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GE Electronic TUBES
Techni-talk on AM, FM, TV Servicing

COLOR RECEIVERS—1

Colorimetry and the NTSC System were covered in earlier issues of Techni-Talk (Vol. 6, No. 1 through Vol. 7, No. 3 and Vol. 8, No. 2). The basic design, adjustment and servicing of color receivers will be discussed in this and forthcoming issues.

REVIEW OF NTSC SIGNAL

Before describing the receiver, the NTSC signal will be briefly reviewed. This will enable easier understanding of the color receiver. The NTSC signal consists of two major components, i.e., the "Y" or brightness signal and the color or chroma information. The characteristics of the brightness signal are as follows:

THE "Y" OR BRIGHTNESS SIGNAL

1. The output of the color TV camera is composed of three color signals, i.e., red, green and blue. Specific percentages of these signals are used to produce the "Y" signal. This "Y" or brightness signal makes the NTSC system compatible since it is the signal used to produce black and white pictures on monochrome receivers. The "Y" signal is used in the color receiver to produce detail as well as brightness. Although the "Y" signal does not provide any color information, it is used as a reference signal to establish color brightness levels. The "Y" signal is composed of 30% red, 59% green, and 11% blue. These color signals are derived from the color camera video output. This mixture closely resembles the color response of the human eye and provides a more natural gray scale when the color scene is viewed on a monochrome receiver. If the reader has operated a color receiver during a color program, it is the "Y" signal which appears as a monochrome picture when the "chroma" control is turned to its minimum position.

2. The "Y" signal also contains synchronizing information which is practically the same as monochrome sync. The scanning rates are only slightly different for color. The vertical frequency is 59.94 cycles per second for color and 60 c.p.s. for monochrome. The horizontal frequency is 15734.26 c.p.s. for color and 15750 c.p.s. monochrome. These differences are so small that they present no problem in receiver synchronization.

3. The "Y" signal is transmitted at full system bandwidth, up to approximately 4.2 mc, and therefore contains all of the picture detail ordinarily found in monochrome transmissions. In conclusion it should be noted that the "Y" signal serves two functions: (1) It provides a high definition signal which a monochrome receiver will reproduce as it would a normal black-and-white signal. (2) It conveys the high definition brightness information which will be combined in the color receiver with the "chroma" information. The combination of these two components will provide complete red, green, and blue voltages which will be applied to the color picture tube.

THE CHROMA OR COLOR SIGNAL

Since the monochrome receiver produces a picture which represents only changes in brightness level, the information presented by the "Y" signal is adequate for black and white picture reproduction. It will be recalled that in order to reproduce a color picture three components are required: i.e., brightness, hue, and saturation. Inasmuch as the brightness component is supplied by the "Y" signal, the chroma signal need only supply the other two components, hue and saturation. The characteristics of the chroma signal are as follows:

1. A considerable amount of investigation has shown that the human eye does not need high detail color information to appreciate a color scene. Because of this only low detail color information is transmitted.

2. The low detail color signal is obtained by subtracting the "Y" component from the red, green, and blue camera outputs leaving R-Y, G-Y and B-Y color difference signals. Actually, only R-Y and B-Y are produced. G-Y is not necessary, since this can be synthesized in the receiver. Specific proportions of R-Y and B-Y color difference signals are combined to provide the "I" and "Q" chrominance components which are then passed through low-pass filters to restrict their bandwidth and, therefore, provide low detail color.

3. The "I" and "Q" signals are transmitted in the form of sidebands related to a 3.579545 mc (3.58 mc) subcarrier. These sidebands are interleaved with the sidebands of the "Y" signal.

4. The 3.58 mc subcarrier is suppressed in the transmitter chroma modulators to reduce a constant interfering "beat" between it and the picture carrier.

5. A reference burst of 3.58 mc is transmitted on the back porch of each horizontal sync pulse, as shown in Fig. 1. This burst of 8 cycles of 3.58 mc provides a synchronizing reference for the color detectors in the receiver.

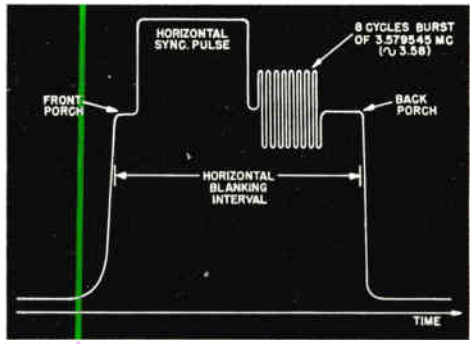


Fig. 1. Location of "burst" signal on back porch of horizontal sync pulse.

