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Know Your '68 Color Circuits

Color TV Service Training

Twelve Vertical

Color Problems!

Sweeping Color IF Amplifiers

ANNUAL COLOR ISSUE

NOV 1967
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- ★ Notes on Test Equipment
- ★ Tube Substitution Supplement
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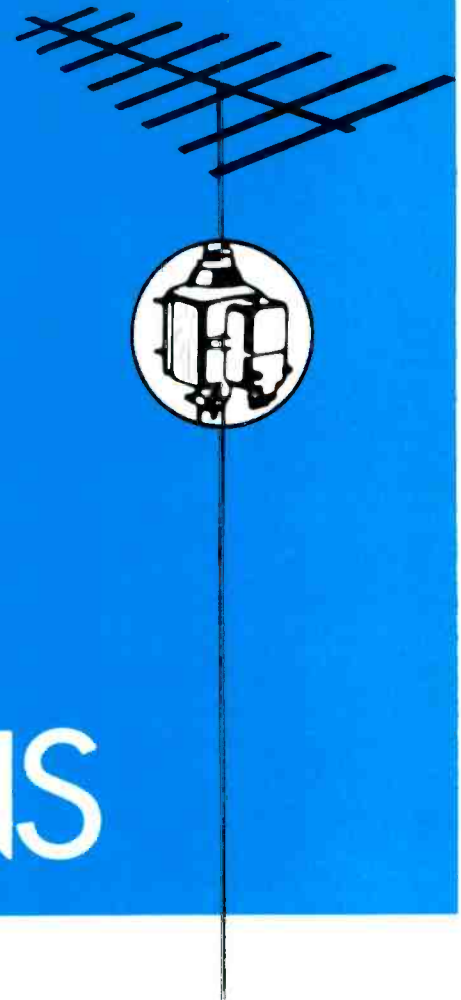
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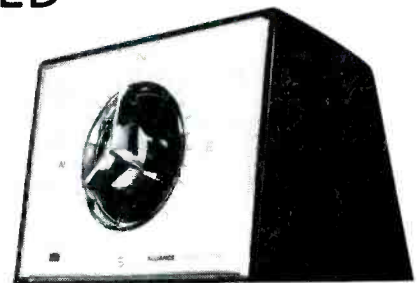
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Subscription Prices: 1 year—\$5.00, 2 years—\$8.00, 3 years—\$10.00, in the U. S. A., its possessions and Canada.

All other foreign countries: 1 year—\$6.00, 2 years—\$10.00, 3 years—\$13.00. Single copy 75¢; back copies \$1.

Indexed in Lectrodex. Printed by the Waldemar Press Div. of Howard W. Sams & Co., Inc.

PF Reporter®

PHOTOFACT

the magazine of electronic servicing

VOLUME 17, NO. 11

NOVEMBER, 1967

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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.

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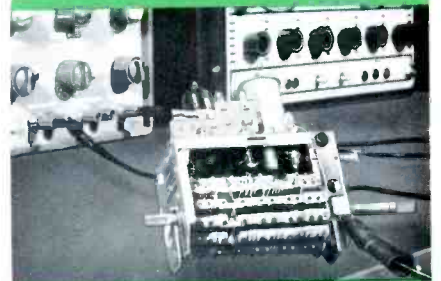


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November, 1967/PF REPORTER 5

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

(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.

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". In-

cluded 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 console. 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.



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Circle 7 on literature card

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 console, 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" console, 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" console, 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.

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

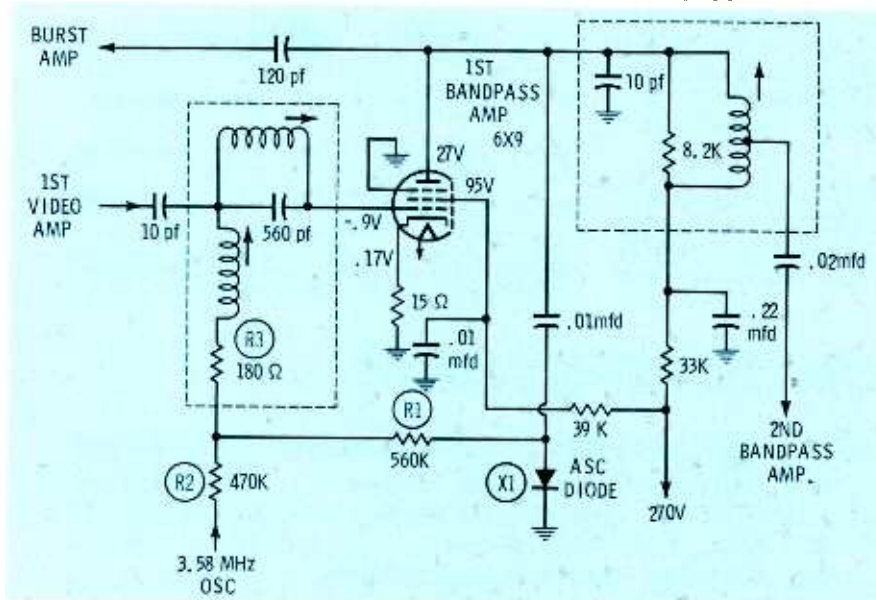


Fig. 3. Admiral's automatic color saturation circuit.

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 amplifiers.

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 forward 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 side-

bands (± 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 supplying forward 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 forward bias

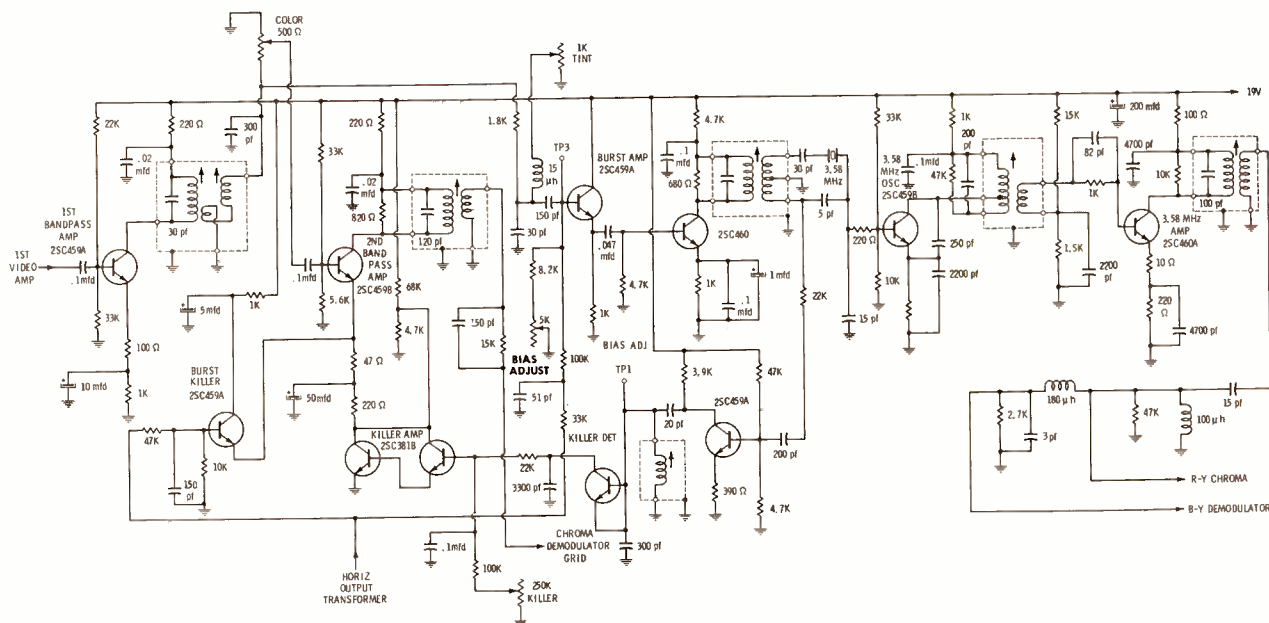


Fig. 4. Transistors dominate chroma section of Delmonico/Nivico's new color chassis.

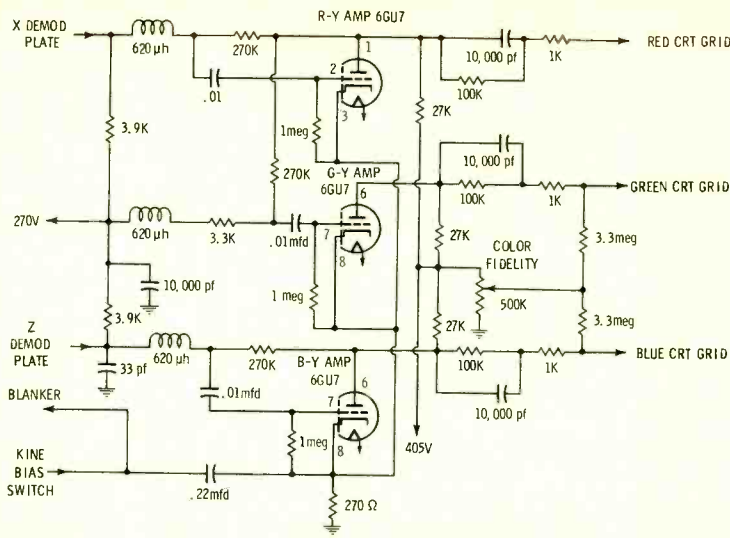


Fig. 5. "Color Fidelity" control is employed in Emerson Chassis.

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 forward 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 forward 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 forward biasing requirements of this stage. There-

fore, 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 inputs 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

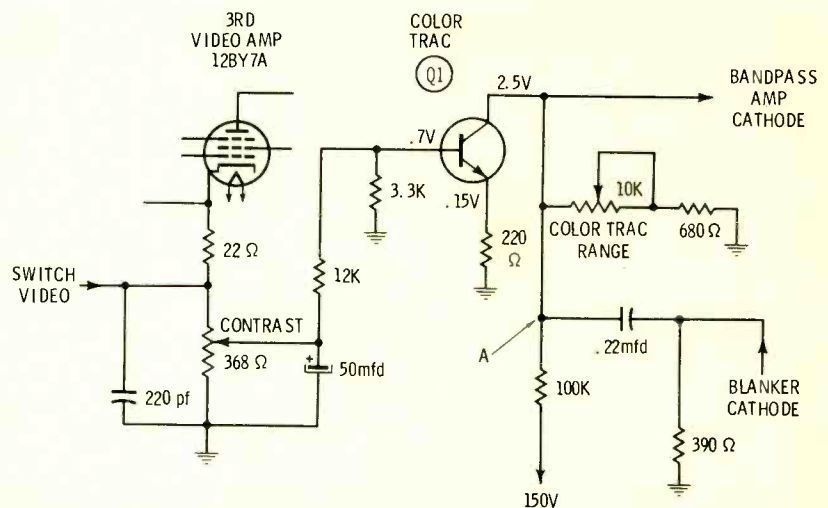


Fig. 6. "Color Trac" in Hoffman chassis tracks chroma with contrast.



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.

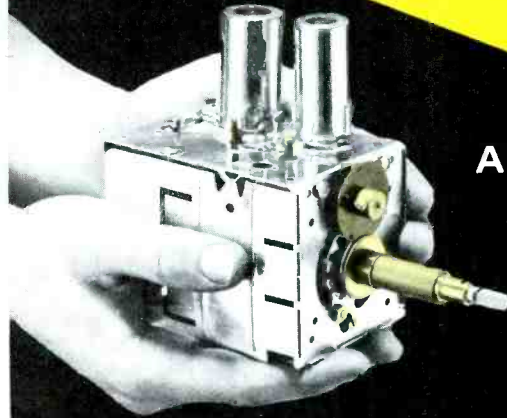
New Line of Replacement Photo Needles

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.

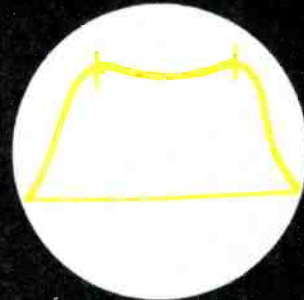
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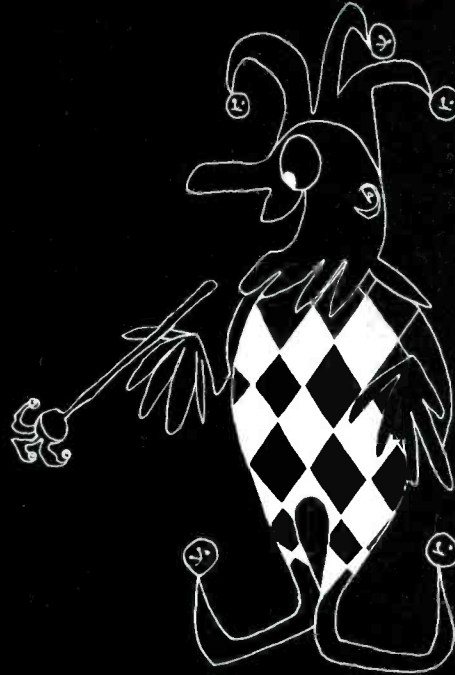
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November, 1967/PF REPORTER 13

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

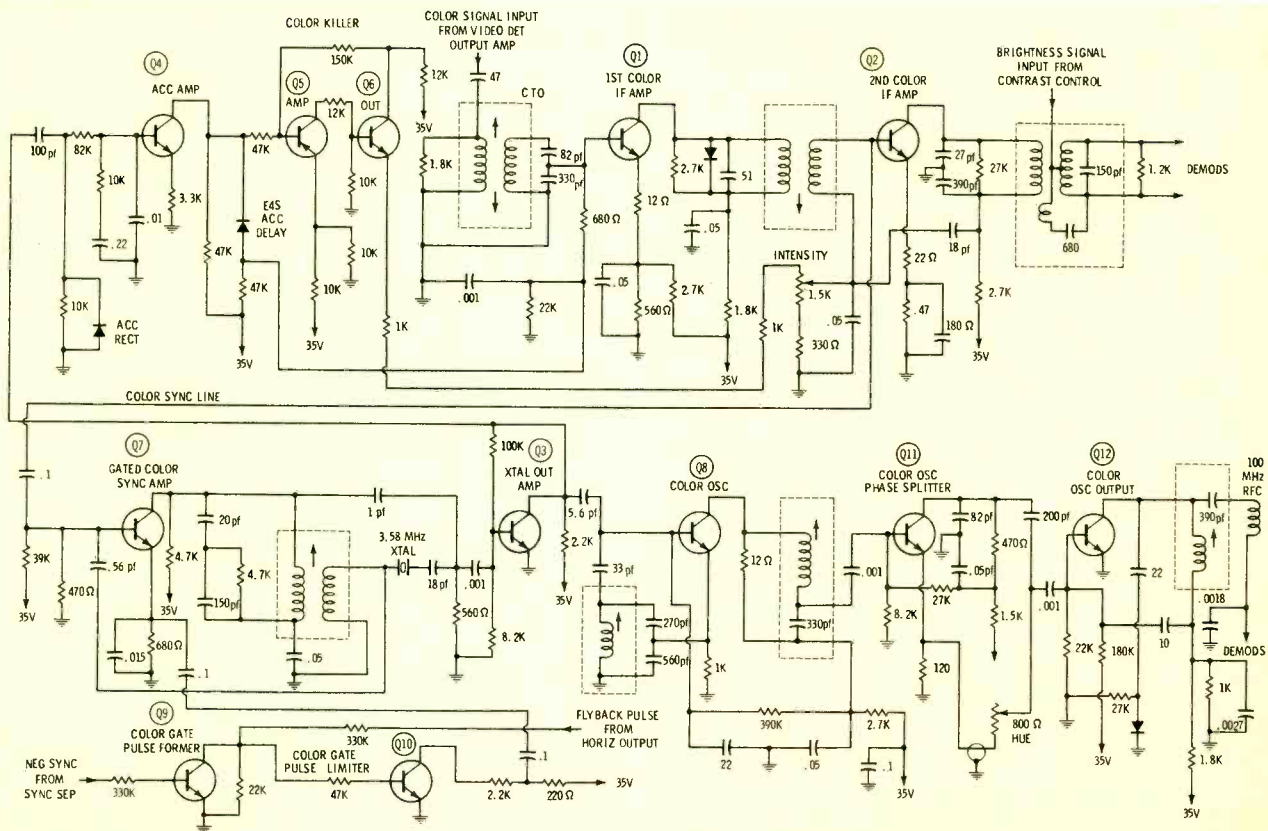


Fig. 7. Part of Chroma circuitry employed in Motorola's new all-transistor chassis.

