Motorola Color TV Receivers

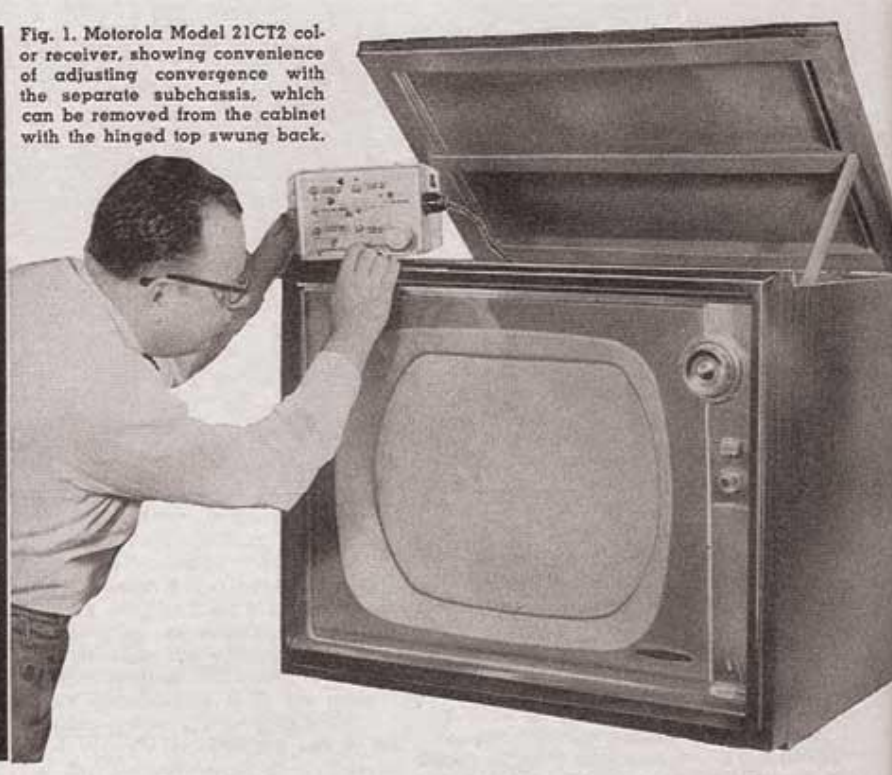


Fig. 1. Motorola Model 21CT2 color receiver, showing convenience of adjusting convergence with the separate subchassis, which can be removed from the cabinet with the hinged top swung back.

By **ROBERT GARY**

New tubes, new circuits, and an improved method for obtaining convergence adjustment are noted.

COLOR TV sets are being offered by more and more of the large-volume manufacturers. In 1956, many TV firms felt that they could still make money on black-and-white sets as long as they used small-size picture tubes and sold them at low prices. Now it becomes increasingly evident that this philosophy will not keep the receiver market booming indefinitely. With color sets, on the other hand, there has been no appreciable slump, although sales are still modest. *RCA* managed to sell practically everything it made in color. As our readers will know from recent articles, *G-E*, *Sylvania*, *Hoffman*, and other manufacturers have joined *RCA* in the color TV field. Now *Motorola* may be counted in.

It may be remembered that, two years ago, *Motorola* started to offer a 19-inch color model, but that, after a short time, this set was discontinued. The new 1957 *Motorola* color TV receiver is, in many respects, similar to other recent color sets, but there are some distinctive features. The color decoder circuits are unique, and *Motorola* has done considerable development work on a more precise system for adjusting purity and convergence. These new circuits, additional adjustment procedures not used on other color sets, as well as the mechanical features of the new *Motorola* Models 21CT2 and 21CK3 are of definite interest to those who wish to keep up with color.

At the time of writing, only two cabinet styles have been announced. One, the Model 21CT2, shown in Fig. 1, is a compact consolette available in sienna mahogany and Swedish oak. The second, Model 21CK3, is a modern-style console, available in the same type of finishes and featuring tapered legs with self-leveling glides. Both cabinet styles house the same chassis and have the same service arrangements. The only controls openly available are the channel tuning, a push-button type "on-off" switch, and a dual control for volume and contrast. All other controls are either located under the subpanel, the rear of the chassis, or on a separate subchassis which can be removed for convergence and purity alignment. The consolette has a small loudspeaker mounted at the side of the cabinet while the Model 21CK3 has the speaker below the screen.