6. The phase of the chroma sidebands varies with respect to the reference burst to produce instantaneous changes in "hue." The phase changes of the chroma signal supply the "hue" component necessary for color reproduction.

7. The amplitude of the chroma sidebands varies in accordance with the instantaneous degree of color saturation. These changes in the amplitude of the color signal supply the "saturation" component. The color signal is therefore simultaneously phase and amplitude modulated to convey the instantaneous nature of each color picture element.

8. The two chroma signals I and Q have different bandwidths and therefore occupy different proportions of the 6.0 mc channel as shown in Fig. 2. The Q signal has an approximate bandwidth 0.5 mc above and below the subcarrier. The frequency of the I signal extends well below the subcarrier and 0.5 mc above. It should be noted that channel frequency limits and the sound and video carrier frequency allocations are precisely the same as for a monochrome transmission. This is an absolute necessity in order to have a compatible color system.

9. The subcarrier frequency is precisely 3.579545 mc above the picture carrier frequency. To assure minimum visibility of cross talk between the brightness signal and color signal, the subcarrier frequency must be an odd multiple of half the line frequency. In fulfilling this requirement the horizontal frequency turns out to be 15734.26 c.p.s. and the vertical frequency 59.94 c.p.s.

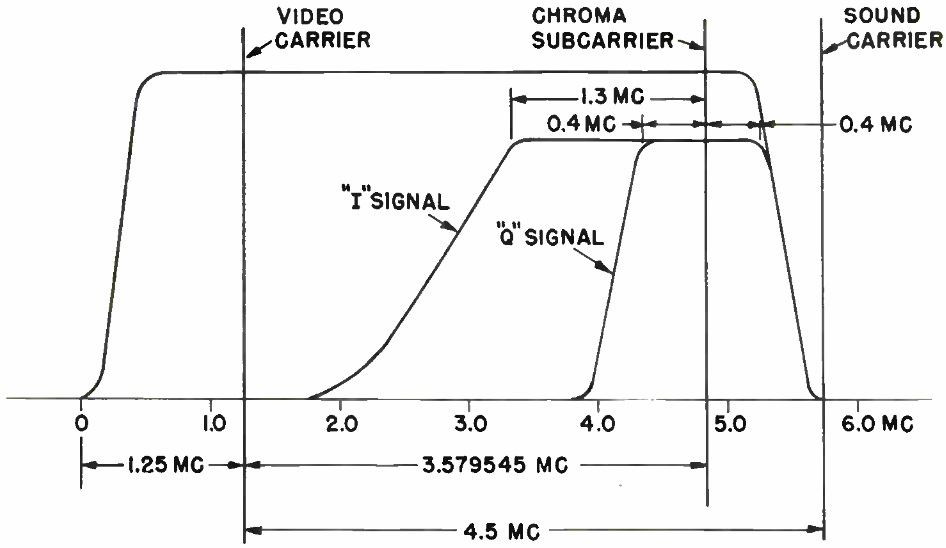


Fig. 2. Six-megacycle television channel showing position and bandwidth of chroma signals.

The composition of the transmitted NTSC signal has been briefly described. The methods used by the receiver to convert this NTSC signal to a color picture will now be discussed.

THE COLOR RECEIVER

A simplified block diagram of a color receiver is shown in Fig. 3. The portion on the left of the color tube typifies a monochrome receiver and the portion on the right represents the additional circuits required for color.

The function and repair of monochrome circuits should be familiar to most service technicians. Defects which occur in monochrome receivers occur in the same circuits of a color receiver. Most service technicians should, therefore, be able to recognize and repair defects in color receivers which are common with monochrome receivers. There are slight differences in the design and tolerances of some circuits and these differences will be discussed in this series.

The function and repair of those circuits in the chroma section at the right of Fig. 3 will not be familiar to the monochrome technician. These circuits will be described and discussed in greater detail than those circuits which are common to both types of receivers.