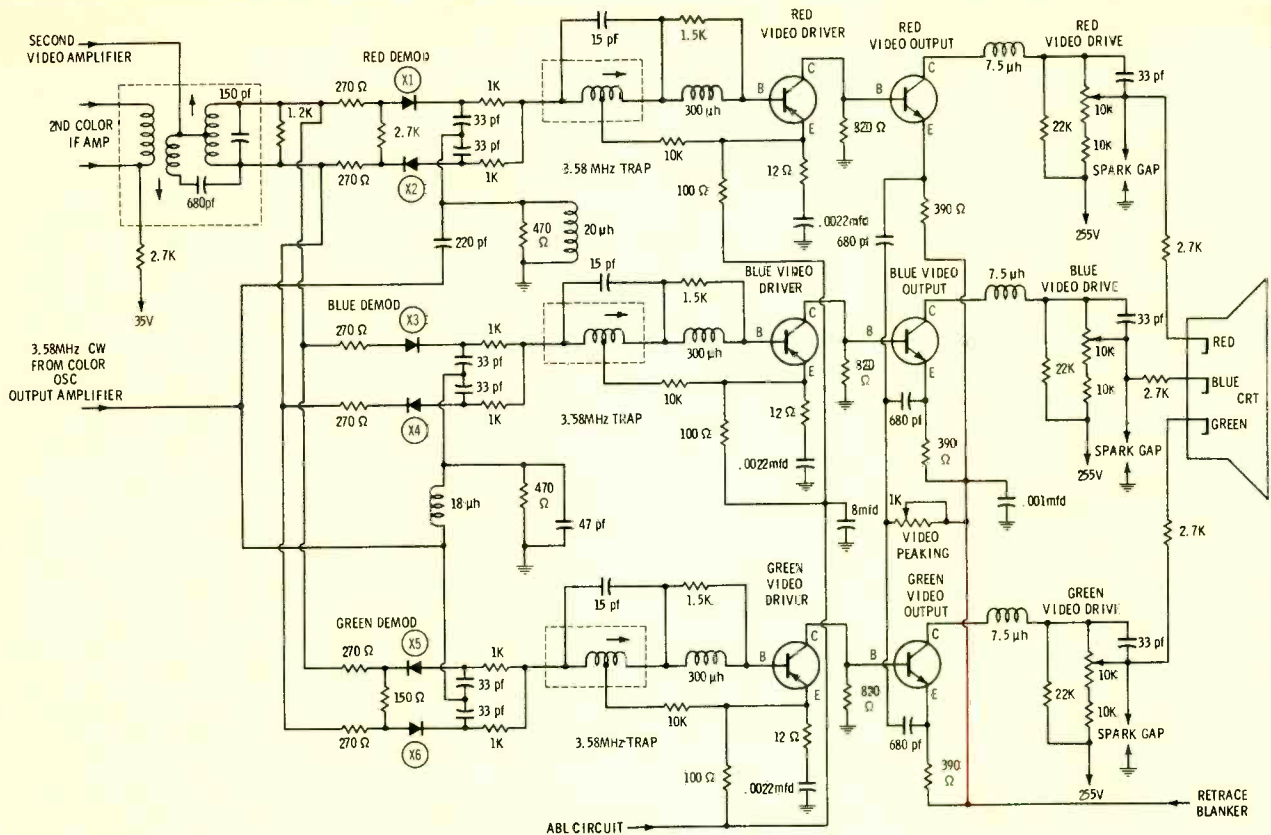
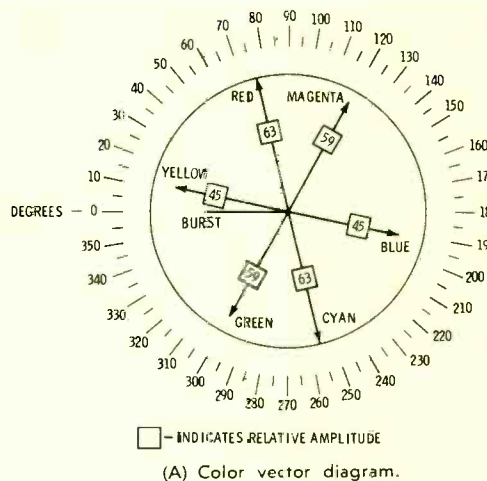


Fig. 8. Both color video and Y signals are fed to CRT cathodes in Motorola's all-transistor chassis

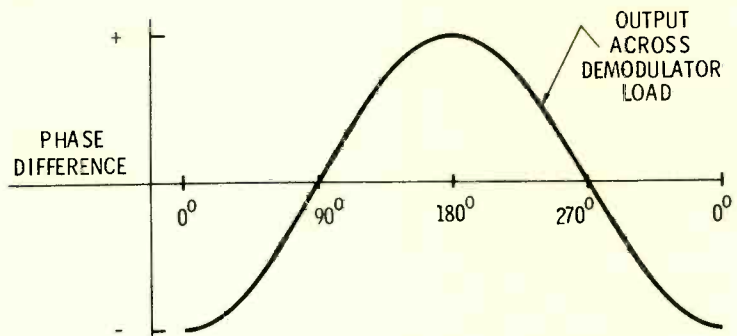
burst from reaching the chroma demodulators. The output of this stage is transformer coupled to the X and Z low-level demodulators.

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.

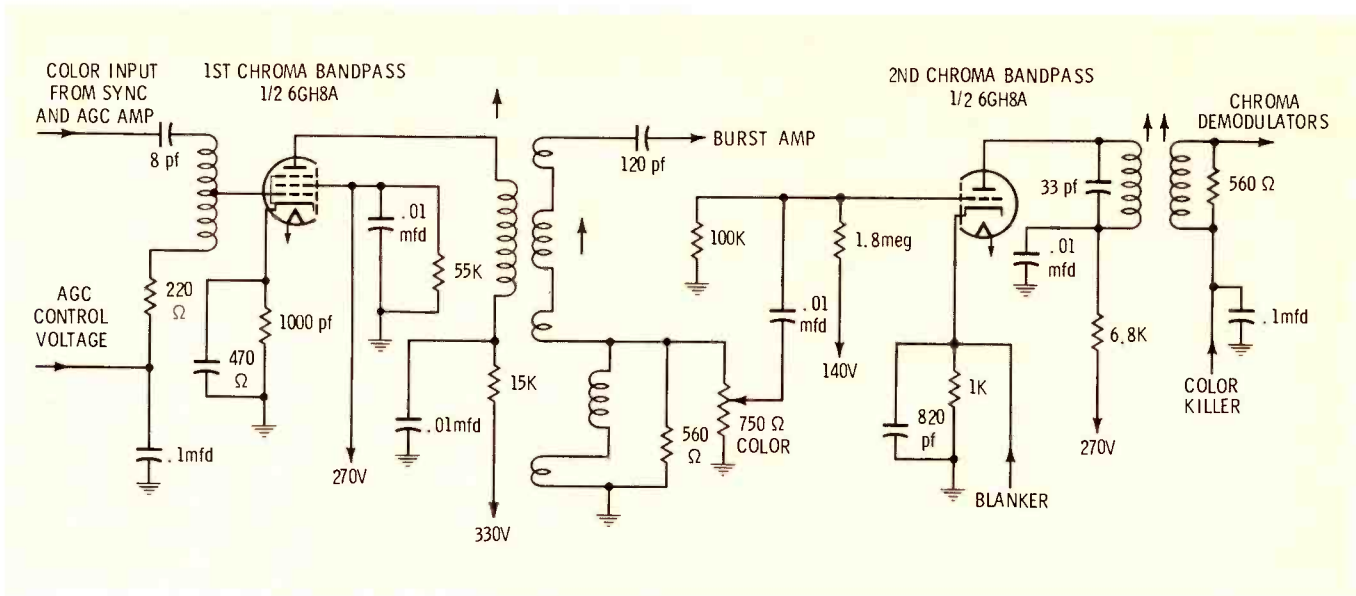


Fig. 10. Two stages of bandpass amplification are found in RCA Chassis CTC27 and CTC31.

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 reduc-

tion 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

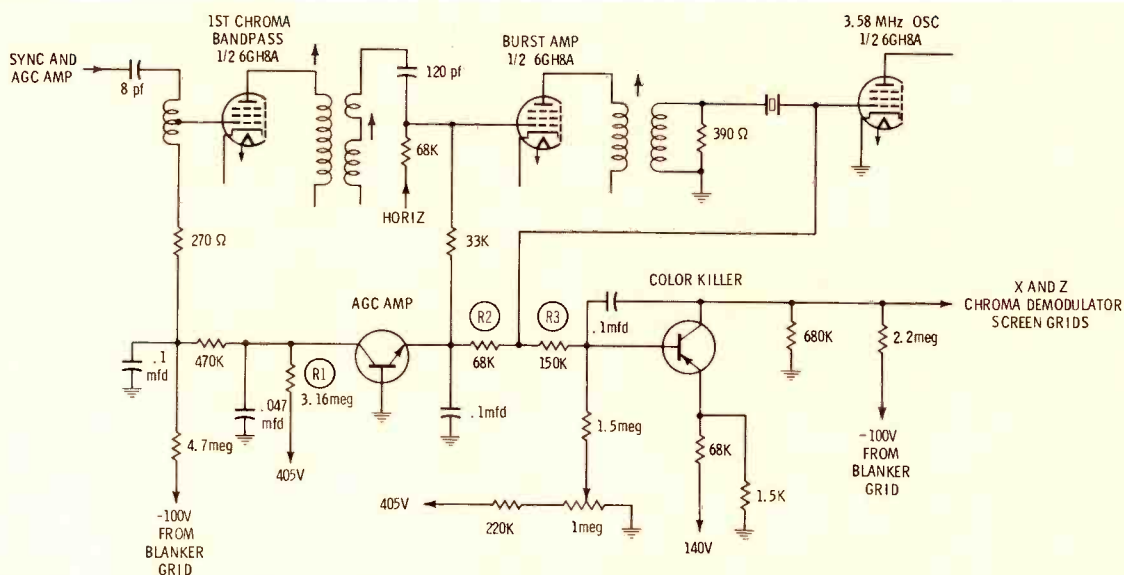


Fig. 11. Chroma circuitry employed in new RCA chassis features a closed-loop ACC system.

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 CTC27 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 resetting 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. ▲

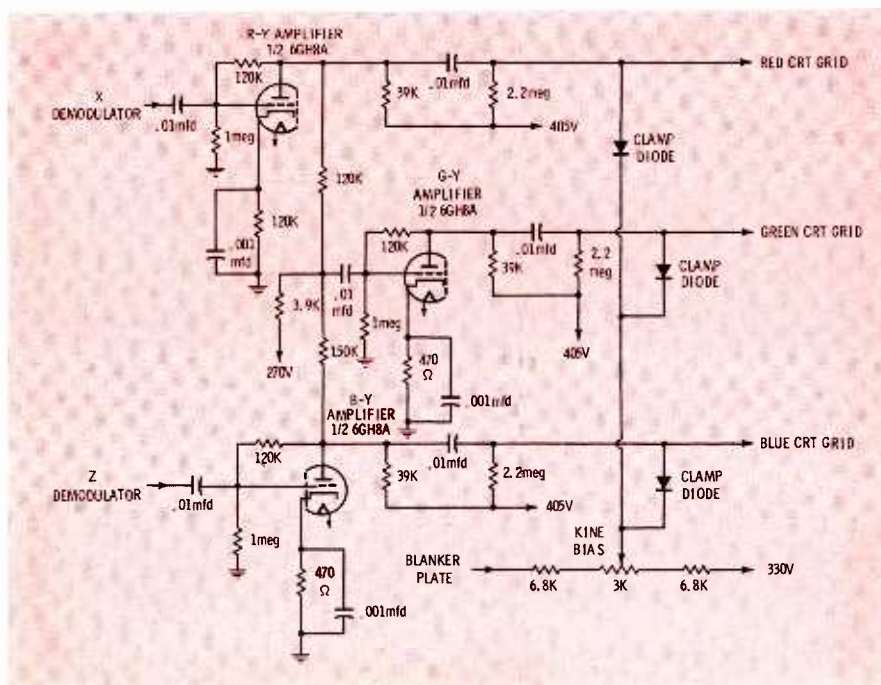
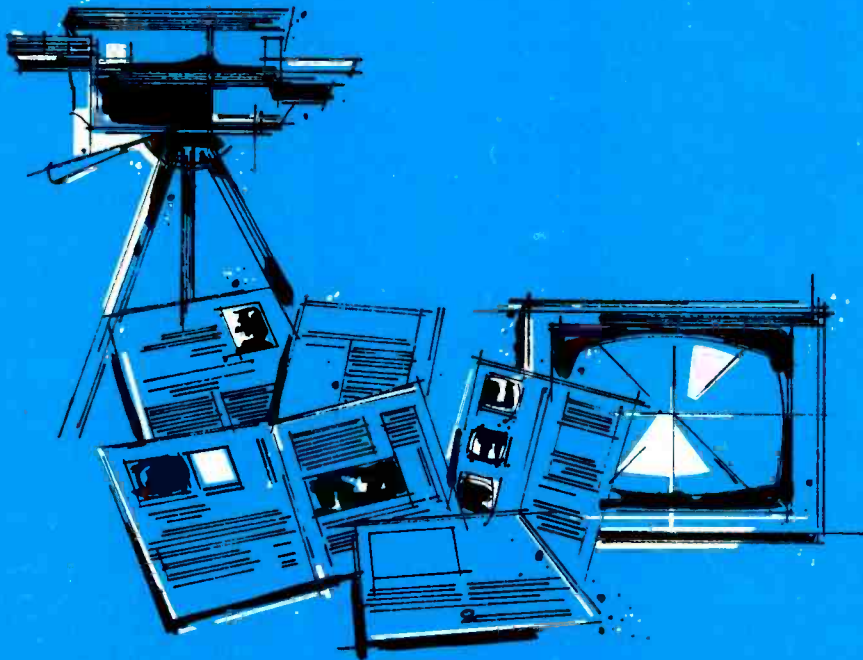


Fig. 12. Clamping diodes are used in CRT grid circuit of RCA chassis.

COLOR TV

PART
4

service training



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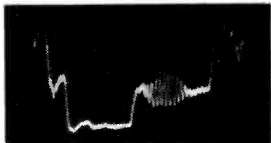
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Here are oscilloscope photographs from the outputs of two typical competitive color generators, one transistorized and one tube type, and the B&K Model 1245. The detailed analysis with each photograph shows a few of the reasons why you'll save time and effort with B&K.

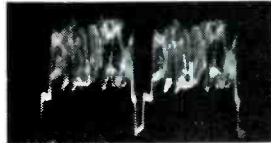
COLOR

CROSSHATCH

STANDARD STATION SIGNAL

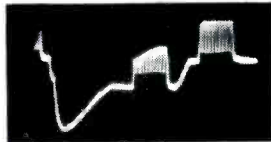


One horizontal sync pulse with its color burst.

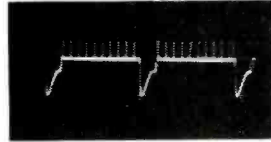


Two lines showing horizontal sync pulse with black and white TV signal.

TRANSISTORIZED B&K MODEL 1245

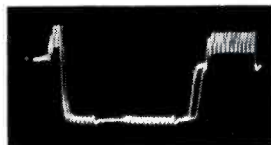


Good duplication of station signal including back porch. If the set won't sync, the set is defective.

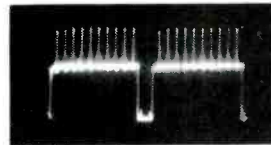


Well defined back porch on horizontal sync pulse permits accurately setting color killer and almost eliminates need to adjust brightness and contrast.

TRANSISTORIZED GENERATOR A

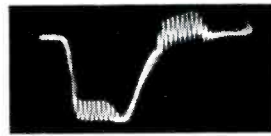


No back porch causes unstable color sync. Burst amplitude compression may permit sync on wrong color bar.

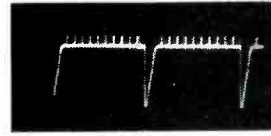


Square wave horizontal sync pulse with no back porch and poor dc coupling forces adjustments of brightness, contrast & fine tuning to obtain usable pattern.

GENERATOR B

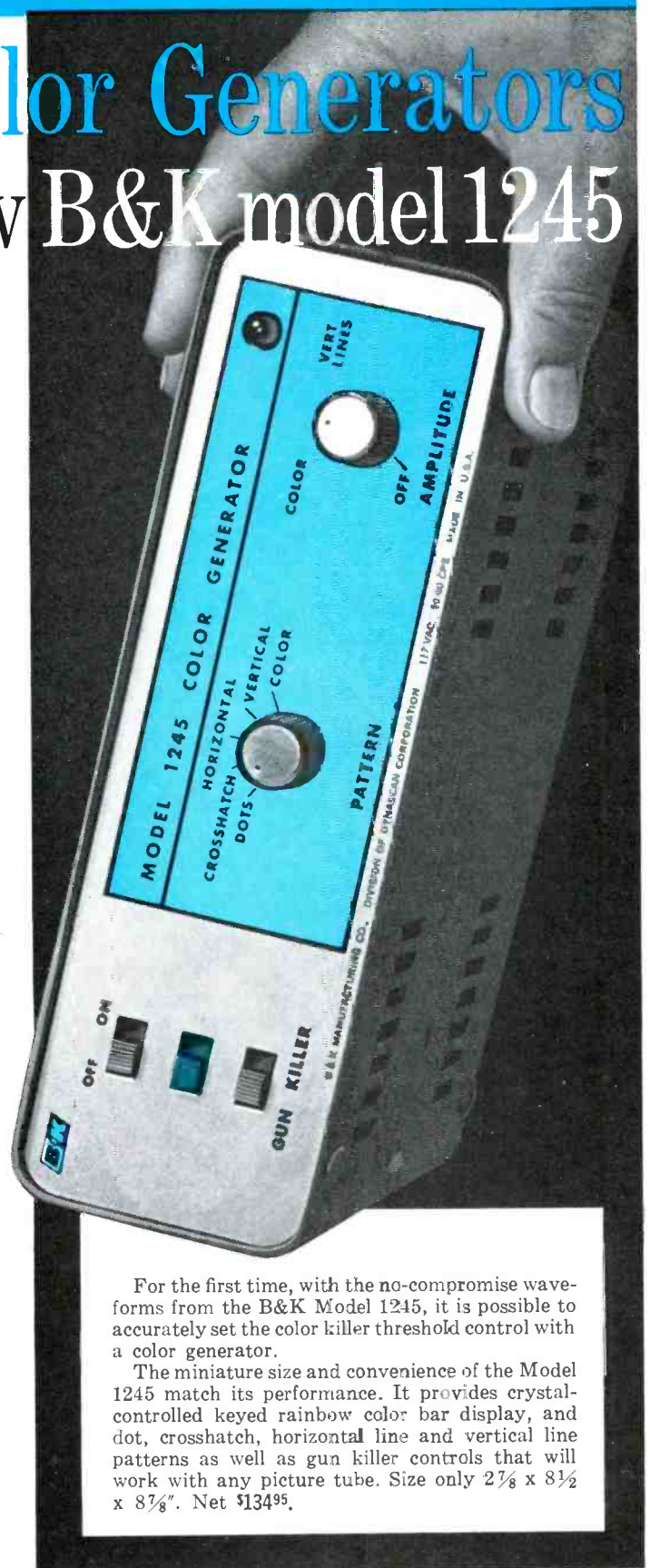


No back porch; color information on top of sync-pulse makes sync difficult on some sets.



