A HOWARD W. SAMS PUBLICATION

NOVEMBER 1967 / 75¢

PF Reporter®

PHOTOFACT

the magazine of electronic servicing

Know Your '68 Color Circuits

Color TV Service Training

Twelve Vertical Color Problems!

Sweeping Color IF Amplifiers

ANNUAL COLOR ISSUE

★ Notes on Test Equipment
★ Tube Substitution Supplement
★ The Electronic Scanner
★ Color Countermeasures
★ The Troubleshooter

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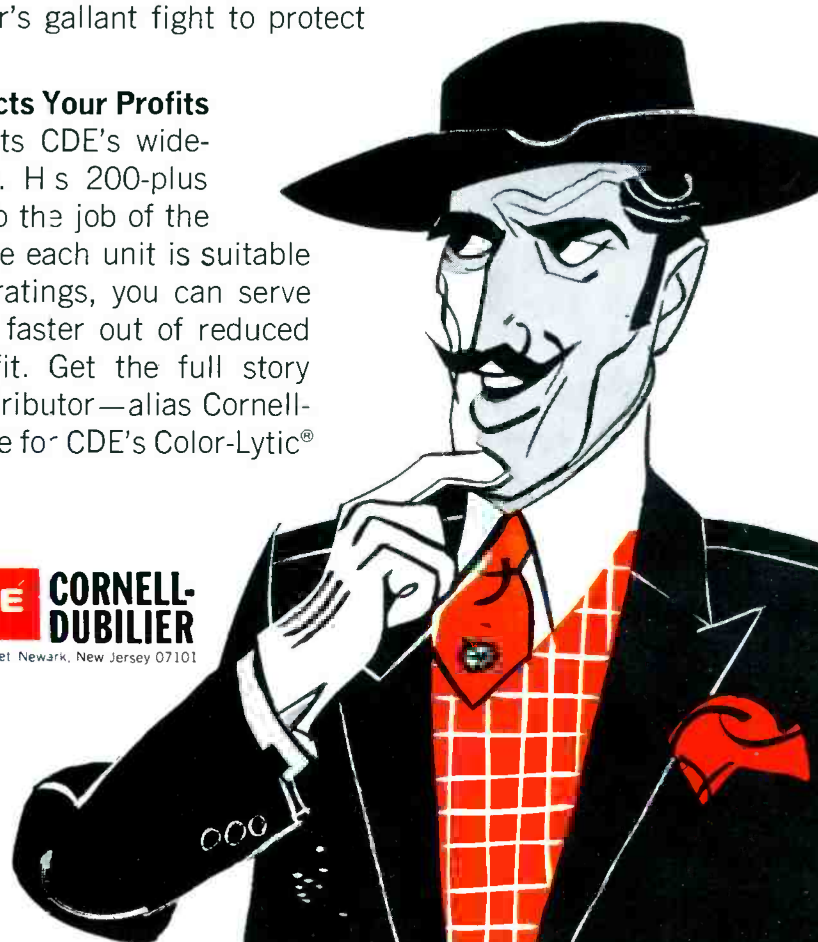

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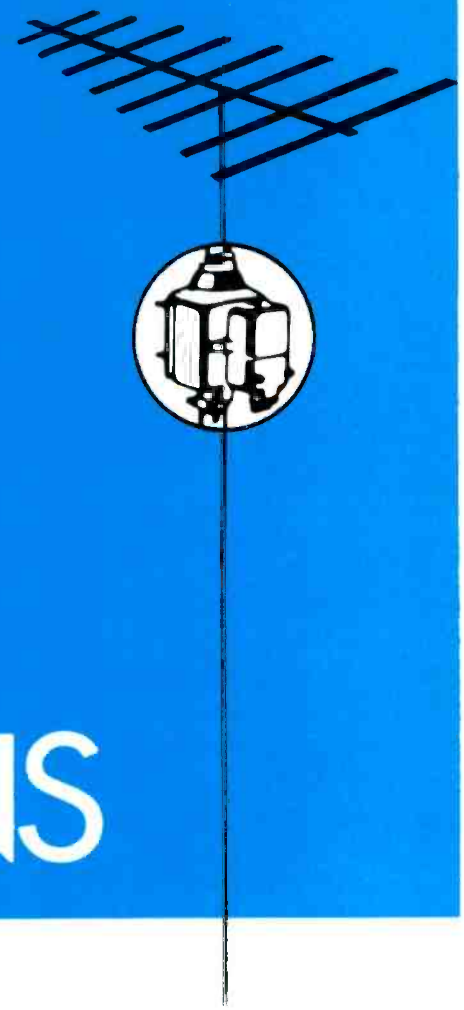

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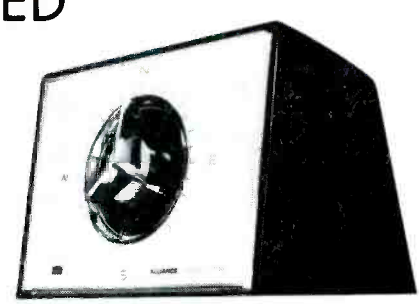

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PHOTOFACT

the magazine of electronic servicing

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ABOUT THE COVER

As indicated by the article titles appearing on the cover, this ANNUAL COLOR ISSUE is packed with an assortment of color information ranging from an analysis of new circuits to tips on keeping the older models operating. Such extended coverage is in line with our policy of keeping you, the service technician, informed and abreast of the latest circuit developments and servicing techniques.

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LETTERS TO the EDITOR

Dear Editor:

Recently we ran into a "tough dog" service problem that was a real puzzler. We thought it would be of interest and help to other readers of PF REPORTER.

We were called to service a set in a town about 35 miles away. It was a Motorola Color TV, chassis WTS-907 (PHOTOFACT Folder 739-3). The complaint was that the picture on Channel 9 (a weaker signal) would fade out after 30-45 minutes of operation. Channels 7 and 2, which are stronger signals, would stay, but with some smearing, ghosting, and ringing.

After removing the back of the set, we found the antenna lead from the back to the tuner was broken. It was repaired and the set appeared to operate normally. As we were ready to leave, we noticed the picture again developing the smeary condition. Again the back was removed and tubes substituted, at times seemingly improving the picture; but shortly after the back was replaced, the same condition returned. So the set was brought to our shop.

In the shop, the set was hooked up to "cook." About 45 minutes later it began to act up. Remove the back and a couple of minutes later it would snap back to normal operation. No amount of probing, tube substitution, etc. would show anything. The tuner was disassembled without finding a thing.

Finally, after checking with the scope and demodulator probe during the brief periods the set would act up, we narrowed the trouble to the IF input from the tuner. The only thing left, apparently, was the shielded cable from the tuner to the chassis. No amount of flexing or pulling would affect it, but application of heat about 6" away from the tuner would cause the set to act up.

We replaced the cable with a piece of coax approximately the same length and checked the set out (with the back on). It continued to work for days; however, we ordered the exact replacement from Motorola.

Upon checking the schematic, we saw that the conventional matching transformers on the tuner output and IF input are not used. Therefore, the capacitance of the cable has a definite effect on the response curve. The capacity of the defective cable changed as heat was applied.

We hope this information might someday save some technicians much time and frustration.

J. K. BENZING

Monona, Iowa

▲

KNOW YOUR 68 COLOR CIRCUITS

PART 1

by J. W. Phipps

The new model year has arrived and with it have come many new chassis designs, as well as drastic refinements in existing circuitry. The most significant changes involve the use of solid-state components in nearly every circuit of the color chassis. To be more specific, the only stage that has escaped the conversion to solid-state design is the high-voltage rectifier. Two all-transistor chassis and a number of hybrid designs are included in the snowballing conversion to solid-state design. Because of the many changes, this year's annual article on new color circuits is presented in two parts, with Part 2 appearing in the December issue.

Models and CRT Sizes

Admiral's new color line is comprised of eight 18″ portables, three basic 20″ portables (variations extend this group to nine different models), eight 20″ consoles (using four basic versions), twenty-eight 23″ consoles, and eight 23″ combination models.

Andrea's top-of-the-line color model for 1968 is truly unique (Fig. 1). Aptly labeled "Theatre in the Round," this combination model is constructed on a swivel base which permits 360° rotation. The unit contains a 23″ color TV, solid-state stereo amplifier with a Garrard 60 MKII turntable, and a solid-state AM-FM radio equipped with FM multiplex. Other new Andrea color models for '68 include three 23″ consoles, one of which is a rollabout design.

Fig. 1. Andrea's unique "Theatre in the Round" combination model.

Catalina is offering two 23″ and three 20″ console models for the coming year, plus two combination models (one 23″ and one 20″).

Coronado's '68 color line features screen sizes ranging from 18″ to 23″. The 18″ screen is offered in one table model. One combination and three consoles are equipped with 20″ CRT's. Next in size is one 22″ console with a 268 square-inch rectangular screen. Four consoles and two combination models utilize 23″ picture tubes.

Delmonico/Nivico's new color line is comprised entirely of 18″ models using the 172 square-inch 490LB22 picture tube. Two table models, one portable, and one console are available from this manufacturer.

Emerson is presenting a wide assortment of screen sizes and models in their new color receiver line-up. Heading the line are six 23″ consoles in a new grouping labeled "Dumont Custom Series by Emerson." Other 23″ models include eleven consoles and one table model. 22″ screens are offered in two consoles and one table model. Two table models and three consoles are available with 20″ screens. Completing the new line are two 18″ table models, two 15″ portables, and a group of combination models.

General Electric's large screen color receiver group for '68 offers a choice of 23 models with screen sizes ranging from 18″ to 23″. Included in the new line are three 18″ table models, two 20″ table models, three 20″ consoles, and eleven 23″ consoles. One 20″ and two 23″ console models are available with remote control. Also included in General Electric's new line are two Porta Color models using the 11SP22 (10″) picture tube. Shown in Fig. 2 is Porta Color Model M227HWD which features a clock timer that automatically turns off the set at any preset time up to three hours.

Hoffman has built an eighteen-model color line for the coming year. Twelve 23″ consoles are offered, including one roll-about consolette. Other screen sizes offered are a 22″, available in one console, and one 18″, utilized in a portable model. Four 23″ combination models complete the '68 listing. All CRT's used in this manufacturer's new line are rectangular types, as are most of the CRT's used in other manufacturer's '68 color lines.

Motorola is presenting an extensive line for 1968. Leading off the new color line are twenty-one 23″ models employing this manufacturer's all-transistor chassis, described in

Fig. 2. General Electric's Porta Color model features a clock timer.

the August '67 issue of PF REPORTER. Included in the all-transistor group are eight 23″ consoles and five 23″ combination models equipped with the TS-919 chassis. Eight other 23″ consoles are also included in the all-transistor group and use the slide-out "briefcase" TS-915 chassis. Both the TS-919 and TS-915 solid-state chassis are electrically identical and employ the same modular circuit panels. The only difference in the two chassis involves the physical layout and service accessibility. Tube-type models offered by this manufacturer are equipped with 20″, 22″, and 23″ CRT's and employ either the TS-914 chassis first introduced in the '66 color line, or the TS-918 chassis that powered the new models in 1967. Included in the 20″ grouping are four table models and seven consoles. The 23″ tube-type chassis is found in three table models, one consolette, and eleven consoles. Completing Motorola's '68 color line are two continuing 22″ combination models equipped with the TS-914 chassis.

Olympic has included one 18″ table model color receiver in their new line. Other new models are two 22″ consoles, three 23″ consoles, and two 23″ combination units.

Packard Bell offers five individual cabinet style groupings for 1968. Models available in these groups total two 18″ table models, twenty 23″ consoles, and seven 23″ combination designs.

Panasonic has presented three color models for 1968. Newest of the three is "The Buckingham," a 14″ portable model employing a hybrid chassis. The other two color receivers are 18″ table models equipped with tube-type chassis.

Philco is one of the few color TV manufacturers employing round CRT's in their '68 color line. The round CRT's are 21FJP22 and 21FBP22 (267 square inch) types used in one 19″ consolette, five 19″ consoles, and one 19″ combination. The remaining models in this manufacturer's new line use rectangular CRT's. These include three 18″ portables, four 20″ consoles, one 23″ consolette, twelve 23″ consoles, and seven 23″ combination models.

RCA is opening the new model year with the addition of fifty-two new models to the color line introduced in March of this year. The 1968 line offers 14″, 18″, 20″ and 23″ CRT's in a variety of portable, table, console, and combination models. Five new chassis are employed in this manufacturer's new line: CTC27, CTC28, CTC30, CTC31, and CTC35. In addition, the CTC22 chassis introduced in March of this year is continued in two 14″ portable color receivers. All '68 RCA color models will employ new rectangular picture tubes with a new red phosphor that, according to RCA, provides a 40% increase in efficiency.

Setchell Carlson's new line features nine 23″ consoles and three 18″ consolettes, all equipped with this manufacturer's unitized chassis.

Sylvania's new color offerings for the coming year include eight 18″ table models, two 20″ table models, seven 20″ consoles, and thirty-three 23″ consoles. Completing this manufacturer's '68 color line are twelve 23″ combination models.

Westinghouse has prepared a 21-model color line offering three CRT sizes. Included are three 18″ models, two 22″ table models, four 22″ consoles, eleven 23″ consoles, and one 23″ combination model.

Zenith's '68 color line consists of 42 models. Three 18″, four 20″, and three 23″ table models are included. In the console grouping there are three 20″ and twenty-four 23″ models. Five 23″ combination models round out this manufacturer's new offerings.

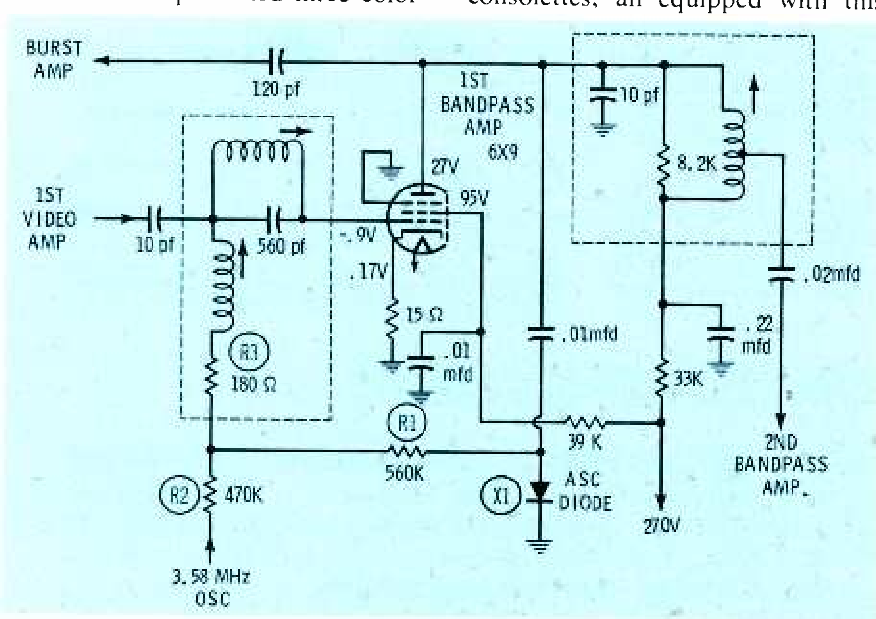


Fig. 3. Admiral's automatic color saturation circuit.

Chroma Circuitry

The three chassis used in Admiral's '68 color models continue to employ the chroma circuitry introduced in early 1965. This circuitry consists of two stages of color amplification, a burst amplifier, color killer (no killer control), twin pentode 6LE8 high-level demodulator, and an injection-locked 3.58-MHz oscillator. Added to this basically unchanged circuitry is an automatic color saturation feature, shown in Fig. 3. ASC diode X1 conducts during the positive half of the chroma signal and produces a DC voltage directly proportional to the level of the burst portion of the composite chroma signal. This DC voltage is then fed back to the grid of the 1st bandpass amplifier along with another DC voltage derived from the grid of the 3.58-MHz oscillator. The combined DC correction voltage, which varies in direct proportion to the level of the burst signal, increases the gain of the 1st bandpass amplifier when the chroma level decreases and, vice versa, decreases the gain of this stage with an increase in chroma level. The actual voltage measured on the grid of the 1st bandpass amplifier will vary from about −1.5 volts with a low-level chroma signal to −3.5 volts with a high-level signal.

Most of the chroma circuitry employed in Delmonico/Nivico's

18" portable is solid-state. As shown in Fig. 4, transistors are used exclusively in all chroma functions from the 1st bandpass amplifier through to the 3.58-MHz oscillator. The only exception to this solid-state design is the high-level chroma demodulator, which employs a twin pentode 10LE8.

Emerson color chassis continue to use 6GY6 pentode X and Z low-level chroma demodulators with separate color difference amplifiers (half of twin triode 6GU7's). Chassis Group C-75 employs a "Color Fidelity" control (Fig. 5) that shifts the CRT color temperature from a predominate red to a greenish-blue by varying the voltage applied to both the green and blue control grids. The same chroma demodulator circuit is used in the other two Emerson chassis groups, but without the color fidelity control.

The basic chroma circuitry introduced in the 1966 CB chassis and continued in the 1967 HC and KC chassis are found again in the new KD chassis employed in General Electric's large-screen color models. This chroma circuitry consists of a single bandpass amplifier which provides a burst signal to the burst gate and composite chroma to the balanced-diode synchronous chroma detectors. The burst gate triggers the 3.58-MHz oscillator, providing a subcarrier reference signal to the chroma detectors which, in turn, demodulate the chroma signal and feed B-Y, G-Y, and R-Y to their respective difference amplifier.

Hoffman's basic chroma circuitry remains unchanged from the design used during the past two years. However, the "Color Trac" circuit shown in Fig. 6 is now employed in the chassis design of some of this manufacturer's new models. The function of this circuit is to maintain the chroma gain at a level proportionate to the setting of the contrast control. As the contrast control is adjusted to provide increased contrast, the foward bias on Q1 is increased, causing it to conduct more. Increased conduction of Q1 reduces the positive potential at point A, thereby decreasing the bias of the bandpass amplifier cathode and, in turn, increasing the gain of this stage. Thus, color saturation tracks with the contrast level.

A partial schematic of the chroma circuitry employed in Motorola's TS-919 and TS-915 all-transistor color chassis is shown in Fig. 7. The 3.58-MHz color signal applied to the 1st color IF amplifier is obtained from an emitter follower immediately following the video detector. Both color IF amplifiers are essentially bandpass amplifiers tuned to pass only the 3.58-MHz color signal and its sidebands (±500 kHz). The input circuit of the 1st color IF is tuned to 4.1 MHz to compensate for the normal attenuation of the color signal sidebands in the video IF stages.

An automatic color control (ACC) circuit is employed to adjust the gain of the 1st color IF amplifier and insure constant color saturation. A burst signal from the crystal output amplifier is rectified by the ACC diode, producing a positive DC voltage that is directly proportional to the amplitude of the burst signal. This positive DC correction voltage is applied as forward bias to the base of the ACC amplifier, increasing the conduction of this stage in direct proportion to the burst level. Since the ACC amplifier acts as a variable impedance across the bias source suppling foward bias to the 1st color IF amplifier, an increase in conduction of the ACC amplifier will cause a decrease (negative going) in the forward bias of the 1st color IF amplifier. Thus, condition of the 1st color IF amplifier varies in direct proportion to the burst level.

The ACC amplifier performs another function in addition to its primary roll of maintaining a constant level of bandpass conduction. Conduction of the ACC amplifier in the presence of a burst signal produces a negative-going collector voltage that acts as foward bias

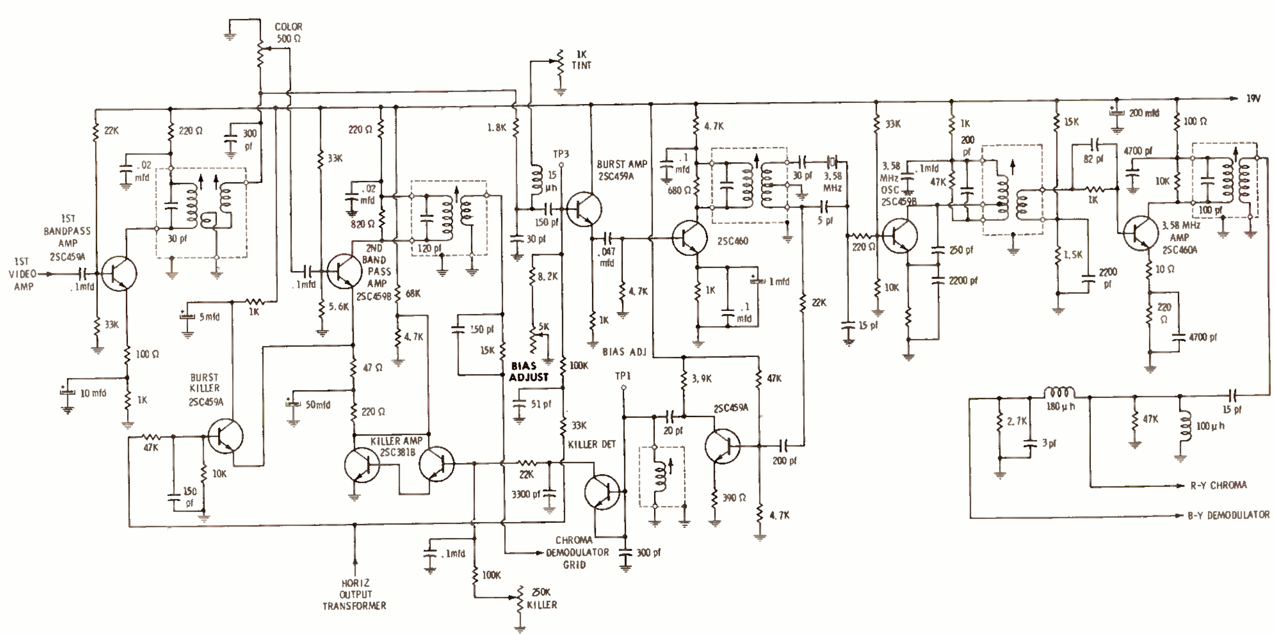


Fig. 4. Transistors dominate chroma section of Delmonico/Nivico's new color chassis.

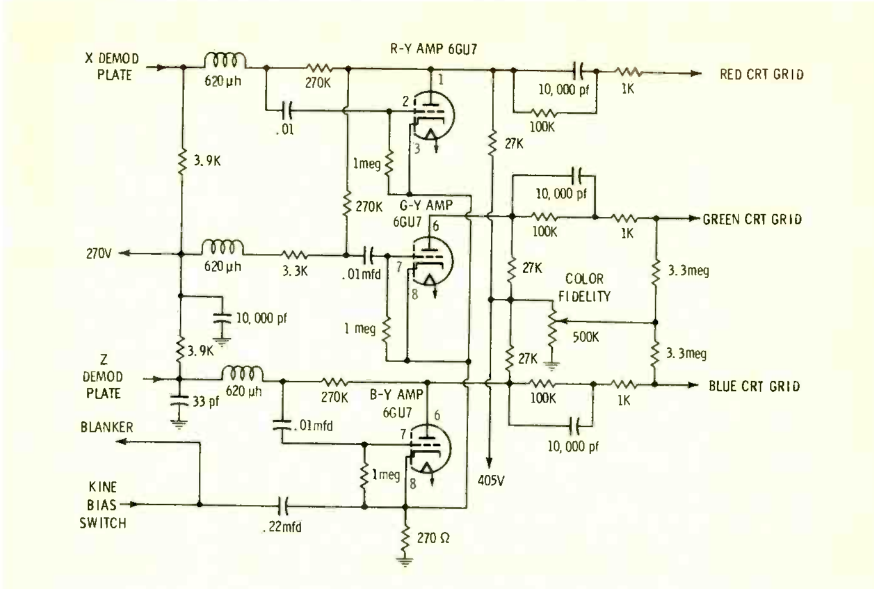


Fig. 5. "Color Fidelity" control is employed in Emerson Chassis.

for the PNP color killer amplifier, turning it on, causing the collector voltage to go more positive. Direct coupling between the color killer amplifier and color killer output stages applies this positive going voltage as foward bias to the killer output stage and, in turn, causes it to conduct. A feedback system employing a 150K-ohm resistor couples the resultant negative-going killer output collector voltage back to the base of the killer amplifier and saturates the color killer system. The output from the emitter of the color killer output stage is applied as foward bias to the base of the 2nd color IF amplifier via a potentiometer (intensity control) that sets the conduction of this stage and therefore, the color saturation. From the foregoing it can be seen that the color burst signal indirectly turns on the color killer section which, in turn, switches on the 2nd color IF amplifier.

The composite chroma signal, taken from the base of the 2nd color IF amplifier, is applied to Q7, the gated color sync amplifier. Since only the 3.58MHz burst signals (riding on the back porch of the horizontal blanking pedestal) are to be processed by this stage, a gating signal in the form of a pulse from the horizontal output transformer is fed to the emitter circuit of Q7 through a pulse shaping system. The gating pulse supplies the negative voltage needed on the emitter to satisfy the foward biasing requirements of this stage. Therefore, Q7 conducts only during the time the horizontal pulse is applied to its emitter and, since the conducting time of Q7 coincides with the arrival of the burst signal at its base, only the burst signal is amplified and passed by this stage.

The output of Q7 is used to shock excite (ring) a 3.58-MHz crystal so that it produces a CW signal. This 3.58-MHz CW signal is amplified by Q3, the crystal output amplifier, and then applied to Q8, a Colpitts oscillator whose tank circuit is tuned to the 3.58-MHz CW signal. Q8 runs free during monochrome reception, but is locked to the phase and frequency of the transmitted color sync (burst) during color reception.

The output of the color oscillator is fed to a phase splitter stage (Q11) that produces two 3.58-MHz CW outputs, one in phase with the received burst signal and one 180° out of phase with it. A potentiometer (hue control) in an RC circuit between the phase splitter and oscillator output stages permits the phase of the two signals to be adjusted over a range of 140°, thereby compensating for any phase shift of the received color sync or color signal caused by transmission differences, component aging, etc. The color oscillator output stage isolates the chroma demodulators from the hue control circuit and helps assure a constant 3.58-MHz reference signal level to the demodulators.

The Motorola solid-state chroma demodulators and CRT color input circuits are shown in Fig. 8. Note that a separate demodulator with associated driver and output stage is employed for each primary color. Three imputs are fed into the demodulator section. One input is the composite chroma signal from the 2nd color IF amplifier and the other is the Y or brightness signal from the 2nd video amplifier. Since the demodulators are connected in parallel, both of these signals are fed to each demodulator.

