this by watching the meter and varying the master brightness control.

To improve regulation or increase the voltage to the correct value, adjust the high-voltage regulator control shown in the simplified diagram of Fig. 4. This control is usually located inside the high-voltage compartment.

Next, turn the color or chromaticity control counterclockwise for minimum color video and adjust the contrast or brightness control for a fairly clear picture. At this stage of adjustment, the coloring of the screen can be neglected and adjustments for a.g.c., horizontal and vertical sync, linearity, size, and centering should be made. Do not attempt to oversweep the edges of the internal screen mask, but rather leave the left and the top edge visible.

For these adjustments, especially for linearity checks, a station test pattern is very helpful. If none is available, the bar generator can be used. In color TV it is absolutely essential that both vertical and horizontal linearity be near perfect. Later adjustments will affect such other criteria as focus and convergence. Incorrect linearity will greatly complicate the dynamic focus and convergence adjustments, so be sure to get the proper aspect ratio, size, centering, and linearity before adjusting any of the color controls. Good synchronization, especially in the horizontal section, is also essential. Most receivers use a modified synchroguide circuit, requiring both locking and phasing adjustments for which standard black-and-white adjustment procedures apply.

The cylinder located near the picture-tube socket, as shown in Fig. 2, is the purity coil assembly. It consists of the purity coil, three small permanent magnet screws, and the magnetic shield cover. See Fig. 3 for the position of the purity coil on the 19-inch tube. Adjusting color purity involves orienting the three electron beams with respect to the center line of the picture tube. It is necessary to vary the location, direction, and magnitude of a transverse magnetic field for each of the three beams and, finally, optimize for best combined operation. One satisfactory method for doing this is outlined below.

1. Remove the video signal and turn down the green and blue screen controls. (See Fig. 5.) Adjust the red screen control for a screen color of almost pure red.

2. Slide the deflection yoke as close to the purity coil as possible, and screw the three permanent magnet screws out from the center for minimum effect. For the 19-inch tube, turn the d.c. convergence controls to minimum.

3. Rotate the purity coil and adjust the current through it until the center of the screen is a deep pure red. Consider only the center and disregard the edges. It is possible to obtain good purity with several combinations of coil current and position; select the one using the least purity-coil current.

4. Slide the deflection yoke forward until the entire screen is a uniform red. Now the neck shadows and color contamination along the edges should be eliminated by proper yoke placement. It may be necessary to touch up the purity-coil adjustment if it is not possible to get a clean red raster with the yoke placement.

5. Turn the red screen down and the blue screen up. If the screen color is not a uniform blue touch up the purity-coil current and rotation slightly.

6. Turn the blue screen down and the green screen up. It may again be necessary to touch up the purity adjustment.

7. Check purity again on red and blue. In some receivers a compromise must be made between best purity on all three colors.

8. It may be that all preceding adjustments cannot be made as smoothly and simply as described. Occasionally some stray magnetic field may interfere and this would be noticeable by sudden rather than gradual variations in purity or by stubborn color contamination at a particular spot on the screen. Such external magnetic fields may be due to a magnetized screwdriver, a permanent magnet speaker, or other magnetic device located near the receiver. Some color sets use a field neutralizing coil located near the screen as shown in Fig. 2, and this coil can be adjusted to overcome the effect of stray fields. In general, the field neutralizing coil is rotated and the current through it adjusted to aid the purity assembly in its operation. The adjustment procedure described appears quite complex and time consuming, but after some practice it is possible to perform the purity alignment in five minutes.

Convergence Adjustment

In order to get sharp and clear color pictures it is necessary for all three electron beams to strike the screen simultaneously at adjacent dots. For the 15-inch tubes, three separate forces make the beams converge and each of these must be carefully adjusted. The first consists of three small magnets located on the purity coil shield around the neck of the picture tube. Each magnet has its major effect on the electron gun lying underneath it, but also affects the beam from the other two guns. The purpose of the magnets is to position the three beams so that the three colored rasters coincide.

In addition to the magnets there is an internal, electrostatic-lens type element in the 15-inch tube which controls the beam convergence at the screen. It receives a high d.c. voltage, adjustment of which determines the convergence at the center of the screen. The convergence element also receives a horizontal and vertical dynamic convergence voltage which, when superimposed on the d.c. potential, determines the convergence at the edges of the screen. This dynamic convergence signal is required to compensate for the variation in electron beam path length as the beam moves from the center of the screen to the edges. Fig. 6 shows the wave shape of the dynamic convergence voltage.