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

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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 possibility.

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-

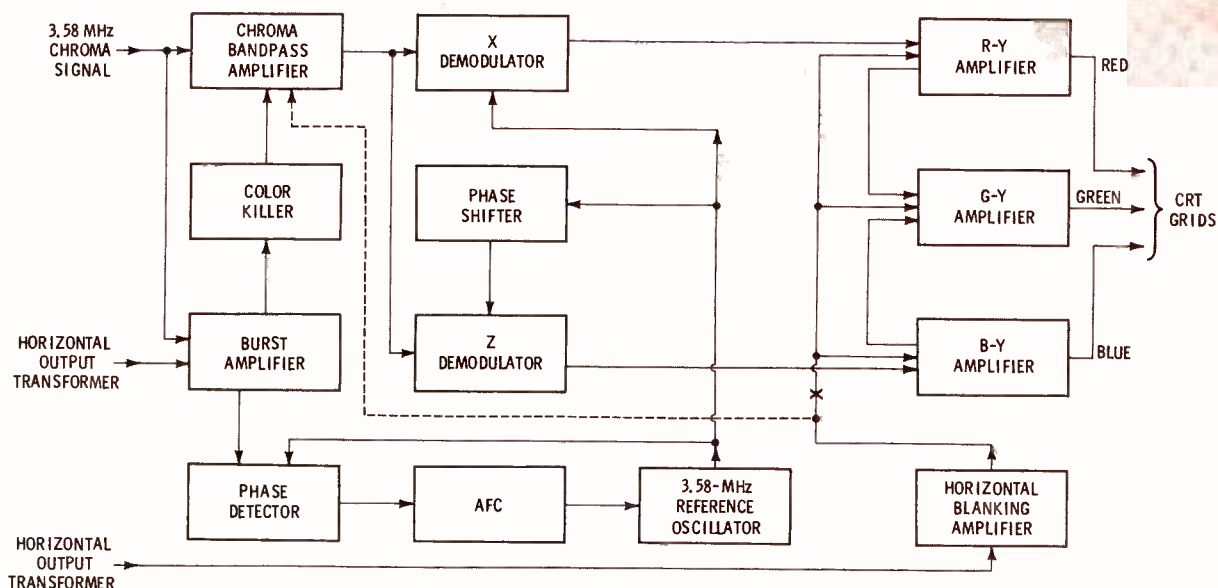


Fig. 1. Functional block diagram of a chroma circuit using low-level demodulation.

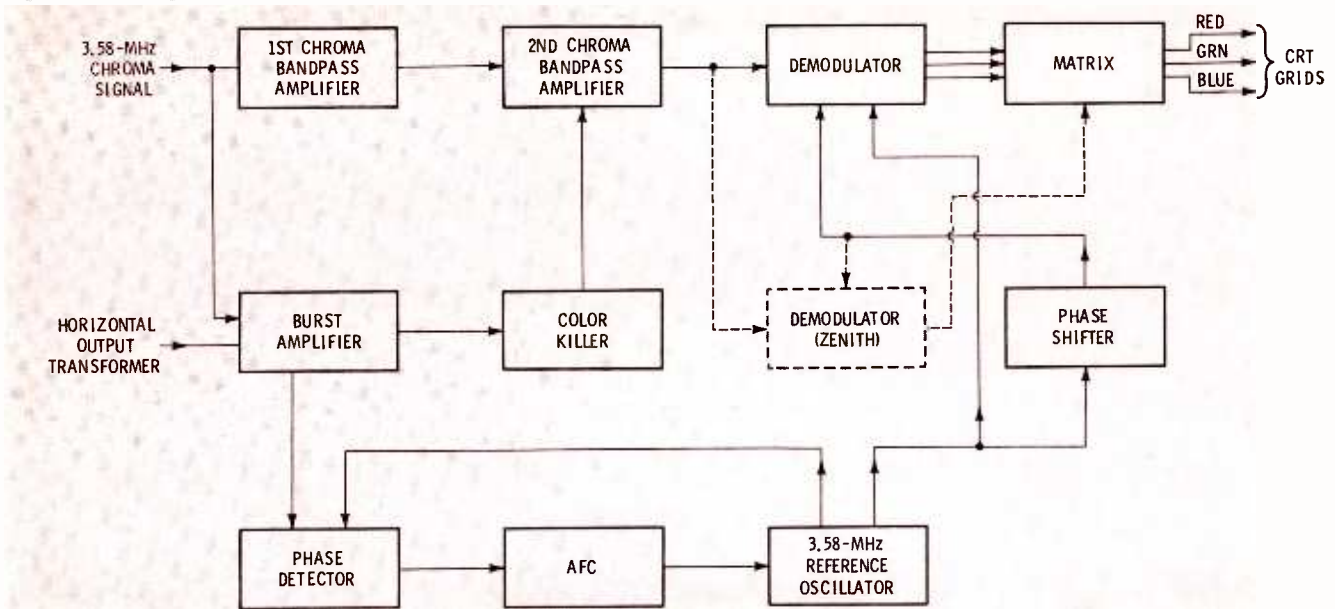


Fig. 2. Functional block diagram of a chroma circuit using high-level demodulation.

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

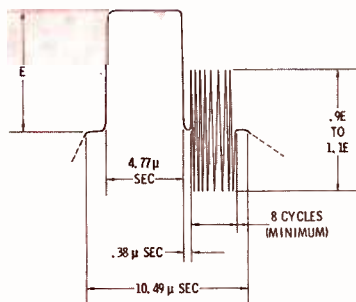


Fig. 3. Sync pulse and color burst.

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 auxiliary 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

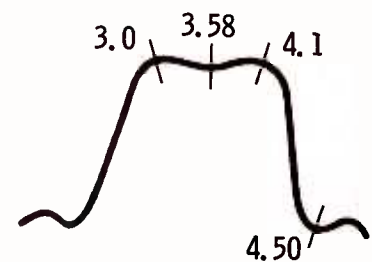
From Part 1 of this series, we recall that the 3.58-MHz chroma subcarrier was suppressed at the transmitter. There are two reasons for suppressing this subcarrier:

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.

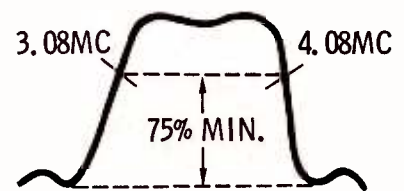
Since the chroma subcarrier is suppressed at the transmitter, it

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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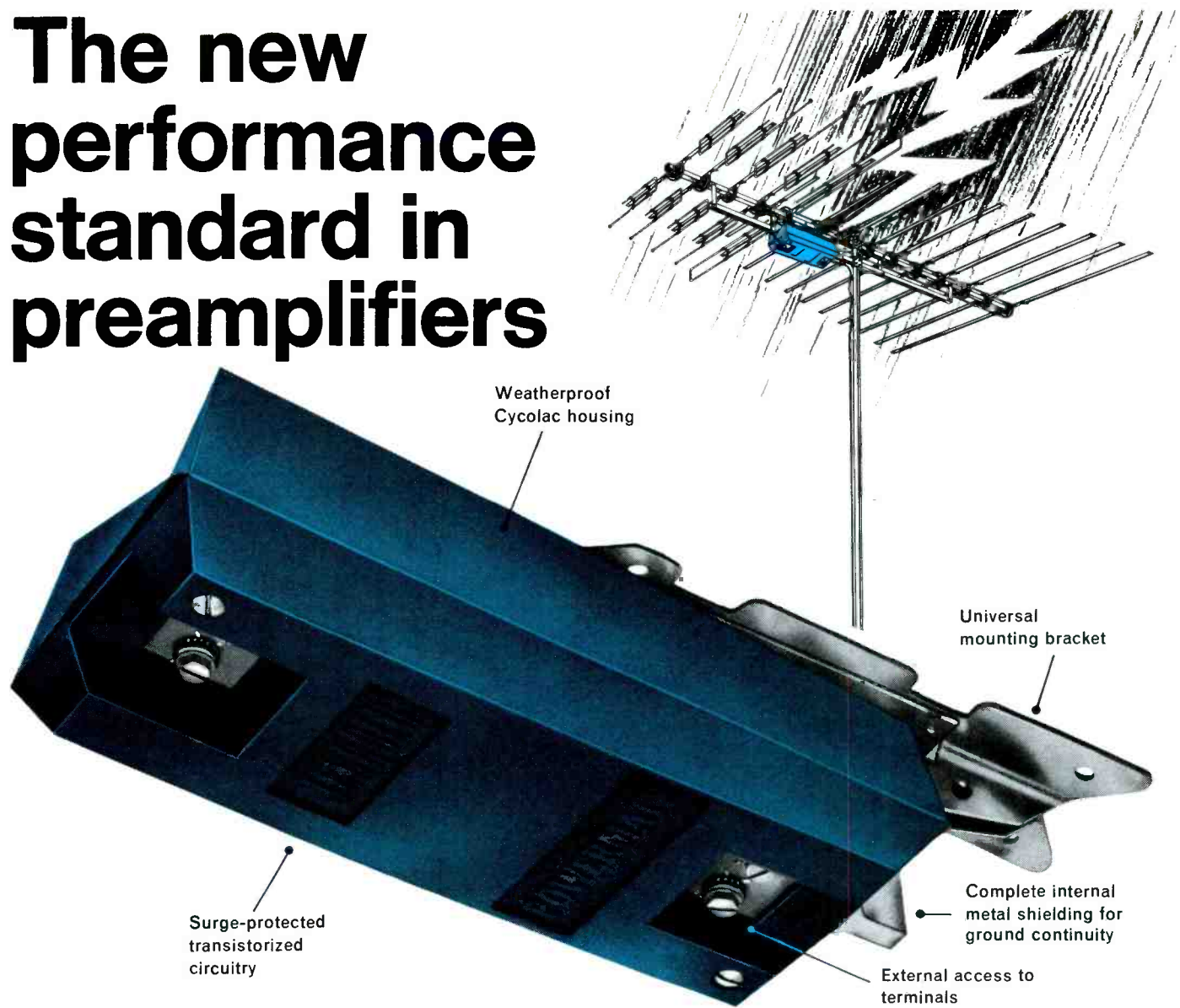
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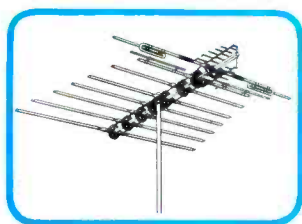


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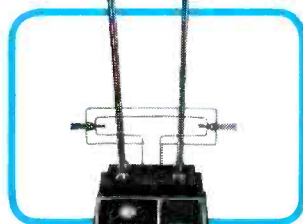
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may be observed at the output of the video detector of the receiver and this is a convenient starting point when troubleshooting a no-color condition.

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 \pm .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.

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 lengthy 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. $E_G - E_Y = -.51 (E_R - E_Y) - .19 (E_B - E_Y)$.

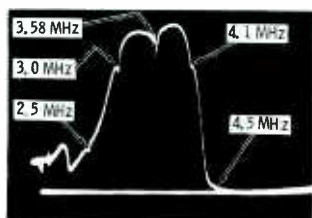


Fig. 5. Typical overall response of IF and chroma (VSM method).

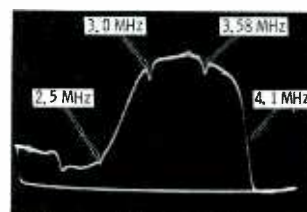


Fig. 6. Incorrect overall response curve (VSM method).

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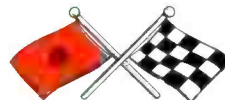
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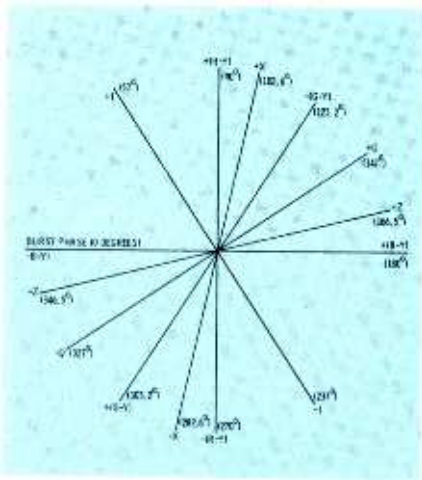


Fig. 7. Chroma demodulator axes.

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 potentiometer 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°

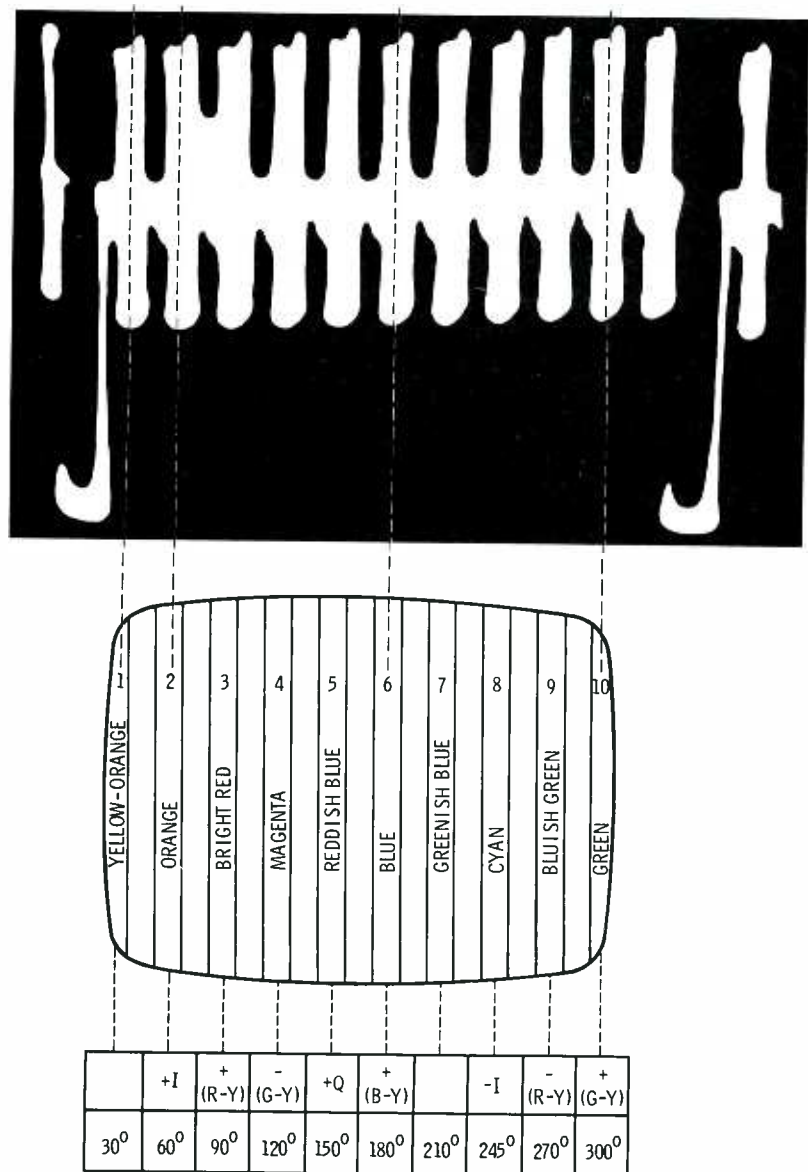
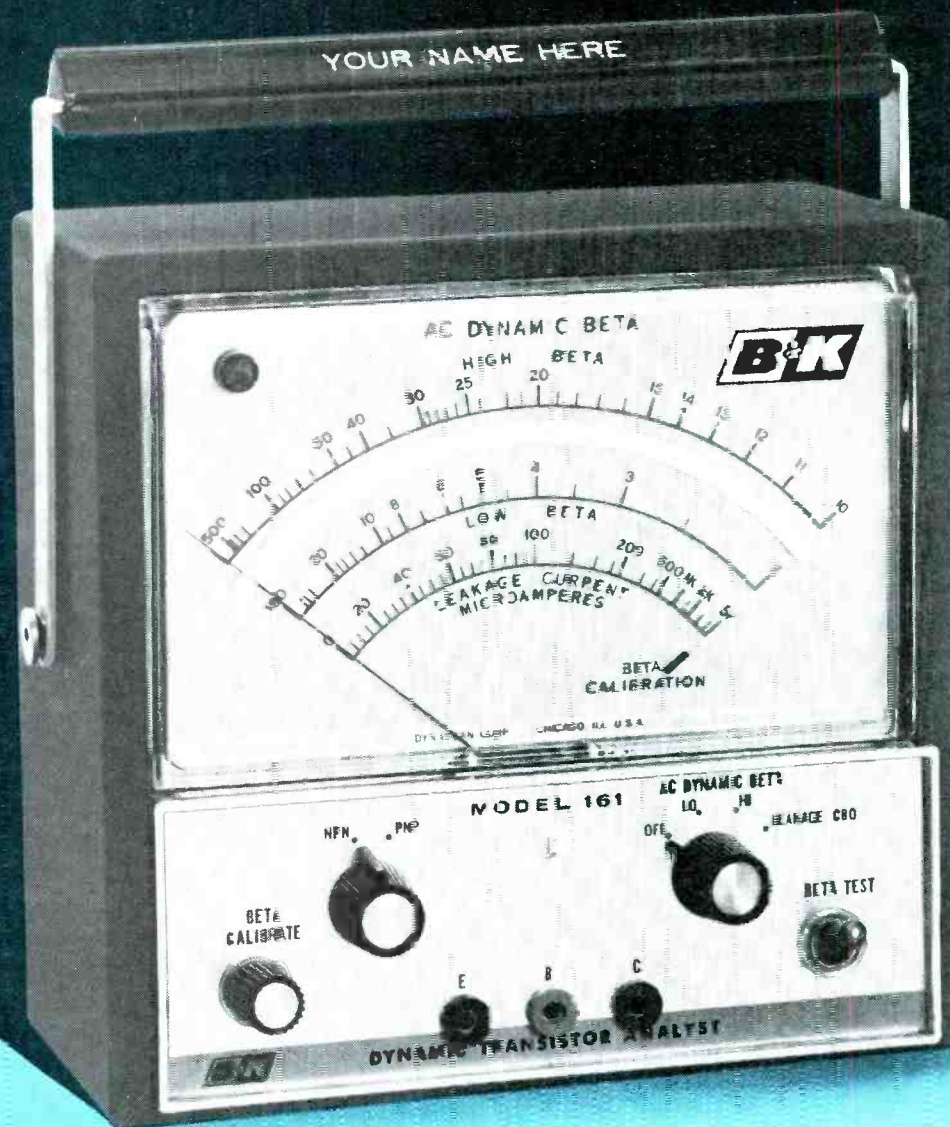


Fig. 8. Keyed-rainbow chroma signal, CRT presentation, and phases.