The set uses conventional wiring and parts; no attempt has been made to employ modules, printed circuits, or any other novel assembly method. Instead, both the mechanical and electrical design features of this receiver show that *Motorola's* engineers have emphasized reliability and circuit performance. Since servicing will always be required to some extent, accessibility of all adjustments and an ample number of test points have been provided. Technicians will find this receiver easier to handle than some earlier models.

A total of 29 tubes plus the picture tube is used. As in most color sets, a great many of the tubes are multiple-purpose types incorporating several tubes in a single envelope. Latest tube types used here are the 6BV8 (a triode and dual diode), 6AU8 (a pentode-triode), and the 6BH8 (a pentode-triode), each contained in a nine-pin miniature glass envelope. Most of the other tubes used are in the usual color set complement. The power supply consists of a conventional power transformer with two 5U4 rectifiers followed by a pi filter network.

The tuner is a cascode type with u.h.f. attachment optional. Four i.f. stages are used, followed by separate video and audio detectors. The 4.5-mc. intercarrier sound section as well as the "Y" channel are conventional.

Vertical and horizontal sweep, h.v., and the color-sync section are also very similar to those previously described in this publication for other sets. A crystal-stabilized 3.58-mc. oscillator furnishes the demodulating signal to the novel color demodulators. The chroma amplifier and the color-killer circuit controlling it are also well known, but the color demodulating section is worthy of some detailed discussion. As shown in the circuit of Fig. 2, the last bandpass amplifier acts as a cathode follower and drives two sets of diode demodulators, which provide the red and blue color-difference signals to the following video amplifiers.

The principles of operation of this type of circuit are identical to those used in the phase-detector circuit found in horizontal and some color-sync sections. Consider first the signals applied through C_3 and C_4 in Fig. 2. Due to the arrangement of L_1, these two signals are of equal amplitude but are 180° out-of-phase. At the common junction of the opposite diode sections, the locally generated 3.58-mc. color-sync signal is applied. The phase of this latter signal is that of the reference signal as sent out by the TV station.

If there were no phase difference between this and the chroma signal, no voltage would appear at the junction of R_2 and R_3. Actually, the difference in phase determines the polarity and amplitude of the "error" voltage, except that in this case the "error" voltage is the desired color video signal. In horizontal-sync circuits, the voltage developed at the junction of R_3 and R_2 would control the horizontal-oscillator frequency. The two series coils, L_2 and L_3, are self-resonant at 3.58 mc., and act as filters to keep the color-sync signal out of the video section.

As in many other receivers, the third color-difference signal is obtained by mixing the output of the red and blue amplifiers and feeding it into a third video amplifier, which then feeds the green color-difference signal to its particular grid in the color picture tube. While the 3.58-mc. oscillator is not shown in Fig. 2, its output network consists of L_4 and L_5, which must be set to give the proper phase relationships at the demodulators. Over-all phase is varied by the color-phase control potentiometer, located under the subpanel on the front of the receiver.

Another novel circuit feature in the *Motorola* set is the addition of three new adjustments in the deflection and convergence section. Fig. 4 shows the top view of the receiver with the top panel tilted upward. Just above the deflection yoke, a small box is visible, its hinged top opened. Inside are the horizontal-yoke balancing coil and the vertical-yoke balancing pot. A lead is visible going to the round, black cardboard-enclosed blue lateral-size switch. This switch is also visible in the photograph of Fig. 6, the rear view of the chassis in the cabinet.

From the circuit of Fig. 3, the operation of these controls can be examined. The horizontal yoke-balancing coil permits adjustment of the current flowing through either of the yoke coils. It should be noted here that the deflection coils are connected in parallel while, in most previously described sets, they have been connected in series. As the horizontal balance adjusts the relative linearity of the horizontal deflection coils, so does the vertical control permit balancing the vertical coils. Again a parallel connection is used. The diagram of Fig. 3 shows only the simplified circuit with the centering controls and their bypass capacitors omitted, for the sake of clarity.

All color sets reviewed to date have used a permanent-magnet blue lateral-position magnet. This magnet is required to position the blue electron beam laterally with respect to the other two colors, an adjustment made for good static convergence after the convergence magnets have been set up correctly. To permit a more accurate adjustment, *Motorola* uses an additional tapped coil and a switch which permits variation of the magnetic field without moving the magnet assembly physically. As apparent from Fig. 3, in addition to the d.c., there is also a small 15-kc. saw-tooth component acting on the lateral magnet which will improve the convergence of the blue beam at the edges of the screen.