It should also be pointed out that the beam focus must be varied as well. In the 15GP22 and 15HP22 there are three electrostatic focus elements connected together which receive a d.c. focus voltage, plus a portion of the dynamic horizontal and vertical convergence signal. The schematic presentation for this connection is shown in Fig. 4.

Before adjusting for convergence and focus, the screen should be tuned for a low-brightness white. This is done by turning the chromaticity control down and adjusting the red, blue, and green

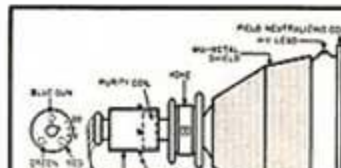


Fig. 2. Shown here are the various focusing and deflection components that mount onto a 15-inch color picture tube. The field neutralizing coil may be omitted in some receivers.

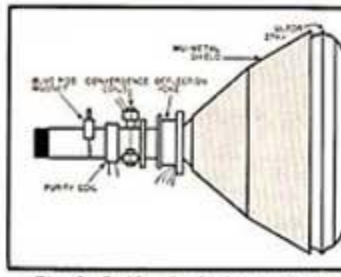
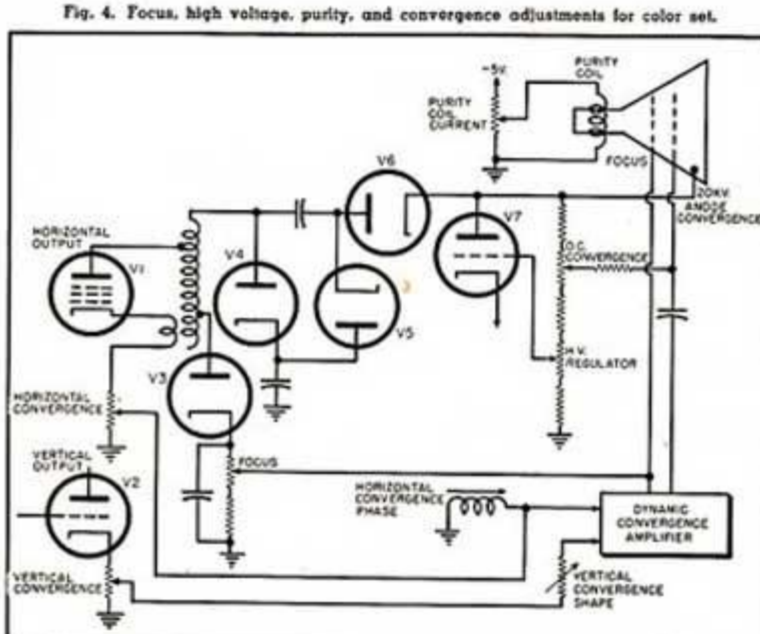


Fig. 3. A 19-inch shadow-mask type color TV tube shown with the various deflection and focus components. Note that here electromagnetic convergence is used rather than electrostatic.

Fig. 4. Focus, high voltage, purity, and convergence adjustments for color set.



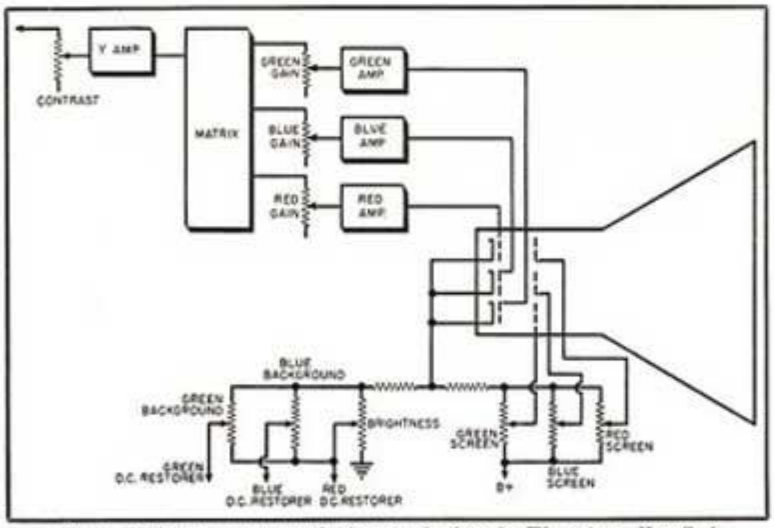


Fig. 5. Brightness, contrast, and color controls of a color TV receiver. Not all of these controls are adjusted by the service technician when he installs the tube.

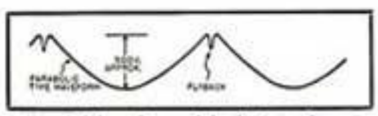


Fig. 6. Waveshape of the horizontal convergence voltage for a 15-inch tube.