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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 occur 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

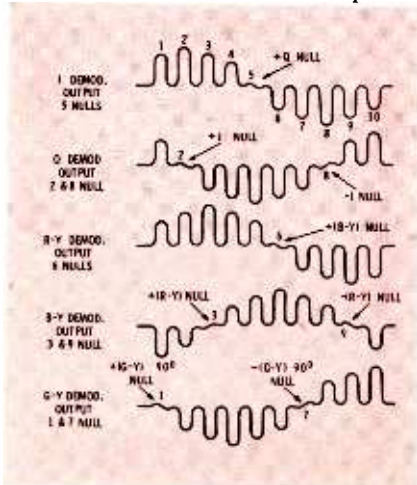


Fig. 9. Demodulator waveforms.

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 band-pass 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

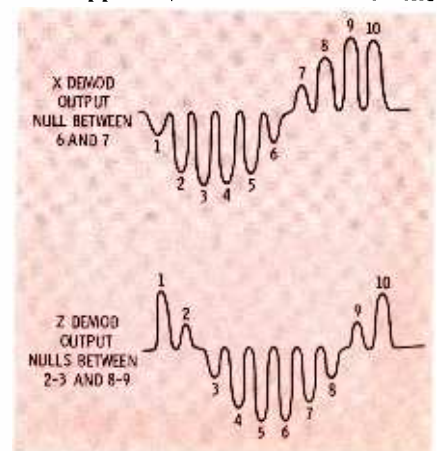


Fig. 10. Demodulator waveforms.

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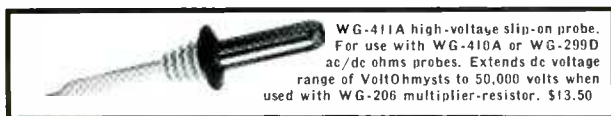


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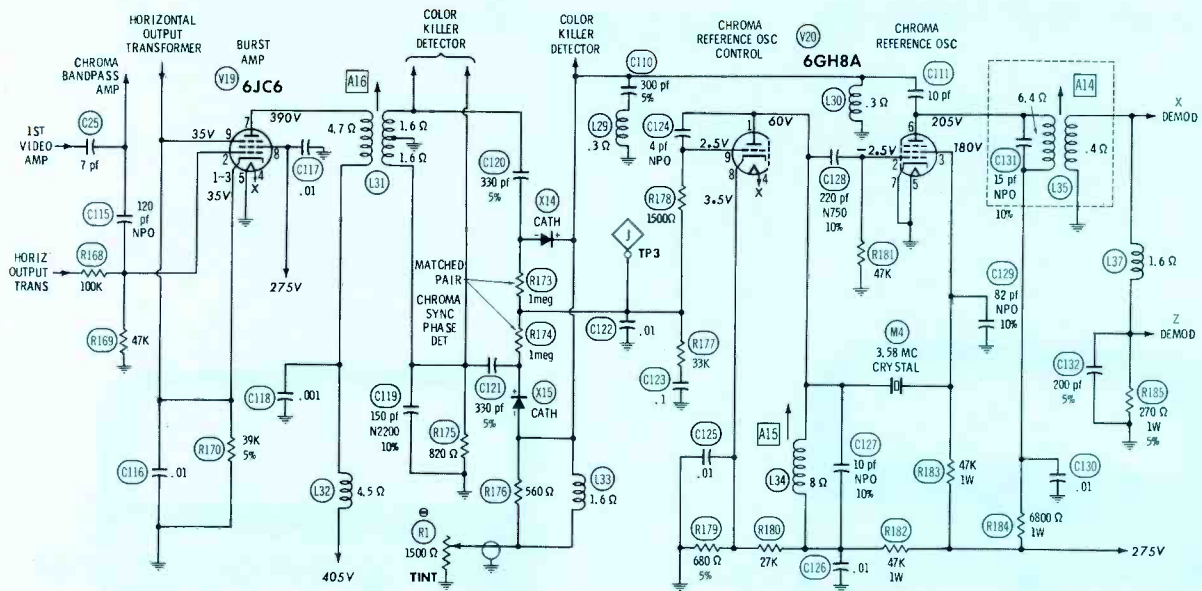


Fig. 11. Reference signal circuits of RCA Chassis CTC25.

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

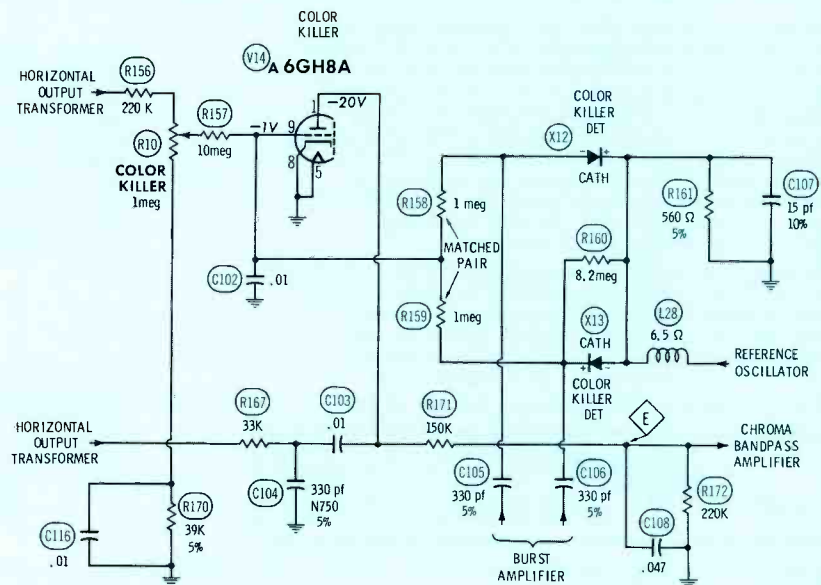


Fig. 12. Color Killer circuit of RCA Chassis CTC25.

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 cut-off.

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 cut-off. 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 control" (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 noticeable 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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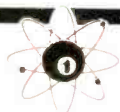
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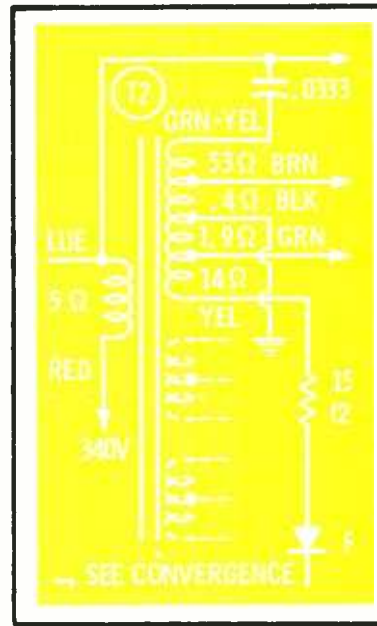
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TWELVE VERTICAL COLOR PROBLEMS

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, re-

place 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

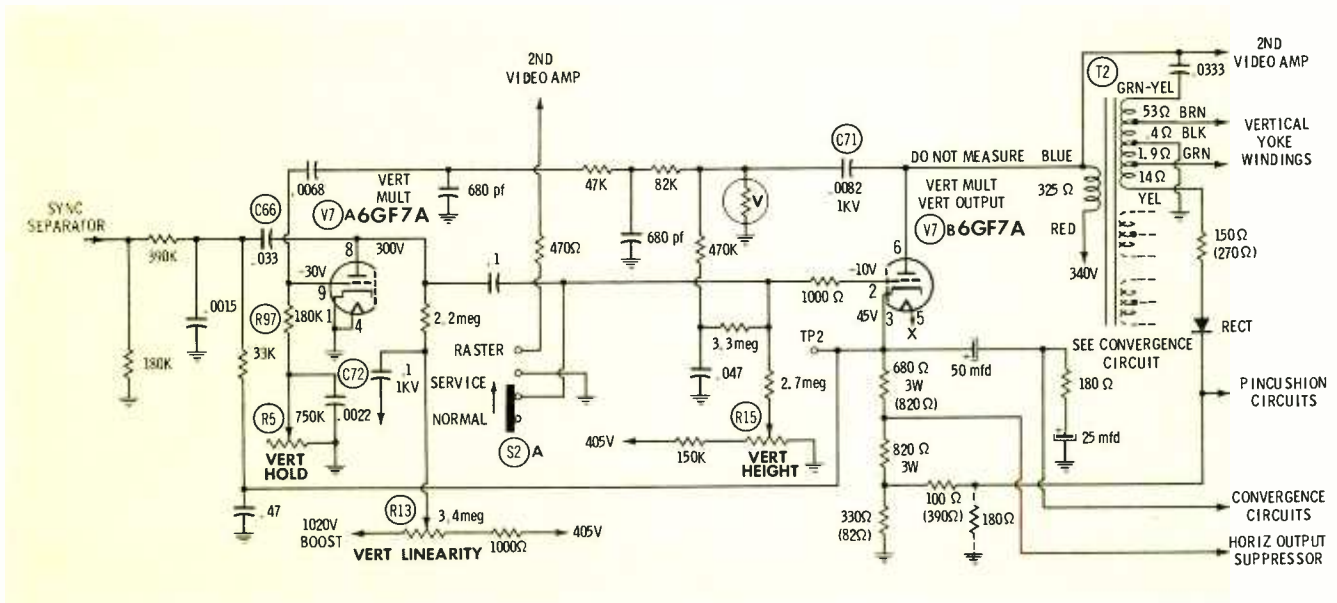


Fig. 1. Vertical sweep circuit employed in RCA Chassis CTC25.

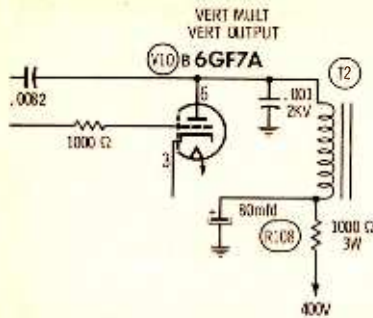


Fig. 2. Increase in plate supply resistor reduced height.

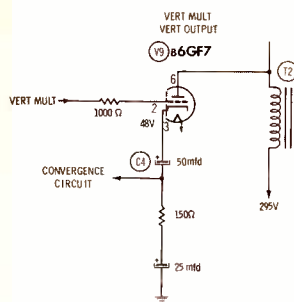


Fig. 3. Capacitor in cathode circuit caused intermittent height.

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

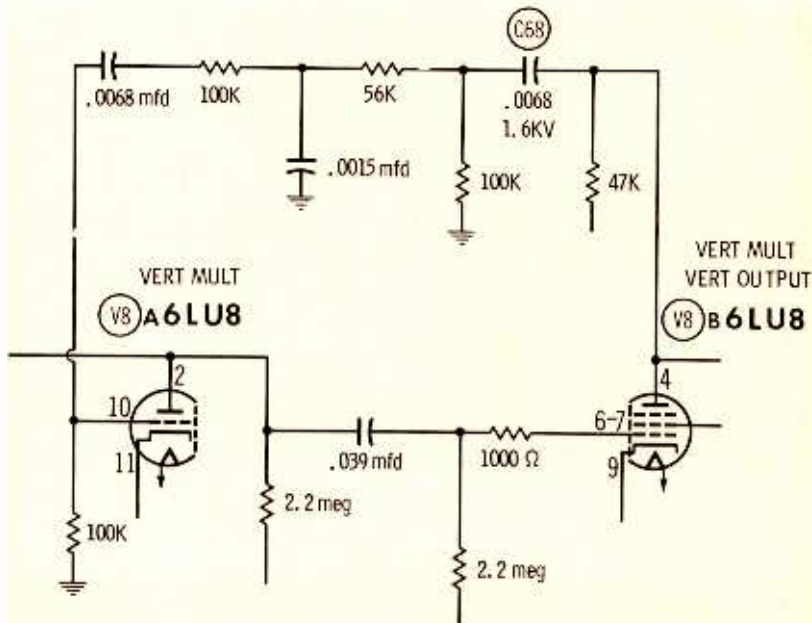


Fig. 4. Poor solder joint collapsed raster of Admiral G13 chassis.

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 losing 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-

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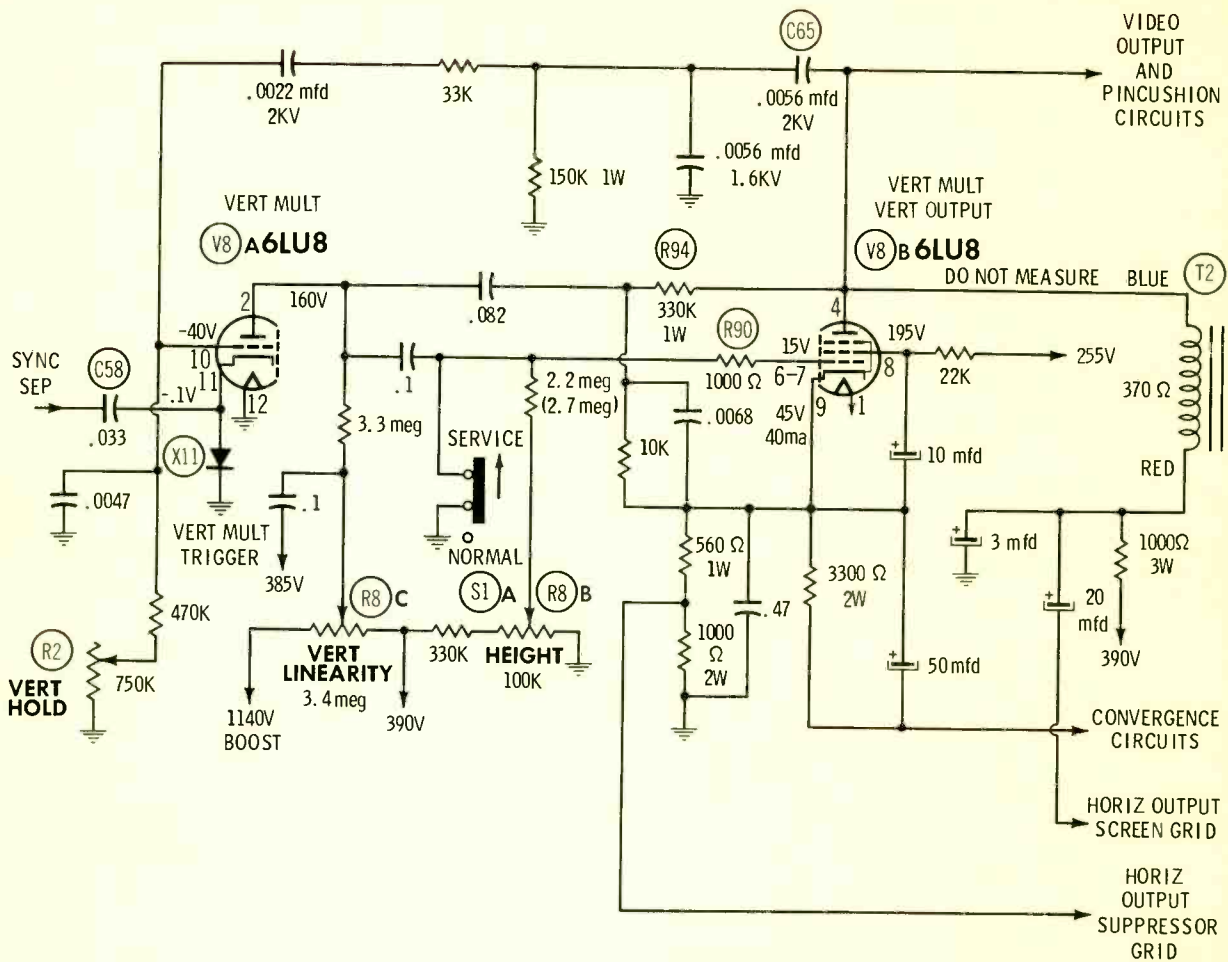


Fig. 5. Vertical multiplier trigger diode caused slow roll.

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 chas-



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

sis. 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

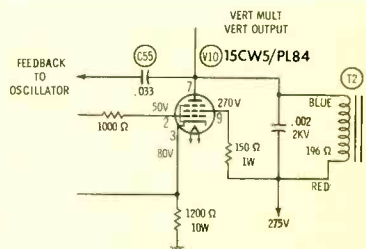


Fig. 7. Leaky capacitor in plate circuit reduced raster size.