The third input signal is the reinserted 3.58-MHz CW reference signal from the color oscillator output amplifier. The CW reference signals are fed to the red and blue demodulators through individual phase shifting networks that produce a fixed phase shift between the reinserted CW reference signal and

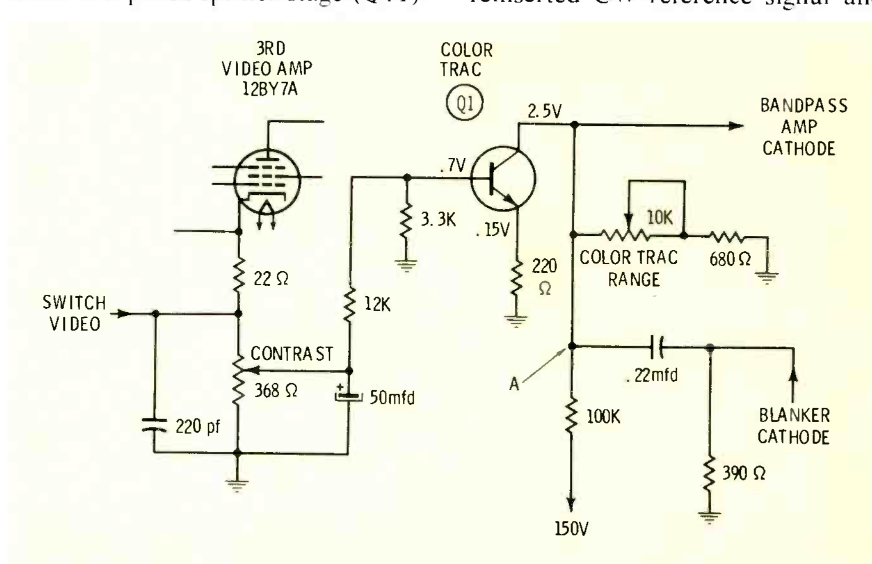


Fig. 6. "Color Trac" in Hoffman chassis tracks chroma with contrast.

THE ELECTRONIC SCANNER

news of the servicing industry

Color Sales At All-Time High

Color television distributor sales set an all-time record for any single week in the period ending September 1, the **Electronic Industries Association's** Marketing Services Department disclosed.

Color TV sales to dealers by distributors reached 155,737 units for the reporting period beginning August 26 and ending September 1. This is the highest figure ever recorded in color television marketing and represents a sharp comeback from the 1967 low point of 39,000 sets distributed in the week ending June 2. Year-to-date distributor sales of color TV sets for the 35 weeks ending September 1 have totaled 2,885.905 sets, 11.3% over the 2.6 million for the same 1966 period.

New Line of Replacement Photo Needles

M. A. Miller Manufacturing Company has announced that they will now sell their line of diamond and sapphire phonograph needles through distributors and dealers. Miller has manufactured phonograph needles for the OEM trade for nearly forty years and numbers such electronic giants as R.C.A., Motorola, Admiral and Zenith among their customers.

M. A. Miller, company president said, "The announced termination of the Jensen Industries Division in this market coincided with our previous plans to expand our sales to the distributor market. In addition to needles we have expanded the line to include phono drives, pulleys, belts, and record care accessories" At this writing, all but one of the former sales representatives of the Jensen Industries Division have now signed up to handle the Miller line.

• *Please turn to page 61*

Circle 9 on literature card

the transmitted burst signal. The CW reference signal applied to the red demodulator is shifted 76.5° from the transmitted burst phase, while the blue demodulator CW reference signal is shifted 193°. The CW reference signal supplied to the green demodulator is shifted 120° from the burst signal and at first would appear to produce magenta tones. However, note that the diodes in the green demodulator are reversed in comparison to the diodes in the red and blue demodulators. This provides an additional 180° phase shift and places the demodulation axis in the green quadrant of the color vector diagram shown in Fig. 9A.

The demodulators are actually nothing more than phase comparers. The phase of two signals—the transmitted color signal, which changes in phase according to the hue being transmitted at any instant, and the reinserted 3.58-MHz reference carrier—are compared in each demodulator. Since the basic operation of the three demodulators is identical, an analysis of the red demodulator will explain the operation of all three. When the two signals are in phase, diode X1 in Fig. 8 conducts, producing a maximum negative output across the demodulator load as depicted in Fig. 9B. This relatively high negative potential biases the CRT cathode for maximum beam current via the video driver and video output stages. As the phase difference between the two signals increases toward 90°, the demodulator output becomes less negative, until at 90° the output drops to zero. From 90° through 270°, diode X2 conducts and produces a positive output which is maximum at 180°. The positive potential at the 180° phase difference is sufficient to bias the CRT cathode "off" with regard to color. The demodulator output drops to zero again at 270°. From 270° to 0° (or 360°), diode X1 conducts once again and produces a negative output across the demodulator load.

Since the Y or brightness signal combines with the demodulated color signal at the demodulators to produce red, blue, and green video signals, no matrixing of color difference and Y signals is required. During reception of a monochrome video signal, the video output from the 2nd video amplifier is fed directly through the demodulators, and the video drivers and video output stages function as conventional video amplifiers. Gray scale tracking is accomplished with the video drive controls.

The design of the chroma circuitry in RCA's CTC31 and CTC27 color chassis is a radical departure from previous designs. Two bandpass amplifier stages are employed. The first bandpass amplifier, shown in Fig. 10, is controlled by a new closed-loop transistor ACC system that will be described later. Note that the takeoff point for the burst amplifier input is from the secondary of the first bandpass output transformer. Since the burst signal must pass through the first bandpass amplifier, a defect in this stage can cause color sync problems.

The second chroma bandpass amplifier is also different. The most obvious change is the fact that this stage is not controlled by the color killer, as in most designs. Instead, the color killer output is used to cut off the demodulator screens during monochrome reception. Also, the second bandpass amplifier is cut off by the blanker during horizontal retrace to prevent color

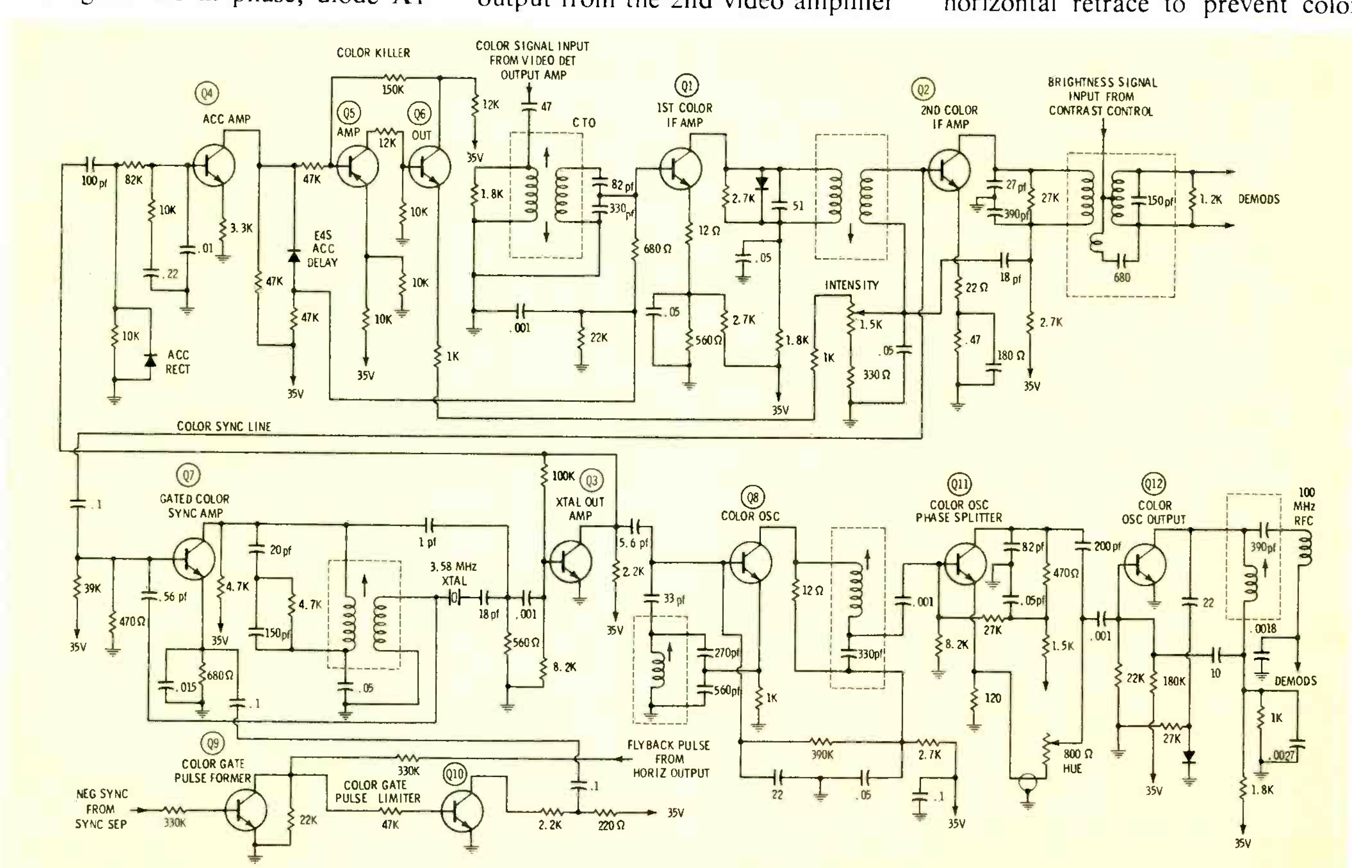


Fig. 7. Part of Chroma circuitry employed in Motorola's new all-transistor chassis.

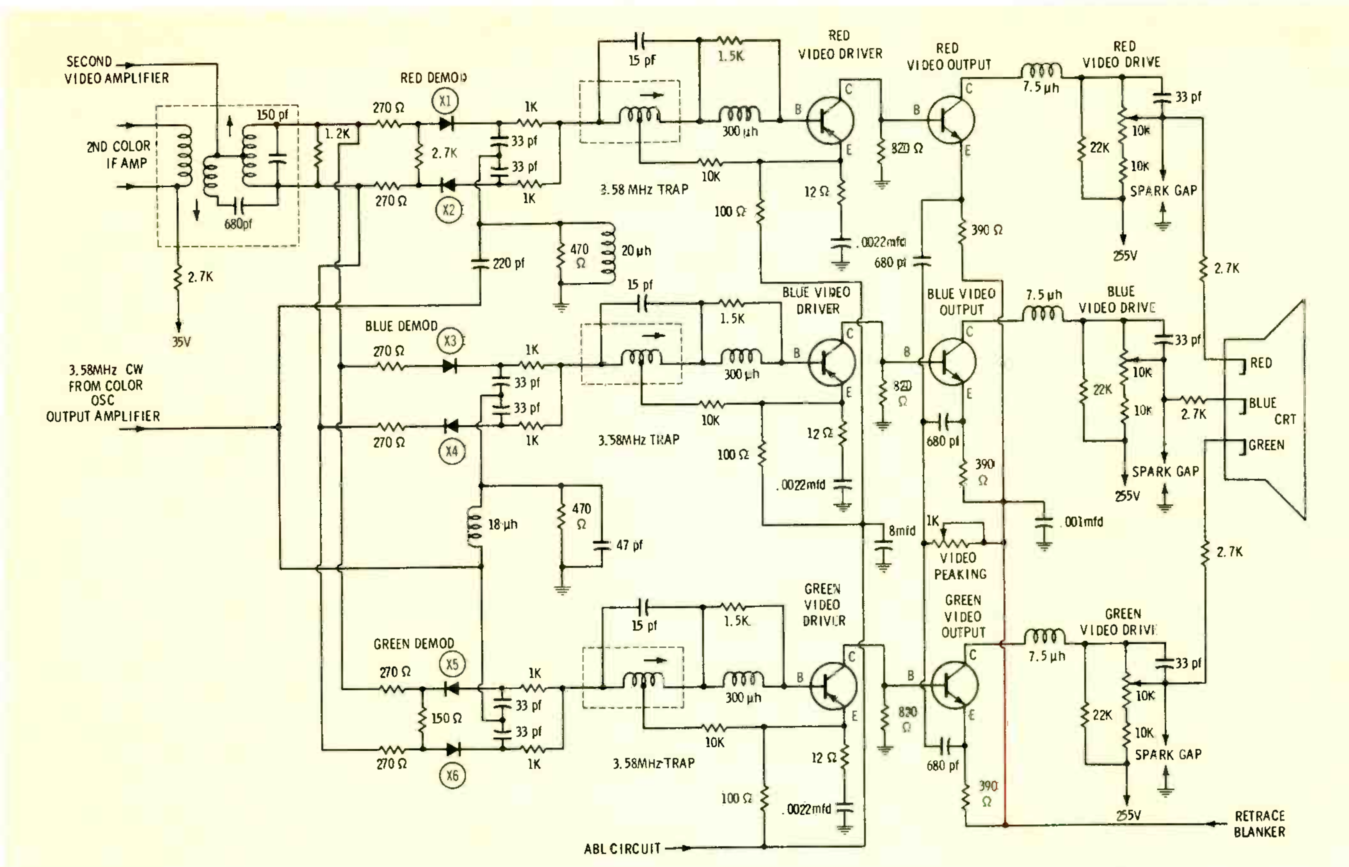
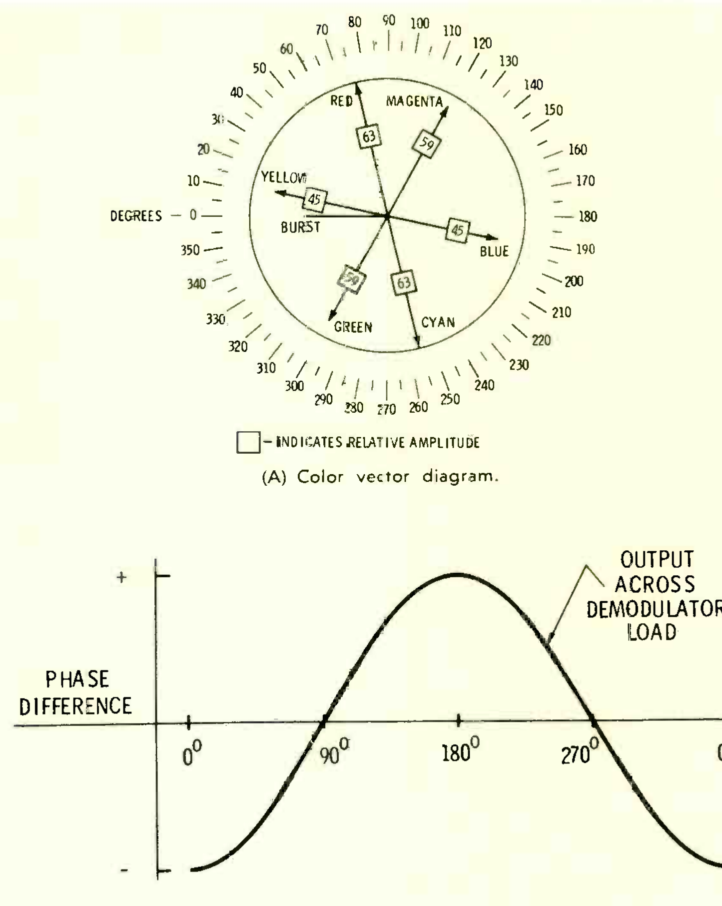


Fig. 8. Both color video and Y signals are fed to CRT cathodes in Motorola's all-transistor chassis

burst from reaching the chroma demodulators. The output of this stage is transformer coupled to the X and Z low-level demodulators.

The burst amplifier employed in the CTC31 and CTC27 chassis is basically the same as that employed in other RCA chassis. The only exception is that the input to this stage is from the 1st bandpass output transformer, as previously described. The output of the burst amplifier is coupled directly into the crystal circuit (grid) of the 3.58-MHz reference oscillator via the burst transformer. The reference oscillator, like the burst amplifier, is nearly identical to the injection-locked oscillator employed in other RCA chassis, except for minor refinements required by the closed-loop ACC system.

Most of these refinements will be brought out in the discussion of the new ACC system. However, one change should be mentioned here and involves the output circuit of this stage, which is applied to the control grids of the X and Z demodulators. Previous RCA chassis designs fed the 3.58-MHz reference signal directly to the Z demodulator from the high side



(A) Color vector diagram.

(B) Demodulator output vs phase.

Fig. 9. Graphical aids help explain operation of Motorola demodulators.

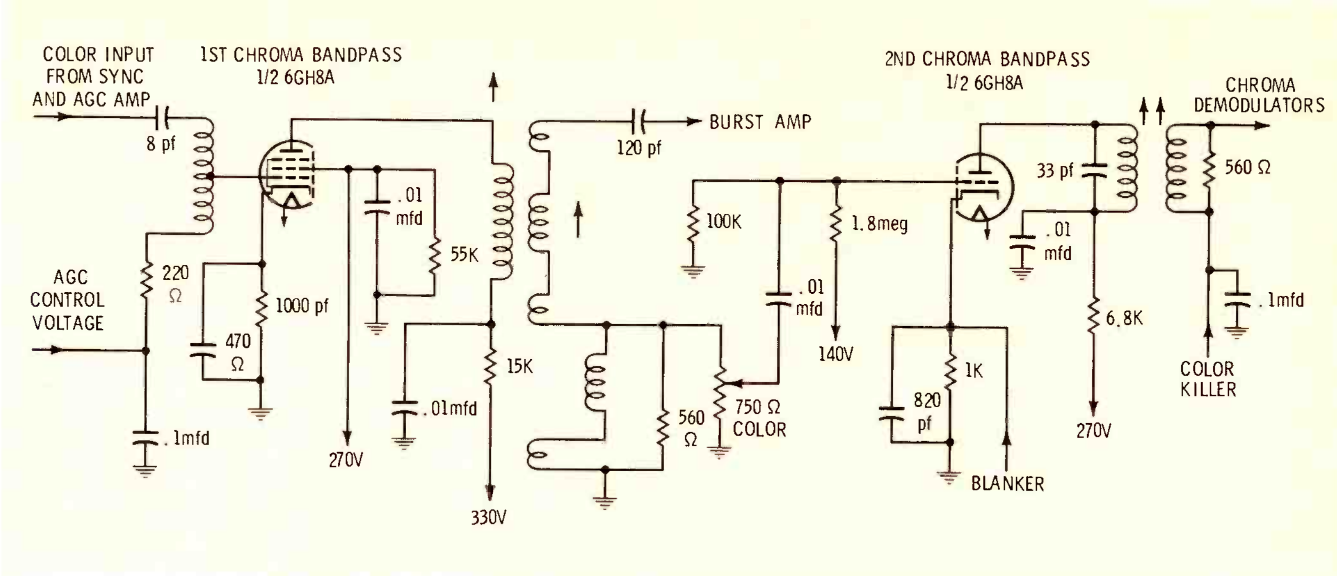


Fig. 10. Two stages of bandpass amplification are found in RCA Chassis CTC27 and CTC31.

of the reference oscillator output transformer. The X demodulator reference signal was obtained from the same transformer, but through a phase shift network. This procedure is reversed in the CTC31 chassis, with the phase shifted reference signal applied to the Z instead of the X demodulator.

Operation of the closed-loop automatic color control (ACC) system employed in RCA's CTC31 and CTC27 chassis (Fig. 11) is based on the fact that the burst signal contained within the composite chroma signal remains at a relatively constant level and does not continually change as does the chroma information. Therefore, the burst can be used as an indication of the overall amplitude of the chroma signal applied to input of the 1st bandpass amplifier.

As mentioned before, the burst signal is fed through the 1st bandpass amplifier, separated from the composite chroma signal by the burst amplifier and applied to the crystal circuit of the 3.58-MHz oscillator. A nominal 80-volt p-p burst level input to the oscillator has been selected as the reference level of the ACC system. A burst signal of this amplitude produces a negative voltage of approximately 8 volts at the oscillator grid. When the overall strength of the composite chroma input to the 1st bandpass amplifier decreases, the burst signal input to the oscillator will decrease below the 80-volt p-p level, producing a proportional reduction in the negative voltage at the oscillator grid. Since the emitter-to-base junction of the ACC amplifier, in conjunction with the killer transistor, provides the ground path for the grid leak bias of the oscillator, less current will flow in the emitter and collector circuits of the ACC amplifier. With reduced collector current, less voltage will be dropped across the collector load circuit, which is tied to the 1st chroma bandpass amplifier grid. Thus, the ACC voltage applied to the grid of this tube will become less negative and the stage will conduct more, increasing the level of the burst signal applied to the oscillator grid.

An increase in the strength of the composite chroma input to the

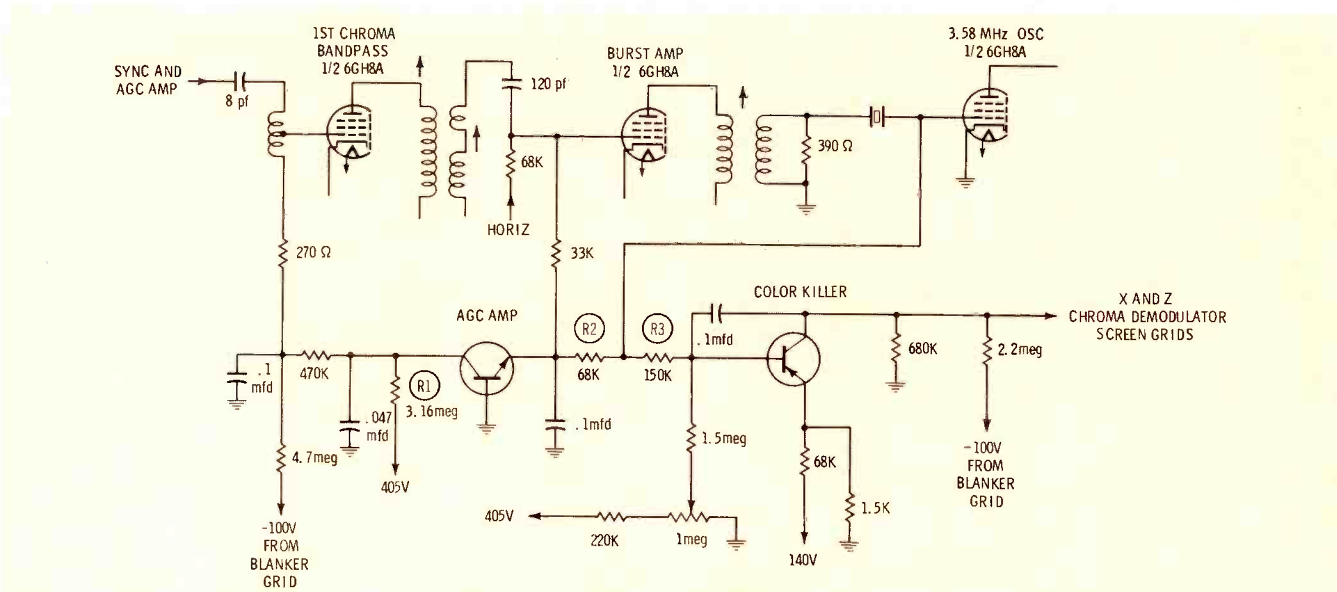


Fig. 11. Chroma circuitry employed in new RCA chassis features a closed-loop ACC system.

1st bandpass amplifier will cause a loop action opposite to that just described. It should be noted here that R1, R2, and R3 are close-tolerance low-temperature coefficient glass resistors and, if found defective, should be replaced only with identical components.

Also shown in Fig. 11 is the transistor color killer circuit employed in the CTC31 and CTC27 chassis. The bias on the base of the PNP color killer transistor is determined by the oscillator grid voltage and the voltage developed across the killer threshold control network. A fixed bias of 2.5 volts is applied to the emitter.

When a monochrome signal is being received, no burst signal will be applied to the oscillator crystal circuit and the grid voltage of this stage will be approximately –3.5 volts which, in turn, produces a positive 3 volts at the base of the color killer. With its base voltage .5 volt more positive than its emitter, the color killer is cut off and its collector voltage stabilizes at –20 volts, which is sufficient to cut off the chroma demodulators via their screen grids.

During color reception, a nominal 80-volt p-p burst signal is applied to the oscillator crystal circuit, increasing the negative grid voltage of this stage to 8 volts. This increase in negative voltage causes the base of the color killer to swing approximately .5 volt negative with respect to the base, saturating the transistor. With the color killer saturated, its plate voltage changes from the previous −20 volts to +2 volts, turning the chroma demodulators on.

The chroma demodulators employed in RCA's CTC31 and CTC-27 chassis are similar to the circuitry found in this manufacturer's most previous color receivers. It has already been noted that the application of the reference carrier to the chroma demodulator control grids has been reversed so that the reference carrier applied to the Z demodulator now lags the reference carrier supplied to X demodulator. It should also be noted that the phase shift angle between the reference carrier signals supplied to the two demodulators has been increased to bring the demodulation axis closer to the 90° R-Y/B-Y angle. One other demodulator change involves an increase in the plate load resistor (now 15K).

The CTC31 and CTC27 color difference amplifiers, shown in Fig. 12, incorporate several changes from previous designs. First, the cathodes are no longer tied together through a common resistor. Instead, individual cathode resistors are used and the G-Y signal is obtained from the plates of the R-Y and B-Y difference amplifiers. Also, no horizontal blanking is applied to the color difference amplifiers, as was done in the past. Instead, horizontal blanking is applied to the CRT cathodes through the video output stage.

The DC level for the CRT control grids is established by new diode clampers in the outputs of the color difference amplifiers. The primary function of the clampers is to maintain a relatively constant operating bias on the CRT grids and prevent changes in the characteristics of the demodulator or difference amplifier tubes from altering this bias enough to affect color temperature.

AC coupling between the demodulators and color difference amplifiers and between the color difference amplifiers and CRT grids prevents the CRT grids from responding to changes in the absolute DC level at either of these stages. It is desirable that the CRT grid respond only to the DC content of the chroma information and not the voltage changes caused by tube drift, etc. One method of accomplishing this is to periodically reset the operating point of the CRT grids. This is exactly what the clampers do. During horizontal retrace, a negative pulse from the blanker stage triggers the clamper diodes. Conduction of the clamper diodes discharges the AC coupling network between the difference amplifier and CRT grid, returning the grid to its 180-volt operating point. At the same time, the blanker cuts off the second bandpass amplifier, removing the input to the demodulators and reseting them to their operating point. Thus, all chroma information developed by the demodulators is fed to the CRT grids as though DC coupling was employed from the demodulators, through the color difference amplifiers, to the CRT grids.

Control of the CRT grid operating point is accomplished by adjustment of the Kine bias control, which varies the level of the horizontal pulse applied to the diode.