At the right side of the deflection yoke in Fig. 6, two small tabs are visible which permit the adjustment of the top and bottom keystone-corrector magnets. In addition to these novel linearity adjustments, the receiver also

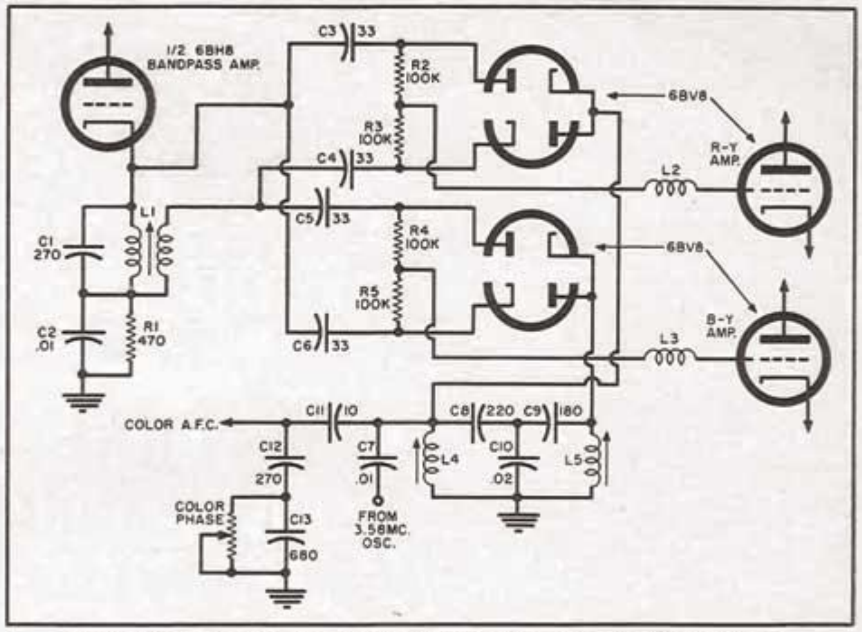


Fig. 2. A cathode-follower bandpass amplifier drives two sets of demodulators.

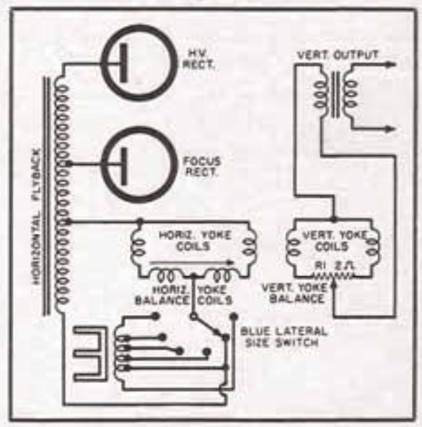
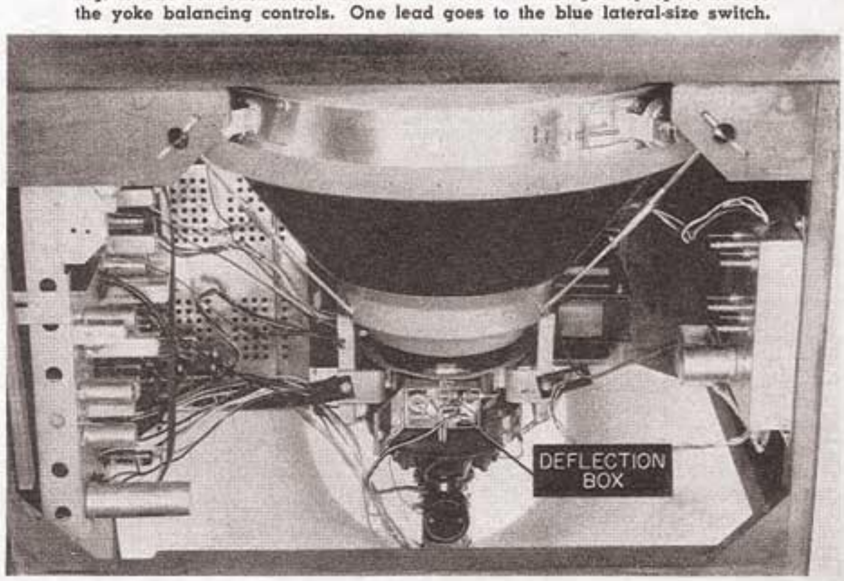


Fig. 3. Vertical and horizontal yoke coils are parallel-connected. The horizontal balancing coil and vertical balancing potentiometer are shown.

Fig. 4. The deflection box, viewed from above with hinged top open, houses the yoke balancing controls. One lead goes to the blue lateral-size switch.