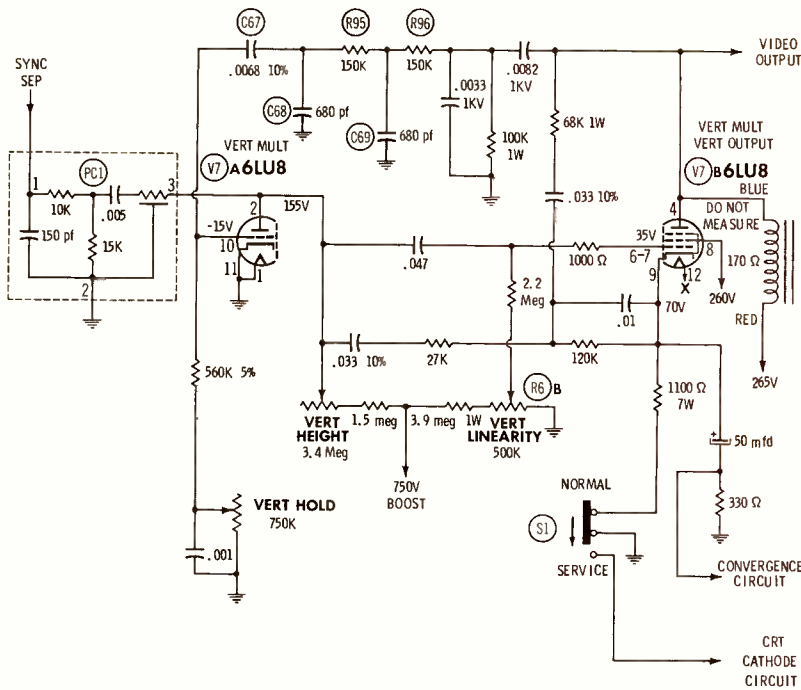


Fig. 11. Leaky feedback capacitor resulted in intermittent roll.

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.

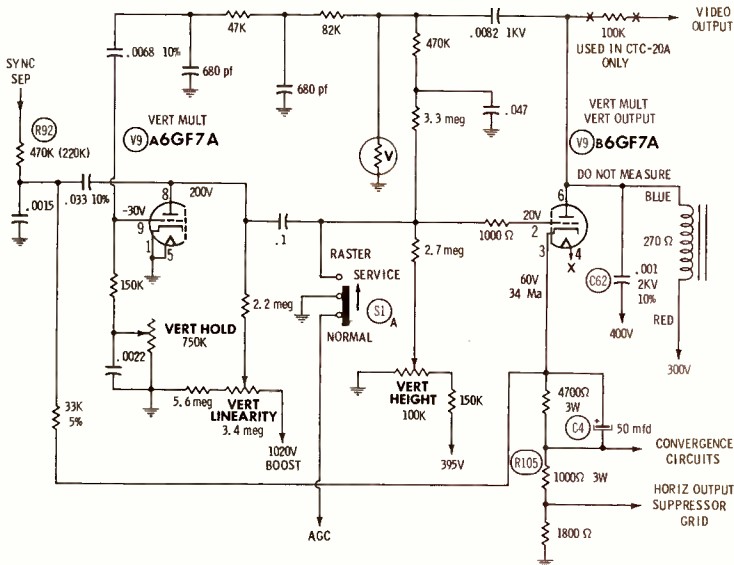
Roll

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-



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 transistor 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.

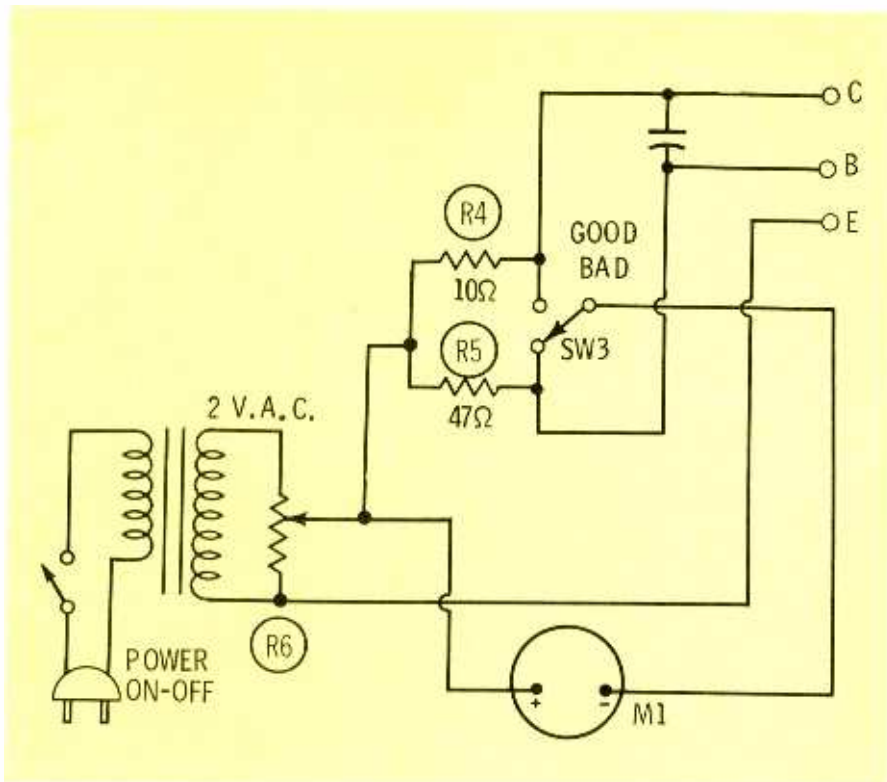


Fig. 2. Simplified schematic of the in-circuit test.

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 μ A, 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 HC 8 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.

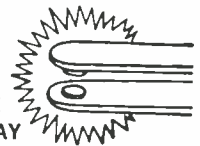
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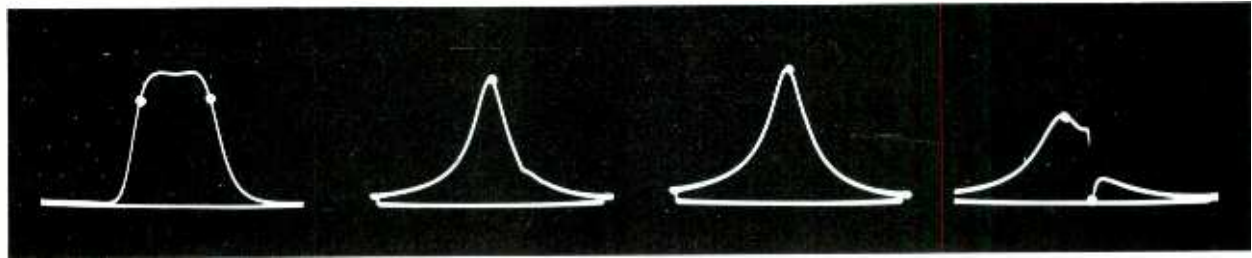
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SWEEPING COLOR IF AMPLIFIERS

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 man-

ner: 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-

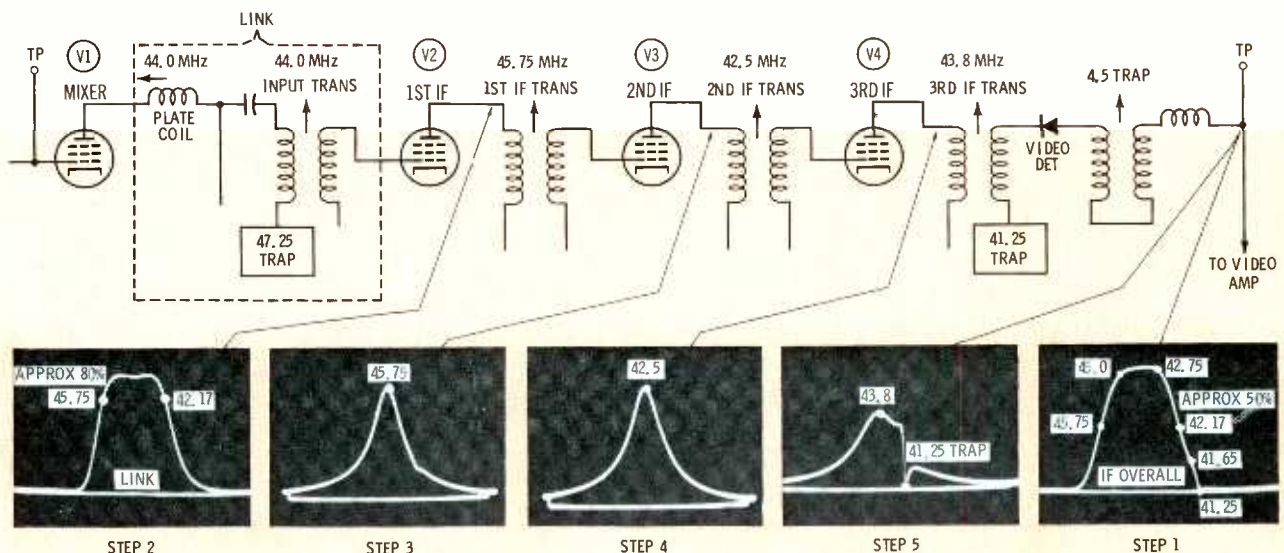


Fig. 1. Simplified stagger-tuned IF system with sweep responses.



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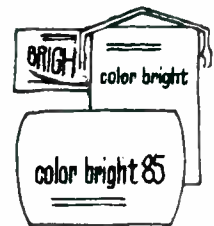
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other. "Tough-dog" troubles such as smear, loss of resolution, ghosts, and/or ringing, are often hard to isolate to one particular stage using normal voltage and resistance checks. These symptoms are usually caused by improper alignment due to poor 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 con-

structed 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

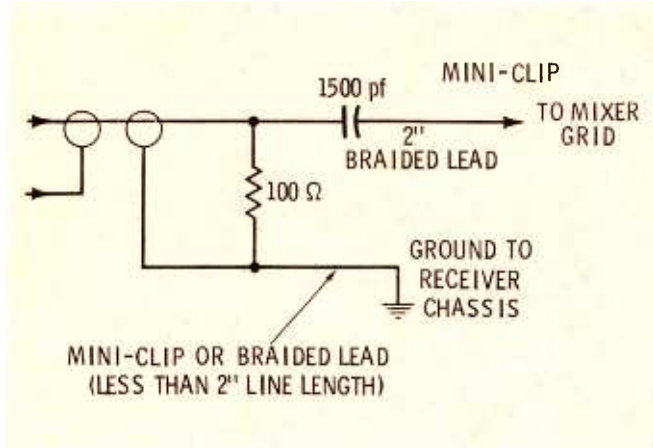


Fig. 2. Schematic of matching pad.

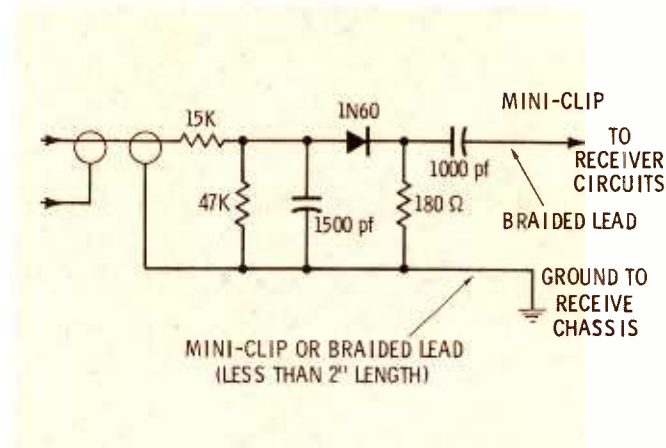
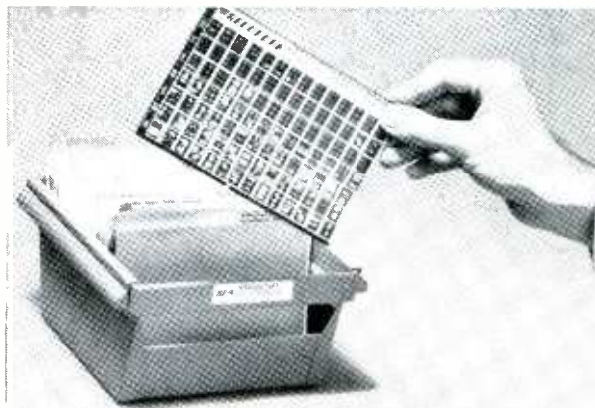


Fig. 3. Schematic of detector probe.

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 CAPACITOR XC3-45	 CAPACITOR XC4-4.2	 CAPACITOR XC4-5.1	 CAPACITOR XC4-6.1
 CAPACITOR XC4-9.1	 CAPACITOR XC4-10.2	 CAPACITOR XC4-55.1	 CAPACITOR XC4-63.1
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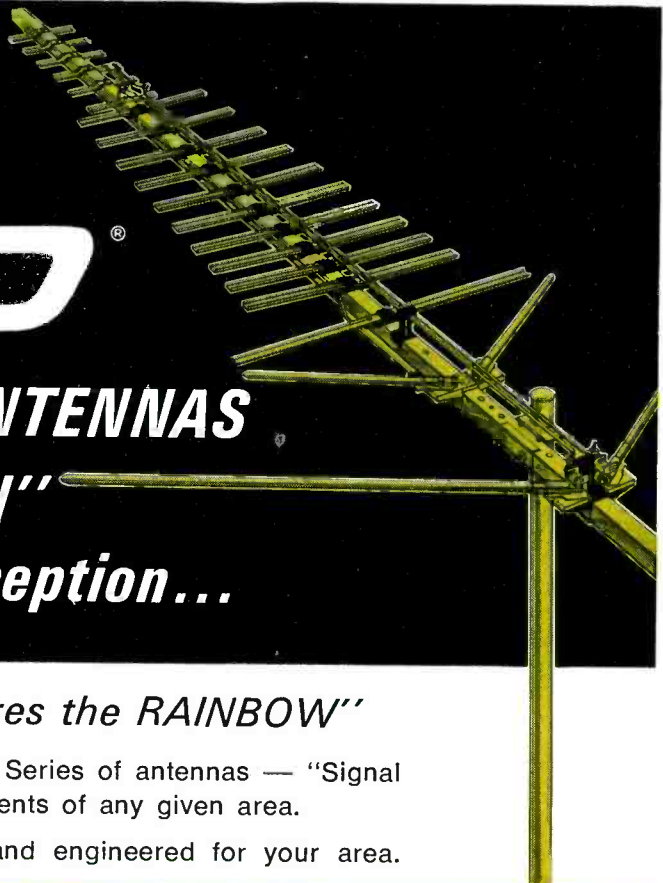


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"the ANTENNA that captures the RAINBOW"

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There is a model scientifically designed and engineered for your area.

Check this chart for the FINCO "Signal Customized" Antenna best suited for your area.

STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION ▼	Strength of VHF Signal at Receiving Antenna Location				
	NO VHF ▼	VHF SIGNAL STRONG ▼	VHF SIGNAL MODERATE ▼	VHF SIGNAL WEAK ▼	VHF SIGNAL VERY WEAK ▼
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



NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable downlead where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

THE FINNEY COMPANY

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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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You'd expect a wide band scope of this quality to cost at least double."—W. L., Chicago, Ill.

"With the PS127, I find I can trouble-shoot those tough ones twice as fast as before—especially color TV."—F. C., Burlingame, Calif.

"Once I compared the specs, I knew Sencore had the best buy in scopes. We now have three PS127's in our shop."—J. S., Ft. Lauderdale, Fla.

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Vert. Freq. Resp. 10 CPS to 4.5 MC \pm 1 db, - 3 db @ 6.2 MC • Rise Time .055 Microseconds • Vert. Sens. .017 Volts RMS/inch • Horiz. Freq. Resp. 10 CPS to 650 KC • Horiz. Sens. .6 Volts RMS/inch • Horiz. Sweep Ranges (10% overlap) 5 to 50 CPS, 50 to 500 CPS, 500 CPS to 5 KC, 5 to 50 KC, 50 to 500 KC • Input Impedance 2.7 megohms shunted by 99 MMF, 27 megohms shunted by 9 MMF thru low-cap. jack • High Voltage Probe 5000 Volts Max. • Dimensions 12"x9"x15½", Wt. 25 lbs. • Price Complete \$199.50



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November, 1967/PF REPORTER 47

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But what's really important is what happens when all those features are sandwiched into one super-performing, super-compact antenna.

And just in case you don't know yet, we'll tell you what happens.

First off, you get an antenna so powerful and with such pinpoint directivity (even without solid state pre-amps) that it eliminates ghosts and snow more effectively than anything you've ever seen before.

And when you drop-in an instant-loading pre-amplifier (there are eight to choose from not counting the color spectrum filter) you've got yourself an antenna that does just about anything you want it to do, just about anywhere—

especially when it comes to color tv.

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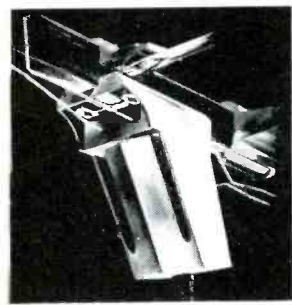
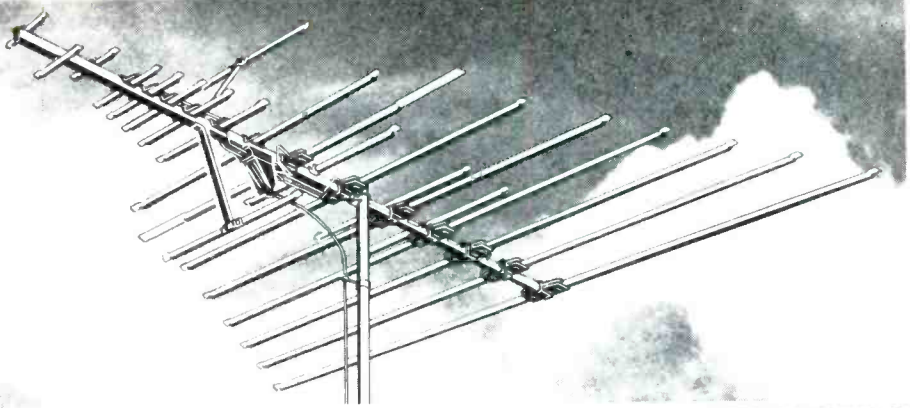
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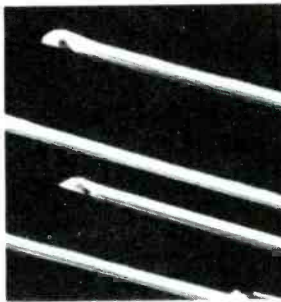
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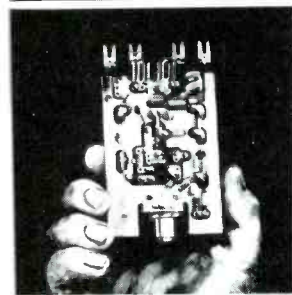
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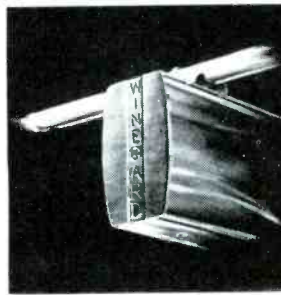
Download and Pre-Amplifier Housing—permanent housing is built into the antenna; provides complete weather-proofing for download connector cartridge or pre-amp cartridge.