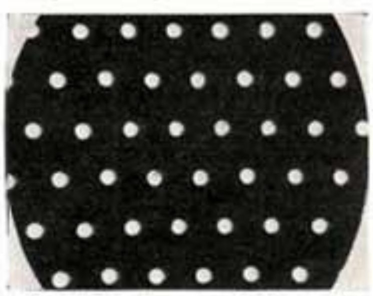
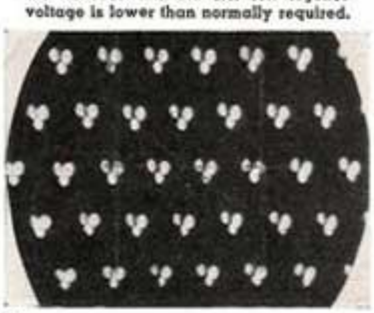


Fig. 7. Dot pattern generated by a dot generator and observed on the screen of a color picture tube when the three guns are in good convergence. Each dot actually consists of three different colored ones, so close they look like one.

screen controls until a neutral white or light gray is obtained. It should be pointed out that this will not be achieved when all three controls are set to exactly the same point. To get white some experimentation is required

Fig. 8. The pattern appearing on the face of a color tube when a dot generator is used and the d.c. convergence voltage is lower than normally required.



which usually provides a demonstration of the principles of colorimetry. When the blue screen is turned down and the red and green turned to about equal brightness, yellow will appear. Red and blue only will result in shades of purple. With some practice it is quite easy to get a neutral light gray quickly.

To set the three positioning magnets roughly, adjust the centering controls until a corner of the raster appears. Usually this corner will show some of the colors even when the rest of the screen is white. It will appear that the three rasters do not overlap completely. Where all three overlap, white will appear. Where red and green overlap the screen will appear yellow. Red and blue give magenta, and blue and green produce cyan (a greenish blue color). At this stage it is best to "make haste slowly."

Turn each of the three permanent magnet screws inward one turn at a time, and observe the effect of each one on all three colors. It will become apparent that each of the magnets has major control over one color but also has considerable effect on the other two electron beams. In other words, the adjustment of each magnet must be followed by adjustment of the other two magnets until a good compromise setting is reached. The aim of this compromise is to get all three colors to coincide as well as possible. It should be pointed out here that perfect corner registry is not essential nor easily attainable.

The convergence adjustments must be made with some kind of video signal, otherwise lack of convergence is not apparent. The best type of signal consists of a number of very sharp pulses, producing a dot pattern on the screen. Other usable patterns consist of vertical and horizontal bars, preferably in a grid pattern, or a regular monochrome video signal. In the last instance it is preferable to use a station test pattern if available.

Poor convergence will give the appearance of three colored pictures out of register. When the monochrome video signal is used, the edges of objects will appear in three colors, rather than uniform gray. If the d.c. convergence is good, this poor registration effect will be most noticeable at the sides. This is somewhat tricky to check especially on moving scenes. For this reason the use of a grid or dot pattern is better. Adjusting convergence with a dot generator is fairly easy.

1. Connect the dot generator and adjust the brightness and contrast controls to avoid blooming and obtain sharp dots, locked in with the sweep circuits. Fig. 7 shows the screen of a color tube with a properly converged dot pattern.

2. Referring to Fig. 4, turn both vertical and horizontal dynamic convergence controls to minimum.

3. Turn the d.c. convergence voltage control to a low value until three separate dots are visible as in Fig. 8. The green dot is at the left, the red next to it, and the blue below.

4. Turn the d.c. convergence voltage control up until the three colored dots merge into a white dot at the center of the screen. If the convergence voltage is too high the pattern of Fig. 9 will appear where the blue dot is on top and the entire color sequence reversed from Fig 7.

5. It may not be possible to obtain perfect convergence at the center of the screen with the d.c. convergence control. In this event the positioning magnets must be reset. Every change in the positioning magnets will require some further change in the d.c. convergence setting. At the same time the focus control must be set each time for best focus. All these adjustments are interdependent to some degree and the best approach is to perform each step slowly, not advancing any control too far and carefully observing the dot pattern on the screen. In some picture tubes it may appear that the magnets should be positioned quite close to the guns, but this means that the optimum position has already been passed and the magnets should be withdrawn several turns.

6. After the center of the screen shows clear white dots without color fringing, the dynamic convergence controls are adjusted. The vertical dynamic convergence controls, see Fig. 4, are set first to make the top and bottom misregistration equal. Observe the dots going down the center line and when top and bottom dots appear equally misregistered, touch up the d.c. convergence control to converge the entire vertical center line of dots.