THE TUNER UNIT

The tuners used in color TV receivers are practically the same as those used in monochrome sets. There are slight but important differences which are not readily apparent either in the appearance or in the schematic of color tuner units. The unseen differences usually lie in the r-f alignment and oscillator drift tolerances. When servicing color receivers, the technician will have to be extremely careful not to disturb the alignment of the tuner circuits.

The monochrome tuner is usually designed and aligned to produce channel bandpass curves similar to either 4A, B, C, or D. Any one of these curves, if used for color reception, would cause the subcarrier and its sidebands to be altered to such a degree as to cause color distortion.

Color TV tuners are designed and aligned to produce curves similar to Fig. 5A, B, C, or D. The ideal curve would be similar to Fig. 5A, but 5B, C, and D show the limits which are acceptable.

The frequency range of the fine tuning control in color receiver tuners is usually narrower than that encountered in monochrome tuners. Since proper color reproduction requires a channel passband curve within the limits shown in Fig. 5, any appreciable change in the oscillator frequency will change the relative positions of the carrier and subcarrier frequencies and cause either color distortion or a complete loss of color. The tuner must therefore have a minimum of oscillator frequency drift plus limited fine tuning range for ease of adjustment.

Experience has shown that tuners in monochrome receivers normally require very little servicing. Since the color tuner must operate more precisely than the monochrome tuner, there is a possibility that additional service problems may occur. As an example, it *may* be necessary

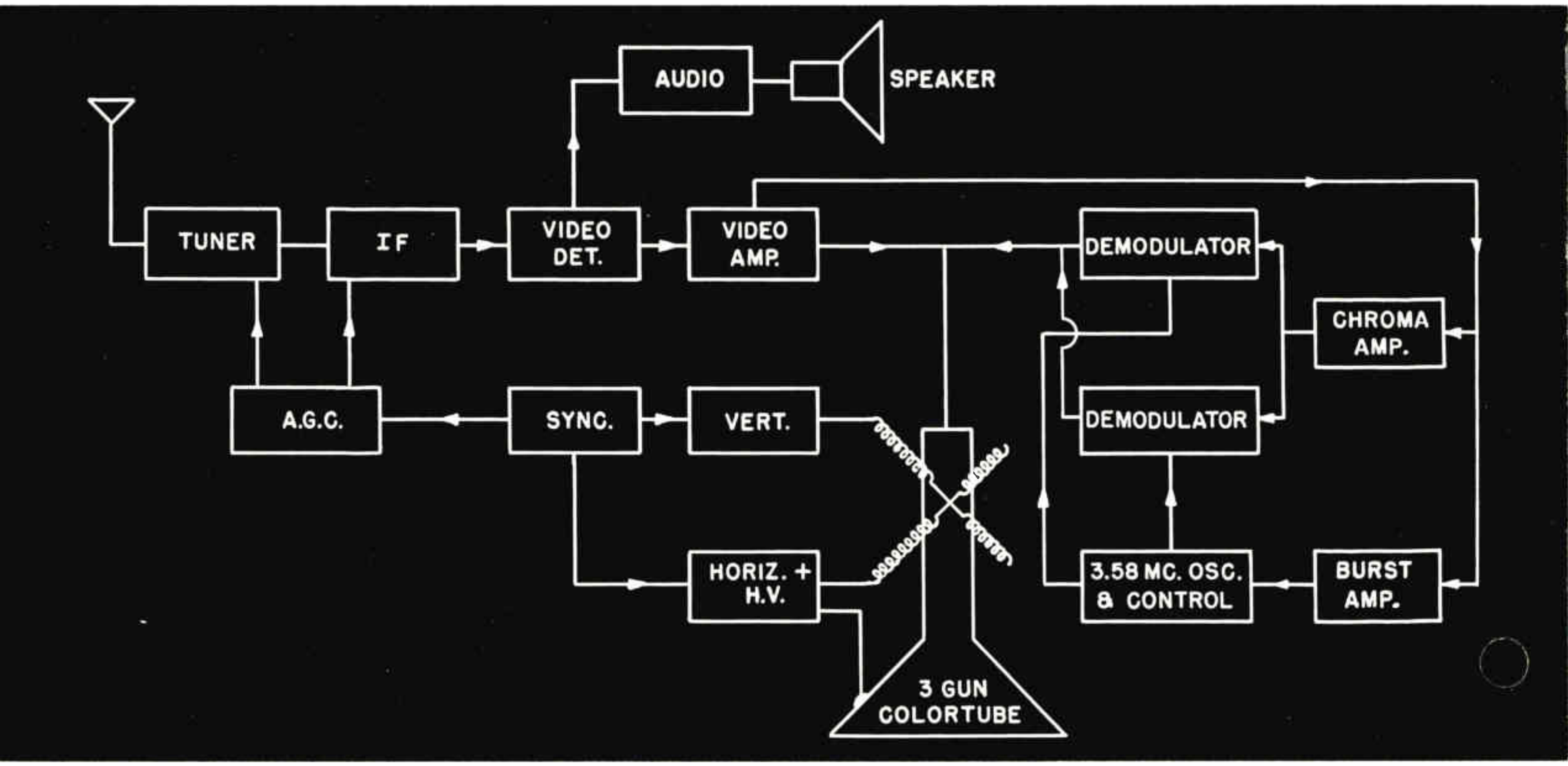
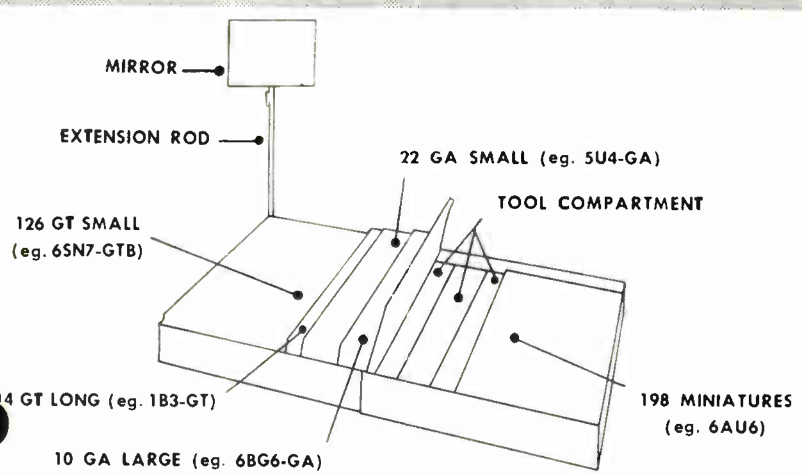