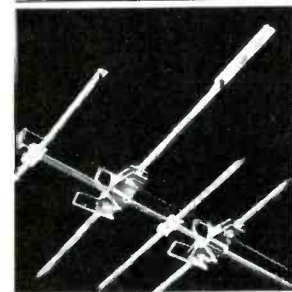
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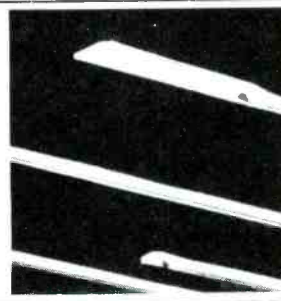


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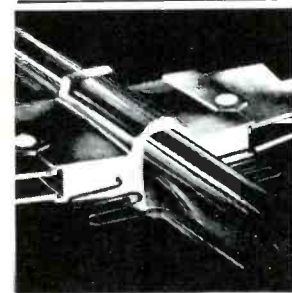


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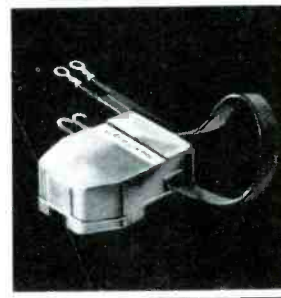
*U. S. Patent No. 2700105
Canada No. 511984



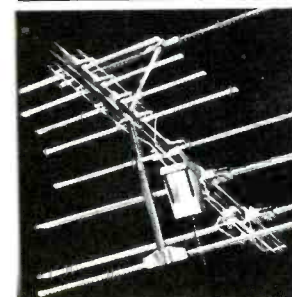
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shown in Fig. 6. Construction is simple and lead length is not really critical.

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

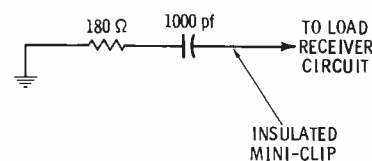


Fig. 6. Schematic of IF load.

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One reason is that the U.S. doesn't permit anyone to service two-way radio systems unless he is licensed by the FCC (Federal Communications Commission). And there aren't enough licensed electronics experts to go around.

Another reason two-way radio men earn so much more than radio-TV service men is that they are needed more often and more desperately. A two-way radio user *must* keep those transmitters operating at all times, and *must* have them checked at regular intervals by licensed personnel to meet FCC requirements.

This means that the available licensed experts can "write their own ticket" when it comes to earnings. Some work by the hour and usually charge at least \$5.00 per hour, \$7.50 on evenings and Sundays, plus travel expenses. Others charge each customer a monthly retainer fee, such as \$20 a month for a base station and \$7.50 for each mobile station. A survey showed that one man can easily maintain at least 15 base stations and 85 mobiles. This would add up to at least \$12,000 a year.

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(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 over-coupled 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 trans-

former 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.

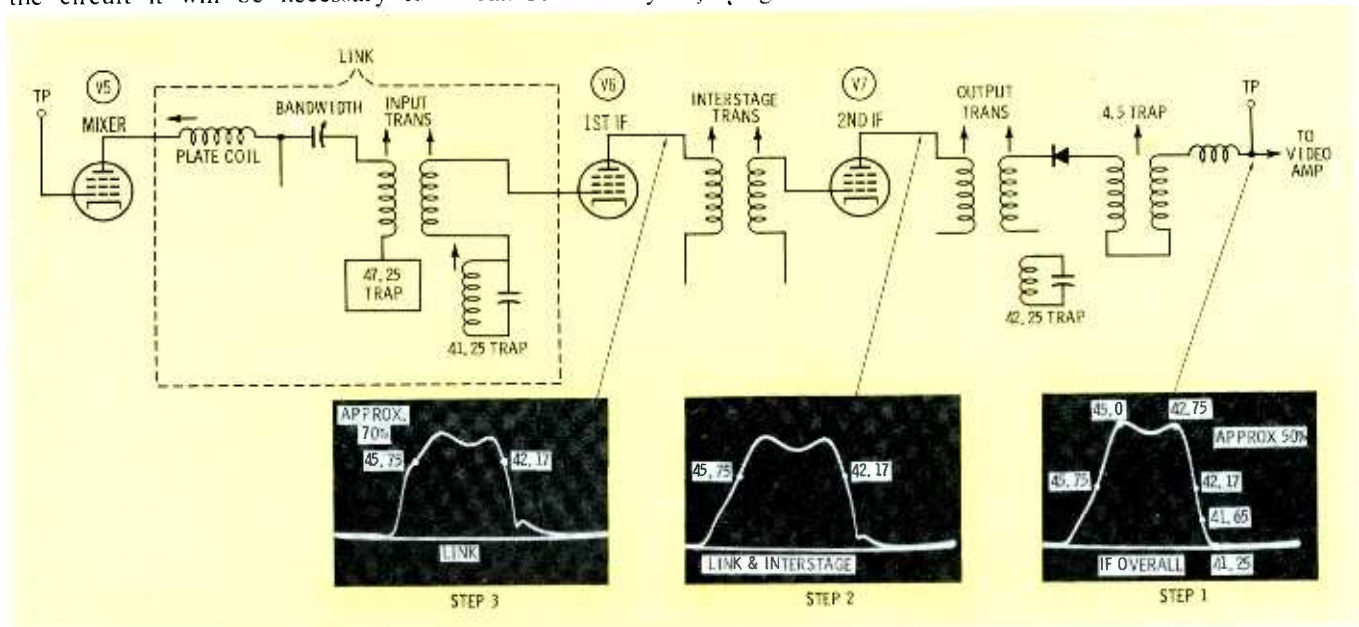


Fig. 7. Simplified double-tuned IF system with sweep responses.

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 re-

sponse 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-

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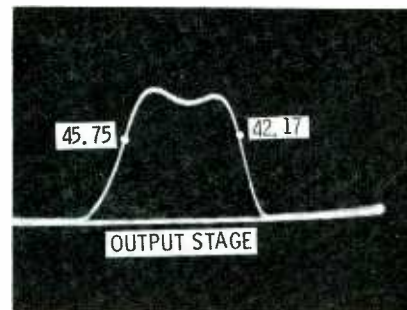
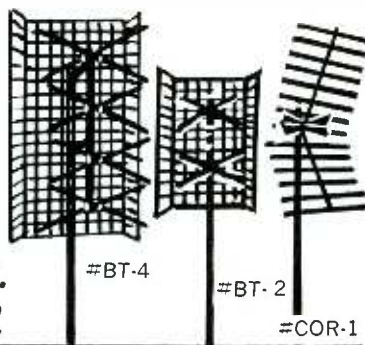




Fig. 8. Output stage response.

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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.



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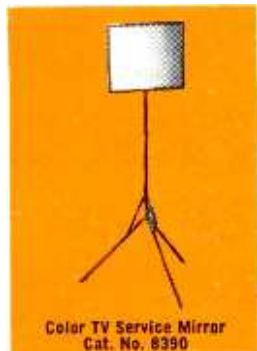
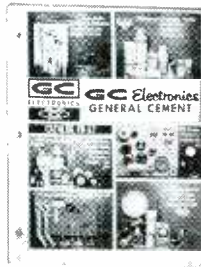
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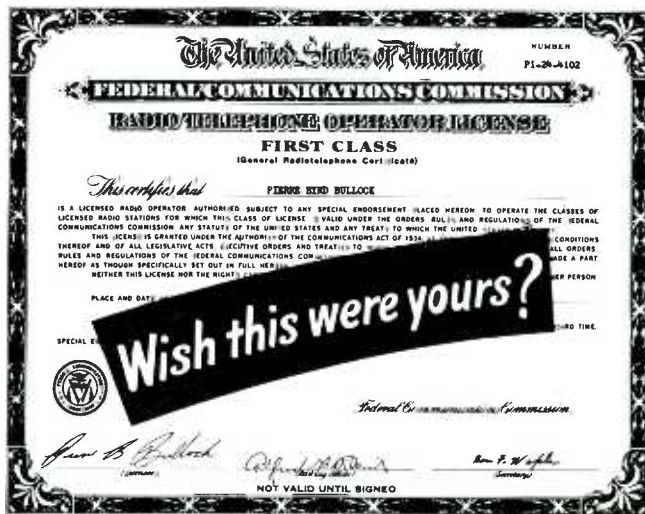


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The same IF sweep signal in the 45.0-MHz range is coupled to the mixer grid test point. The scope, via a direct probe, is then connected to the output of the video detector. In this step, we are checking the overall response of the IF amplifier stages 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.

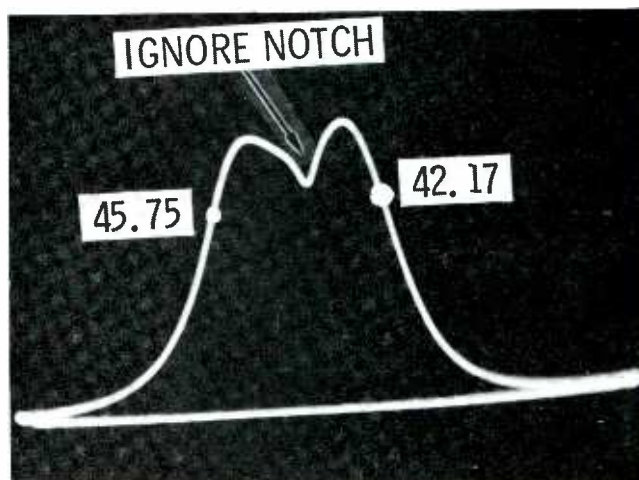
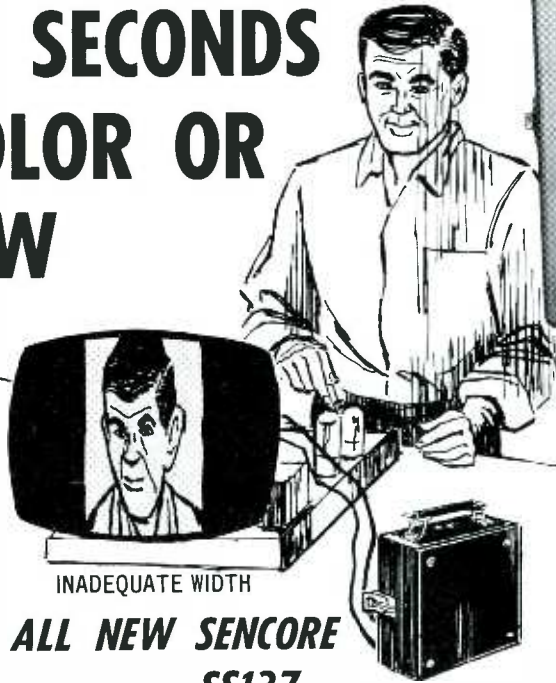


Fig. 9. Interstage response curve.

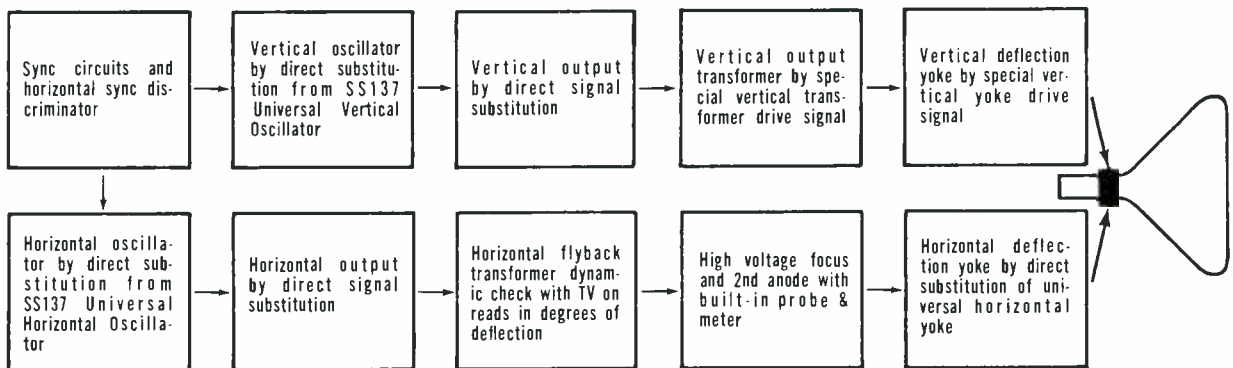
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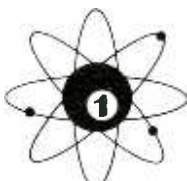


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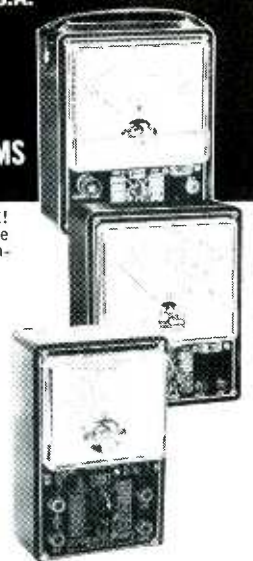
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VOLOMETER

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 4 1/2", 2% accurate, 800 μ a D'Arsonval type meter. One zero adjustment for both resistance ranges. High impact bakelite case. 5 AC voltage ranges: 0-12-120-600-1200-3000v. 5 DC voltage ranges: 0-6-60-300-600-3000v. 5 db ranges: -4 to +64db. 5 AC current ranges: 0-30-150-600ma. 4 DC current ranges: 0-6-30-120ma; 0-1.2A. 2 resistance ranges: 0-1K, 0-1 meg. 5 1/4" W x 6 3/4" H x 2 7/8" D.

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Model 102A
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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 connected 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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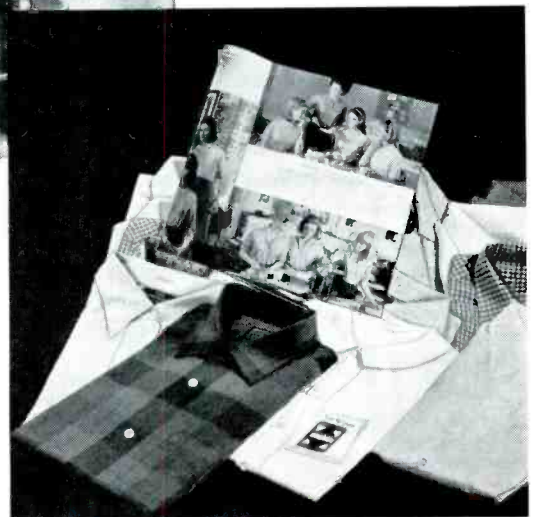
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In the stagger-tuned IF system, the response of the individual stages can be viewed independent of the other stages. It's not a good idea to depend on the visual DC indication from a VTVM to check the action or adjustment in the IF stage.. Once RF 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 troubleshooting jobs much easier. ▲

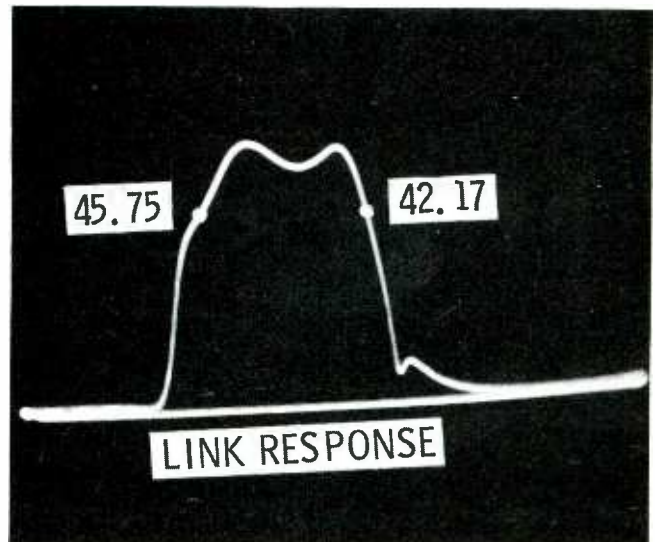


Fig. 10. Response curve of the link.