7. Now adjust the horizontal dynamic convergence control for equal misregistration of the left and right dots on the horizontal center line. As in step 6, touch up the d.c. convergence control to converge the entire center line.

8. If it appears impossible to converge both left and right edges, the horizontal dynamic phase control, as shown in Fig. 4, should be adjusted. Similarly, if vertical convergence cannot be achieved properly, the vertical

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convergence voltage shape control can be adjusted.

9. The vertical dynamic convergence adjustments affect the horizontal and d.c. convergence settings and *vice versa*. Again it will be necessary to spend some time and care in making all adjustments and subsequent touch ups. The author had to start all over twice during his first convergence adjustment problem, but after some practice the convergence procedure now takes only about 10 minutes.

10. As a final check, vary the d.c. convergence control slightly and see if it improves convergence at the edges. If it does, some improvement in the dynamic convergence setting is needed. When d.c. adjustments show no such improvement, the dynamic convergence controls are properly set.

In the large screen, 19-inch shadow-mask picture tubes, the convergence adjustment is somewhat different since magnetic rather than electrostatic convergence is used. Between the purity coil and deflection yoke a set of three electromagnetic assemblies are located as shown in Fig. 3. In place of the three positioning magnets a single permanent magnet assembly is used which has major control over the blue electron gun. To adjust convergence in this system it is again helpful to use a dot pattern. Proceed as in the case of the 15-inch tubes up to the d.c. convergence adjustment, then follow the steps given below.

1. Set all dynamic convergence controls to minimum and adjust the red and green d.c. convergence potentiometers to give yellow dots in the center of the screen.

2. Adjust the blue d.c. convergence control and positioning magnet to obtain white dots in the center.

3. Adjust vertical and horizontal dynamic convergence controls for equal color triangles along the vertical and horizontal axes.

4. Readjust the three d.c. convergence controls for uniform white dots. Slight touch ups of the dynamic convergence controls may be required. Because the convergence forces are magnetic, the a.c. through the convergence coils will look like the voltage waveform in Fig. 6. The voltage across the coils will look somewhat like a sawtooth. Another feature of the 19-inch tube convergence adjustment is the reduced interdependence between the different controls. This makes for simpler and faster convergence adjustment.

Fig. 9. Dot pattern when the d.c. convergence voltage is too high. Here, the blue dot is on top with the red to the left and the green to the right below.

Before looking at color pictures, the brightness and screen controls must be set properly. First, with no picture on the screen, turn the brightness control to maximum and adjust the red, green, and blue screen controls (see Fig. 5) to obtain a medium gray screen appearance. This should be approximately the brightness of an almost dark monochrome raster such as appears when no signal is received on a monochrome receiver. Balance out the three colors until a neutral gray shade is achieved. Now tune in a monochrome picture and set the contrast control for good white highlights. Adjust the blue and green background controls until the white is a true white and contains no dominant color. Next, turn the brightness control down until the white highlight is medium gray and touch up the green and blue background controls until this is again a neutral shade. The correct adjustment of these controls is achieved when the brightness control variation does not produce a change in hue, but only in brightness.

Color Adjustment

The great moment has arrived and we are ready for the first color pictures. In Fig. 5, separate red, green, and blue gain controls are indicated. Many manufacturers do not advise touch ups of these controls without special test signals or test equipment. Usually these controls are set carefully at the factory and do not need further adjustment.

Tune in a color telecast just like any other TV signal. Adjust the chromaticity control slowly until the colors appear vivid enough. Too little chromaticity will result in pastel shades or pale colors instead of rich saturated colors, while too much chromaticity will result in dark flesh tones. If it appears as if a red, green, and blue rainbow moves over the picture, the color sync section is out of synchronization. If flesh tones appear purple and red appears blue, the color sync phase is wrong. These adjustments are usually on the chassis or under a panel together with other secondary controls.

If it appears that the various colors are wrong, that red is too purple, yellow too orange, etc., this should never be compensated for with the screen, background, or brightness controls. Such a defect is best adjusted with a color test signal of known colors, such as can be obtained from a color bar generator or else from a station test pattern. Then the red, green, and blue gains can be set, the *I* and *Q* channels adjusted, and the entire matrixing unit can be serviced.

The customer should be carefully instructed in the use of the operating controls and warned against adjusting the secondary controls under the hinged front panel of the set and on the side or back of the chassis. —30—

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Courtesy of Wallace Dickson