Fig. 3. A simplified block diagram of a color receiver.

G-E SUPER DELUXE TV SERVICE CASE HOLDS UP TO 370 TUBES PLUS TOOLS

Save trips! Save time! This new design enables you to carry the full tube complement and the tools you need for home-service calls. Holds up to 370 tubes with all type numbers visible, yet caddy weighs only twelve pounds. Used tube cartons can be replaced upside-down to give visual inventory and stock rotation (see below). Equipped with metal-backed mirror, extension rod and tool compartment. Durable, baked-on finish, continuous piano-type hinge, welded compartments, heavy-duty fittings, leather handles and canvas-web shoulder strap. Size $19\frac{3}{4}$ in. x $19\frac{1}{4}$ in. x 7 in. Color—grey.



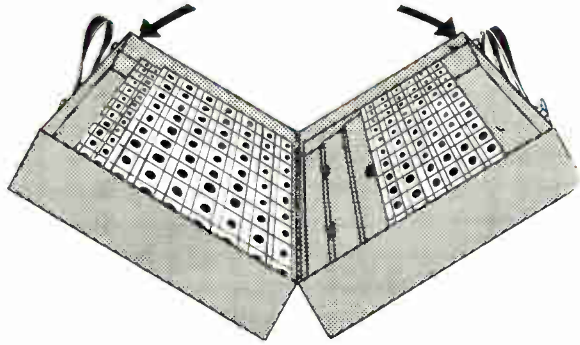
ETR-1315 | **Super Deluxe TV Service Case**

ETR-1320 | **Replacement Mirror for ETR-1315**

UTILIZE YOUR SERVICE CASE FOR MAXIMUM EFFICIENCY

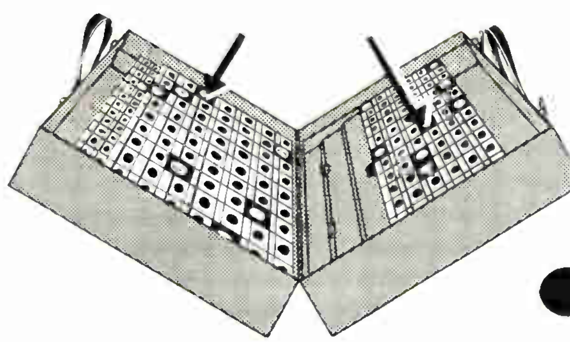
Your case is flexible . . . carry the quantity of tubes best suited to your needs.