The color reference oscillator AFC phase detector and color killer detector circuits of Setchell Carlson's U806 and U807 chassis now employ solid-state diodes in place of the tubes formerly used. ▲

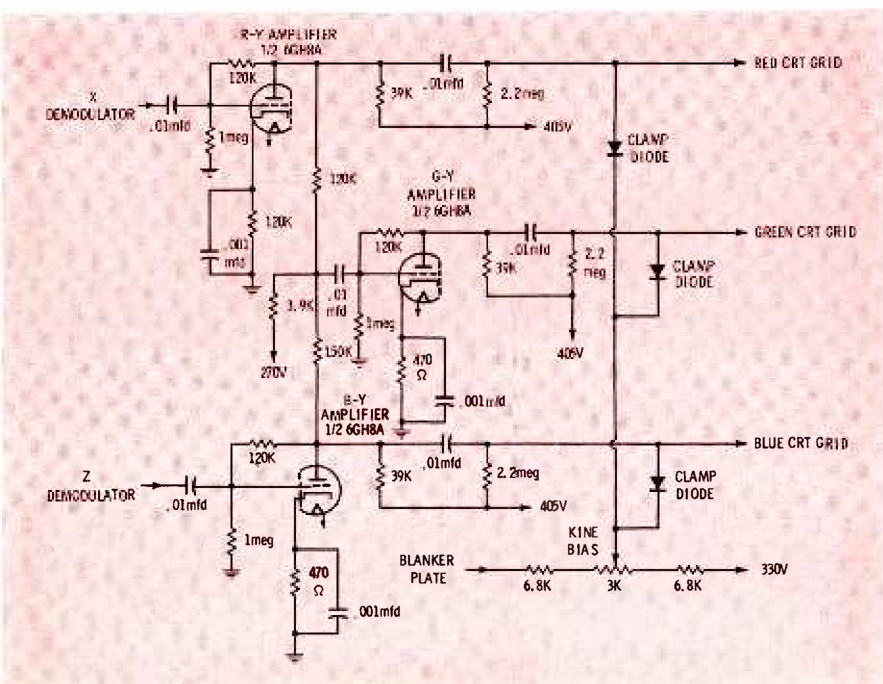


Fig. 12. Clamping diodes are used in CRT grid circuit of RCA chassis.

PART 4

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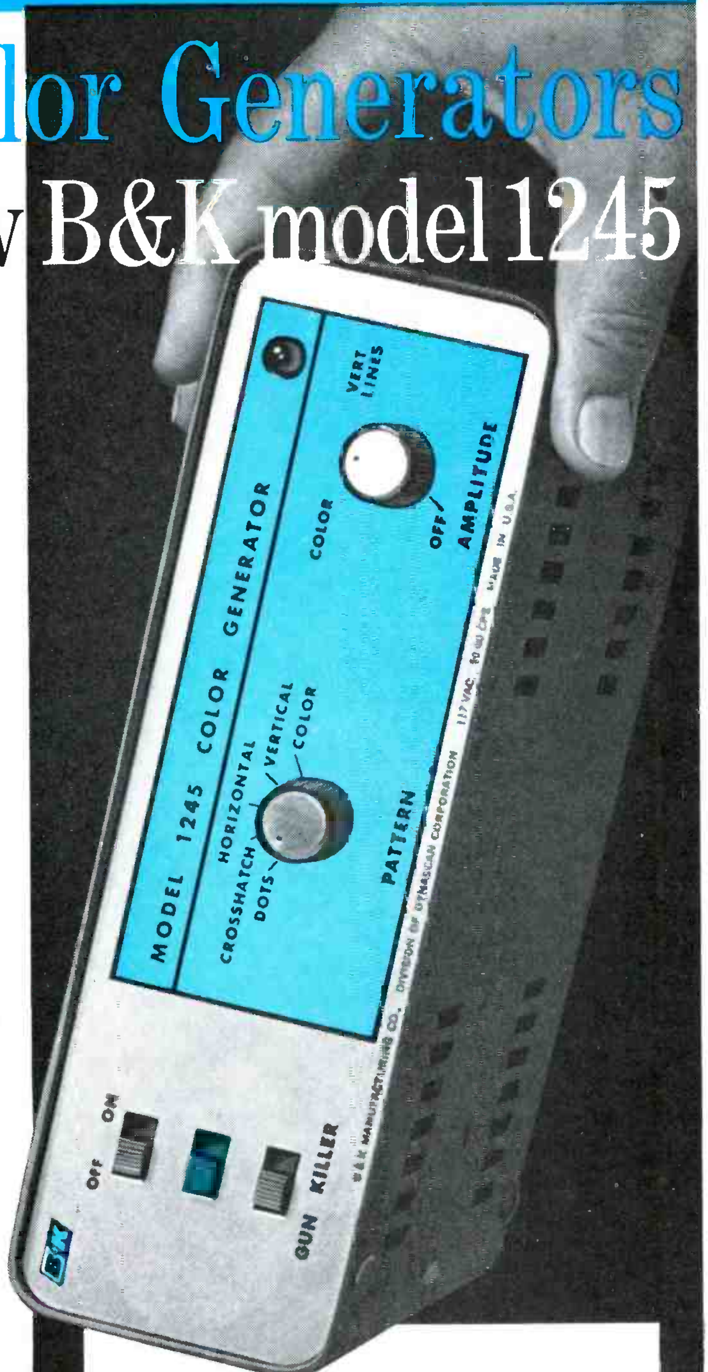

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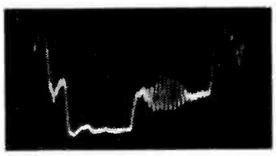
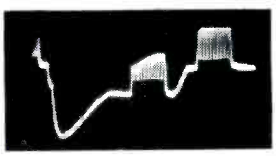


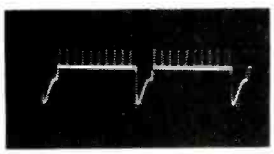
One horizontal sync pulse with its color burst.

Two lines showing horizontal sync pulse with black and white tv signal,

TRANSISTORIZED B&K MODEL 1245

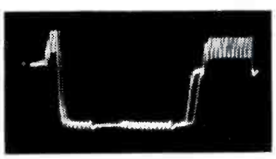


Good duplication of station signal including back porch. If the set won't sync, the set is defective.

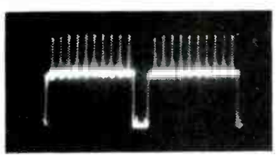


Well defined back porch on horizontal sync pulse permits accurately setting color killer and almost eliminates need to adjust brightness and contrast.

TRANSISTORIZED GENERATOR A

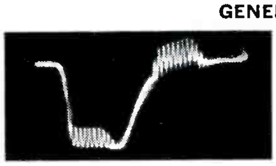


No back porch causes unstable color sync. Burst amplitude compression may permit sync on wrong color bar.

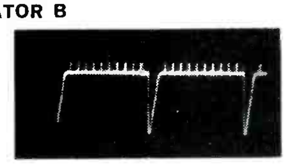


Square wave horizontal sync pulse with no back porch and poor dc coupling forces adjustments of brightness, contrast & fine tuning to obtain usable pattern.

GENERATOR B



No back porch; color information on top of sync-pulse makes sync difficult on some sets.



Complete absence of any back porch necessitates readjustment of brightness, contrast and fine tuning to obtain a usable pattern.

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CHROMA CIRCUITS

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Difference Amplifier
Demodulators
Color Killer

As we have seen from Parts 2 and 3 of this series, much of the circuitry of a color receiver is similar to that which is found in a well-designed monochrome set, and many of the modern circuit refinements are nothing more than the result of the normal progress of the art of electronics. The two sections of a color TV whose circuits differ from black-and-white circuitry are the chrominance channel and the picture tube itself.

In considering the chrominance circuits and the color picture tube, it is well to remember one important point: Black-and-white TV designers in the late '40's had a wealth of information from which to draw, including a great amount of practical experience obtained from WW II electronics devices similar to television. On the other hand, many brand-new concepts were involved in the design of the first color sets. Thus, the chroma circuits are of much more recent design and are still undergoing a certain number of "growing pains."

To cite two examples, consider the continuing development of the color CRT and the numerous variations in demodulator designs in present-day sets. In this discussion of the chrominance circuits, we will consider the more popular present-day designs, realizing that radically different designs are a possiblity.

Block Diagram

Figs. 1 and 2 are block diagrams of two chrominance circuits. The essential difference is whether high-level or low-level chroma demodulation is used. Low-level demodulation (Fig. 1) is an earlier design but it is by no means obsolete. At present, all the major manufacturers, with the exception of Admiral, Motorola, and Zenith, are using low-level demodulation. As shown in Fig. 2, the Zenith design uses two tubes in the high-level demodulator while Admiral and Motorola use only a single tube.

Most of the sets that use low-level demodulation use two demod-

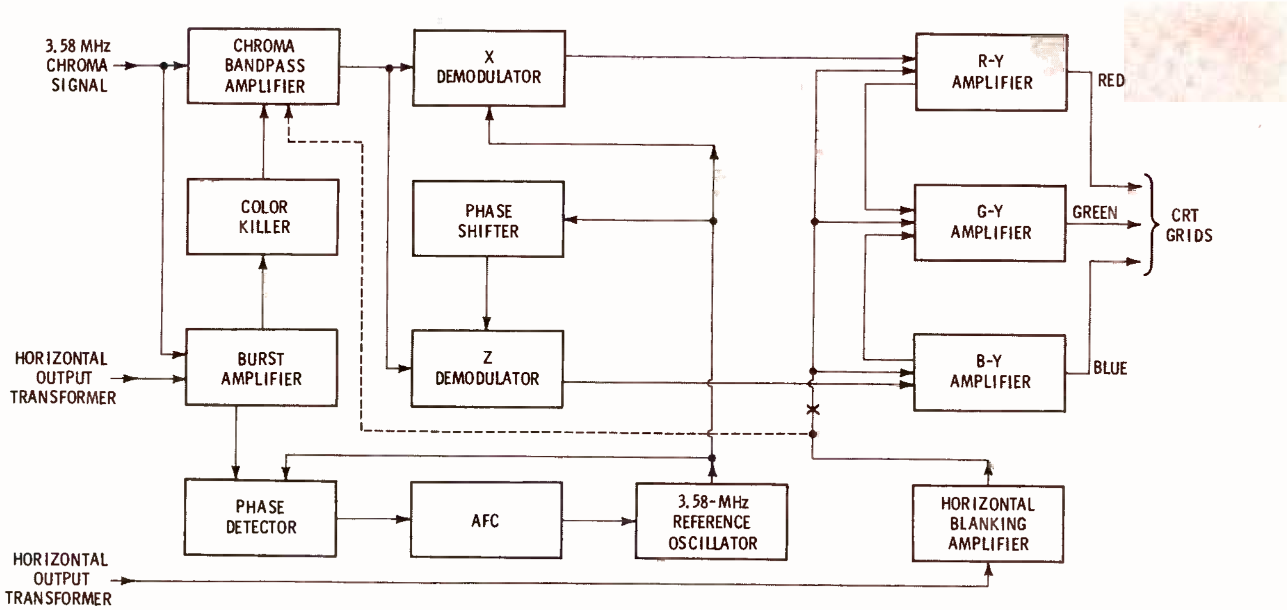


Fig. 1. Functional block diagram of a throma circuit using low-level demodulation.

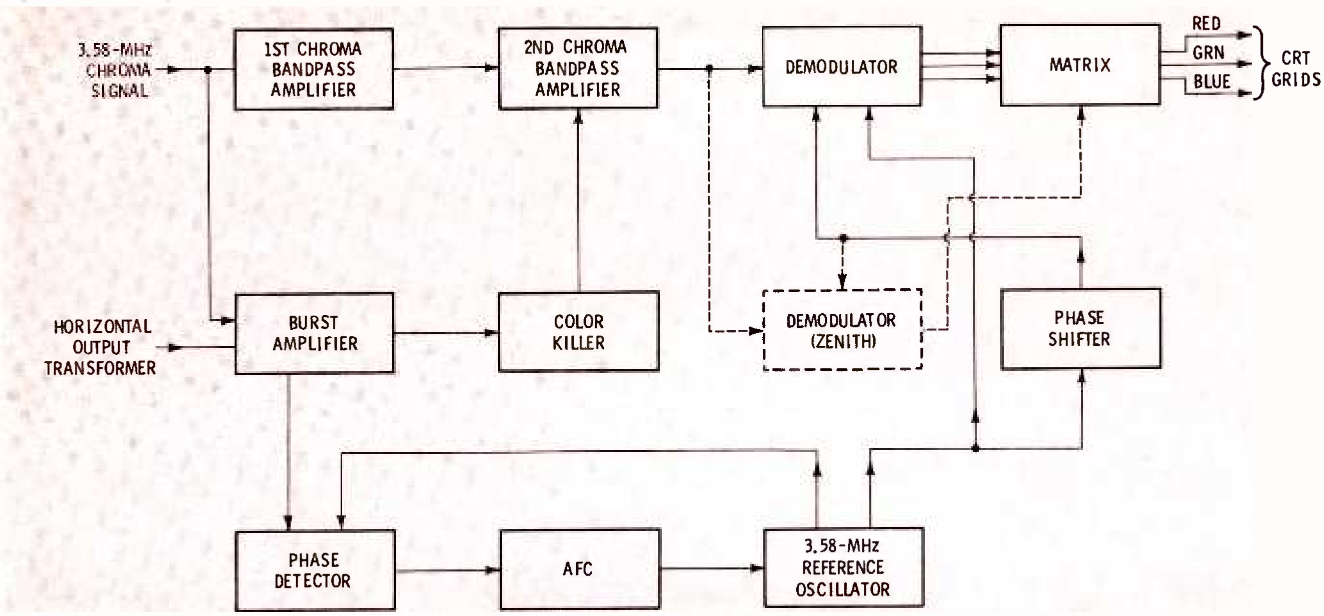


Fig. 2. Functional block diagram of a chroma circuit using high-level demodulation.

ulator tubes operating on the X and Z axes. Three color-difference amplifiers are used, R−Y, B−Y, and G−Y. The input for the G−Y amplifier is derived from a matrix circuit driven by the other two difference amplifiers.

General Electric has developed a demodulator circuit using diodes in a modified phase-sensitive detector. Some of their sets use three-axis chroma demodulation, but others demodulate only two axes and derive a third signal, G−Y, from a matrix. In either case, R−Y, B−Y, and G−Y color-difference amplifiers are used. Electrohome also uses diode demodulators in some of their models.

Referring to Fig. 1, there are four major functions which the chroma circuits must perform. They must reconstitute the 3.58-MHz color reference signal, amplify the chroma sidebands, demodulate these sidebands to develop the R−Y, B−Y, and G−Y color-difference signals, and amplify the

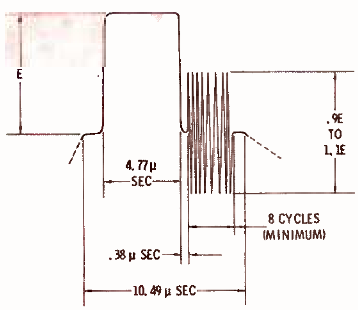


Fig. 3. Sync pulse and color burst.

difference signals to a level which is sufficient to operate the picture tube. (These last two functions are combined in circuits using high-level demodulation.) The chroma circuits perform two auxillary functions, color killing and horizontal blanking; however, these are not essential to color operation. In fact, the color killer only operates during b-w reception, and not all chroma circuits have blanking.

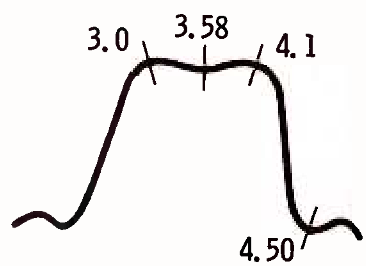
The Reference Signal

From Part 1 of this series, we recall that the 3.58-MHz chroma subcarrier was suppressed at the transmitter. There are two reasons for suppressing this subcarrier:

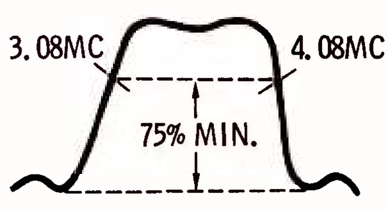
1. The energy contained in the subcarrier would be part of the total available transmitter power and the useful signal power would be decreased accordingly.
2. The presence of a strong 3.58-MHz signal at the video detector of the receiver would make it very difficult to prevent a 920-kHz beat from appearing in the picture. This interference could have been trapped out of sets built subsequent to the date when the color transmission standards were implemented, but b-w receivers already in service at that time would have been almost useless during color broadcasts.

Since the chroma subcarrier is suppressed at the transmitter, it must be regenerated in the receiver. This is accomplished by the 3.58-MHz reference oscillator. This is a crystal-controlled oscillator whose phase is controlled by the color burst signal which is part of the transmitted composite video.

The color burst is a short burst of the 3.58-MHz signal generated in the color modulator. A minimum of eight cycles of this signal is transmitted immediately following each horizontal sync pulse. Fig. 3 shows the position and amplitude of the color burst relative to the horizontal sync pulse. This waveform



(A) Zenith Chassis 24MC32.



(B) RCA Chassis CTC19.

Fig. 4. Bandpass amplifier response.

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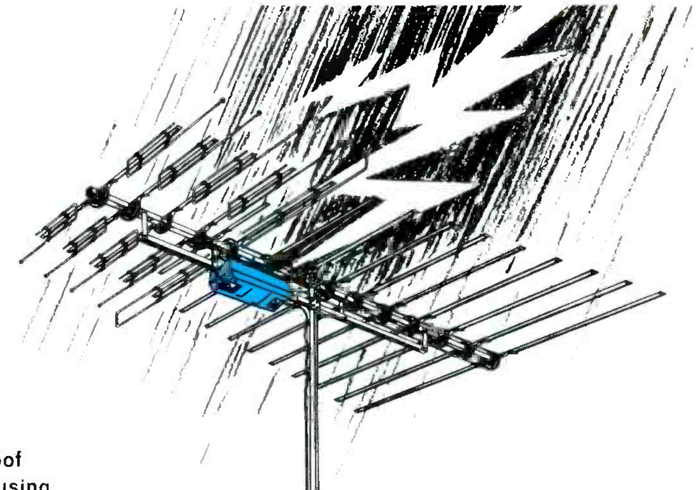

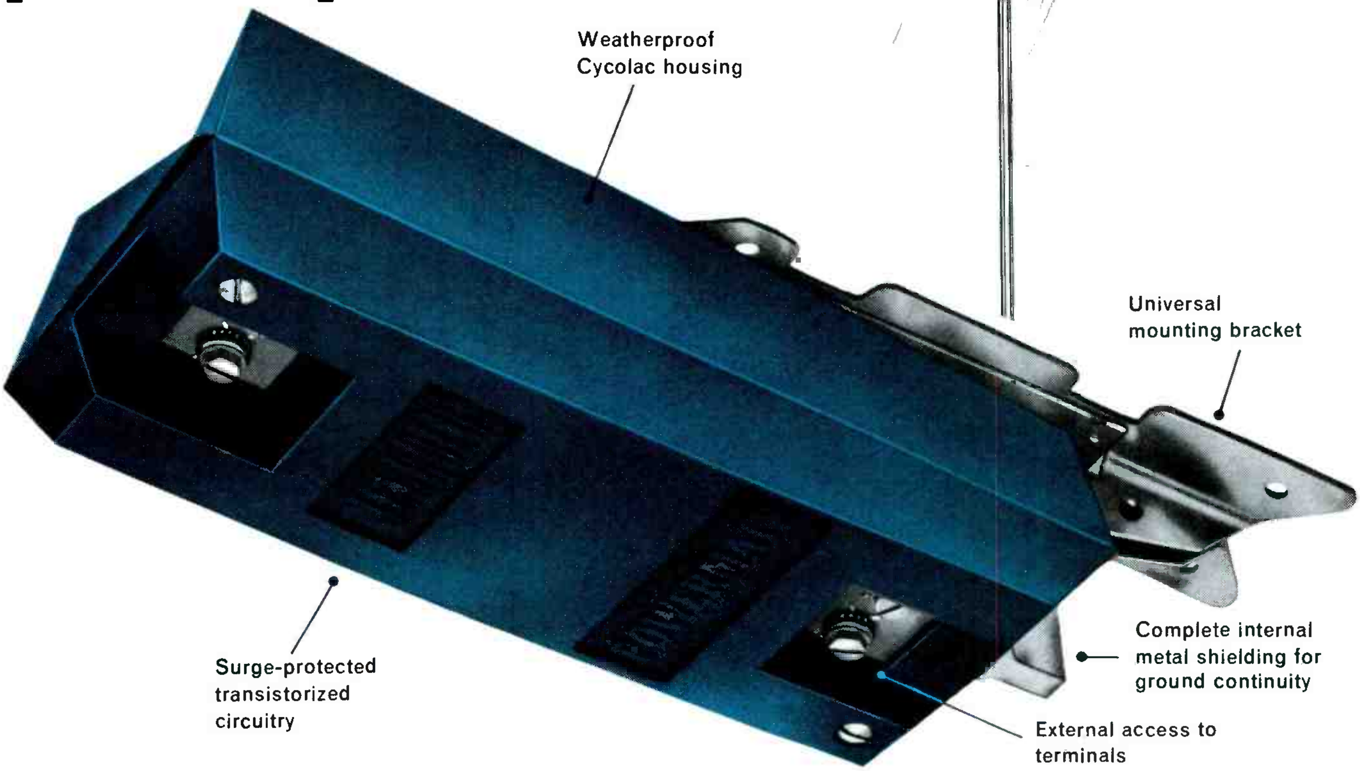

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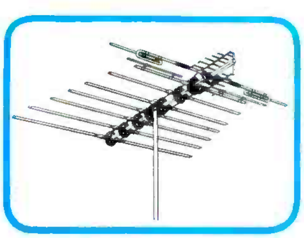

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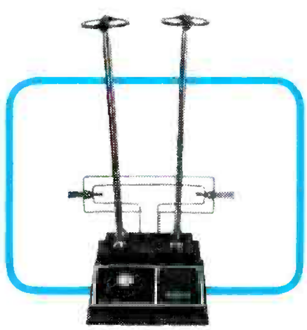

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may be observed at the output of the video detector of the receiver and this is a convenient starting point when troubleshooting a no-color condition.

Referring again to Fig. 1, the composite video signal, including the color burst, is applied to the input of the burst amplifier which is biased below cutoff. A second input of the burst amplifier is an "on" gating pulse, usually taken from the horizontal output transformer. Thus, the burst amplifier is a coincidence gate which can amplify only the color burst.

After the color burst is separated from the remainder of the composite video by the burst amplifier, it is applied to the phase detector. The function of the phase detector is similar to the familiar horizontal phase detector in that it compares a synchronizing signal with a locally generated signal and develops an error voltage proportional to the difference in phase of the two. This error signal is used by the AFC circuit to correct the phase of the 3.58-MHz reference oscillator and synchronize it with the color burst.

The reference oscillator is a crystal-controlled oscillator which operates at the exact frequency of the reference oscillator at the transmitter. The FCC standards for the oscillator at the transmitter are 3.579545 MHz ± .0003% with a maximum rate of change of frequency not to exceed .1 Hz per second. In a well-designed receiver, the reference oscillator output approaches this same precision because it is corrected at the start of each horizontal trace—15,734 times per second.

Returning for a moment to the burst amplifier, let's consider its second function. During a colorcast, a portion of the burst signal is used to cut off the color killer tube. During a black-and-white broadcast, the color killer conducts and biases the chroma bandpass amplifier below cutoff to prevent colored "snow" from appearing on the CRT.

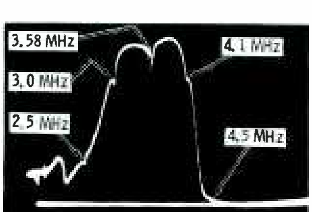

Fig. 5. Typical overall response of IF and chroma (VSM method).

Bandpass Amplifier

The chroma bandpass amplifier is similar to a conventional IF amplifier having a center frequency of 3.58 MHz. Fig. 4A is the chroma amplifier response curve of Zenith Chassis 24MC32 which uses two stages of amplification, and Fig. 4B shows the response of the single-stage amplifier of the RCA Chassis CTC19. Notice that the Zenith response is somewhat broader. Nearly all current sets have response curves which lie within the limits set by these two curves.

The curves obtained in Figs. 4A and 4B were obtained by injecting a signal from a sweep generator at the video detector output and observing the response at the signal grid of a demodulator. An interesting variation in the method of determining the response is discussed in an article by Carl Babcoke which appeared in TEST EQUIPMENT CYCLOPEDIA, Howard W. Sams & Co., Inc.; Cat. #50007. Using this method, known as "video sweep modulation" (VSM), a signal at the receiver intermediate frequency (45.75 MHz) is modulated by a video-frequency sweep generator operating between approximately 2 and 5 MHz with suitable markers injected. The response curve shown in Fig. 5 is typical of the curve that should be observed at a demodulator grid. This method of observing the response of the chroma bandpass amplifier takes into account any misalignment of the video IF strip and is a valuable "quick-check" for overall alignment of the receiver.

This rather lengthly discussion of the bandpass characteristics of the chroma amplifier and the reference to overall bandpass was included because of the importance of correct bandpass in obtaining a good color picture. Even the rather moderate change in response shown in Fig. 6 (same method of observation as Fig. 5) will seriously degrade the color performance of a set. Indeed, there are cases on record where a too sharply tuned antenna has made color reception impossible even though the receiver bandpass was well within tolerance.

Again referring to Figs. 1 and 2, the input to the chroma bandpass amplifier is the 3.58-MHz chroma information. The 4.5-MHz audio subcarrier is rejected by traps, discussed in Part 2 of this series, and the luminance or Y signal and the sync pulses are blocked by a small coupling capacitor between the video detector and the bandpass amplifier. The design of some receivers (the RCA CTC12 chassis, for example) incorporates a circuit which cuts off the bandpass amplifier during horizontal retrace.

Generally, a single-stage bandpass amplifier is used in conjunction with low-level demodulators, and two stages of amplification precede a high-level demodulator. At any rate, the output of the bandpass amplifier, which is applied to the demodulators, is a 3.58-MHz signal whose phase is determined by the hue of the picture being transmitted at that particular moment. The amplitude of this same 3.58-MHz signal is determined by the intensity, or degree of saturation, of the hue.

Chroma Demodulation

In part 1 of this series, it was explained how the three primary colors could be modulated on a single carrier without losing any of the information. By a reversal of this modulation process, the color information may be obtained from the chroma signal. It is not necessary to demodulate on three separate phase axes since the third color-difference signal usually (G − Y) may be derived from a suitable combination of the other two (R − Y and B − Y). The G − Y voltage is a combination of −.51 R − Y voltage and −.19 B − Y voltage. $E_G - E_Y = -.51\,(E_R - E_Y) - .19\,(E_B - E_Y)$.

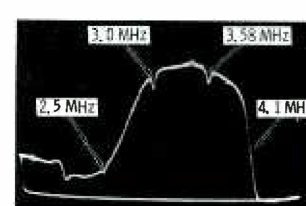

Fig. 6. Incorrect overall response curve (VSM method).

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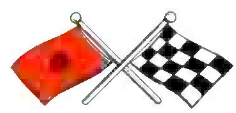

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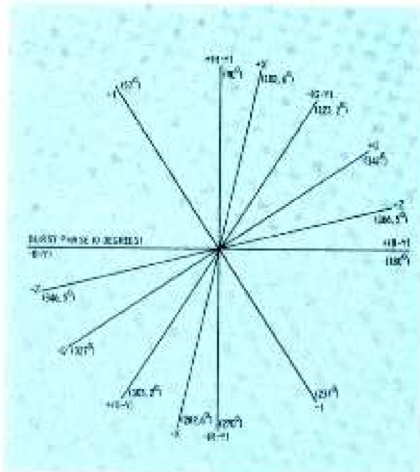


Fig. 7. Chroma demodulator axes.