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

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November, 1967 / PF REPORTER 59

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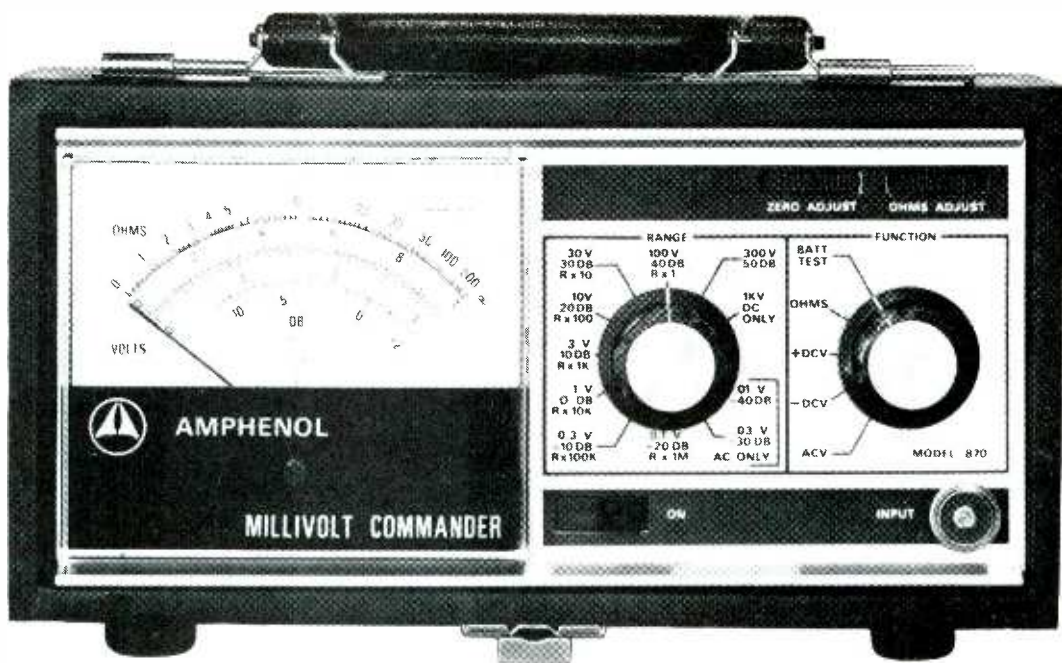
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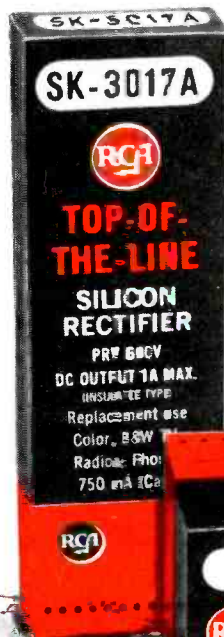
RCA SK-Series transistors and rectifiers and the 9,000 types they replace are cross-referenced in the RCA Solid-State Replacement Guide. It's a handy booklet listing comparably-rated types including industry standard EIA types, foreign types, and those identified only by device manufacturers' or equipment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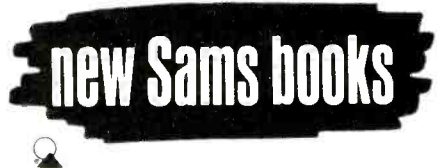
Know Your Sweep Generators



by Robert G. Middleton. This detailed reference book explains the basic principles of sweep alignment, methods of f-m test-signal generation, and the proper operation of beat-frequency generators and associated instruments. Describes practical troubleshooting methods for generators. Explains generator kit construction and how to avoid common errors; how to check the flatness of generator output, how to measure sweep width, and how to calibrate the completed instrument. A useful "refresher" book for old-timers, and a valuable basic reference for the beginner. Makes an excellent text for technical institute and junior college use. 176 pages; 5½ x 8½". Order 20593, only... \$325

ABC's of Radio & TV Broadcasting

by Earl J. Waters. A fascinating explanation of what goes on at the transmitting end in radio and television broadcasting. Describes how the radio and television signals are formed, built up, and transmitted, and in the process, provides a basic understanding of transmitter principles and operation. Here is a full explanation of how radio energy is developed and radiated from an antenna, how it is made stronger, and how it carries an audio and video signal. Also details the use of accessory systems, such as power supplies, antennas, and remote transmission equipment. A readily understandable book. 128 pages; 5½ x 8½". Order 20575, only... \$225



FET Circuits

by Rufus P. Turner. Since field-effect transistors (FET) are now commercially available at lower prices, interest in their use is growing. While this book begins with the principles of FET operation and describes their construction, it stresses the application of FET's in practical circuits. Describes oscillator and amplifier circuits and shows examples for use in receivers, transmitters, and accessory equipment. Also covers types of test instruments where circuitry can use FET's to advantage. All circuits described have been tested to verify their effective performance; a number of these may help generate ideas for designers and experimenters. Appendices include basing diagrams of the FET's covered in the book, and a list of manufacturers. 160 pages; 5½ x 8½". Order 20585, only... \$325

Citizens Band Radio Handbook (3rd Ed.)

by David E. Hicks. This latest edition of an extremely popular book, is the comprehensive, authoritative work on all aspects of CB. It is a complete guide for anyone who uses CB equipment, for the service technician who installs and maintains CB gear, and for anyone planning a CB purchase. Describes some of the latest equipment (including solid-state) and accessories to help you select the proper gear for a specific application. Explains how to obtain a license and required operating procedures. Also describes transmitter and receiver circuitry; antennas; installations, both fixed and mobile; adjustments, maintenance, and servicing procedures. Appendices include complete Part 95 of the FCC Rules and Regulations, radio districts of the U.S., and a glossary. 192 pages; 5½ x 8½". Order 20569, only... \$425

Fundamentals of Digital Magnetic-Tape Units

by UNIVAC Division of Sperry Rand Corp. Provides a thorough background for understanding magnetic-tape units which are coming into wide use for information storage. Presents the basics concerning magnetism and magnetic fields and shows their application in magnetic tape recording. Describes in detail recording heads and tape-handling mechanisms. Explains the circuits required for writing and reading magnetic tape. Shows the latest recording techniques applicable to the most recent digital recording processes. Includes many illustrations. Review questions are included at the end of each chapter. An invaluable book for computer operators, programmers, and maintenance and servicing personnel. 96 pages; 5½ x 8½". Order 20580, only... \$225

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Circle 67 on literature card

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. ▲



JEWELRY for your best gal— STUNNING PINS

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Perma-Power

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Brightening up is a Perma-Power specialty, although it's usually directed at faded picture tubes. Vu-Brite and Tu-Brite boost picture tube brightness, and boost your popularity with your customer. Always keep both kinds on hand!



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Circle 38 on literature card

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BAD

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- No numerical readings to interpret.



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One Year Warranty

IN-CIRCUIT TESTS. Positive Good/Bad in-circuit and out-of-circuit testing. No numerical readings to interpret. In-circuit testing is a measurement of dynamic AC gain. No transistor leads to unsolder or disconnect.

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PNP OR NPN determined immediately . . . no set-up book needed for testing.

NON-DESTRUCTIVE TESTING. Regardless of misconnections, you cannot damage transistors or components tested.

SPECIFICATIONS

- Large easy to read 6" meter • 3 color-coded test leads with self-storing feature • Power and Milliwatt Sockets on panel for ease of out-of-circuit testing • Zener Diode Regulated Power Supply • All steel case • Size: 10½" x 7" x 4" • Wt. 5½ lbs. • 115 volts, 60 cycles.

NET 87⁵⁰



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LECTROTECH, INC.

1221 W. Devon Ave., Chicago, Illinois 60626

Circle 39 on literature card

COLOR

COUNTERMEASURES

SYMPTOMS AND TIPS FROM ACTUAL SHOP EXPERIENCE

Chassis: RCA CTC24

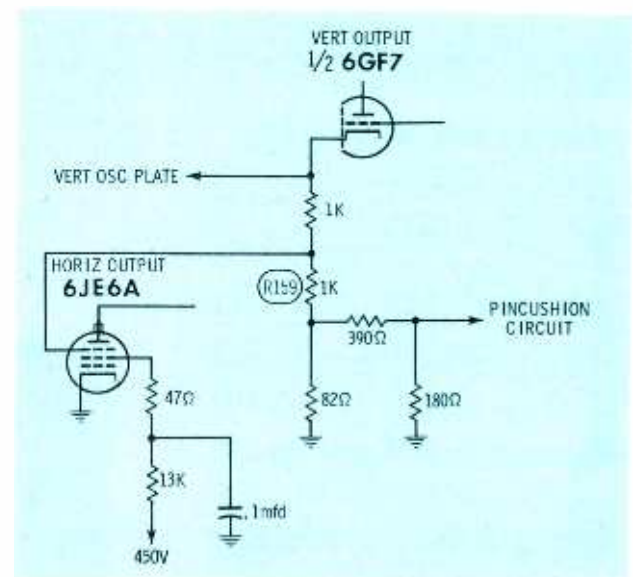
Symptoms: Vertical jitter.

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 fluctuation 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.



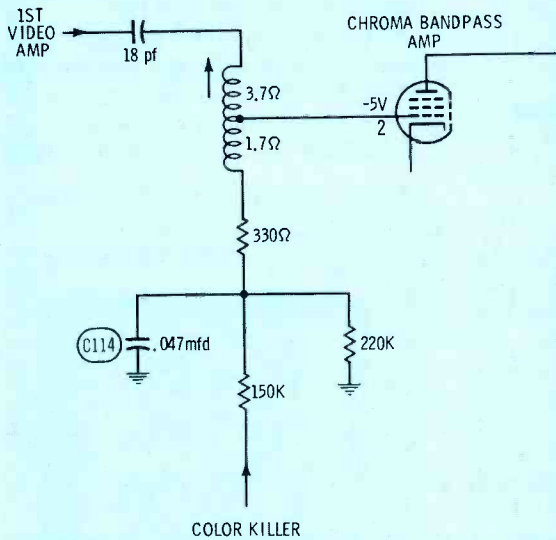
Chassis: RCA CTC12, 15

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.

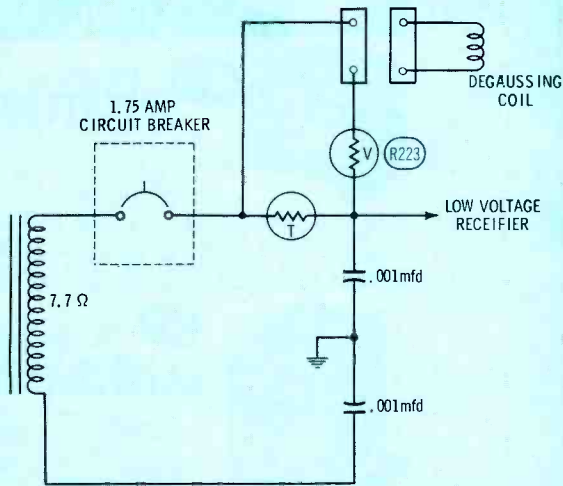
If screen temperature shifts when color and/or tint is adjusted, look for open C114 (.047 mfd) in grid circuit of bandpass amplifier. Unbypassed horizontal pulses applied to grid circuit cause tube to conduct during burst interval.



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.



MOVING?

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Why is a Vectorscope essential for Color TV servicing?

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Color Vectorscope: Until now, available only in \$1500 testers designed for broadcast use. Accurately measures color demodulation to check R-Y and B-Y, for color phase and amplitude. A must for total color and those hard-to-get skin tones. **Self-Calibrating.** Adjust timing circuit without external test equipment. **Dial-A-Line.** Adjust horizontal line to any width from 1-4 lines. **Solid State Reliability** in timer and signal circuits. **Plus:** All Crosshatch, Dots, Vertical only, Horizontal only and Keyed Rainbow Patterns. RF at channels 3, 4 or 5. Video Output (Pos. and Neg. adjustable) for signal injection trouble-shooting. Red-Blue-Green Gun. Killer. All transistor and timer circuits are voltage-regulated to operate under wide line voltage ranges. Lightweight, compact—only 8¼x7½x12½". **NET 189⁵⁰**

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For the full story, see your distributor or write for literature.
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LECTROTECH, INC.
1221 W. Devon Ave., Chicago, Ill. 60626

Circle 40 on literature card

November, 1967/PF REPORTER 67

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 con-



vert 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 1/2" x 4 1/2" x 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



fat, ugly machine that can make you a lot* of money.

Just so you'll be sure . . . it's an oven. Not for pies. Nor cakes. Not even for pizzas. It's for television picture tubes, and performs chores like tube evacuation, cathode bombarding, induction heating, and more. Most important, it is part of the exclusive Windsor System of picture tube rebuilding — your key to a business you can run (right along with what you're doing right now), and make extra money with in amounts you might not have thought possible (like \$4,000, \$5,000, \$10,000 a year and more!).

Sound good? Then send for the full story. Write direct, or circle our number right away. Who knows, that happy guy in the picture could be you.

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MODEL 610C-ELIF . . . 6 volts at 10 amps, or 12 volts at 6 amps. Shipping weight 22 lbs.

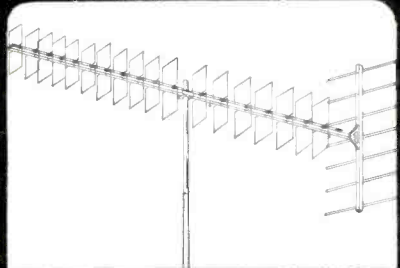
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This system in which there are no electrical connections,

PROVIDES HIGH GAIN ACROSS THE ENTIRE UHF BAND

and eliminates noise caused by loose elements at high frequencies. High overall gain across the entire UHF band makes this antenna more desirable than any frequency conscious yagi types being marketed today. Excellent color reception assured. More gain than a Parabolic. Top quality construction.

Write for literature and low retail prices. All inquiries given prompt attention.

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Phone 419-693-0528

Circle 45 on literature card

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 9½" × 2½". The design provides fool-proof operation so that

NEW

Model 2900

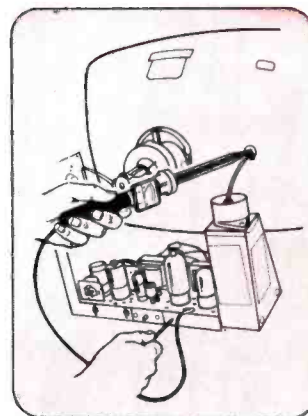
FROM POMONA ELECTRONICS

30 KV CRT TEST PROBE with built-in meter

New self-contained unit – small enough to carry in a tube caddy – tests high voltage on any color or black & white television set.

The CRT High Voltage Test Probe built by Pomona Electronics is the most advanced instrument of its kind on the market; the only test probe featuring a built-in voltmeter. It is easy to make high voltage adjustments in the home because the unit is small enough to fit in a tube caddy. You save repeated call-backs, and keep your customers happy.

Easy to operate! Just ground the test probe instrument by attaching alligator clip to chassis, contact test probe tip to high voltage anode, read voltage from the built-in meter, and adjust as required. No warm-up time. No batteries.



Patent Pending

SPECIFICATIONS

Range: 30,000 volts DC **Sensitivity:** 20,000 ohms/volt (50 µa) movement
Accuracy: ±3% full scale **Multiplier Resistance:** 600 Megohm ±2% **Material:** Handle – high impact thermo plastic
Probe – high impact polystyrene
Length: 14¾" **overall Weight:** 8 ounces.

MODEL 2900 NET \$19.95

SOLD ONLY BY
ELECTRONIC PARTS DISTRIBUTORS

POMONA ELECTRONICS CO., INC.

1500 East Ninth Street, Pomona, California 91766
Telephone (714) 623-3463



Circle 44 on literature card

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



Knuckle-Saver.



Putting a sleeve on a connection can be frustrating. (If your hand slips, it can also be rough on the knuckles.)

Why not use Krylon Crystal Clear Spray Coating instead?

Krylon forms a hard, waterproof coating that stops many of the causes of high-voltage section loss and picture

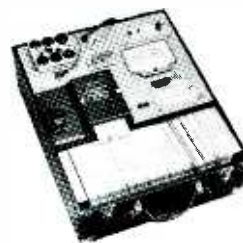
fading. It doesn't dry out or crack. It prevents rusting.

Try it. All you have to lose are a few skinned knuckles.

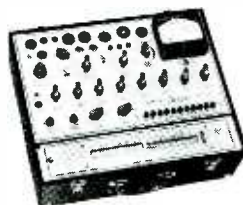
Krylon Crystal Clear...standard equipment for all TV/Radio installation and repair work.