The case is designed to hold tubes in place by (1) "friction fit" between tubes in each row and, (2) tubes in opposing rows pressing against one another. Therefore, if you carry a full case of tubes, *be sure that all rows are completely filled.* However, if you desire to carry fewer tubes, *be sure to leave opposing rows completely empty.* (See illustration)



Your case allows visual inventory and good stock rotation.

When a tube is used on a service call, the empty carton should be replaced in the case upside down to maintain the "friction fit" between tube cartons. Also, cartons placed "bottom up" indicate replacement is needed when you return to the shop.

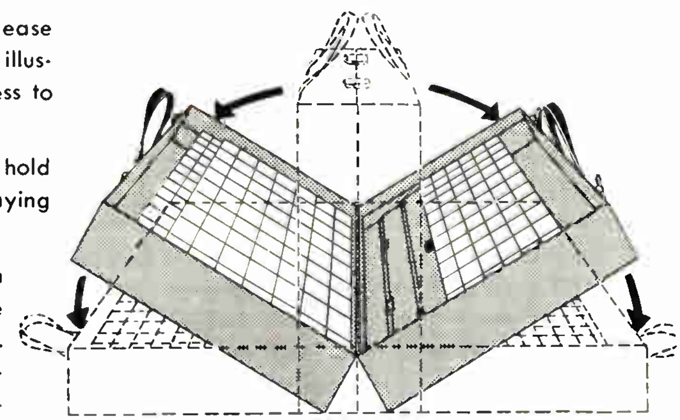


Your case is easy to open . . . gives full view of all tubes.

To open the case, place it on end, release catches, and open like a book. (See illustration.) You will then have easy access to tubes and tools.

Remember, the "friction fit" will not hold tubes in place if case is opened while laying on its side.

To unlock your tool compartment, open the lunch-box type clip through the opening in the tool compartment cover. To relock the compartment automatically, return the clip to the closed position, then close the cover.



Set the case on this end.

MAXIMUM TUBE CAPACITY SAVES TRIPS—SAVES TIME

Available thru your G-E Tube Distributor. Ask about your SUPER DELUXE TV SERVICE CASE today!

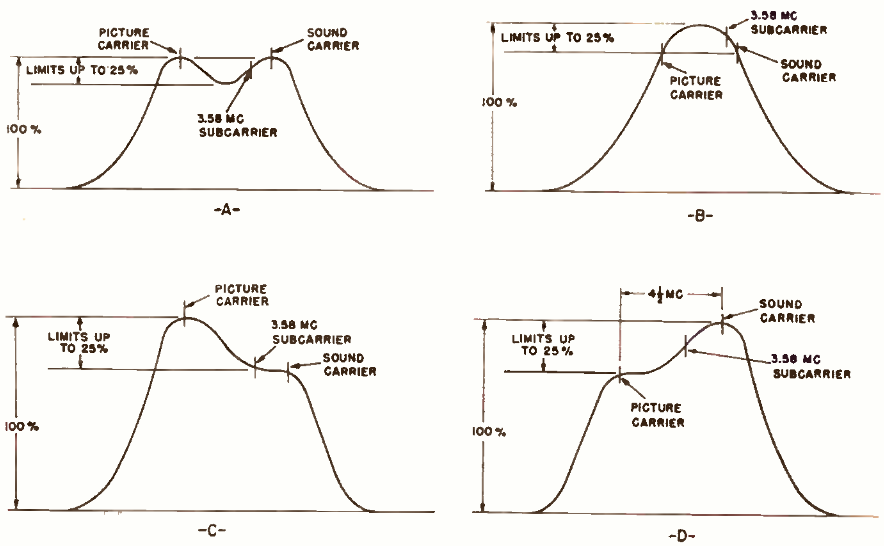


Fig. 4. Typical bandpass curves and limits for monochrome tuners.