It can be proven mathematically that the chroma signal can be demodulated on nearly any pair of axes, but considerations of economy in design have resulted in the use of the X and Y axes in most sets. However, some manufacturers (Admiral and Zenith, for example) use the R−Y and B−Y axes. Fig. 7 shows the more important phase angles involved in color modulators and demodulators. The I and Q axes are no longer being used for demodulation, by the way.

An inspection of Fig. 7 will show that the R−Y and B−Y axes are not far removed from the X and Z axes. Thus, the axes of demodulation of nearly all sets of current design are approximately the same.

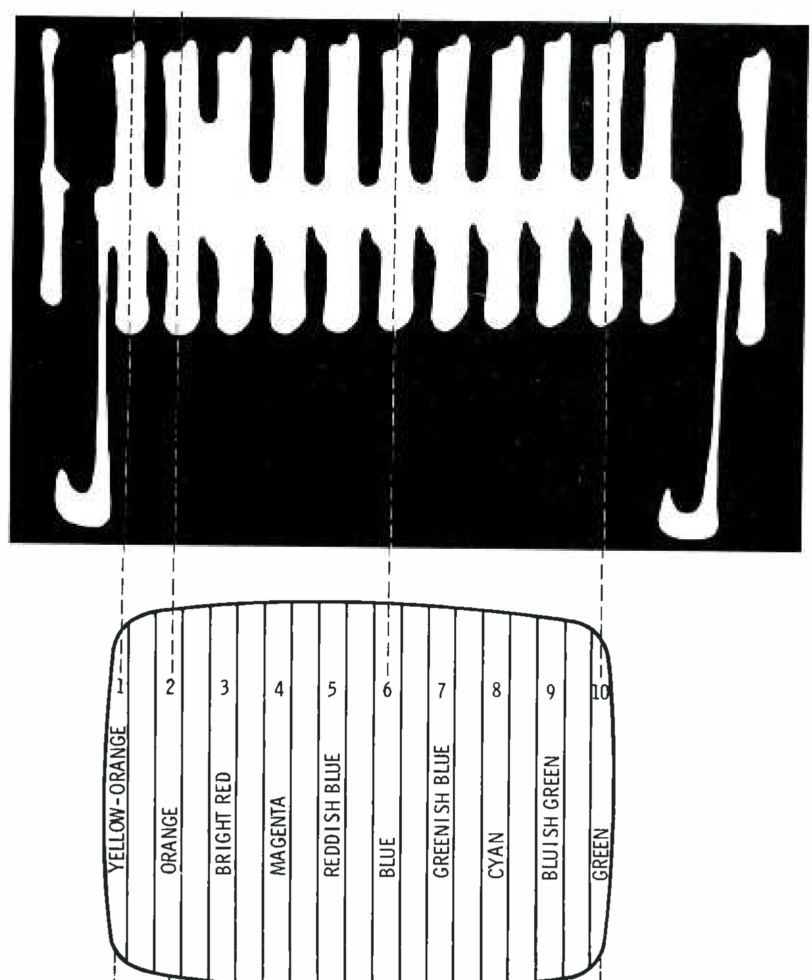
Referring to Fig. 1, the chroma signal is applied to the X and Z demodulators in the same phase. A potentometer in the output of the bandpass amplifier is used to adjust the amount of color signal which is fed to the demodulators. This is a front-panel control and is usually labeled "Color".

A second input, from the reference oscillator, is also fed to the demodulators; however, the phase of the reference signal is **not** the same at each demodulator. If the X and Z axes are being used, the reference signals at the two demodulators differ by 63.9°; or, in the case of R−Y and B−Y demodulators, the phase difference is 90°.

In any event, the function of the X demodulator is to produce an output which is proportional to the chroma information present along this particular axis. By the same token, a Z demodulator produces an output corresponding to the chroma information on the Z axis, an R−Y demodulator detects the information present on its axis, etc. We will take up the specific circuitry of the various demodulators later in the series.

While many texts explain the operation of the demodulators by proving what outputs will be present for a number of hypothetical input-signal phases, it is perhaps more meaningful to show the demodulator outputs which result when a keyed-rainbow signal is fed into the set. Fig. 8 shows the waveform that will be observed at the signal grids of the demodulators. Notice that there are eleven energy pulses, in addition to the color burst, although only ten bars are normally seen on the color receiver. The eleventh pulse occurs during retrace and cannot be seen, and, of course, the burst pulse is invisible on the CRT. Fig. 8 also shows the color bars produced by the first ten energy pulses along with the phase angle of the chroma signal at the center of each color bar. The various axes which were shown in Fig. 7 also appear again in Fig. 8.

Fig. 9 shows the outputs of I, Q, R−Y, B−Y, and G−Y demodulators. Notice that the output of each demodulator reaches a positive maximum when the signal phase is the same as the axis of the particular demodulator and reaches a negative maximum 180°



	+I	+(R-Y)	-(G-Y)	+Q	+(B-Y)		-I	-(R-Y)	+(G-Y)
30°	60°	90°	120°	150°	180°	210°	245°	270°	300°

Fig. 8. Keyed-rainbow chroma signal, CRT presentation, and phases.

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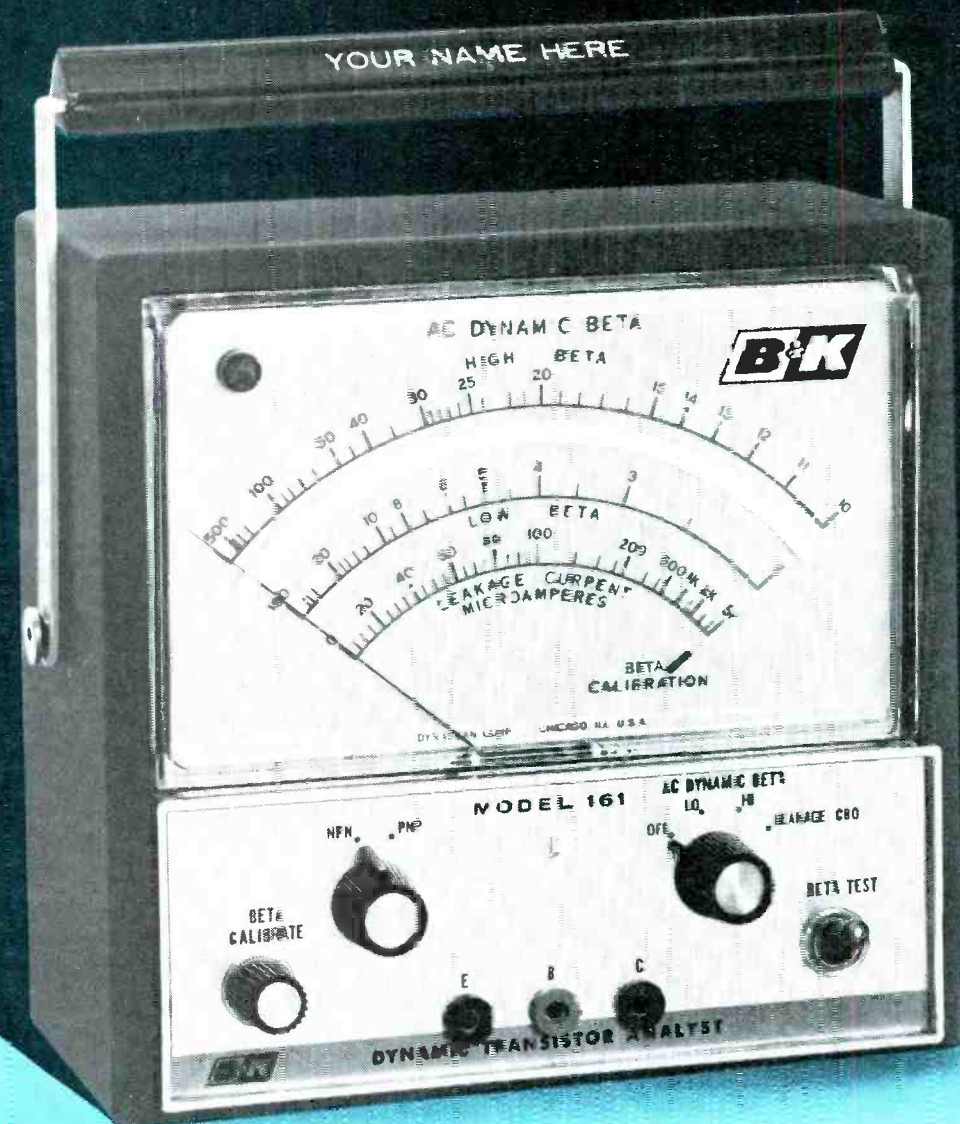

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later. Also notice that the output of a demodulator is zero when the signal is displaced 90° from its axis. These zero-output points, or nulls, are more frequently discussed since they are more easily observed than the maximum output points.

It is customary to observe the waveforms of the X and Z demodulators after their outputs have been amplified by the color-difference amplifiers. Under these conditions, the X and Z signals will be identical to the R − Y, B − Y, and G − Y signals because the points of observation are the same; i.e., the CRT grids. If the output of the X demodulator is observed directly, the waveform is similar to an inverted R − Y output waveform; but the maximum negative output will accur at a point between the third and fourth bars, the null is between the sixth and seventh bars, and the maximum positive output is between the ninth and tenth bars. Fig. 10 shows the output from the X and Z demodulators when a keyed-rainbow signal is fed into the receiver. Notice that the output of the Z demodulator is similar to the inverted B − Y waveform of Fig. 9, but that it is shifted slightly in phase (13.5°).

Color Difference Amplifiers

Referring again to Fig. 1, the outputs of the X and Z demodulators are fed to the R − Y and B − Y difference amplifiers, respectively. These amplifiers and their associated circuitry amplify and invert their inputs and feed them to the CRT control grids. It is common practice to connect the cathodes of the three color difference amplifiers

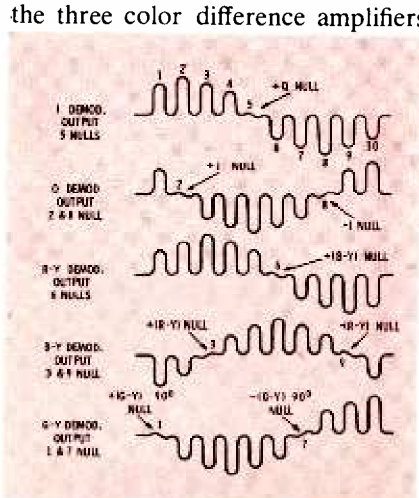

Fig. 9. Demodulator waveforms.

together and to leave the cathode resistor unbypassed. Thus, a portion of both the R − Y and B − Y signals are mixed together and fed to the cathode of the G − Y amplifier. In addition, a portion of the R − Y amplifier output is fed to the grid of the G − Y amplifier. In this manner, R − Y and B − Y are combined to form G − Y. Also notice that, because of the common-cathode arrangement, some B − Y voltage is fed to the R − Y difference amplifier and vice-versa. The effect of this is to cause the output of the R − Y amplifier to actually be the R − Y voltage although the apparent input to the amplifier is the X-axis voltage. A similar action takes place in the B − Y difference amplifier.

As noted previously, not all manufacturers incorporate horizontal blanking in the chroma circuit. When horizontal blanking is used, the usual arrangement is to apply a positive pulse to the cathodes of the difference amplifiers to cut them off during horizontal retrace. In some sets, horizontal blanking is accomplished in the chroma bandpass amplifier.

A variation from the conventional low-level demodulator design was noted previously in this article. This is the circuit used by General Electric in which three separate demodulators (R − Y, B − Y, and G − Y) were used. Obviously, since the G − Y axis is demodulated, it is not necessary to derive this voltage from a matrix.

Referring to Fig. 2, notice that the outputs from the demodulators are of sufficient amplitude to drive the CRT. By definition, this is high-level demodulation. Since there are no color-difference amplifiers, it is somewhat more convenient to use the R − Y, B − Y, and G − Y axis for demodulation. The circuitry used by the three principal proponents of high-level demodulation (Admiral, Motorola, and Zenith) will be discussed later in this series.

Circuit Analysis of Reference Oscillator Circuits

Fig. 11 shows the portion of the RCA chassis CTC25 chroma section which reconstitutes the 3.58-MHz reference signal. These circuits are the burst amplifier, chroma sync phase detector, chroma reference oscillator control, and the chroma oscillator. Two signals are applied to the control grid of V19, a positive gate pulse and the output of the first video amplifier. Because of the filters which are incorporated in the first video amplifier and the very small value of the coupling capacitor, C25, the low-frequency components of the video signal have been removed and only the chroma information remains.

Between pulses from the horizontal output transformer, which are fed to its grid, V19 is cut off by a positive pulse from the horizontal output transformer applied through a divider to the cathode. This pulse is integrated by C116, and the average cathode potential is maintained at about 35 volts. The positive gate pulse applied to the grid of V19 is sufficient to overcome the cathode bias and the tube amplifies the color burst which is applied at this same instant.

The output of V19 is developed across the primary of L31 which is tuned to 3.58 MHz. Transformer coupling is used between the burst amplifier and the phase detector to block the enabling pulse from the circuits which follow. Thus, the input to the phase detector, which comes from the burst amplifier, is eight or nine cycles of the 3.58-MHz signal which originated at the transmitter, and nothing else.

In the absence of a signal from the reference oscillator, the output of the phase detector at the junction of R173 and R174 is zero. Since the signals at the extreme ends of these resistors are equal and opposite, and the center of the

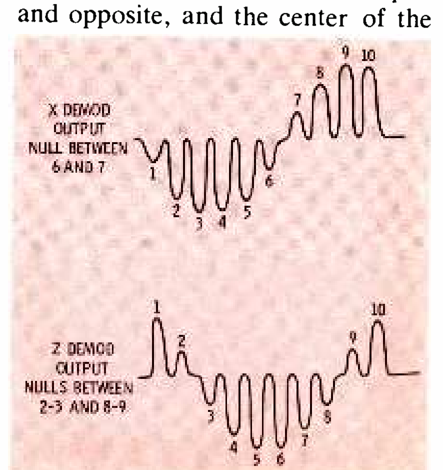

Fig. 10. Demodulator waveforms.

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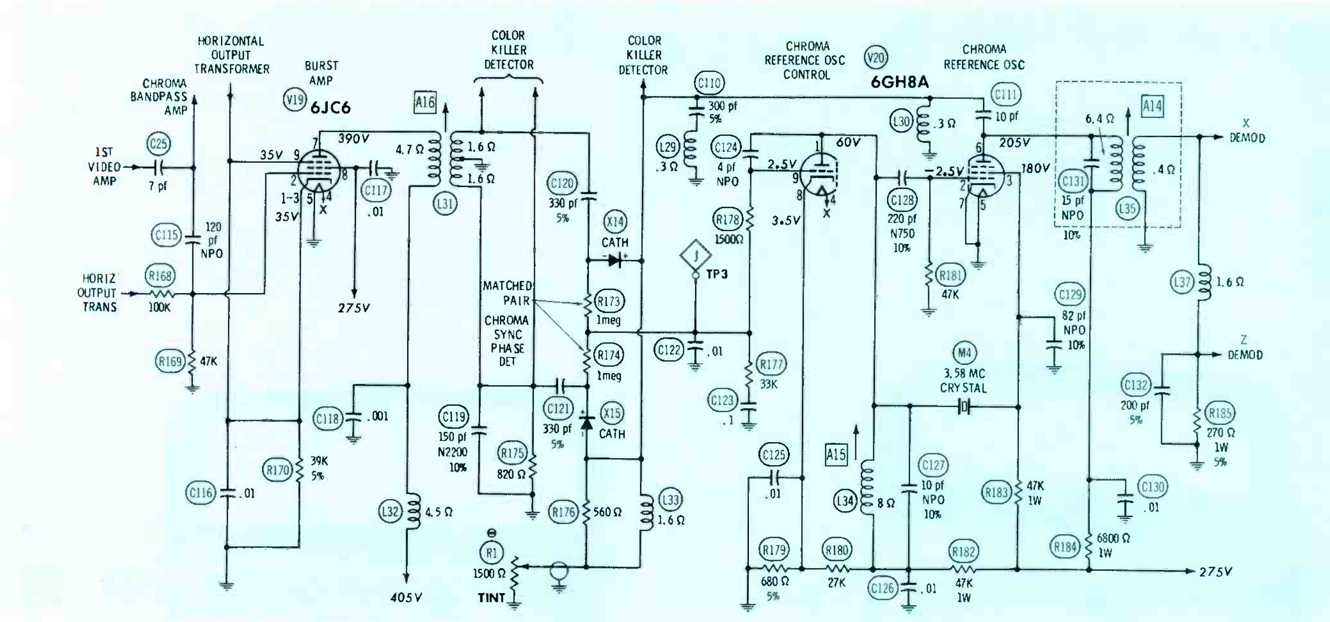

Fig. 11. Reference signal circuits of RCA Chassis CTC25.

secondary of L31 is grounded, the junction of R173 and R174 remains at ground potential during the half-cycle when the diodes are conducting—as well as when they are cut off.

Since the reference oscillator signal is fed to the cathode of X14 and the anode of X15, one diode is forward biased at the same instant that the other is reverse biased. During the half-cycle when the burst signal causes the diodes to conduct, it is possible for X14 to be reverse biased or forward biased depending on the phase of the signal from the reference oscillator. At the same instant, X15 will be biased in the opposite direction. Unless the reference oscillator is operating at the correct phase, the amounts of conduction in X14 and X15 are no longer equal and the voltages at the extremes of R173 and R174 are no longer equal and opposite. Therefore, the voltage at the junction of R173 and R174 can swing either positive or negative depending on the phase relationship of the reference signal and the color burst.

The network consisting of R176, L33, and R1 along with C110, C111, L29, and L30 determines the phase shift of the feedback signal from the reference oscillator to the phase detector. By changing the setting of R1, this phase shift may be varied. This generates an error signal in the phase detector which eventually changes the phase of the reference oscillator. The range of this control is adequate to shift the reference oscillator about 30° in either direction. This will shift a keyed-rainbow pattern one complete color bar from normal in either direction.

The output of the phase detector is integrated, or filtered, by C122, R177, and C123 and fed to the grid of the chroma reference oscillator control tube. This is essentially an AFC tube and the operation is very similar to that of the horizontal oscillator AFC tube discussed in Part 3 of this series. The principal differences are the frequency of operation and the fact that the DC component of the plate current flows through the oscillator tank circuit.

The reference oscillator is a crystal-controlled electron-coupled oscillator. The tuned circuit, L34 and C127, is tuned to the exact frequency of the color burst and the crystal stabilizes the frequency. Grid-leak bias is developed by C128 and R181. The output is developed across the primary of L35 which is tuned to the oscillator frequency. The output of the X

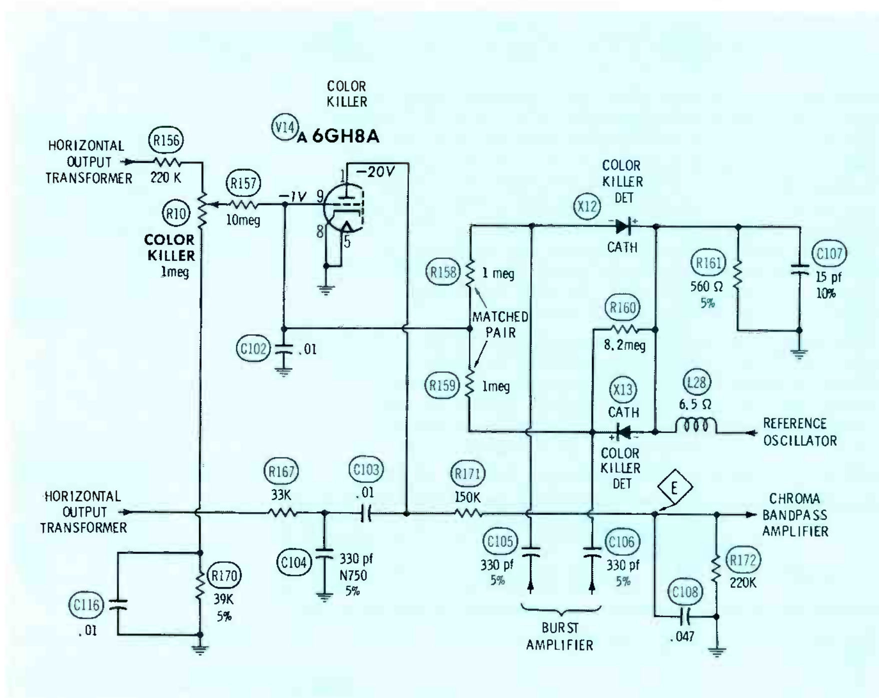

Fig. 12. Color Killer circuit of RCA Chassis CTC25.

demodulator is taken directly from the top of the secondary of L35. The reference signal for the Z demodulation is shifted in phase by L37, C132 and R185.

Color Killer

Fig. 12 is the schematic of the color killer circuit of the RCA CTC25 chassis. This circuit is immune to noise because it is actuated by the phase difference between the reference oscillator and the color burst rather than by the mere presence of the burst signal.

First, consider the operation of the circuit when no color burst is present. Notice that its operation is quite similar to a keyed AGC circuit. A positive pulse from the horizontal output transformer causes current flow through V14 to charge the right side of C103. Between pulses, C103 must discharge through R172 to ground, developing about −15 volts at the top of R172. The long time constant of C108 and R172 maintains this voltage at a steady level. This filtered voltage is used to hold the chroma bandpass amplifier in cutoff.

The actual amount of conduction of V14, and hence the amount of bias at the chroma bandpass amplifier, is determined by the amplitude of the positive pulse, also from the horizontal output transformer, applied to the grid of V14. The magnitude of this grid pulse is set by the color killer adjustment.

In the absence of the color burst, only the reference oscillator signal is applied to X12 and X13. Both diodes conduct the same amount and the output at the junction of R158 and R159 is zero. When a color burst is present, the conduction of X12 and X13 is unequal and a negative output appears at the junction of R158 and R159. This negative voltage opposes the positive pulse voltage at the grid of V14 and the tube remains in cutoff. As a result, no bias is developed in the plate circuit and the chroma bandpass amplifier is allowed to amplify the chroma signal.

Unlike the chroma sync phase detector whose output can be either positive or negative, the output of the color killer detector is always negative. This is true because the phase relationship between the reference oscillator output and the color burst is a constant in the color killer detector but a variable in the chroma sync phase detector.

Automatic Chroma Control

Another refinement of the chroma system has been incorporated in some sets. Called "automatic chroma controll" (ACC), this circuit is essentially an AGC circuit for the chroma bandpass amplifier. A means of automatically controlling the gain of the chroma bandpass amplifier is desirable for two reasons:

1. The receiver AGC circuit is controlled by the amplitude of the horizontal sync pulses, not the color burst level. In theory, the relation between these two levels is constant, but this may not be true under all circumstances This condition is especially noticable in fringe areas. Accordingly, the level of the chroma signal may vary even though the sync pulse level is maintained fairly constant by the AGC.
2. No AGC circuit, or any other closed-loop correcting system for that matter, is 100% efficient. (If it were, no error signal could be developed.) Therefore, an "auxiliary" AGC circuit will maintain a more nearly constant output with varying inputs.

The ACC detector circuit used in RCA Chassis CTC21, CTC28, and CTC30 has about the same configuration as the color killer detector circuit shown in Fig. 12. The phasing is set so that an increase in the level of the color burst produces a negative-going output and a decrease in the level of the color burst produces a positive-going output. This output voltage is used to raise or lower the bias of the chroma amplifier to maintain a more nearly constant level of chroma signal. This helps to prevent changes in color intensity and precludes the owner having to readjust the color control everytime the input signal level changes.

Part 5 of this series will continue the discussion of specific circuits in the chroma system. ▲

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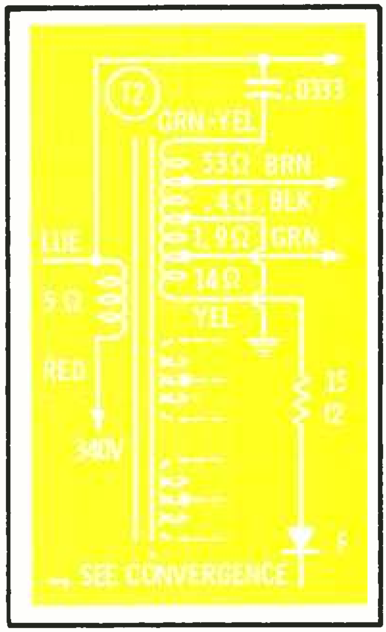
by *Homer L. Davidson*



Today, most color receivers employ a multivibrator in the vertical oscillator circuit. Both the vertical oscillator and amplifier are contained in one tube envelope. Generally, this single tube is a twin triode. The phase and frequency of the vertical oscillator are controlled by a 60-Hz sync pulse. The sawtooth output of the vertical oscillator is coupled through a capacitor to the vertical output stage, shaped, and then amplified. The vertical output transformer couples the shaped waveform to the deflection yoke. Tube types found most frequently in the vertical section of color chassis are a 6GF7, 6EW7, 6LU8, or 6EM7.

Vertical Trouble Symptoms

A typical color vertical circuit (RCA CTC25) is shown in Fig. 1. This circuit is a plate-coupled multivibrator using a triode in both the oscillator and output stages. Vertical sync is fed to the oscillator via capacitor C66.

Horizontal White Line

This symptom can be caused by a dead vertical tube, a defective plate feedback capacitor (C71), or practically any other defective component that completely kills the multivibrator. First, check the normal-service switch, it may be in the service position. Next, replace the vertical tube and adjust the vertical height and linearity controls in an attempt to fill the face of the CRT. If the foregoing fails, a safe bet is to check C71 or C72. Both capacitors have a 1-kv voltage rating and should be replaced with capacitors having the same rating, or better. Open height and linearity controls (R15 and R13) will also produce a horizontal white line.