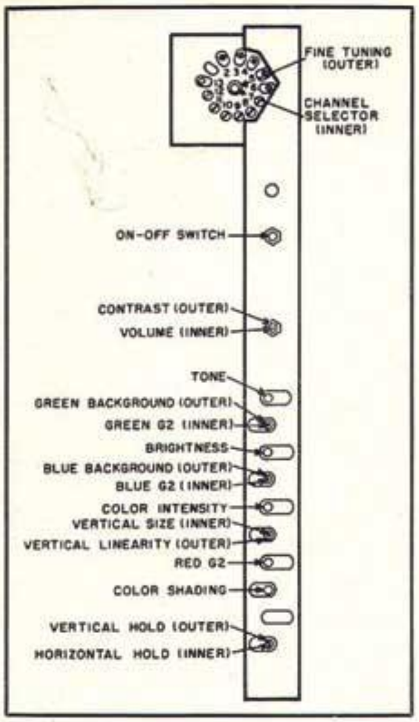


Fig. 5. Controls on the front subpanel.

has the purity, convergence, and neutralizing-magnet adjustments, found in all other color TV sets. The remaining color controls, such as the gray-background, gray-scale, and chroma-gain controls, are very similar to previously described circuits.

Color Adjustment

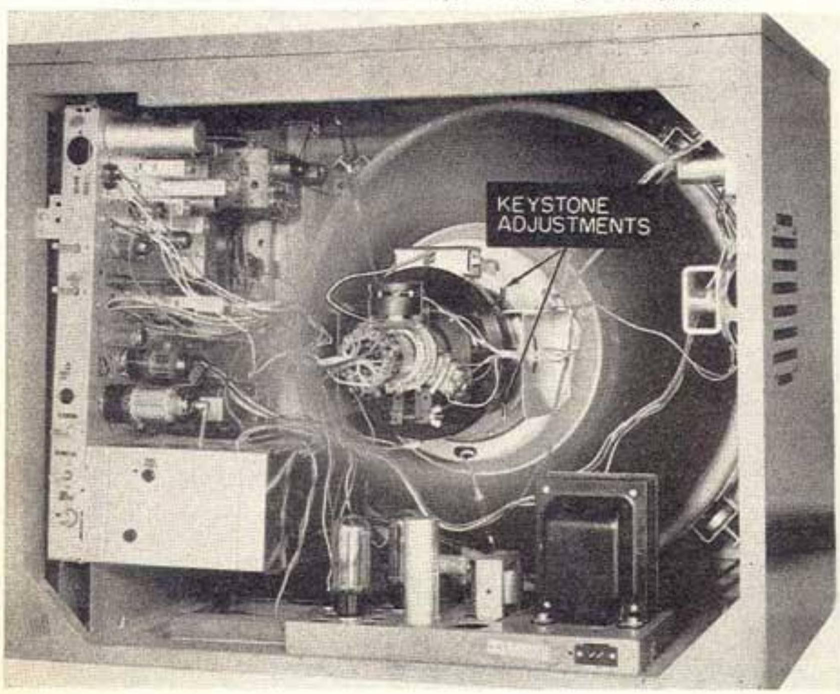
As mentioned in the beginning of this article, all service controls are concentrated in three areas: the subpanel on the front, the rear of the main chassis, and a separate subchassis which can be removed for servicing. Fig. 5 shows the location of these controls on the front subpanel. Fig. 1 shows how, by lifting the cover, the convergence subchassis can be removed and adjustments made from the front of the set. Since the adjustment of the customer-operated controls has been described many times before, we shall concentrate here on the unusual procedures required for the *Motorola* set and also cover those service adjustments which are made in connection with the novel circuitry already noted.

First adjust the vertical and horizontal controls for the correct monochrome picture stability. Adjustment of these controls will have some effect on the convergence system; for that reason, they should not need further setting after the initial setup. The horizontal-sync circuit is especially subject to marginal adjustment, and should be checked on all channels. Both centering controls will also affect convergence, and should therefore be set accurately on the monochrome pictures of various channels.

Next, adjusting the high-voltage, contrast, and three screen-voltage controls for a proper shade of gray with correct brightness and contrast is in order. To remove the convergence subchassis, open the hinged cabinet top and loosen the subchassis mounting screws. The rear panel of the cabinet must be removed in order to get to the two locking bars at the inside of the cabinet which hold the hinged top in place.