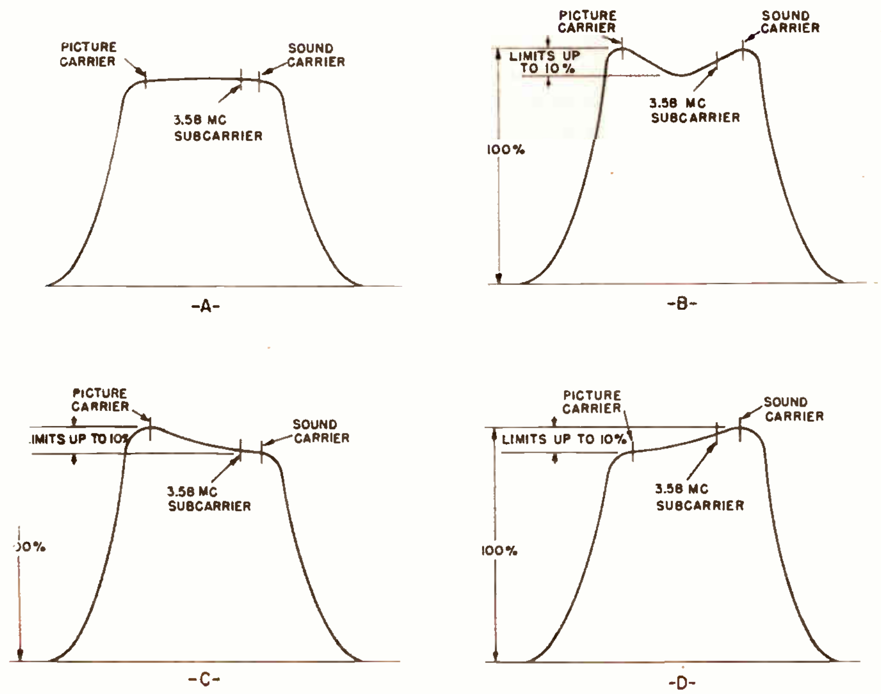


Fig. 5. Typical bandpass curves and limits for color tuners.

to adjust the oscillator slug whenever the oscillator (mixer) tube is replaced. If it should be necessary to replace any tuner component, an *exact* replacement part should be used. This is particularly true of capacitors not only because the exact capacitance should be used, but also because of temperature compensation. Obviously, the position of tuner components, as well as lead dress, should not be disturbed when repairing the color tuner. The lead length of the new component should be cut the same as the original and dressed in the same manner. If all these precautions are observed, it should not be necessary to realign the tuner. However, it may be advisable to check the tuner alignment before returning it to service.

VIDEO I-F AMPLIFIERS

The video i-f amplifiers are very similar to those used in monochrome receivers. The differences will be found mainly in the number of tubes and traps used. Since the bandpass curve was very important for the tuner, it is equally important for the i-f amplifiers. It has been pointed out that the passband for monochrome receivers may vary from 2.0 mc to 4.0 mc, depending on the design of the receiver. The passband for color receivers may vary slightly, depending on the receiver design, however, it cannot vary over the range found in monochrome receivers. It is necessary that the i-f passband be at least wide enough to pass the video carrier, the chroma subcarrier, and the lower sideband of the subcarrier with a minimum amount

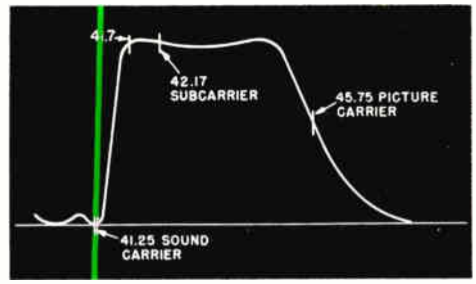


Fig. 6. A typical video i-f response curve showing the location of the sound and picture carriers, plus the chroma subcarrier and its lower sideband.

of distortion. A typical over-all video i-f response curve is shown in Fig. 6.

Note that the left side of the curve in Fig. 6 is quite steep with 41.7 mc which is the low-frequency sideband of the chroma subcarrier at the top and the 41.25 mc sound carrier at the bottom. It is important that this lower sideband, the subcarrier, and the upper sideband be on that portion of the curve which is approximately flat, otherwise the color signal and hence the colors will be distorted.

The i-f section of a color receiver will usually have more trap circuits than are ordinarily found in a monochrome receiver. These trap circuits are used to properly shape the i-f response curve, as well as to establish the proper amplitude and location of specific frequencies on the curve. The additional sound traps are particularly important since the sound carrier must be maintained at or below a specific level. If the sound carrier level is too high, it beats with the subcarrier and produces a 920 kc (4.5 mc minus 3.58 mc) interference pattern which is visible over the entire screen.