Insufficient Height

The trouble causing this symptom will probably be found in the vertical output section. Quick checks can be made with the scope for correct waveforms in the vertical output stage. Of course, do not

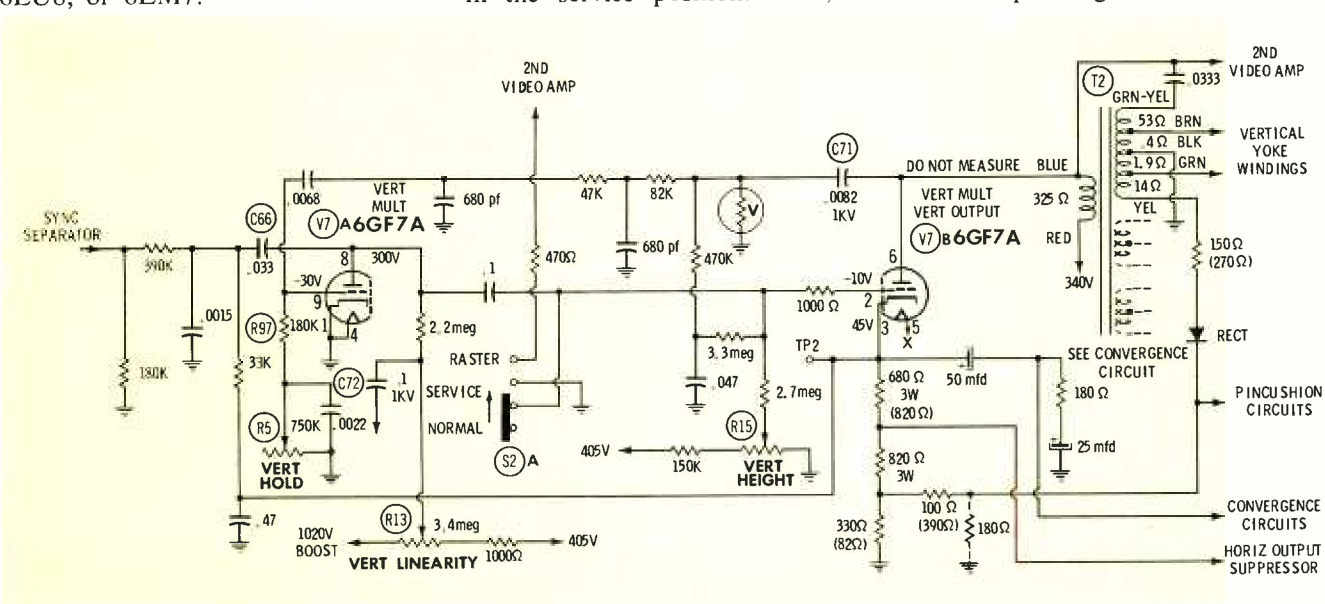


Fig. 1. Vertical sweep circuit employed in RCA Chassis CTC25.

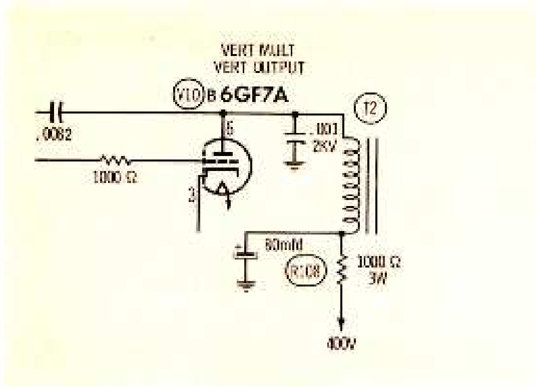


Fig. 2. Increase in plate supply resistor reduced height.

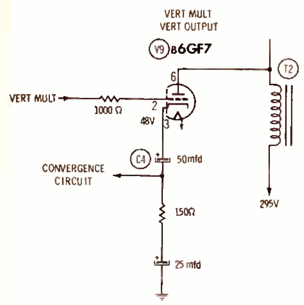


Fig. 3. Capacitor in cathode circuit caused intermittent height.

measure the voltage at the plate of the vertical output tube; you may damage the VOM or VTVM.

Burned cathode resistors or height and linearity controls will result in insufficient vertical sweep. Check decoupling and vertical filter capacitors for physical signs of a defect, such as a dried-up condition. Measure the resistance of the vertical output transformer for shorted or open windings; both shorted windings and increased resistance of the vertical output transformer result in insufficient height.

Rolling

Generally, a constant rolling picture that cannot be stopped with the vertical hold control indicates trouble in the vertical oscillator section. Insufficient sync will produce intermittent roll, especially in extreme fringe areas. Check for changes in the integrator network or input resistors. In some older models, the original input resistors were too large and a 100K resistor was shunted across them to correct the rolling problem. Check the PHOTOFACT Production Change Bulletin for a particular set to see if this should have been done.

Increased resistance in the grid input of the vertical oscillator stage will also cause a rolling condition. Likewise, a change of resistance in the plate load resistor of the vertical oscillator will also cause the picture to roll. A jittery or bouncing picture may be caused by a defective plate load resistor in the vertical oscillator circuit or a defect in the vertical output transformer.

Foldover

When vertical foldover occurs, check the coupling capacitor between the vertical oscillator and vertical output stages. Incorrect setting of the vertical linearity control or a change in resistance of the cathode resistor in the vertical amplifier stage will cause vertical foldover. Insufficient height or foldover can also be caused by a weak vertical tube.

Intermittent vertical troubles

Intermittent symptoms can be caused by defects in any section of the multivibrator circuit. The probe of a VTVM sometimes causes the vertical sweep to return before the actual trouble is diagnosed, thus hiding the defect. However, the scope will usually uncover the defective section.

There are a number of vertical symptoms and a multitude of causes. Some troubles are easy to find, and with experience, a technician can quickly pinpoint the defective component. However, there are a few trouble symptoms that defy a technician's experience and are just plain hard to solve. Twelve assorted color vertical problems are presented in the following paragraphs, along with the troubleshooting techniques used to uncover the defects that caused them.

Reduced Height

An RCA CTC16XL color chassis produced only a 3″ vertical raster. Every three or four months this same trouble would crop up again. Although the 6GF7 vertical output tube caused this problem in a number of similar chassis, the 6GF7 in this chassis checked good. Voltage and resistance checks in the vertical output section finally pinpointed the trouble. An increase in the value of R108 (Fig. 2) had lowered the voltage supplied to the plate circuit of V10B. Replacing R108 with a 1K-ohm, 10-watt resistor corrected the shrunken raster.

The same resistor (R108) caused intermittent vertical height in another CTC16 chassis. The resistance of R108 varied, changing the amount of voltage supplied to the vertical output transformer.

Intermittent Reduced Raster

The complaint with an RCA CTC19 chassis was intermittent

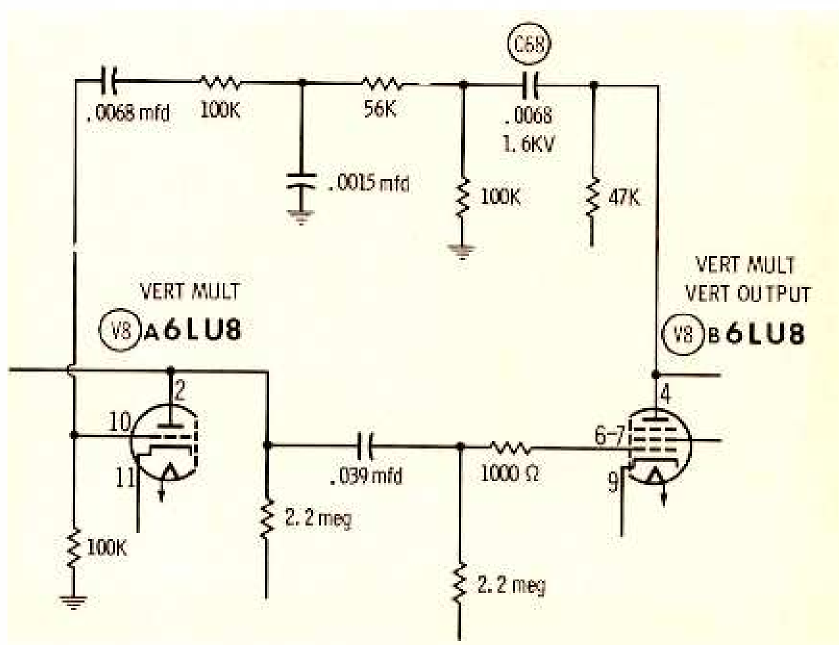


Fig. 4. Poor solder joint collapsed raster of Admiral G13 chassis.

reduction in the size of the raster. The symptom was not present when the technician arrived at the home (naturally). Acting on a calculated guess, the technician changed the 6GF7 vertical output-vertical multivibrator tube.

Two days later the customer called again to report that the same symptom had returned. The receiver was brought into the shop and placed on the bench, where it operated for four days without loosing raster size. When the customer called to inquire about the set, it was explained to her that the trouble had not reoccurred and, therefore, had not been fixed. However, she was unable to do without the set and requested that it be returned immediately. The receiver, trouble and all, was returned to the customer, who paid the bill for having the receiver checked. It was explained to her that the trouble would undoubtedly return again.

Sure enough, about a month later, the same customer called to complain about the same trouble. This time, a b-w receiver was loaned to her when her set was returned to the shop and placed on the bench for observation. Three days later, the raster suddenly shrunk to 3″. Using a scope, the waveform at the grid (pin 2, Fig. 3) of the vertical output stage was checked and found to be normal. However, the waveform at the plate (pin 6) of the same stage had low amplitude. When an attempt was made to check the voltage at the cathode (pin 3), the raster suddenly filled out to normal size, but then quickly decreased to 3″ once again. From all indications, the trouble was in the cathode circuit. The obvious suspects were the two electrolytics. Bridging C4 with a known good capacitor produced a full raster.

Intermittent Collapsed Raster

An Admiral G13 chassis would perform perfectly for days and then, suddenly, the raster would collapse completely to produce only a white horizontal line. The vertical tube was changed during the house call and seemed to clear up the trouble. However, while the technician was making out the bill, the raster collapsed again.

The chassis was removed and brought to the shop, where it was connected to the bench test CRT. Previous experience with the same chassis and symptom made C68 (Fig. 4), the .0068 coupling capacitor, a prime suspect. Shunting this capacitor produced no results; however, when a VTVM probe was placed on the low side of the capacitor, full vertical sweep returned. The voltmeter indicated no apparent leakage.

Before further troubleshooting could be done, a customer brought in a radio for immediate repair, so the technician turned the television off and repaired the radio. In a few minutes, the technician returned to the color receiver, turned it on and, once again, shunted C68 with an identical capacitor, this time from the capacitor to the circuit board itself rather than across the capacitor terminals. This produced a full raster, thus pinpointing the trouble to a poor solder connection on the PC board.

Slow Roll

This vertical problem involved a Sylvania D02 chassis. The picture would come on with a full raster and a slow roll. The picture would not lock in. First, the 6LU8 vertical multiplier and output tube was checked and replaced. Next, the sync tube was replaced, but the picture continued to roll.

The chassis was pulled and an extension harness used to connect it to the picture tube and yoke assembly. The voltages on the vertical oscillator and output section (Fig. 5) were checked and found to be normal. A scope check seemed in order.

The waveform on the plate of the sync separator tube was normal. However, when the scope probe was placed on the cathode (pin 11) of the vertical oscillator, the waveform appeared drastically reduced. Either the coupling capacitor (C58) between the sync separator and the oscillator was leaky or diode X11 in the cathode circuit was bad. Zero potential on the cathode terminal ruled out a leaky capacitor. An ohmmeter read-

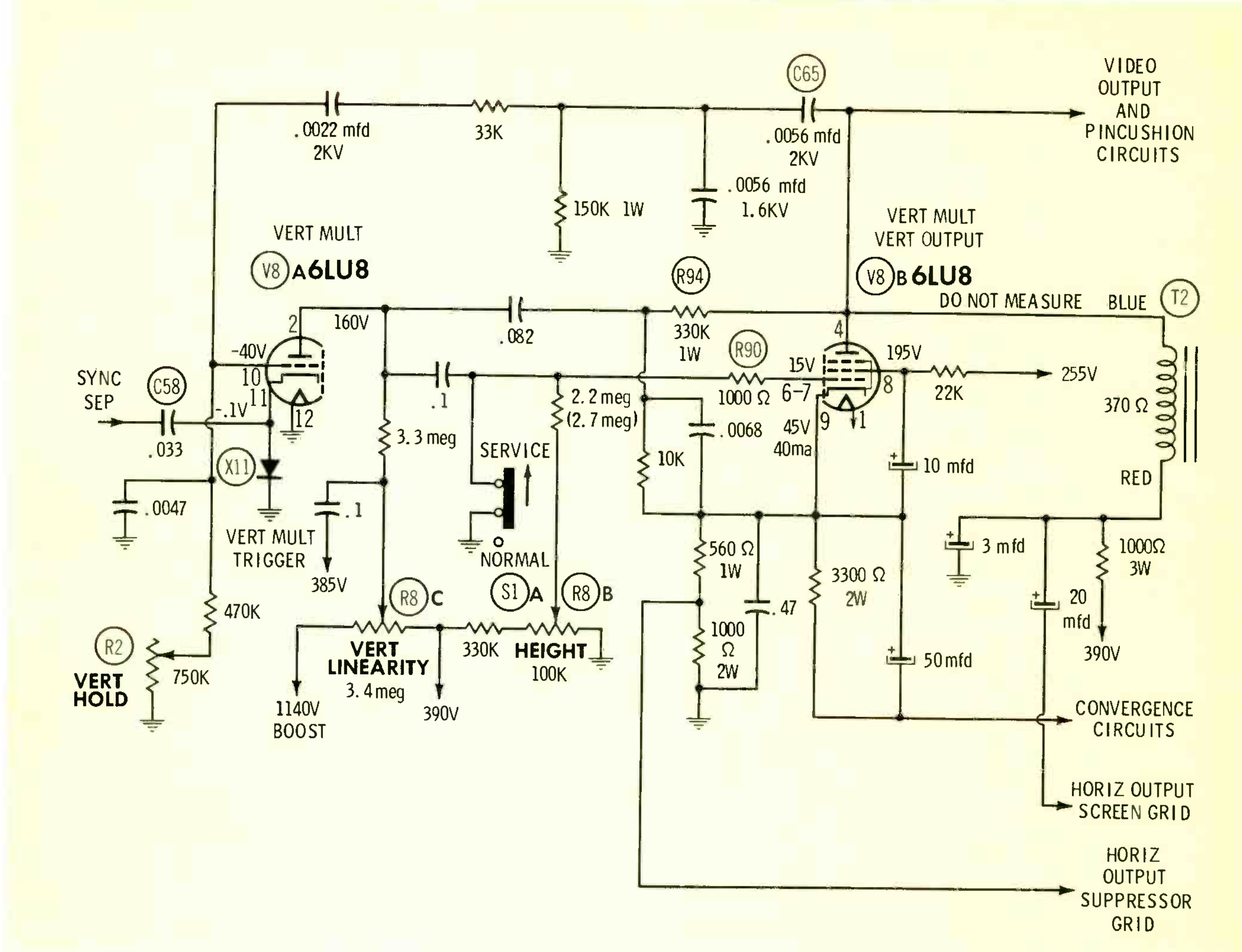


Fig. 5. Vertical multiplier trigger diode caused slow roll.

ing across X11 indicated 5 ohms. Reversing the ohmmeter leads produced the same reading. Obviously, the diode was shorted. The diode was replaced with a 1N60 type and vertical sync was restored.

When replacing trigger diodes, such as X11, be sure the positive terminal is connected to ground. If the diode is soldered in backwards, the oscillator will be cutoff and a horizontal white line will be displayed on the CRT. In other Sylvania models, this same diode has caused vertical jitter and bounce. Also, when repairing a D02 or D03 chassis, check C65. In early factory runs a 600-volt capacitor was installed in these chassis. Replace the 600-volt unit with a 2-kv type to prevent a callback.

Shrunken Raster

The symptom shown in Fig. 6 was displayed by a Motorola TS-912 chassis. From all indications, the trouble was obviously in the vertical section. Both the 4BL8 and 15CW5 vertical tubes checked good. Voltage measurements in the output stage produced no clue until the feedback circuit was checked. A reading of 167 volts on the oscillator side of C55 (Fig. 7) indicated that this capacitor was leaking. When C55 was replaced, the raster returned to normal.

Vertical Foldover

A Sylvania D03 chassis had severe vertical foldover. A burned resistor was found in the preliminary visual inspection of the chassis. The schematic showed that the burned resistor (R91, Fig. 8) was in the cathode circuit of the vertical output tube. Speculating that the tube shorted internally and burned out the 1200-ohm resistor, the technician replaced both the resistor and the tube.

When the receiver was again turned on, the new resistor started to smoke. Quickly, a few voltage measurements were taken. All voltages were normal. Remembering that large vertical coupling capacitors can produce vertical foldover problems, the technician

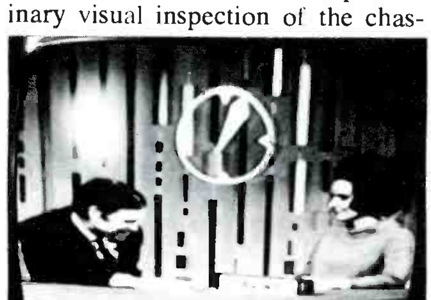


Fig. 6. Shrunken raster displayed by Motorola TS-912 chassis.

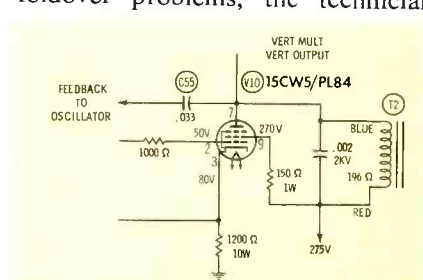


Fig. 7. Leaky capacitor in plate circuit reduced raster size.

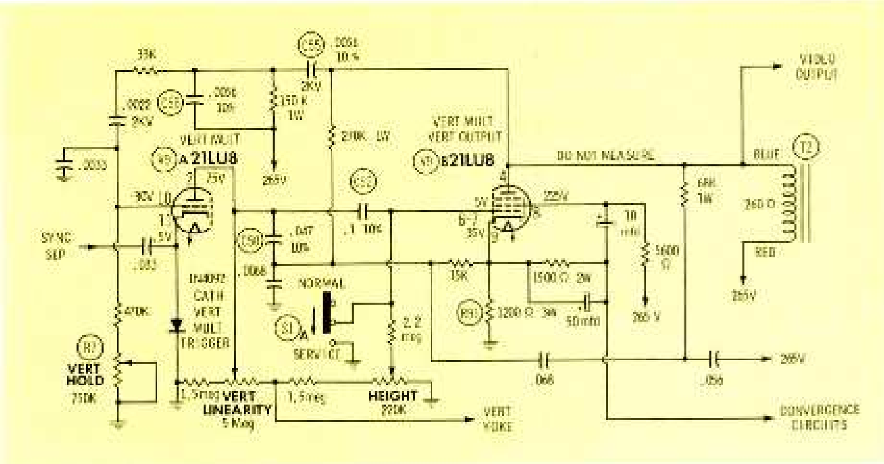


Fig. 8. Shorted C56 caused vertical foldover in Sylvania chassis.

directed his attention to C50 and C52. C52 was good, but C50 had a small leakage. However, replacing C50 had no effect on the foldover.

Feedback capacitor C55 was then checked for leakage with one lead cut loose, but checked out good. After the loose lead was resoldered, the technician found excessive voltage on the oscillator side of C55. Checking the schematic, the technician concluded that C56 leaking could produce this high voltage reading. He cut the oscillator side of C56 loose and, sure enough, there was the same high voltage reading. An ohmmeter check of C56 indicated a dead short.

Intermittent Height

The sweep problem illustrated in Fig. 9 occurred in an Admiral D11 series chassis. The defective component was C70 in Fig. 10. In this case, C70 was leaky and intermittently changed the raster height. If shorted, C70 would have killed the vertical sweep.

Jitter and Bounce

A defective feedback capacitor in RCA's CTC15 chassis will cause vertical jitter and bounce. Also, as in the previously mentioned Admiral D11 series chassis, a shorted

Fig. 9. Symptom displayed on screen of Admiral chassis.

.0082-mfd coupling capacitor in the plate circuit will kill the vertical sweep, reducing the raster to a white horizontal line. Another component common to both the Admiral and RCA chassis is C72 (Fig. 10). If leaky or shorted, this capacitor can also kill the vertical sweep completely or, at the least, reduce the height. Always replace such capacitors with a component having the same value and working-volt rating as the original.

Intermittent Roll

After the vertical hold on a Philco Chassis 17MT80 was readjusted, the raster would sometimes remain stable for up to an hour; however, it usually began to roll immediately after the customer sat down.

Voltage and scope checks of the integrater circuit and vertical multiplier failed to turn up any reason for the loss of sync. Next, attention was focused on various resistors and capacitors in the feedback circuit. C68, R95, R96, and R97 (Fig. 11) were all good. Proceeding along the feedback circuit, the trouble was isolated to C67. This

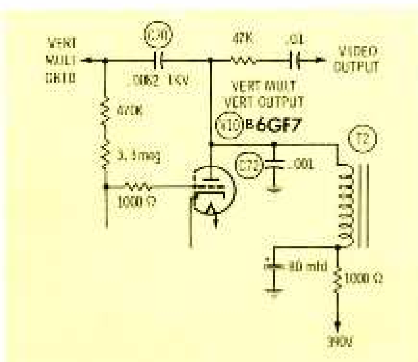


Fig. 10. Leaky capacitor in plate circuit intermittently changed height.

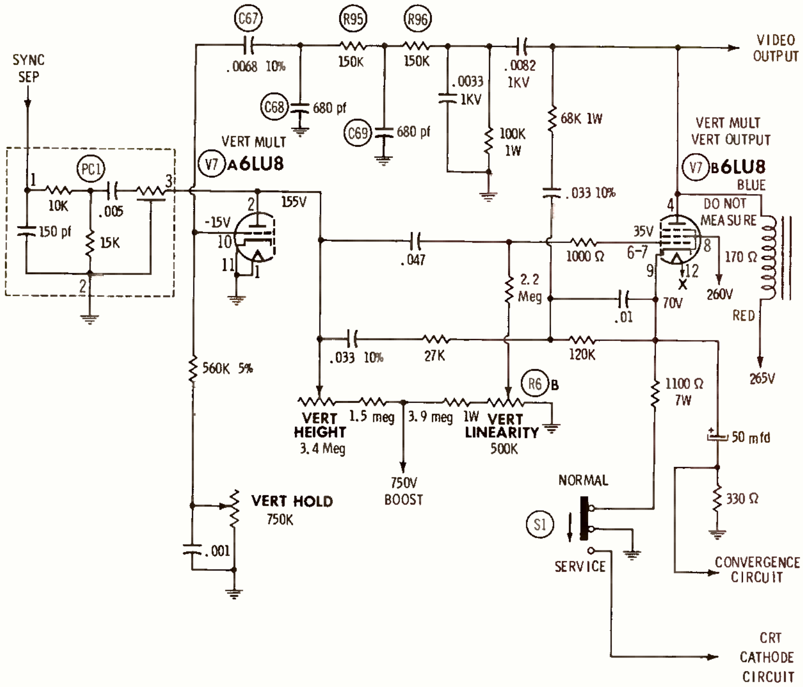


Fig. 11. Leaky feedback capacitor resulted in intermittent roll.

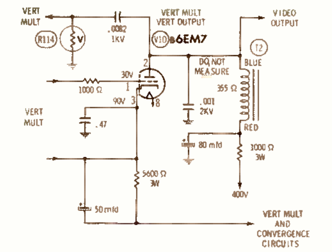
capacitor was checked in a capacitor checker and only a small leakage was evident. However, when a soldering iron was placed close to it to simulate the heat of an operating chassis, the leakage drastically increased.

Roll

Early versions of RCA chassis CTC20 are prone to roll problems, especially if the chassis is located in a fringe or difficult reception area. This tendency to roll with only the slightest provocation is caused by R92 (Fig. 12), located in the vertical oscillator grid circuit. Earlier runs of this chassis had a 470K resistor. Later, this resistor was changed to 220K for better sync stability.

VDR Causes Roll

A recent case of critical vertical hold in an Admiral 25H6 chassis was traced to a defective voltage dependent resistor (VDR), R114 in Fig. 13. Such components, find-



Fg. 13. Defective VDR causes critical vertical hold.

ing increased usage in the feedback circuits of color receivers, can cause various degrees of critical vertical hold if defective. VDR's cannot be accurately checked with an ohmmeter; therefore, substitution is the most positive check.

Top Reduced

An RCA CTC20A chassis displayed a raster that was 1" short at the top. A new 6GF7 vertical tube helped a little, but the raster was still short at the top. The only abnormal voltage reading found was on the cathode (pin 3) of V9B, the vertical output stage (Fig. 12). The 120 volts indicated at this point was double the normal cathode voltage.

From all evidence, either the output tube was drawing excessive current or C4 was leaky. After clearing both of these suspects, the resistance from pin 3 of V9B to ground was measured and found excessively high. Further measuring uncovered the fact that R105 was open. Replacing this resistor cleared up the trouble.

Conclusion

Although the preceding analysis involved ouly a few chassis makes of the many currently produced, the troubles and troubleshooting techniques discussed apply to nearly all color receivers. Although some vertical troubles are easily diagnosed and require only voltage and/or resistance readings to isolate, a great many can be solved much quicker using the scope and comparing the waveforms with those shown in the PHOTOFACT Folder for that particular receiver. After tackling and successfully servicing a few vertical problems in color chassis, you will find that they aren't as difficult as you once thought. ▲

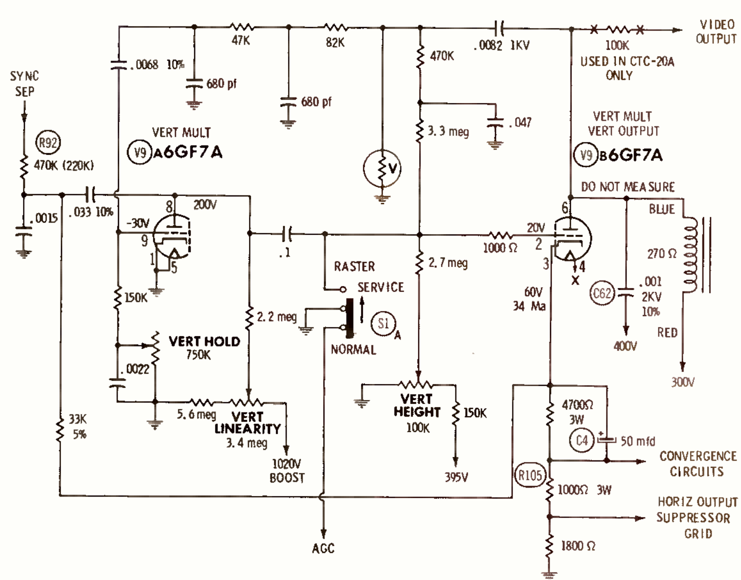


Fig. 12. Vertical circuit of RCA Chassis CTC20.

NOTES ON TEST EQUIPMENT

analysis of test instruments ...operation...applications

by T. T. Jones

Transistor Analyzer

The latest addition to the Lectrotech test equipment line is the Model TT-250 transistor checker. It performs several tests, including checking of transistors on a good-bad scale both in- and out-of-circuit, diodes for forward and reverse conduction, and low-voltage electrolytic capacitors for leakage.

The good-bad test is the feature of which Lectrotech is most proud. The circuit is shown in Fig. 2. The transistor is connected up either in- or out-of-circuit, and the meter will monitor the emitter-base current. R6 is adjusted to an arbitrary point, the bias adjust point on the meter scale. The actual point does not really matter, as we shall see. Depressing SW-3 switches the meter to read emitter-collector current. If the transistor is capable of amplification, the meter will move up-scale. For a quick check of the transistor's condition, it doesn't matter how far up-scale the transsistor moves, because circuit components will affect the current readings. Since beta in a transistor doesn't normally change with age, the fact the transistor can amplify at all indicates it is good.