HICKOK



123R CARDMATIC TUBE TESTER—Automatic tube testing using card-programmed switch, eliminates errors. A fast, automatic tube tester which includes tests for saturation and cut-off in addition to mutual conductance.
\$655.00



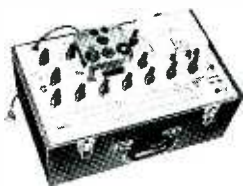
580A TUBE TESTER— Entirely new. Can be set up to any test condition, including handbook parameters. Also includes built-in roll chart. Features ultra-sensitive grid condition test with sensitivity to 0.05µa.
\$585.00



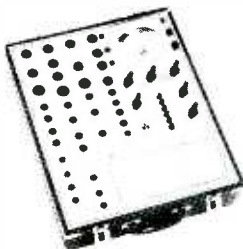
539C TUBE TESTER— Laboratory and industrial instrument. Provides both handbook condition tests and tests "tailored" to specific individual conditions. Roll chart data.
\$545.00



752A TUBE TESTER— Communications and industrial maintenance instrument. Includes tests for 4-digit industrial tube types, VR tubes, and low power thyratrons. Best buy for general purpose industrial maintenance. Roll chart data.
\$385.00



6000A TUBE TESTER— Service technician's high-speed, portable tester. Tests all popular entertainment types, also transistors and diodes. Time-saving leakage and short indicators. Replaceable socket plate for obsolescence protection. Roll chart data.
\$259.50



799 MULTI-SOCKET TUBE TESTER— Ideal for television service and repair. Provides true mutual conductance tests with no paralleled elements. Solid state sensing circuit provides 50 megohm leakage tests, 0.1µa gas and grid emission tests. Replaceable panel plate for future tube additions.
\$199.95

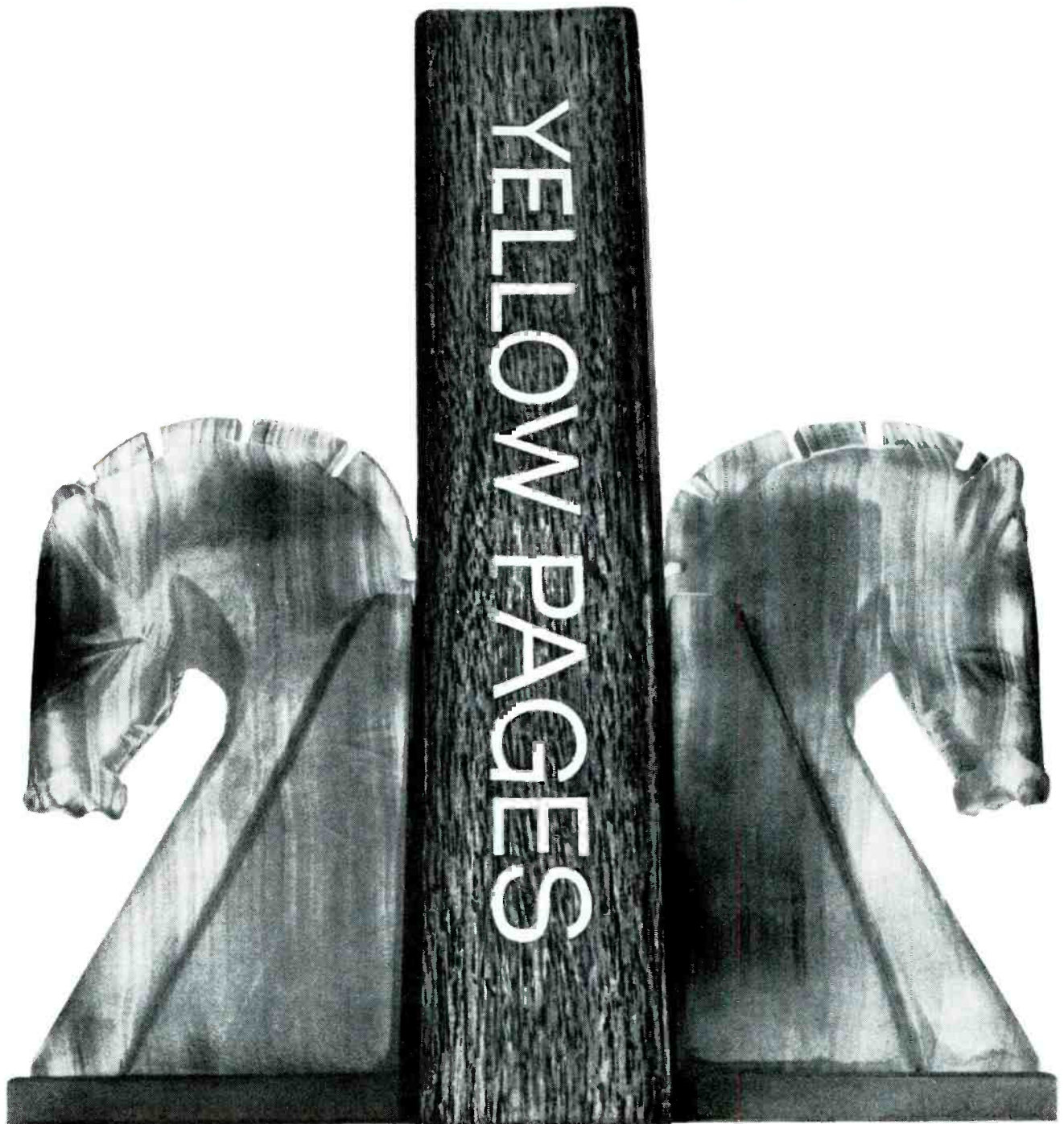
THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 Dupont Avenue • Cleveland, Ohio 44108

Circle 47 on literature card

The book they open just to read the ads.

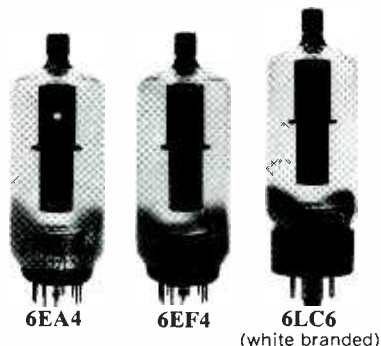
If you want to be sure your business
customers read your advertising,
try putting some of it in this book.

When a businessman
settles back with a good
Yellow Pages, he's not
looking for entertainment.



Reward

for the recovery of each of these shunt regulator tubes



General Electric has discovered that certain of its large screen color TV sets containing these high voltage regulator tubes could emit soft X-radiation in excess of desirable levels.

Almost all of the sets which might have this potential X-ray emission have been found and modified with a new regulator tube specially designed for the purpose. We are now conducting a nationwide search for the remaining obsolete regulator tubes.

We are looking for these tubes in two ways. **Those in use** in any model General Electric color television set. **And new tubes in cartons**, on shop shelves, in trucks and kits.

Now here's how you can help us and pick up your reward.

First, look for the above tube types of any brand in every large screen GE color set you service. If you find one, remove it and return it to this address:

General Electric Product Service Section
Northern Concourse Building
North Syracuse, New York 13212

For every one you turn in, you will receive a check for \$5.00 plus a new replacement tube at no extra charge. To qualify, you need only to provide the customer's name and address and the model and serial number of the TV set serviced.

Second, should you have unused tubes bearing these numbers in your shop or truck, send them to the following address, and you will receive a check in the amount of 50% of list price (plus transportation expense) for each and every tube returned:

General Electric Company
Building #12, Old Hartford Road
P.O. Box 1008
Owensboro, Kentucky 42301

Remember, every used tube will get you \$5.00 when mailed to Syracuse. And every new, cartoned tube when mailed to Owensboro will bring you a check worth 50% of the list price.

If you haven't seen it, we recommend you ask your GE Distributor for a copy of GE's recent "Service Talk" on X-ray precautions in servicing color TV receivers.

GENERAL ELECTRIC



FREE Electronics Data Guide

Want help in working out those tricky electronics calculations? Send for our FREE Electronics Data Guide. This heavy-duty plastic guide fits right in your shirt pocket—gives you instant reference to over 40 indispensable electronics formulas...plus conversion factors, color codes and decibel table as well. Saves you time and the trouble of memorizing or "looking it up." A "must" for every man interested in electronics—provided as a service by CIE. Why not get your FREE Data Guide today? Just fill in your name and address below, then cut out this ad and mail it to:

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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.

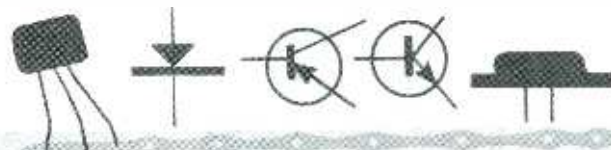
Although the preceding two models provide no boost, other Color-Brite units are available for color



PHOTOFACTTM 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
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	CTC22B/C	917-1
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Truetone	WEG1815A-77 (2DC1815A), WEG1817A-77 (2DC1817A)	913-2
Production Change Bulletin		
Catalina	1220662B, 122-666B	913-3



TEST TRANSISTORS IN SECONDS in circuit

TR139
\$89⁵⁰



Also check all
transistors, diodes,
and rectifiers out
of circuit for true AC beta
and Icbo leakage.

Your best answer for solid state servicing, production line testing, quality control and design.

Sencore has developed a new, dynamic in-circuit transistor tester that really works—the TR139—that lets you check any transistor or diode in-circuit without disconnecting a single lead. Nothing could be simpler, quicker or more accurate. Also checks all transistors, diodes and rectifiers out of circuit.

BETA MEASUREMENTS—Beta is the all-important gain factor of a transistor; compares to the gm of a tube. The Sencore TR139 actually measures the ratio of signal on the base to that on the collector. This ratio of signal in to signal out is true AC beta.

ICBO MEASUREMENTS—The TR139 also gives you the leakage current (Icbo) of any transistor in microamps directly on the meter.

DIODE TESTS—Checks both rectifiers and diodes either in or out of the circuit. Measures the actual front to back conduction in micro-amps.

COMPLETE PROTECTION—A special circuit protects even the most delicate transistors and diodes, even if the leads are accidentally hooked up to the wrong terminals.

NO SET-UP BOOK—Just hook up any unknown transistor to the TR139 and it will read true AC beta and Icbo leakage. Determines PNP or NPN types at the flick of a switch.

Compare to laboratory testers costing much more. . . \$89.50

See America's Most Complete Line of Professional
Test Instruments — At Your Distributor Now.



NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT

SENCORE

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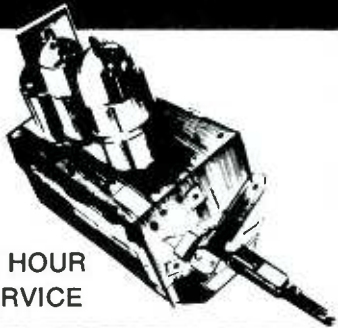
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November, 1967/PF REPORTER 73

Speedy TUNER REPAIR

FAST SERVICE

ONE YEAR WARRANTY



24 HOUR
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COLOR • UHF • VHF

\$950 (\$14.50 COMBO)
COMPLETE

Includes all parts
(except Trans. & Tubes)

We are new in name only—
Behind every tuner repair is
15 yrs. of experience. Our base
price is compatible with other
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and high quality workmanship
makes our service cheaper
in the long run. Send the defective
tuner with all parts, include
tubes, make, model No. and
complaint. Pack well and insure.
All tuners returned C.O.D. unless
accompanied by an open check.
(Dist. write for price structure)



**SUPERIOR
TUNER SERVICE**

1377 N. CURRY PIKE
BOX 368

Bloomington, Indiana 47401

Circle 53 on literature card

74 PF REPORTER/November, 1967



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-

NEW FROM INJECTORALL



HERE'S PROOF!

PROOF that "SUPER 100"
tuner cleaner is BETTER!

Tested by a leading independent
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	SUPER 100	A	B	C
CLEANING	Excellent	Good	Fair	Fair
LUBRICATION	Good	Fair	Fair	Poor
PLASTIC ATTACK	None	None	None	None
FLAMMABILITY	None	None	None	None
CONDUCTIVITY	None	None	Slight	Slight
ANTI-STATIC PROTECTION	Excellent	Fair	Poor	Poor
DRIFT	None	Slight	Yes	Yes



SUPER 100 TUNER CLEANER . . . for COLOR
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6 oz. spray can with INJECTORALL steel needle
CAT. NO. 100-6 net \$1.95

Buy it at your Electronic Parts Dealer.
For free catalog on the complete line, write to:

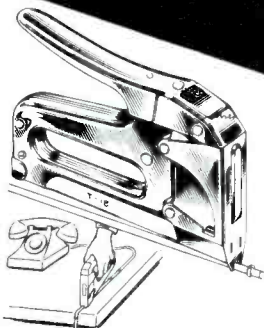
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Automatic
STAPLE GUN TACKERS

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SAFE — FAST — SECURE
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Uses round crown
staples in
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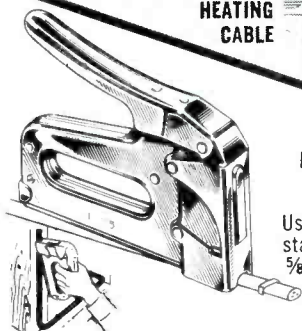
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low voltage
wiring.



No. T-25
For wires up to
1/4" in dia.
Uses round crown
staples in 9/32",
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Fastens same wires
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Also
used for
RADIANT
HEATING
CABLE



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For Almost A Half Century"

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50,000

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- Emission Test at full rated cathode current
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- Mighty Mite accurately checks over 3,000 tubes, including foreign



NEW MIGHTY MITE V TC142

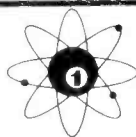
Now, Sencore's new Mighty Mite V gives you the same reliability and accuracy, plus new features that make the "V" the most up-to-date tester of all.

- NEW—Magnoval socket so you check many more tubes.
- NEW—Horizontal in-line switch layout saves setup time.
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The new TC142 is truly Sencore's mightiest Mighty Mite and it's only

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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 an-

nounced 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-

1968

Howard W. Sams PUBLICATION. 

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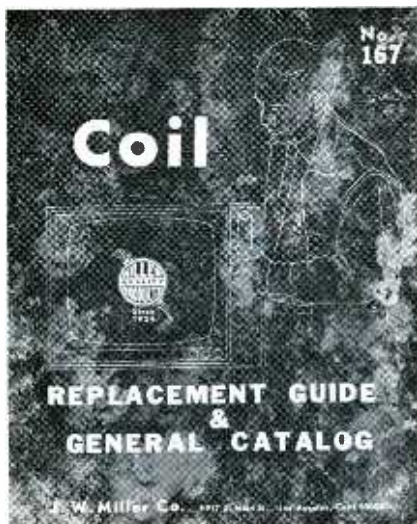
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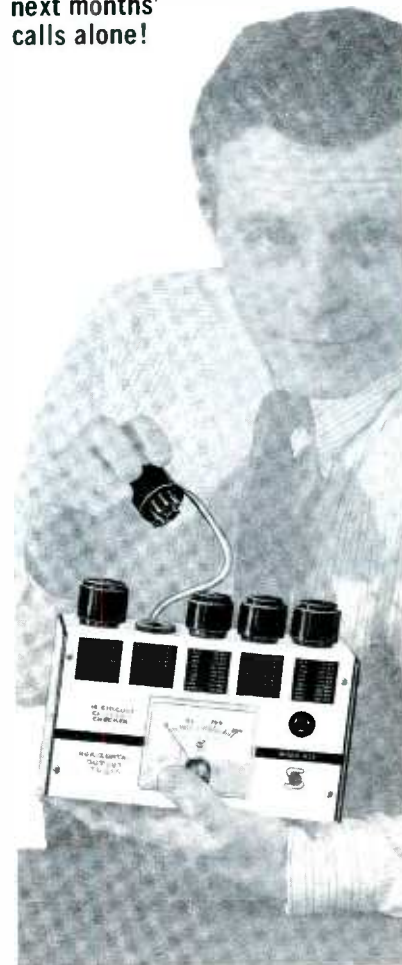
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November, 1967 / PF REPORTER 77

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TEST AFTER TEST HAS PROVEN
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- To cause no drifting

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3. Frequency of Issue—Monthly.
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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, Unac- counted, Spoiled After Printing	3,839	4,665
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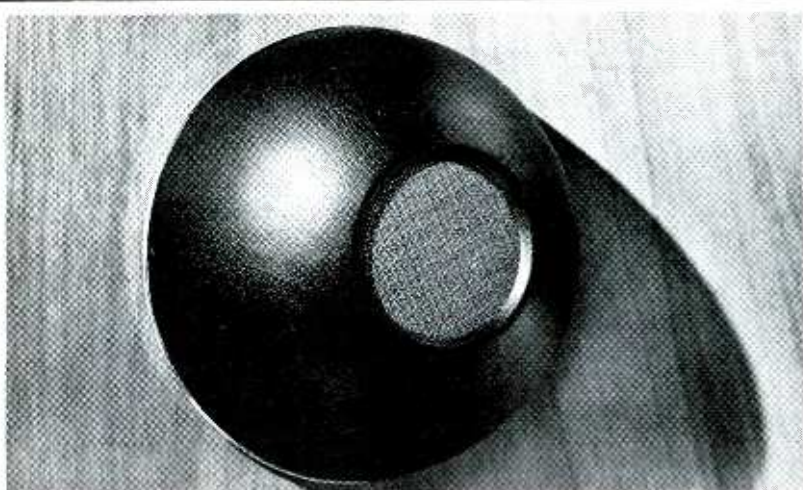
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102. *CORNELL-DUBILIER* — NEW 4-page brochure with instructions for installation of AR10B Skyline Series rotor.*
103. *DELHI*—Twelve-page catalog introducing a complete new line of home TV towers, ham towers, citizen's band towers, masts and telescoping 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. *SPAUDLING*—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. 671) 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 VTM 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

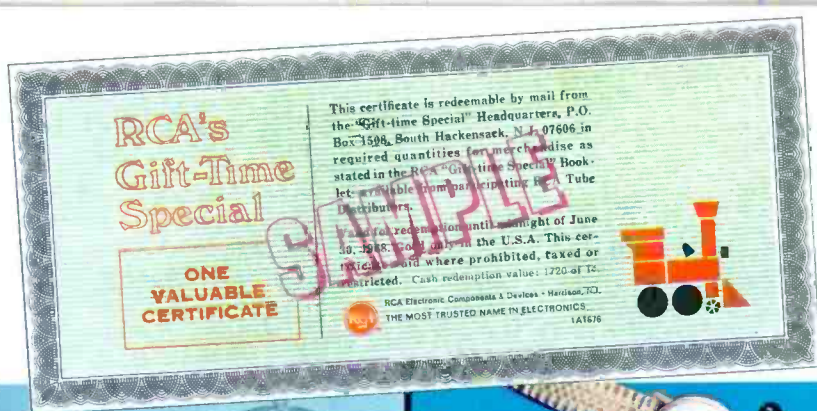
156. *ARROW*—Catalog sheet showing 3 staple gun tackers designed for fastening wires and cables up to 1/2" diameter
157. *CHANNELOCK*—General catalog No. 66 features the entire line of hand tools.
158. *DIAMOND*—16-page booklet, W-68, lists wrenches, pliers, snips, and electronic tools.
159. *ENTERPRISE 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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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.

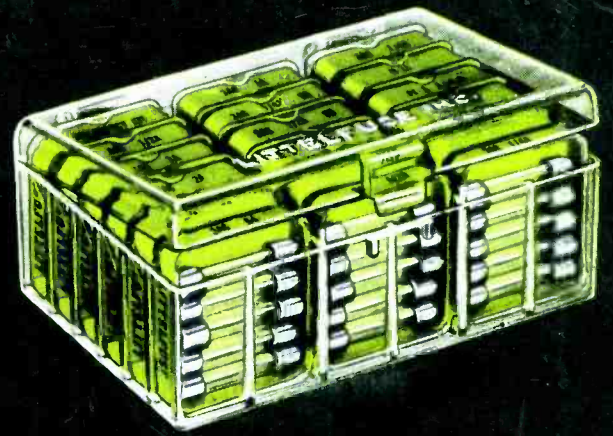
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