Once these bars have been retracted, the top cover can be raised from the front and propped open by the small wooden brace provided for this purpose. The subchassis can be slipped out without unscrewing the screws and there is sufficient cable length, as shown in Fig. 1, to permit operating the receiver with the convergence subchassis held in front of the screen. For d.c. convergence, which is the first step, the dynamic-convergence circuitry can be disabled by disconnecting the octal plug from the subchassis.

Fig. 6. Rear view of receiver, with keystone adjusting tabs highlighted.



The manufacturer suggests that, for red-purity adjustment, the blue and green grid leads be removed from their plugs on the main chassis and plugged into adjacent grounded jacks. Without any station being received and with rather low brightness setting, the red-screen control is set for a red background. Then the purity magnet is adjusted for the largest possible purely red area. Moving the deflection yoke forward or backward will show the best position for red purity around the edges of the raster. Neutralizing magnets are adjusted in the usual manner for best over-all purity. Next the procedure is repeated individually for the green and blue fields, and any necessary compromises and re-adjustments are made until a satisfactory gray raster is obtained.

A cross-hatch pattern can be used for adjusting the d.c. convergence by means of the three permanent magnets on the convergence assembly and by positioning the blue lateral-correction magnet. Set the switch on top of this magnet for zero current, which is the second position as indicated on the circuit diagram in Fig. 3.

Observe the red and green horizontal lines at the center of the screen and adjust the tuning slug of the horizontal yoke balance coil until these lines are parallel to each other across the entire center of the screen. This coil is located in the little box over the deflection yoke, but the adjustment handle protrudes over the side of the yoke housing. The top keystone corrector magnet is adjusted until the green and red horizontal lines at the top of the raster are parallel across the screen. Similarly, the bottom keystone magnet is set for parallel green and red lines at the bottom of the screen.

The purpose of the vertical yoke balance adjustment is to give equal deflection over the upper and lower halves of the screen. To check this, observe the relative position of a green and red horizontal pattern line at the top and at the bottom of the screen. If, at the top, the *red* line is above the *green*, while at the bottom the *green* line is above the *red*, the vertical yoke needs better balancing. The correct setting of the potentiometer on the yoke housing is achieved when the red and green lines are in the same relative position at the top and bottom.

With the cross-hatch pattern still on the screen, the blue horizontal-size switch is varied until, at the left and right edges of the raster, the blue vertical lines fall *in between* the red and green vertical lines. Once all these adjustments are made, the convergence subchassis is connected again, and the

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dynamic convergence set-up procedure is followed. This latter procedure is essentially the same as for other color sets using the 21AXP22 picture tube.

Service Hints

The *Motorola* color sets use two fuses. One is a 2-ampere, pigtail type which is located in the power-supply subchassis. To get at this fuse, the four mounting screws holding the subchassis in the cabinet must be removed and the cables going to the power supply disconnected. The second fuse is a ⅜-ampere, time-lag plug-in type located at the rear of the main chassis between the 6AU4 damper tube and the 6CM6 vertical-output stage. This fuse is accessible simply by removing the back cover of the cabinet.

Several separate test receptacles are available in these receivers. The five-pin plug on the rear chassis apron is used for checking a.g.c., video, and horizontal-oscillator operation. On the main chassis near the front of the set, the three picture-tube grid leads are plugged into a receptacle, and their signals can conveniently be checked there. The conventional mixer-grid test point is located on the tuner, and then there are two i.f. test points located on the main chassis near the first and third i.f.'s respectively. Individual test points are also provided for the color sync and color demodulator section.

Since the bell of the color CRT is made of metal, there is always the chance that one of the fields in the receiver may magnetize it. This will result in the inability to achieve proper color adjustment over one or more areas of the screen. Demagnetization is accomplished by placing next to the magnetized area a coil that is energized by a.c., then withdrawing it to a distance of about 10 feet before current is cut off.

The safety glass in front of the screen is removable for cleaning purposes. The h.v. should either be shorted out after the set is turned off or a "cooling off" period of at least 10 minutes should be observed before probing inside the set is undertaken. When the channel selector and fine-tuning knobs are pulled off, two screws become visible holding a circular insert. Remove the screws. Remove the five screws holding the metal molding trim at the bottom of the safety glass, as well as the four hex-head screws holding the metal glass retainer at the bottom. Finally, unscrew the five screws at the top of the screen, but be sure to hold the glass at this time to prevent it from falling out with the last screw. The glass has to be jiggled slightly to move it out, since it has to clear the flexible molding. When returning the glass be sure to attach the flexible molding at the top, bottom, and left side before inserting it into the frame again. —30—

Radio and TV News, June 1957

Courtesy of John Yurkon