If the meter moves backwards or not at all when SW-3 is depressed, it indicates that the transistor is drawing more base current than collector current, and therefore is not amplifying.

Circuit components, especially in power transistor circuits, may give "false readings." So if the transistor reads bad in circuit, the test should be repeated out-of-circuit. If, however, the TT-250 says the transistor is good, then it is. Exceptions are in RF circuits, where the transistor may check good at the 60-Hz line check, but may not be able to function at operating frequency. These latter cases are rather uncommon.

The TT-250 will also read beta on two scales; 0-250 and 0-500. This is useful for picking matched pairs in push-pull circuits.

The instrument is housed in a black crackle-finish steel cabinet and has all necessary leads and instructions packed with it—there are no "accessories at extra cost."

For further information circle 65 on literature card

Fig. 1. The Lectrotech TT-250 transistor analyzer.

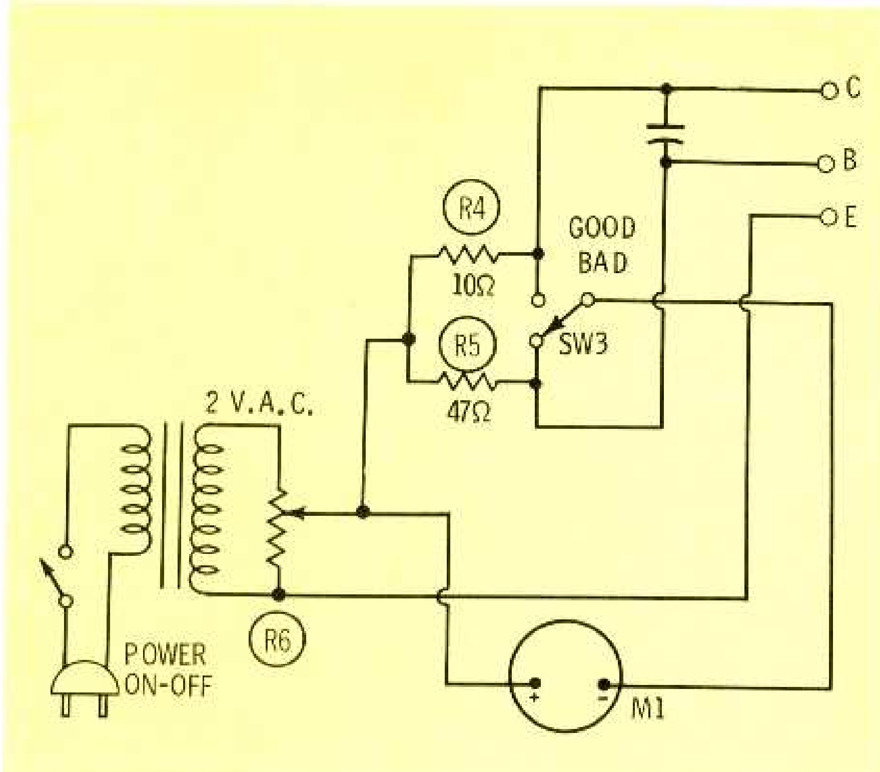


Fig. 2. Simplified schematic of the in-circuit test.

Lectrotech TT-250 Transistor Analyzer Specifications

Tests Performed:
Transistors:
Quality on a good-bad scale, in- or out-of-circuit.
Beta 0-500 in two ranges, out-of-circuit.
Leakage (I_{cbo}) 0-5000 μA, out-of-circuit.
Diodes:
Quality on a good-bad scale, in- or out-of-circuit.
Forward and reverse current @ 5.6 Volts.
Electrolytic capacitors:
Leakage current.
Leakage Test Power Supply:
5.6 V, zener-regulated.
Size: (HWD):
7" x 10" x 4½".
Weight:
5½ pounds.
Power Requirements:
115 volts, 60 Hertz.
Price:
$87.50.

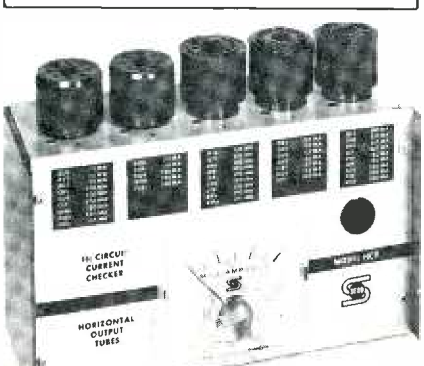


Fig. 3. HOT cathode-current checker.

Cathode Current Checker

One of the more unusual instruments released this year is Seco's Model HC8 in-circuit current checker. It's a rather simple instrument and performs but one function —it reads cathode current in horizontal output tubes.

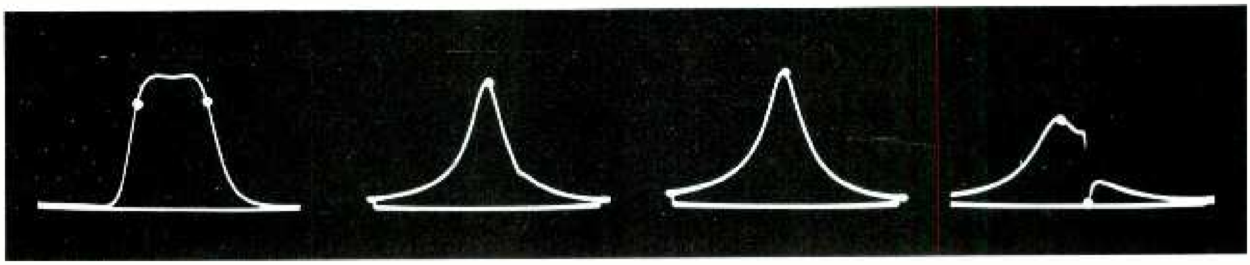
This reading is very necessary during color setups, horizontal sweep alignment, and even troubleshooting. Heretofore, in order to make the current measurement, it's been necessary to either break the cathode connection, which often means pulling the chassis, or to carry a variety of tube socket adaptors, and a VOM. And it always takes time to select the proper adaptor, hook up the VOM, etc.

The HC8 makes the job as simple as unplugging the output tube, plugging in the adaptor, and plugging in the tube. As can be seen in Fig. 3, the adaptors are numbered by tube type, and the maximum current ratings are included for each type. All popular octal, Novars, and compactrons are included.

We tried the HC8 on our own color set at home, and found that it's a real time-saver. Price is $34.50. ▲

For further information circle 66 on literature card

Circle 20 on literature card



SWEEPING COLOR IF AMPLIFIERS

by Robert F. Heaton

The video IF stages used in color television, like most of the other circuits, are going through a gradual evolution from one year to the next. Although no drastic changes have taken place in the video IF stages, there are a few important modifications you should know about to keep abreast of color servicing.

For the past few years (and the trend will probably continue) the majority of color television instruments have contained a three-stage video IF amplifier system. The typical system illustrated in Fig. 1 has three stagger-tuned video IF amplifiers and is very popular. In the arrangement shown in Fig. 1, the overall response of the IF stages is accomplished in the following manner: Three single-tuned IF transformers, adjusted for maximum gain at frequencies of 43.8MHz, 42.5-MHz, and 45.75MHz, combine to give an overall passband. Also included as part of the IF system are the mixer plate coil and the IF input transformer. This particular section, commonly referred to as the "link circuit", matches the output of the tuner to the IF strip. Usually this section includes an adjacent channel trap (47.25MHz), and often it includes a trap for the 41.25-MHz co-channel sound frequency.

Normally, this type IF system is aligned using a VTVM or sweep generator. The usual procedure is to align using the "peak" method first, then check the overall response using the sweep generator. Some technicians prefer to bypass the peak alignment in favor of the sweep alignment method. This procedure is more commonly accepted when only a touch-up alignment is needed and/or a simple check on alignment is necessary. However, if the receiver is greatly out of alignment, peak alignment should be done first, followed by the overall response check.

In perhaps the past three years, alignment as a troubleshooting aid has gained in popularity. The response curves (consult the individual service data for each particular chassis) provide a convenient method to check the individual IF stages — independent of one an-

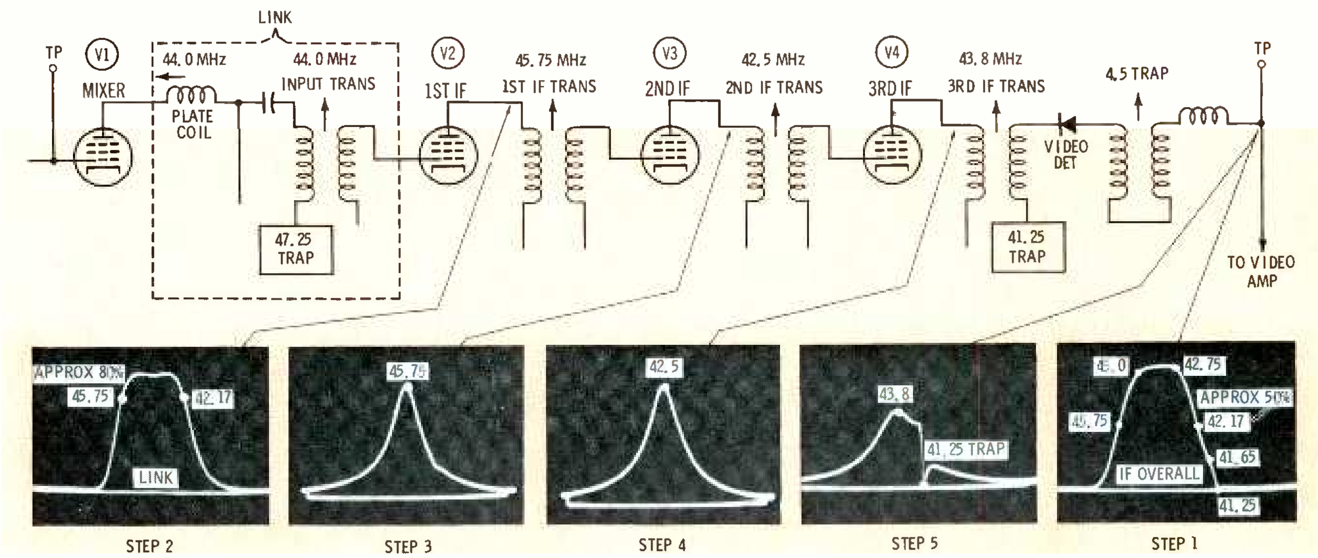


Fig. 1. Simplified stager-tuned IF system with sweep responses.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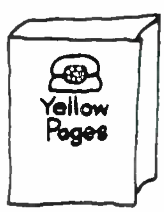

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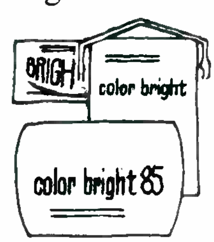

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other. "Tough-dog" troubles such as smear, loss of resolution, ghosts, and/or ringing, are often hard to isolate to one particular stage using normal voltage and resistance checks. These symptoms are usually caused by improper alignment due to poor procedures by the previous technician servicing the chassis, damage to some circuit area caused by overheating (or some other reason), and/or normal aging and drift in the tuned circuits. Take for example a receiver with symptoms of smear or poor resolution — often time consuming to isolate. It would be convenient to connect a sweep generator and look at the individual response of each IF stage shown in Fig. 1, to quickly pinpoint which stage is defective. All that's needed are a good sweep generator, marker generator, VTVM, oscilloscope, and a procedure. Often overlooked, and sometimes the reason many technicians dread alignment setup, are the matching pads necessary to facilitate alignment and make it simple.

There are two very important accessory pads that should be constructed by the technician previous to starting any alignment job. These are an input pad, for connection of the sweep generator to the receiver circuits, and a detector pad to facilitate viewing the response in the IF and link circuits. The two pads shown in Figs. 2 and 3 are typical of those that can be used with most sweep generators. However, if the manufacturer of the test gear you own suggests a different pad, it should be used. The matching pad shown in Fig. 2 should be constructed using miniclips or braided

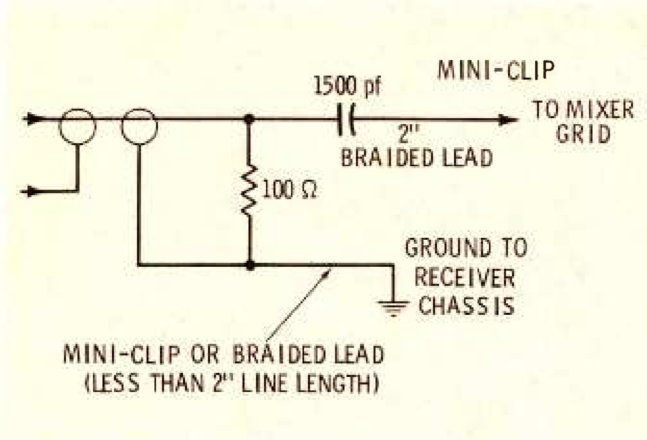


Fig. 2. Schematic of matching pad.

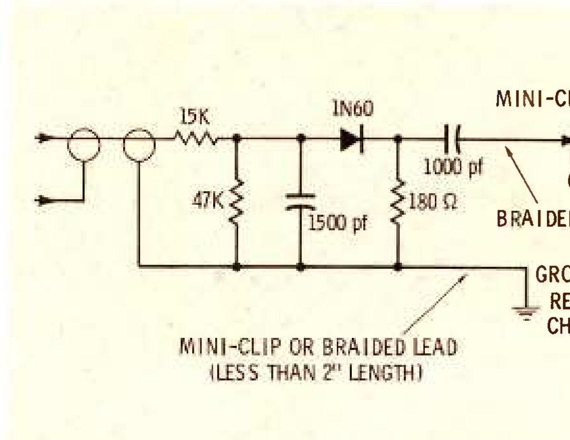
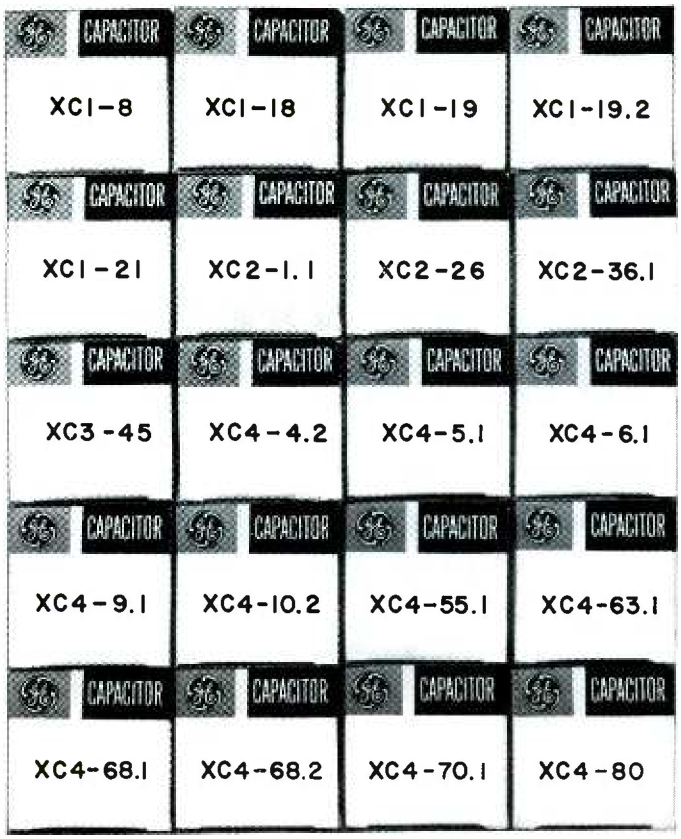


Fig. 3. Schemotic of detector probe.



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NO UHF		CS-V3 $10.95	CS-V5 $17.50 / CS-V7 $24.95	CS-V10 $35.95	CS-V15 $48.50 / CS-V18 $56.50
UHF SIGNAL STRONG	CS-U1 $9.95	CS-A1 $18.95	CS-B1 $29.95	CS-C1 $43.95	CS-C1 $43.95
UHF SIGNAL WEAK	CS-U2 $14.95	CS-A2 $22.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95
UHF SIGNAL VERY WEAK	CS-U3 $21.95	CS-A3 $30.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95

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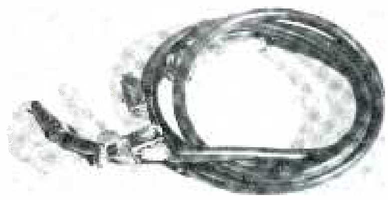

Fig. 4. Home-built matching pad.

lead for both the ground and the hot leads. A value of 1500pf is nominal for the capacitor which is used for insertion of a signal into the mixer grid circuits of most VHF tuners, and into the grid circuits of most IF amplifiers. The value of the shunt resistor, in this instance 100Ω, should be the value specified for termination of your particular sweep generator. Particular attention should be paid to the ground lead on any test pad. The ground lead, to be a true RF ground, should not exceed a length of 2 inches. A 1-inch clip lead in lieu of the braided wire would be better still. As shown in the drawing, the length of the "hot" lead should also be kept to a minimum. Illustrated in Fig. 3 is a common-type detector probe that can be used to view the response at the plates of the IF stages, where signal detection is needed. Again, the cardinal rule is to keep the ground and hot leads as short as possible.

The photographs in Figs. 4 and 5 illustrate construction of the two pads, using small terminal boards. Notice that to facilitate alignment, the cable has already been connected to the pad. Also needed is a pad to "load" the circuits in the IF stages to prevent them from interfering with the response. Such a pad, acceptable in most IF circuits, is

Fig. 5. Typical detector probe.

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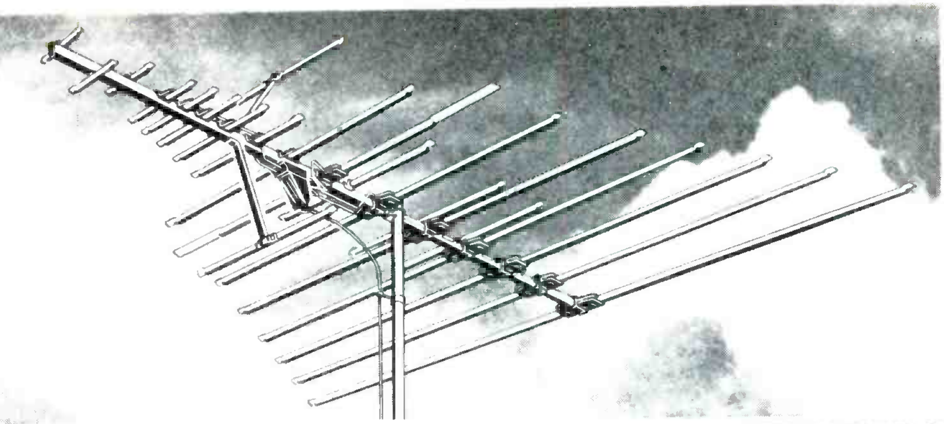

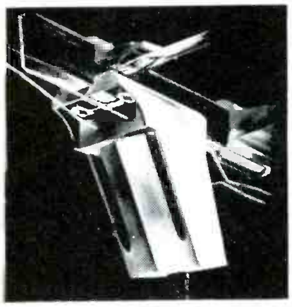

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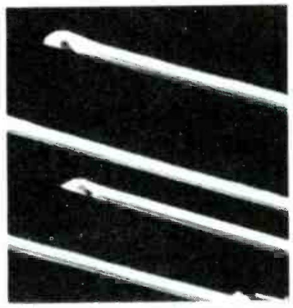

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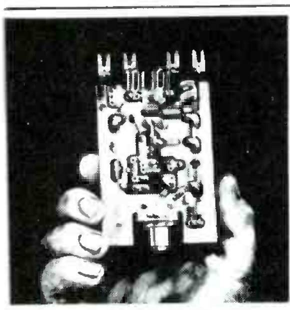

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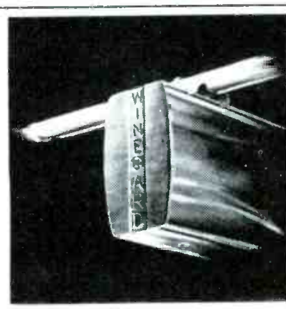
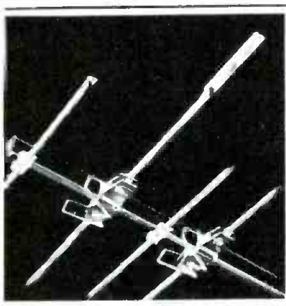
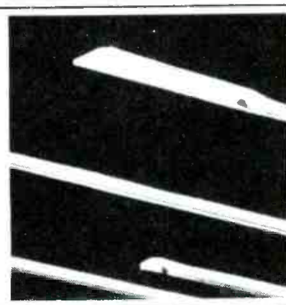


Ellipsoidal Boom—the only aluminum shape engineered especially for antenna use; proved far stronger than any other boom design.

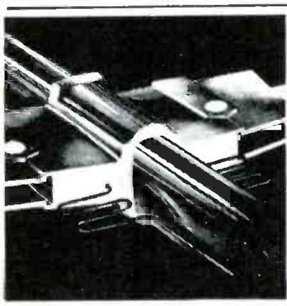


Electro-Lens* Director System—patented system absorbs entire signal and focuses it directly onto driven elements for pinpoint directivity.

*U. S. Patent No. 2700105
Canada No. 511984

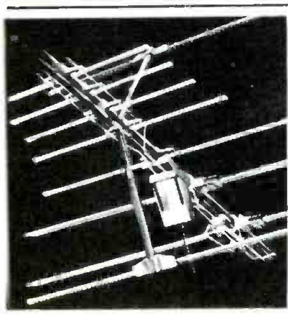


FM Control Element—provide exceptionally high gain on FM bands and provide for the attenuation of FM bands in areas where strong FM signals interfere with tv reception.

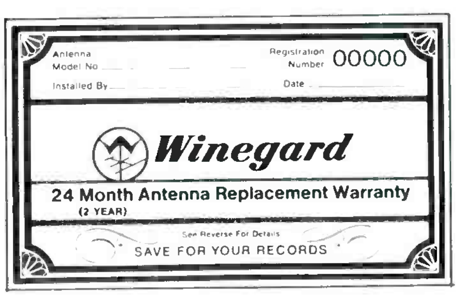


Impedance Correlators—patented correlators automatically increase 75 ohm driven elements to 300 ohms to provide 100% signal transfer from antenna to set.

CS-285 Band Separator (with printed circuit)—comes at no additional cost with all 82 channel Super Colortrons to separate UHF and VHF signals. Attaches easily to terminals on back of set.



Vertical Resonant Reflectors—UHF reflectors achieve highest realizable gain on channels 14 to 83 because of exceptionally large vertical capture area; more UHF gain than any other 82-channel design.



2-Year Antenna Replacement Warranty—the only antenna in the industry that gives your customer a 2-year replacement privilege.

Circle 26 on literature card

shown in Fig. 6. Construction is simple and lead length is not really critical.

The Stagger-Tuned System

As stated previously, some technicians prefer to use peak alignment for a stagger-tuned system, then check the overall sweep response. This is a perfectly sound method. However, for troubleshooting the system—particularly the individual and/or combined stages—sweeping the stages is the best approach. The indication on the VTVM during peak alignment does not give a complete analysis of the tuned circuit that is being checked. On the other hand, viewing the sweep response of a stage gives a visual representation not only of gain, but of the frequency to which the tuned circuit responds. Let's develop a fast procedure to troubleshoot the stagger-tuned system using sweep alignment.

Assume for example, we have poor black-and-white resolution or smear on the screen. Or the black-and-white response seems to be acceptable, but the color response is less than desirable, with noise and/or color smear. We'll assume the color stages are operating normally for both the examples, and concentrate on problems in the IF stage.

As illustrated in Fig. 1, the overall response at the video detector depends on the combined responses of the individual stages of V2, V3, V4, and the input link circuit. The first approach, naturally, is to connect a sweep input to the test point at the mixer grid circuit. Our sweep input signal should be in the 45.0-MHz video IF range, with approximately 6-MHz sweep width.

Step 1: Apply RF and IF bias and connect an oscilloscope to the video detector test point, following the instructions given in service data for the particular color chassis. In this step, we are looking at the overall IF response from the mixer grid to the video detector at the tuned circuits in between these two points. The response should appear as shown in the waveform (Step 1) Fig. 1.

Two key markers are shown on this particular waveform, those for 45.75 MHz (the picture carrier) and 42.17 MHz (the color carrier). In the typical color receiver, these carrier frequencies are located at approximately 50% on the response curve. (Check the appropriate service data for the instrument you are servicing, as the response positions do vary between manufacturers of different color chassis.) If these two frequencies are located at their proper positions on the curve, chances are the receiver is in alignment, and the problem is being caused by the trouble in the video amplifier and/or output stages. If an improper waveform is obtained at this point, it will be necessary to sweep the individual sections looking at their individual response.

Go on to step 2. (Author's note: The order of the following steps

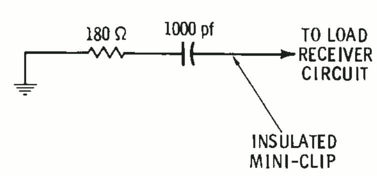


Fig. 6. Schematic of IF load.

(sweeping the individual stages) can be reversed if desired by the technician. The same results are obtained using the sweep alignment sequence from front to rear or from rear to front.)

Step 2: This step involves checking to see if the defective overall response is being caused by a defect in the link circuitry. Leave all connections as for the previous step with sweep input to the mixer grid. However, connect the oscilloscope through a *detector probe* (shown in Fig. 3) to the plate of the first IF amplifier. Due to the loss of the IF gain it will be necessary to increase the output of the sweep generator. However, do not overload the circuit, and make sure IF and RF bias is applied. In some instances it may be necessary to lower the bias voltages. To view the link response it will be necessary to shunt the plate of the second IF amplifier with a load, to swamp the latter's response. An acceptable load, consisting of a 180-ohm resistor and a 1000-pf capacitor, is shown in Fig. 6.

Now using our typical link response curve or that shown on the service data for the particular chassis, check for position of the key markers. These markers will be located on the upper slope of the response curve. If the markers are out of position, try adjusting the mixer plate coil and the input transformer to see if they respond as they should.

If any trap circuits are located in the circuit it will be necessary to see if they are causing interference with the response. They may be tuned to the wrong frequency, or be defective; they are included as part of the link and will affect the response. A simple check that usually is sufficient is to place your fingers around the trap coils and see if this causes a drastic shift in the response. This usually reveals if traps are interfering.

If the proper response is obtained in this step, our trouble must exist in the remaining IF circuits. Naturally, if the link circuit will not align properly, then trouble exists in that particular section. It should be noticed at this time, that the response of the link is similar to that found in double-tuned and/or overcoupled transformer responses. This is in contrast to the response found when the individual tuned stages are checked with a generator.

Step 3: Sweeping the first IF stage to check the action of the plate transformer is fairly simple to accomplish. Using the same pad, move the sweep input to the grid of the first IF amplifier. Connect the scope via the detector pad to the plate of the second IF amplifier. So connected, we are equipped to view the individual response of the first IF stage, including V2 and the plate transformer. The result here should be a sharply peaked curve with the 45.75-MHz marker appearing at the approximate center location on the upper response.

A check on transformer action can be made by adjusting the transformer to see if the 45.75-MHz marker can be positioned on the peak of the response curve. If this action is successful, chances are the first IF stage is operating normally. Again, it may be necessary to adjust the IF bias voltage to obtain a usable response.

Step 4: The procedure used to check the second IF stage is identical to that used for checking the first IF stage—on an independent basis. The procedure involves moving the sweep input to the grid of V3, and moving the scope via the detector probe to the plate of V4. In this step, look for a response with a peak frequency in the neighborhood of 42.5 MHz. Adjust the second IF transformer to see if the marker responds to adjustment and can be peaked on frequency.

Step 5: If all stages and responses are normal up to this point, it will be necessary to check the third IF response as shown in the waveform in step 5. Move the sweep input to the grid of V4 and connect the oscilloscope (this time via a *direct probe*) to the video detector test point. We are now sweeping the individual third IF stage and viewing the response at the video detector.

As a check on the action of the third IF transformer, attempt to adjust the transformer and see if 43.8 MHz can be placed approximately at the tip of the response curve. The sharp slope on the right side of the waveform is caused by action of the 41.25-MHz trap.

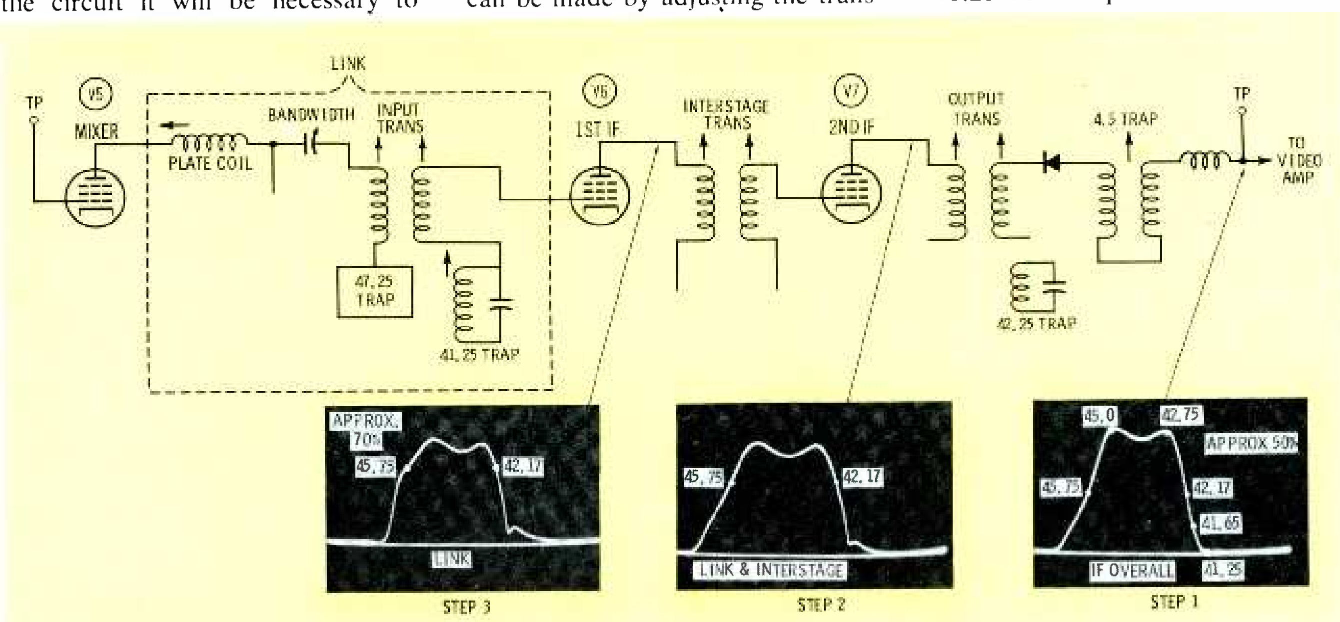


Fig. 7. Simplified double-tuned IF system with sweep responses.

As mentioned previously, the sequence of steps can be reversed, switched, and/or altered to the technician's own choice. If any adjustment fails to produce a reaction on the response curve during the response checks, or the particular frequencies shown on the curves cannot be positioned close to their respective points on the curve, then look for trouble in that stage not responding. On the other hand if all stages *do* respond, and the IF overall response is still improper, it will be necessary to troubleshoot in the RF tuner input circuits. These can also be checked using the sweep method. But in this instance it will be necessary to connect the sweep input to the antenna terminals, and check the overall response at the RF/IF video detector.

Some color instruments may also include one double-tuned IF stage, and it will usually be the third IF stage. Checking the individual stage is still accomplished by sweeping the grid of the third video IF amplifier, and scoping at the video detector test point. However, the response obtained with the overcoupled transformer should approach a "saddle" curve shape.

Double-Tuned, Two-IF System

Contrast the three-IF, stagger-tuned system just discussed, with the double-tuned system having two IF amplifier stages. This particular IF system, first used in the RCA Victor CTC 19 color chassis, depends on a tuned link and double-tuned interstage and output stages to obtain the correct response for color bandpass. In this system, there are a few adjustments that may be quite new or unfamiliar to many technicians, although they should not be unfamiliar to older service technicians. In previous years, a similar system of double-tuned transformers was utilized in black-and-white instruments.

Particular attention should be given to the bandwidth adjustment in the IF input circuit. This is a trimmer capacitor which is adjusted to give the nominal bandwidth to the overall response; adjustment has quite an effect on the response throughout the system. Usually, the bandwidth trimmer adjustment is the final step in the alignment procedure of this IF system.

Notice the similarity in the overall response of the double-tuned system, versus the stagger tuned system in Fig. 1. The responses at the video detector are basically identical, in that the picture carrier and the color carrier are both located at the 50% point on the slope of the curve.

Particular attention should be noted that in the double-tuned system, a similar response is obtained throughout the complete system. That is, the link response, the link-

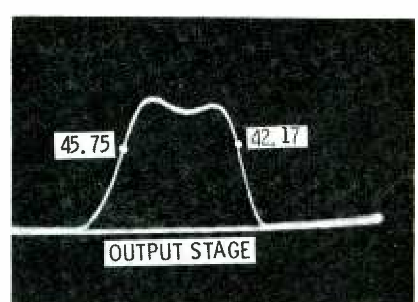


Fig. 8. Output stage response.

plus-the-interstage response, and the IF overall have a common appearance—the "saddle" response. In this particular system, as in all color instruments, one of the most important circuits to be adjusted is the input link circuit. Whether alignment is being used as a troubleshooting aid, or the instrument is actually being realigned, it is very important to the overall response of the instrument that the link be aligned correctly.

Troubleshooting The Double-Tuned IF System

The signal tracing procedure described for the stagger-tuned system is also adaptable for double-tuned amplifiers. In fact, this type system is much simpler to check. The procedure is basically the same, since the stages can be checked in a combined or individual basis.

Step 1: Follow the instructions given in the service data for the particular chassis being serviced, for the preliminary steps. The same pads and loads that we used in the previous method are also applicable for use in the double-tuned system.

The same IF sweep signal in the 45.0-MHz range is coupled to the mixer grid test point. The scope, via a direct probe, is then connected to the output of the video detector. In this step, we are checking the overall response of the IF amplifier stages from the mixer grid to the video detector. The response should appear as shown in the waveform of step 1, (Fig. 7) with the 45.75-MHz and 42.17-MHz markers at approximately 50% on the response curve. If an improper response curve is obtained, do not make any adjustments at this time. Instead, perform the following:

Step 2: Connect the scope to the plate of V7 via the detector probe. The sweep input is left at the mixer grid. In this step, we are using the signal tracing method by using one common input to the mixer grid, while checking the response of the combined stages. Scoping at the plate of V7 will reveal the response shown under Step 2. This is the combined response of the link plus the interstage circuits.

At this time, we are omitting the output stage, viewing only the combined response of the link plus interstage transformer circuitry. (It is not necessary during this procedure to load any of the IF circuits while checking the others.) If a proper response is obtained, then the trouble is in the output stage. In this step, the marker should be positioned at approximately the 70 to 80% point and most important, they should be equal. If any improper response is obtained then the trouble is isolated to the link or interstage circuit. Go on to step 3.

Step 3: The next simple check is to move the detector probe to the plate of the first IF amplifier, to view the link response. Notice that at no time have we made any adjustments to any of the coils associated with the circuits. We're merely trying to isolate the trouble to one or two major areas. If a proper link response is obtained with the markers positioned at approximately the 45.75-MHz and 42.17-MHz positions, then the circuits from the grid of the mixer to the video detector are in good alignment—suggesting possible trouble in the tuner RF stage. If a good link response cannot be obtained, then naturally trouble exists in the mixer plate, the bandwidth, the input grid circuit, and/or its associated traps.

Although it's often not necessary to sweep the individual stages, this can be accomplished very simply.

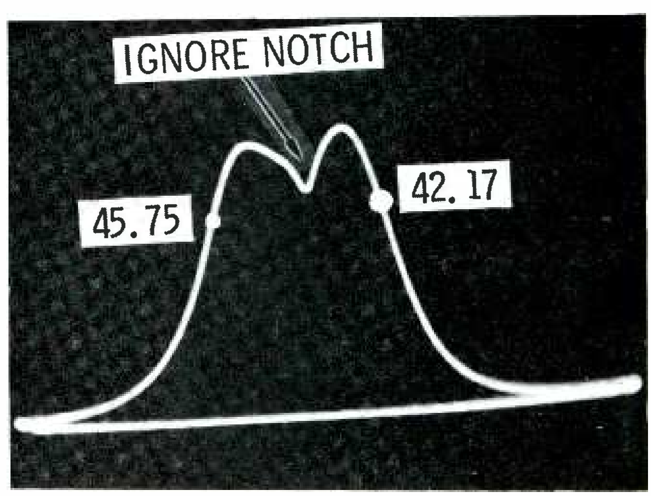


Fig. 9. Interstage response curve.

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For example, we might desire to sweep the output stage independent of the other stages. This is accomplished by connecting the video sweep via the input pad to the grid of V7. The scope is conncted to the video detector test point. The double-tuned response is illustrated in Fig. 8 should be obtained, with the markers positioned as shown.

Individually sweeping the interstage follows a similar pattern: Connect the sweep input to the grid of V6, and connect the scope via the detector pad to the plate of V7. The interstage response as shown in Fig. 9 should appear on the scope. The "notch" is caused by absorption in the input grid circuit, and should be ignored.

The link response is viewed in a similar manner by connecting the sweep input to the mixer grid test point and connecting the scope, via the detector probe, to the plate of V6. This waveform is illustrated in Fig. 10. If so desired, this simple procedure can be reversed. The scope remains connected to the video detector test point and the sweep generator is removed from the mixer grid to the grid of V6 and then to the grid of V7. Using this procedure, we are viewing the response of the overall IF, then the interstage plus the output stage, then the output stage.

Summary

Troubleshooting color chassis for lack of resolution, smear, ringing, and other symptoms of misalignment is facilitated by sweeping the overall and then the individual stage that is causing the problem.

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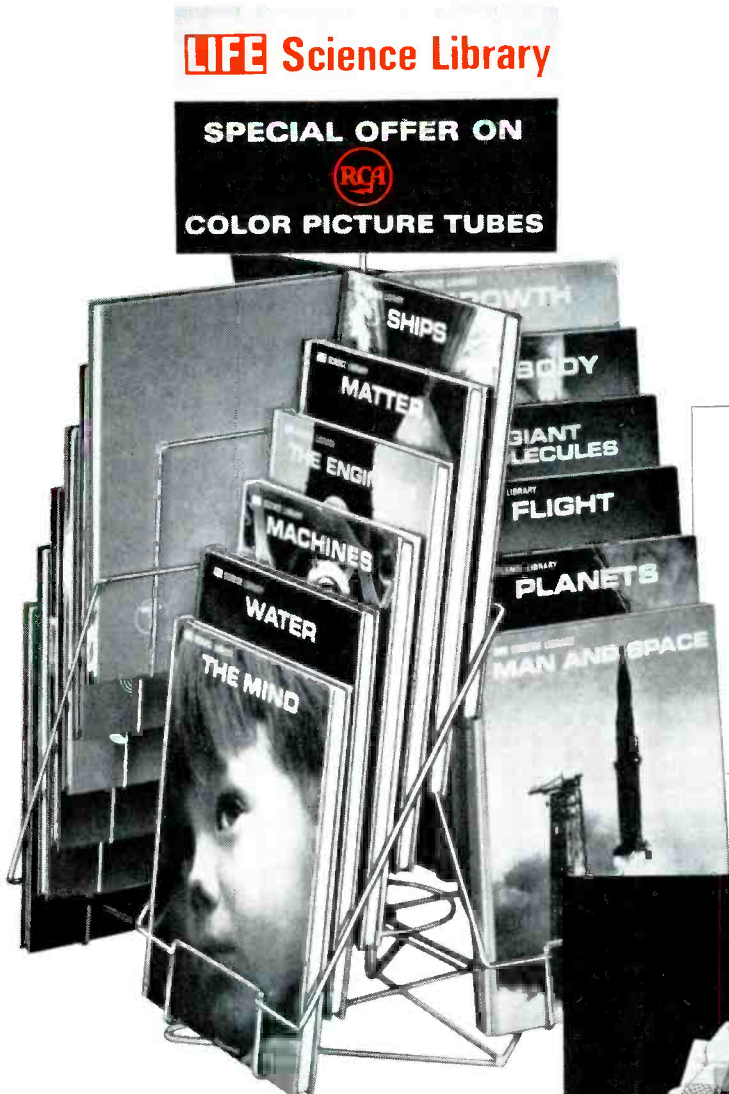

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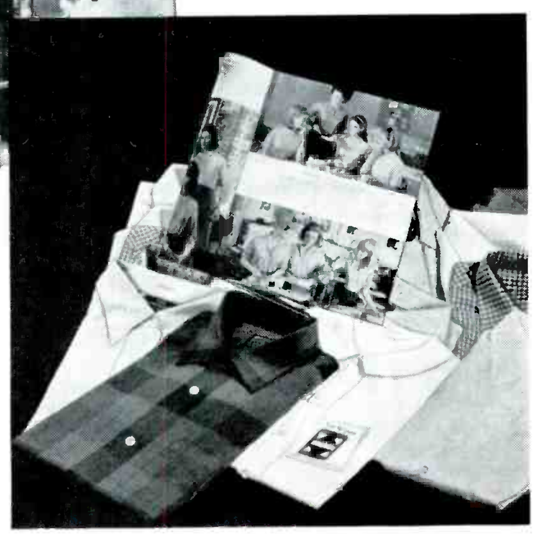

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In the stagger-tuned IF system, the response of the individual stages can be viewed independent of the other stages. It's not a good idea to depend on the visual DC indication from a VTVM to check the action or adjustment in the IF stage.. Once RF and IF bias and test equipment are adjusted properly, it's a simple matter to run a complete check on the individual stages.

A similar method can be used for checking a double-tuned IF system. However, it should be remembered that peak alignment cannot be used with the double tuned system, and that each of the stages in this type arrangement should reproduce a double-tuned or saddled response.

Also, it should be remembered that service data for the particular chassis you're servicing should be consulted for the proper overall alignment. If the system is stagger-tuned, look for a peak response at particular frequencies of the individual stages. This will indicate which adjustment should position that particular frequency at the maximum gain point of the curve.

A word of caution regarding the double-tuned system: alignment requires that the stages be checked on both an individual and a combined basis while adjustments are being made. There is a 'pitfall" in that it is possible to misadjust the double-tuned system easier than the stagger-tuned system. For example, the interstage transformer can be adjusted to compensate for an error which may exist in the alignment of the output transformer. It is best to select a starting point, and use a particular sequence during alignment of a double-tuned system.

One of the best ways to become acquainted with the alignment of a color television instrument, is to investigate the service schematic to see which type system is used, and read the alignment instructions in an attempt to get an overall view of the system and what its response should approach. You'll find your servicing and your troublshooting jobs much easier. ▲

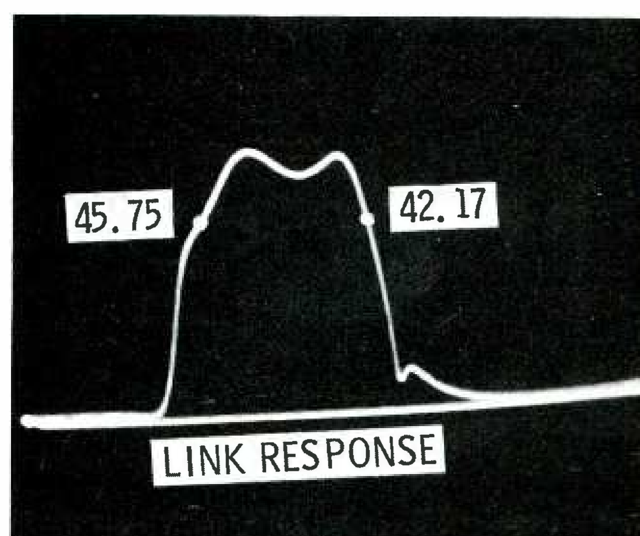


Fig. 10. Response curve of the link.

THE TROUBLE-SHOOTER

Weak Horizontal

I have several 23-inch RCA color sets which go into horizontal lines on station breaks. I have not been able to correct this, and wonder if you have any information on a possible cure? CTC25X is the chassis I am having trouble with.

ART WHEELER

Melrose, Fla.

We understand that a few of the earliest models of CTC25X were manufactured with a horizontal AFC diode which had a higher than normal failure rate. These diodes were physically different than the normal plastic-encapsulated diodes. If these are present in your problem sets, replace them with RCA part No. 10974 or equivalent.

Hot Cabinet

I have a Zenith Model Z1511BUZ which originally had vertical troubles. After repairing the chassis and returning it to cabinet, I found 100VAC present on the cabinet. I removed the chassis and found the same voltage present on the chassis. I've checked all the wiring and can find no reason for the problem. What can I do to eliminate it?

FRANK MCADAMS

Jacksonville, Fla.

The Zenith Z1511BUZ is a "Hot Chassis" set. There is a caution note (here reproduced) on the first page of the PHOTOFACT Folder for this set.

The mounting screws between cabinet and chassis should be insulated. A common cause of "hot cabinets" is the use of a cabinet screw which is longer than the original and which may touch the internal wiring or the chassis. Another common cause is improper lead dress, such as shielded cables etc. If, for instance, the shielded cable to the volume control should touch the cabinet, then the cabinet would be at chassis potential.

CAUTION

ONE SIDE OF AC LINE CONNECTED TO CHASSIS

Care should be exercised when connecting test equipment or physically contacting the chassis.

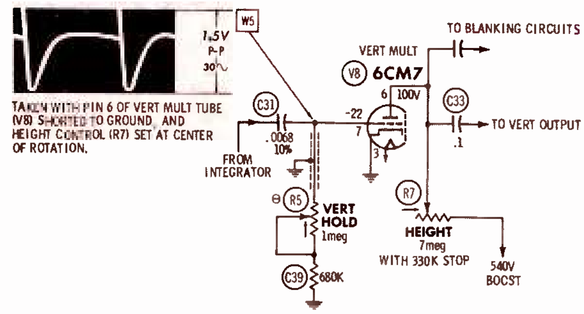
Weak Vertical Sync

I have a Sears Model 9156B which has weak vertical sync. The vertical will not lock in for any length of time. The vertical blanking bar shows that the sync is not lost in the IF's, though there is a slight pull to the left at the top of the equalizing pulses.

Scope pictures show that all seems normal in the vertical circuits, except for W5. I did not try to measure W5, as I do not understand how I can short the plate to ground without cooking something.

FRED BERNAS

Latrobe, Pa.



It is essential that you measure W5 in this instance, since it is the output of the vertical sync integrator. If this waveform is in error look for trouble in the vertical stages, or possibly in the power supply feeding the vertical stages. Do not be afraid to short the plate to ground when making this measurement; by Ohm's law computation, the power consumed by the height control will be less than .09 watts.

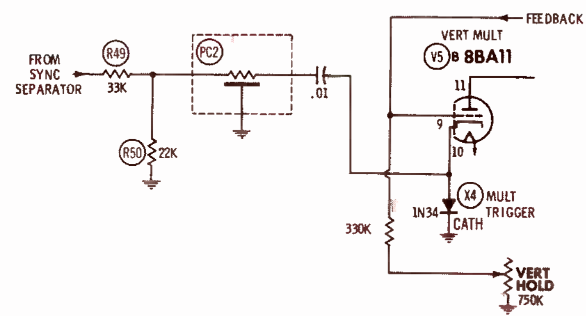
The pull you notice in the blanking bar indicates that the horizontal sweep circuits are slightly out of alignment.

More Weak Sync

Please help out a loyal Sams fan. My Zenith Chassis 14N33 has critical vertical sync. Retrace lines are also a problem, since I must tune the vertical hold almost to the rolling point to tune out the lines.

CHARLES H. PATTEN

St. Louis, Mo.



Weak vertical sync in the 14N33 chassis may be cured by two slight changes: (1) Substitute a Zenith part No. 103-51 for X4. (2) Reverse R49 and R50 so that the signal passes through the 22k resistor and the 33k resistor is grounded.

These changes should help the retrace lines; if not there may be some difficulty in the blanking circuits. ▲

Scanner *(Continued from page 11)*

Statistics Pinpoint Import Penetration of U.S. Market

The **Electronic Industries Association's** Marketing Services Department published total United States market statistics for consumer electronic products for the first six months of 1967. The "total market" is defined as domestic factory sales, plus foreign-brand imports, plus U.S.-brand imports. Covering radios, television receivers, phonographs, and tape equipment, the report pinpoints import penetration in the major consumer electronic product categories.

Total U.S. sales of radios for the first half of 1967 amounted to 17.8 million units, EIA reported, of which 7.7 million (43%) were U.S.-produced. In addition, 1.7 million sets (8% of the total) came into the country bearing U.S. company trademarks. Thus, American producers accounted for about 52% of the U.S. radio market in the first half of 1967.

Television set sales for the period amounted to 5.1 million units, 86% of which were U.S.-produced. Adding the 320,000 sets (6% of the total) imported under U.S. brands indicates that "direct" import penetration in the U.S. television market amounted to only 7% of the total, or 360,000 units.

Likewise, in the phonograph market, U.S.-manufactured machines accounted for a large majority (70%) of the January-June 1967 U.S. sales. U.S.-brand imports constituted an additional 6% of sales, leaving about a quarter of the market (about 582,000 units) to foreign producers.

Home magnetic tape equipment, traditionally an area of strong importer influence, showed factory sales of 427,564 U.S.-produced machines, well over 40% of the estimated one million units making up the first-half market. U.S. brands took another 17% of total sales, with 184,000 units.

NATESA Awards

Philco-Ford has received the "Friends of Service" Award from the National Alliance of Television and Electronic Service Associations (NATESA) for the seventh straight year.

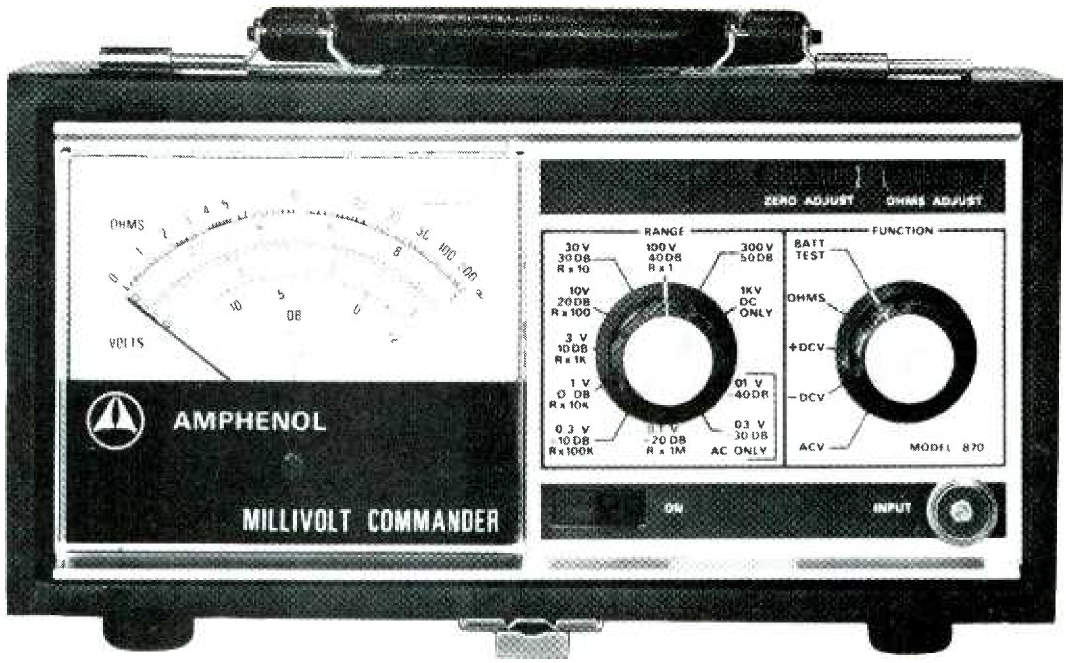
The award, in the form of a plaque, is presented annually by NATESA in recognition of outstanding service in creating better customer relations.

The latest Philco-Ford award was presented at the recent NATESA directors conference in Detroit. The plaque was accepted by Stephen Zaher, parts and accessories representative.

The 1967 award was also presented to **Howard W. Sams & Company.** NATESA president Clyde Ellis presented the award to William D. Renner, vice-president of Sams and director of Sams Technical Institute. This is the 14th consecutive year the Sams Company has earned the "Friends of Service" award.

Color Comes To Germany

Color television in Germany had its official premiere in West Berlin, at the 25th annual German Radio-Television Exposition, Aug. 25-Sept. 3. The greater portion of the initial color programs originated directly from the exhibition area on the landscaped grounds



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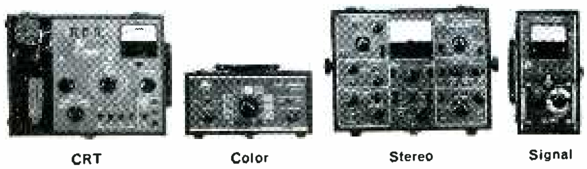
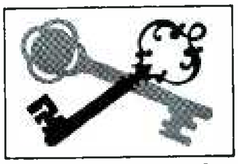
Take advantage of this limited offer. Buy a Millivolt Commander today. Same $5 test offer applies to the Color Commander, CRT Commander, Stereo Commander and Signal Commander, too.





A Keyman Tool

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Circle 36 on literature card

"King of the hill"

Keep on top of your solid-state replacements . . . with RCA "Top-Of-The-Line" SK-Series. They make up just a handful of types—17 transistors, 2 rectifiers, and 2 integrated circuits. Together these 21 RCA SK-Series types can keep you ahead of 9,000 solid-state replacements in entertainment-type equipment. Designed especially for this purpose, you'll find these devices useful in line-operated and battery-operated radios, phonographs, tape recorders, TV receivers, AF amplifiers, and automobile radios.

RCA SK-Series transistors and rectifiers and the 9,000 types they replace are cross-referenced in the RCA Solid-State Replacement Guide. It's a handy booklet listing comparably-rated types including industry standard EIA types, foreign types, and those identified only by device manufacturers' or equipment manufacturers' parts numbers.

Check with your RCA Distributor. He stocks the complete line in either cartons or see-through display packs. Also, pick-up your copy of the RCA Replacement Guide SPD-2(2-D available through your RCA Distributor.

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dominated by the city's 492-foot radio tower. The ten-day event was of equal importance to the eleven other West European countries (including Britain) that have agreed to adopt the German PAL system for color TV developed by Dr. Walter Bruch of the AEG-Telefunken Laboratories. Even when France and the East Bloc countries headed by the Soviet Union use the alternative SECAM system, a "transcoder" also invented by Bruch will enable PAL sets to receive relayed SECAM programs, and vice versa.

In addition to more than 30 models of the new color television receivers, and color TV studios at work in full view of the public, this year's Show featured also the latest developments in radio, as well as hi-fi and stereo components produced by some 150 German firms of which 30 are located in Berlin itself. ▲

COLOR COUNTERMEASURES

SYMPTOMS AND TIPS FROM ACTUAL SHOP EXPERIENCE

Chassis: RCA CTC24

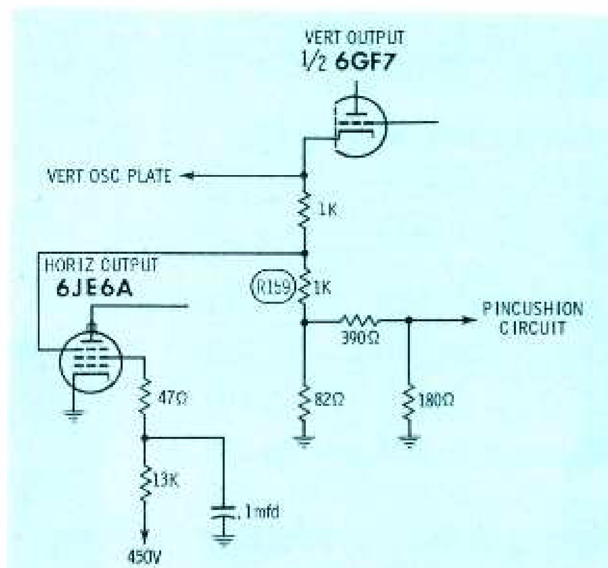
Symptoms: Vertical jitter.

Tip: The cause of jitter in several of these chassis has been traced to a defective horizontal output tube. The suppressor grid of this tube is returned to the vertical circuit; voltage fluxuation on the suppressor grid (due to bad tube) causes interference to vertical stage, producing jitters. Horizontal deflection operates normally.

Chassis: RCA CTC24

Symptoms: Loss of height.

Tip: Before making routine checks throughout vertical circuit, check condition of R159 in suppressor grid circuit of horizontal output stage .R159 (1K, 2W) is also connected to cathode circuit of vertical output tube. Change in value causes loss of height.



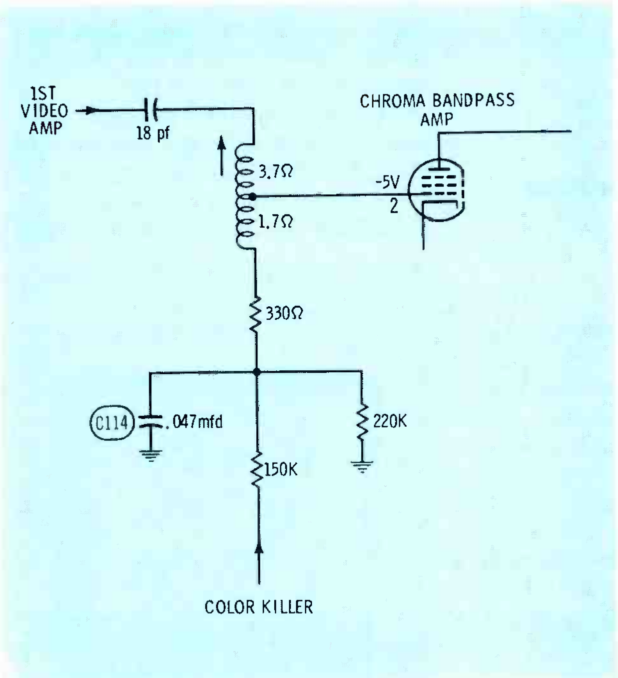
Chassis: RCA CTC12, 15

Symptoms: Intermittent or complete loss of color; one predominate color strip may appear on left side of screen.

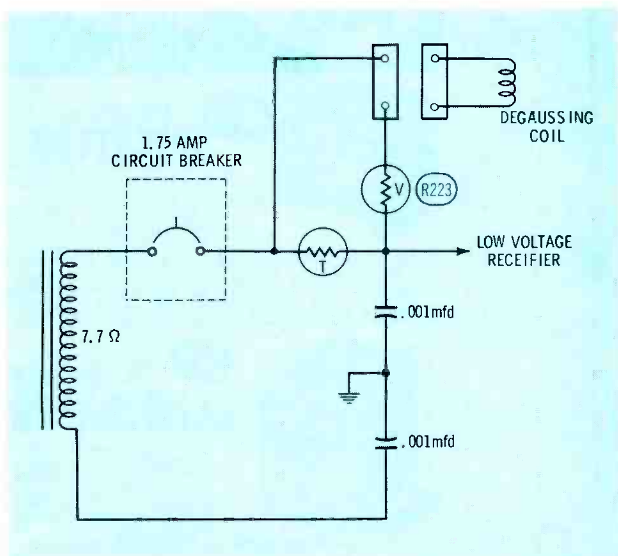
Tip: Perform the following tests before checking circuits:

1. Tune in color program (or color generator).
2. Advance color control full on.
3. Adjust tint control and color control while viewing screen.

If screen temperature shifts when color and/or tint is adjusted, look for open C114 (.047 mfd) in grid circuit of bandpass amplifier. Unbypassed horizontal pulses applied to grid circuit cause tube to conduct during burst interval.



Chassis: RCA CTC16, 16X, 17, 17X
Symptoms: Faint horizontal bars of color on b-w and color programs. Bars are more visible on color.
Tip: A shorted VDR (R223) in the automatic degaussing circuit may be causing this problem. A simple check is to unplug the degaussing coils; if the horizontal bars disappear, the VDR is probably shorted.



PRODUCT REPORT

for further information on any of the following items, circle the associated number on the Catalog & Literature Card.

Universal Power Supply
(70)

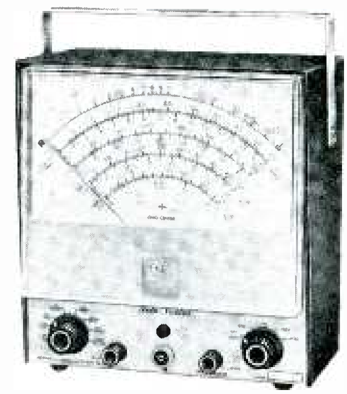
A new 117-volt AC power supply for 12- to 14-volt CB transceivers is being marketed by **Regency Electronics, Inc.** This new Model 103, called a Universal Power Supply, will convert 117-volt AC to 12-volt DC for operating any solid-state CB transceiver which does not draw more than 1.7 amps on receive or transmit. The unit is fused for short-circuit protection; however, momentary shorts will not affect fuse or set operation.

The unit measures 6 ½″ × 4 ½″ × 5″ and features an all-aluminum cabinet finished in light blue baked-on enamel. The Model 103 is priced at $19.95.

VTVM
(71)

The new VTVM shown here provides a 0.5-volt full-scale DC range, which meets the ever-increasing servicing demands of today's solid-state circuitry. The **Jackson** Model 806 provides direct readings of true p-p voltages of any complex waveform including TV sync, deflection voltages, video pulses, AGC, and color gating pulses. Accuracy is 3% full scale on both AC and DC.

The unit measures complex waveforms directly from 0.2 volt to 4200 volts p-p in 7 overlapping ranges. RMS values of sine waves are measured from 0.1 volt to 1500 volts in



7 overlapping ranges. DC voltages from 0.01 to 1500 volts are measured on 2 scales in 8 overlapping 3-to-1 ranges. Input resistance is 11 megohms on all DC ranges. Resistance readings extend from 0.2 ohm to 1000 megohms on a single scale, with 7 overlapping ranges.

Additional features of the instrument include overload protection and a 7" meter. The unit is housed in a portable, high-impact case. Price is $84.95.

Audio Amplifier

(72)

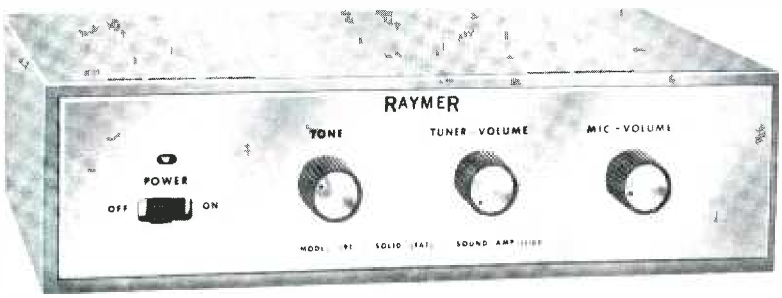
This all-silicon solid-state audio amplifier, with a sine-wave output of 10 watts, is designed for use in offices, schools, homes, buildings, or other installations where microphone paging and/or music are desired. Model 791 is designed with one microphone input and one tuner input. The speaker is 8 ohms, using either a 25-volt or 70-volt line. Provision is made for matching either a high- or low-impedance microphone to the input of the amplifier by means of a self-contained selector switch.

The **Trutone Electronics** amplifier is housed in a tan metal cabinet measuring $9\frac{1}{2}''$ × $2\frac{15}{16}''$. The design provides fool-proof operation so that no harm will be done to the transistors should the output of the amplifier be shorted, mismatched or operated without a load. The amplifier carries a one-year warranty and is priced at $82.50.

Isolation Brightners

(73)

The new units shown here solve the problem of washed out, unclear pictures caused by shorts between the heater and cathode in color



Circle 49 on literature card

CRT's. Since color tubes are constructed with three separate guns, the possibility of a filament-to-cathode short is tripled. When it occurs, the black-and-white picture information is lost, leaving only color shadings.

The **Perma-Power** Color-Brite Isolation Briteners correct for the short, restoring the black-and-white information path to the cathode, and returning detail, contrast, and quality to the color picture. Thus, the unit, easily installed between the tube base and socket by any television serviceman, salvages the color picture tube for months or years of serviceability and continued life.

Model C-502 is designed for round picture tubes having a 70° shell base. Model C-512 fits rectangular picture tubes with a 90° small button base.

Although the preceeding two models provide no boost, other Color-Brite units are available for color

• *Please turn to page 74*

 Circle 48 on literature card

PHOTOFACT™ BULLETIN

PHOTOFACT BULLETIN lists new PHOTOFACT coverage issued during the last month for new TV chassis. This is another way PF REPORTER brings you the very latest facts you need to keep fully informed between regular issues of PHOTOFACT Index Supplements issued in March, June, and September.

Admiral

G13 (Late Production) 915-1

Airline

GEN-13168A (63-13168) 914-1
GMW-17447A/B, GMW-7627A/B, GMW-7647A/B, GMW-7657A/B 915-2

Coronado

TV2-7110A 912-1
TV2-7111A 915-3
TV2-9707A, TV2-9710A 914-2
TV21-9643A 916-1

Motorola

AG23TS/ANTS/E23TS/F23TS/H23TS/J23TS-A914D/E 912-2

RCA Victor

AJ079E/H (Ch. KCS155F) 916-2
CTC22B/C 917-1
CTC24A/AA/B/H/J 912-3

Sears

7160 (Ch. 562.10220/221) 916-3
8109 (Ch. 562.10380) 917-2

Setchell-Carlson

U803, U805 913-1

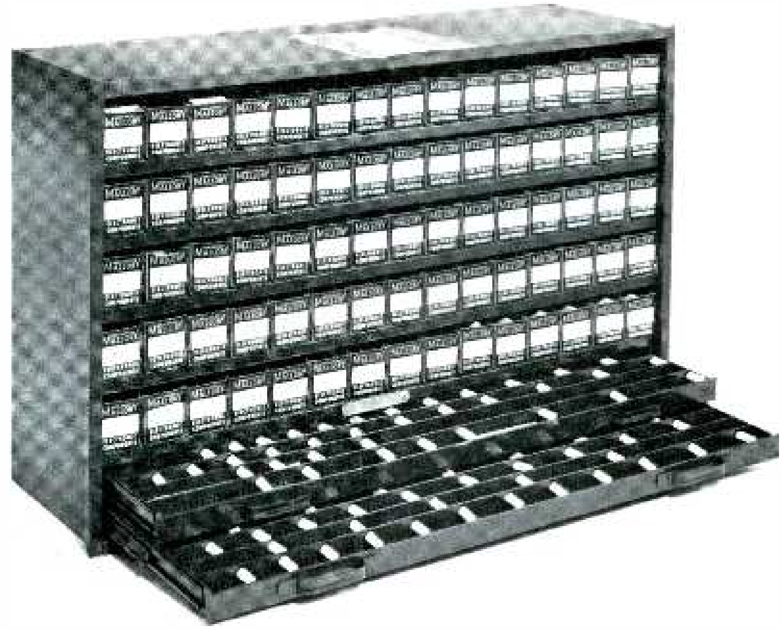
Truetone

WEG1815A-77 (2DC1815A), WEG1817A-77 (2DC1817A) 913-2

Production Change Bulletin

Catalina

1220662B, 122-666B 913-3



picture problems requiring boosting action. Price of both Model C-502 and Model C-512 is $11.95.

Control Kit
(74)

The cabinet shown here holds replacement color TV controls, switches, shafts, and circuit breakers that enable any one of 5 million dual or single control replacements to be made on the spot. The **Mallory** kit offers complete STA-LOC replacement control coverage for color TV sets and hundreds of black-and-white sets, plus radio and stereo.

One feature of this cabinet is that it can be easily mounted in a service truck, thereby eliminating time-con-

Circle 55 on literature card

Circle 54 on literature card

suming trips back to the shop for replacement controls. The metal cabinet organizes and stores all control elements in easy-to-use trays. A special lock prevents accidental opening of the unit.

The SLD-3 Super Color Control Kit measures 29" wide by 18" high by 9" deep and is furnished with complete instructions and cross references. Price is $199.95.

Noise Eliminator
(75)

A new semiconductor noise eliminator for TV applications is announced by **R. Bruce Engineering Company.** Designated Model 191, the unit is designed to remove high-amplitude transients and interference that enter the television antenna and cause spots, tears, and general picture deterioration. Noise producing signals of this type can originate in automotive ignitions, shavers, diathermy equipment, and many other sources.

The Model 191 Noise Eliminator, an especially designed diode limiter for VHF and UHF television receivers, is connected across the antenna terminals and does not disturb nor-

mal picture quality. It uses no power and requires no tuning. The unit is sealed in a plastic jacket and is equipped with spade lugs that make it simple to install. Price is $1.85.

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A. Total No. Copies Printed (Net Press Run)	82,007	79,186
B. Paid Circulation		
1. Sales Through Dealers and Carriers, Street Vendors and Counter Sales	9,603	8,600
2. Mail Subscriptions	64,590	60,571
C. Total Paid Circulation	74,193	69,171
D. Free Distribution (including samples) by Mail, Carrier or Other Means	3,975	5,350
E. Total Distribution (Sum of C and D)	78,168	74,521
F. Office Use, Left-Over, Unaccounted, Spoiled After Printing	3,839	4,665
G. Total (Sum of E & F—should equal net press run shown in A)	82,007	79,186

I certify that the statements made by me above are correct and complete.

(Signature of editor, publisher, business manager, or owner)
WILLIAM E. BURKE, Editor

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$FREE$ CATALOG AND LITERATURE SERVICES

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ANTENNAS

100. *ALLIANCE*—Colorful 4-page brochure describing in detail all the features of Tenna-Rotors.*

101. *BLONDER-TONGUE* — Colorful new flyer describes line of solid-state UHF-VHF-FM antenna Boosters.

102. *CORNELL-DUBILIER* — NEW 4-page brochure with instructions for installation of AR10B Skyline Series rotor.*

103. *DELHI*—Twelve-page catalog introducing a complete new line of home TV towers, ham towers, citizen's band towers, masts and telescoping masts.*

104. *FINNEY*—4-color brochure with description and technical details on new Finco color spectrum frequency dependent antennas for UHF-VHF-FM, VHF-FM, and UHF. Form 20-413.*

105. *JERROLD*—New 4-page full-color catalog describes the new Paralog Plus antennas.*

106. *JFD*—Color Laser and LPV antenna brochures. New 1967 dealer catalog covering complete line of log-periodic outdoor antennas, rotators, and accessories.

107. *MOSLEY*—Information on new Mosley MATV system for up to 8 TV/FM sets. Includes TV antennas, distribution system and outlets.

108. *SPAULDING*—Brochures about EP series economy-priced towers.

109. *WINEGARD*—New 40-page MATV catalog features Ultra-Plex amplifier system and installation instructions.*

AUDIO

110. *ATLAS SOUND*—Catalog 567 illustrates complete line of speakers, horns, microphone stands and booms, transformers, patio speakers, and accessories.

111. *BELL P/A*—Commercial sound equipment catalog.

112. *BENJAMIN* — Brochures on compact radio-phonographs, automatic turntables, and Hi-Fi speakers.

113. *ELECTRO-VOICE* — Catalog 167 on microphones and PA equipment.*

114. *KOSS*—Brochure about Acoustech kits.

115. *OXFORD TRANSDUCER* — Bulletin A-109 features speaker installation in automobiles, hospitals, and recreation rooms.*

COMMUNICATIONS

116. *AMPHENOL*—2-color spec sheets on new Model 650 CB transceivers and Model C-75 hand-held transceiver.*

117. *E. F. JOHNSON*—Booklet about a plan-it-yourself business/industrial radio system.

118. *MOTOROLA*—New brochure tells how to reach people on-the-move through use of personal two-way radio.

COMPONENTS

119. *AMERTEST*—Inventory/price sheet for over 225 drive parts used in phonos and tape recorders.

120. *BELDEN*—Catalog 867, a 56-page catalog of the complete Belden line.

121. *BUSSMANN*—Small TV Fuse leaflet designed to fit pocket or tool kit, shows list prices of fuses most commonly used in TV sets. Ask for BUSS Leaflet TVLP.*

122. *CENTRALAB* — 24-page replacement parts catalog No. 33GL.

123. *CORNELL-DUBILIER* — 32-page replacement cross-reference covers electrolytic capacitors used in color chassis from 32 manufacturers.

124. *LITTELFUSE*—Pocket-sized TV circuit breaker cross-reference gives the following information at a glance. Manufacturer's part number, corresponding Littelfuse part number, price, color or b/w designation. A second glance gives trip ratings and acquaints you with a line of caddies. Ask for CBCRP.*

125. *MALLORY* — Bulletin 4-82 describes radial and axial lead tantalum capacitors.

126. *NATIONAL TEL-TRONICS* — Flyer about a new flexible terminal block.

127. *QUAM-NICHOLS*—New catalog No. 67 has complete, detailed information on the entire Quam line.*

128. *SPRAGUE*—C617, a complete catalog of the Sprague line.*

129. *TEXAS CRYSTALS*—12-page catalog of crystals including engineering data, specifications and prices.*

SERVICE AIDS

130. *CASTLE TUNER*—How to get fast overhaul service on all makes and models of television tuners is described in leaflet. Shipping instructions, labels, and tags are also included.*

131. *GC*—FR-67, the full-line catalog.*

132. *INJECTORALL*—24-hour service on any make tuner is described in a colorful brochure.*

133. *PERMA-POWER* — Catalog sheet describes new isolation boosters for color TV.*

134. *VECTOR*—Short-form catalog lists current measuring and socket change adaptors, Vectorboard, terminals and accessories.

SPECIAL EQUIPMENT

135. *ANDREA*—Folders on the new line of color and B/W TV receivers.

136. *ATR*—Literature about DC-AC inverters up to 600 watts load.*

137. *GIBBS* — Flyer sheets on frequency standards and static converters.

138. *SETCHELL CARLSON* — Brochures about the 1968 color and B/W lines.

139. *WINDSOR ELECTRONICS* — Booklet entitled "The Open Door to TV Profits".*

TECHNICAL PUBLICATIONS

140. *CLEVELAND INSTITUTE OF ELECTRONICS*—Free illustrated brochure describing electronics slide rule and four lesson instruction course and grading service.*

141. *PHILCO*—Information about Tech Data & Business Management service. Also, free parts catalog.

142. *RCA INSTITUTES*—New 1967 career book describes home study programs and course in television (monochrome and color), communications, transistors, industrial, and automation electronics.*

143. *SAMS, HOWARD W.*—Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1967 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

144. *B & K*—New 1967 catalog featuring test equipment for color TV, auto radio, and transistor radio servicing, including tube testers designed for testing latest receiving tube types.*

145. *COLETRONICS*—Flyer sheet about a new tube-tester adaptor.

146. *EICO*—New spec sheet describes model 100A4 multimeter with DC sensitivity of 100K ohms per volt.

147. *HICKOK*—Quick reference catalog No. 671D gives brief descriptions and prices for complete test equipment line. Also specification data on Models CR-35 CRT tester, GC-660 color generator, and 860 Injecto-Tracer.

148. *JACKSON*—Literature on the new in-circuit transistor checker and the new VTVM with 7" dial.

149. *LECTROTECH*—Two-color catalog sheet on new Model V6-B color bar generator, the latest improved model of the V-6. Gives all specs and is fully illustrated.*

150. *MERCURY*—All-new 16-page test instrument catalog.

151. *PRECISION APPARATUS* — 12-page illustrated catalog describes the application and features of a complete line of test equipment—scopes, sine-square wave generators, RF generators, sweep generators with marker adder, Low- and Hi-voltage power supplies, VOMS and VTVMS.

152. *SECO*—Operating manual for the HC8 in-circuit current checker for horizontal output tubes.*

153. *SENCORE*—8-page full color catalog plus a new 4-page supplement catalog.*

154. *SIMPSON*—Test equipment brochure featuring the palm-sized Model 160, the Model 260 and adaptors, and all other instruments in the line.*

155. *TRIPLETT*—Catalog No. 51-T features the complete line of VOM's, VTVM's, tube and transistor analyzers, and accessories.

TOOLS

156. *ARROW*—Catalog sheet showing 3 staple gun tackers designed for fastening wires and cables up to ½" diameter

157. *CHANNELOCK*—General catalog No. 66 features the entire line of hand tools.

158. *DIAMOND*—16-page booklet, W-68, lists wrenches, pliers, snips, and electronic tools.

159. *ENTERPRISE DEVELOPMENT* — Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering methods for speeding and simplifying operations on PC boards.

160. *PORTABLE ELECTRIC*—20-page catalog describes complete Shopmate line of drills, sanders, grinders, saws, etc.

161. *VACO*—Catalog No. SD-105 describes complete line of hex keys and hex drivers.

162. *XCELITE*—Bulletin N567 lists two sets of nut drivers with color coded handles and plastic cases.

TUBES AND TRANSISTORS

163. *RADIO CORP. OF AMERICA*—PIX 300, a 12-page product guide on RCA picture tubes covering both color and black-and-white. Includes characteristics chart, terminal diagrams, industry replacement, and interchangeability.*

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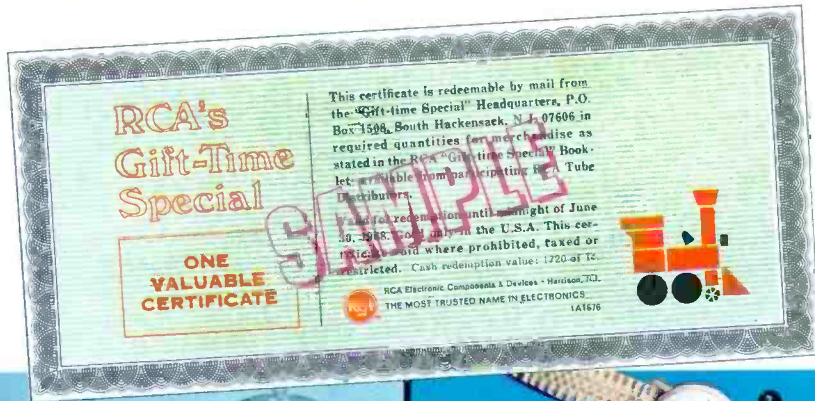

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1. Argus Electromatic Slide Viewer. 51-126. 43 Cert. **2. Polaroid 215 Color-Pack Camera. 51-170.** 155 Cert. **3. Polaroid Flash Gun Attachment. 51-174.** 22 Cert. **4. Toastmaster "Sovereign" Automatic Toaster. 35-80.** 51 Cert. **5. Rival Slimline Electric Knife. 35-141.** 33 Cert. **6. West Bend 8-Cup Automatic Aluminum Percolator. 35-73.** 27 Cert. **7. Man's Elgin "Armada" 17-jewel Watch. 53-80.** 61 Cert. **8. Longines-Wittnauer Man's Watch. 53-11.** 146 Cert. **9. Hickock Man's Alligator Belt. 20-765.** 36 Cert. **10. Sterling Silver Candlesticks. 52-25.** 15 Cert. **11. Star Rogers and Bros. Silverplate "Starlight" by The International Silver Company. 52-45.** 37 Cert. **12. Oneida 4 pc. "Paul Revere" Coffee Service. 52-46.** 81 Cert. **13. Sterling Silver Salt and Pepper Shakers. 52-26.** 15 Cert. **14. Sterling Silver and Crystal Cake Plate. 52-75.** 17 Cert. **15. Reed and Barton Color-Glazed "Paul Revere" Bowl. 52-96.** 29 Cert. **16. Man's Alligator Raincoat. 20-568.** 103 Cert. **17. Lady's Alligator Raincoat. 20-571.** 103 Cert. **18. Lady's Twin-Pearl Ring. 49-147.** 39 Cert. **19. Lady's Linde Star Ring. 49-149.** 105 Cert. **20. Hamilton "Loralie" Lady's Watch. 53-65.** 133 Cert. **21. "Buddy L" Aerial Ladder Fire Engine. 48-90.** 18 Cert. **22. Toddler's "Tiger Trike". 47-51.** 16 Cert. **23. "Buddy L" Sit N Ride Truck. 48-207.** 19 Cert. **24. "Kiss Me" Doll. 48-137.** 13 Cert. **25. Cosco Doll High Chair. 48-43.** 10 Cert. **26. "Drink and Wet" Doll and Cradle. 48-139.** 13 Cert.

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