Since the location of the sound carrier and the chroma subcarrier on the video i-f response curve in Fig. 6 is critical, any condition which changes their normal position will materially affect color reproduction. A shift in oscillator frequency, either because of frequency drift or fine tuning adjustment, will produce certain visible changes. If the sound carrier moves out of its hole and starts up the slope toward the subcarrier, the 920 kc beat will appear. This would cause the video carrier and the subcarrier with its sidebands to be shifted to the right on Fig. 6. Sound bars and loss of the video carrier would also occur depending on the amount of oscillator frequency change. If the shift is toward the left side of Fig. 6, the lower sideband of the subcarrier (41.7 mc) and then the subcarrier (42.17 mc) would slide down the left slope. This obviously would produce first color distortion and then a complete loss of color. It can be seen that very little frequency drift can be tolerated in the tuner of a color receiver. It can also be seen that the over-all alignment must be precise and cannot shift or vary without affecting color reproduction.

(Continued in next issue)

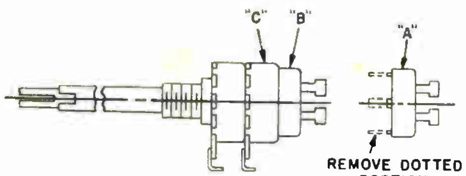
BENCH NOTES

Contributions to this column are solicited. For each question, short-cut or chronic-trouble note selected for publication, you will receive $10.00 worth of electronic tubes. In the event of duplicate or similar items, selection will be made by the editor and his decision will be final. The Company shall have the right without obligation beyond the above to publish and use any suggestion submitted to this column. Send contributions to The Editor, Techni-talk, Tube Department, General Electric Company, Schenectady 5, New York.

A-C SWITCH REPLACEMENT

Here is a short cut that has been very helpful to me, especially if my shop is full and a TV customer is waiting for his set which is inoperative because of a bad a-c switch.

I have found that I can make this repair on most TV sets which have false, perforated or wire mesh bottoms without pulling the chassis.



First I pry off the bad switch (A) with a knife blade or thin screwdriver, then from stock I locate the desired type switch (B). I clip the three locking ears off close, but not all the way off. The stubs of the locking ears position the switch while I spot solder (A) to (C) in two places. When the two power wires are soldered on, the job is complete.

In some extreme cases, it has taken weeks or months to secure a new control for early model receivers. I have also removed switches from new dual controls to speed up repairs.

This type of repair works equally as well on car radios where the switch gives lots of trouble.

O. H. Williamson
Williamson Radio Service
631 W. Dallas Ave.
Cooper, Texas

CLICKING IN G-E '56 9-IN. PORTABLE

Clicking in speaker hard to locate. High-voltage wire ran between chassis and printed circuit board near audio output and volume control.

To correct this, I ran the high-voltage wire (2nd anode) over top of chassis.

W. C. Cawthon
Bills Radio & Appliance
5 & 6 Baptist St.
Pelzer, S. C.

SYNC SEPARATOR SUBSTITUTION

I replace the 6BE6 tube in sets such as Westinghouse, Zenith, Conrac Fleetwood, etc., with a G.E. 6CS6. This tube is designed for sync separation and is a direct replacement. This results in improved operation of the TV set and removes many cases of pulling.

George Hoffmann
Forstner & Hoffmann
Radio & Television Service
314 W. Grand Ave.
Port Washington, Wisconsin

VERTICAL LINEARITY

Recently a Dumont RA112A3 developed a case of poor linearity (vertical) showing up in the picture as compression on the bottom. This made people's legs short and stumpy in proportion to the body and head. No amount of adjustment of the vertical linearity and vertical size controls would correct the condition.

I localized the trouble with my scope connected to the vertical output tube grid. The waveshape at that point showed spurious oscillation superimposed on the usual sawtooth shape. This looked like regeneration from the oscillator so I checked the two links to that tube (6SN7). The coupling condenser was good but the B+ filter electrolytic C294 30 mfd. 450 wv. showed high resistance. This is the plate supply filter condenser for the vertical output tube and also vertical oscillator (6SN7). Upon replacing it, the picture returned to normal.

William Adams
TV Service
68-77 218th St.
Bayside 64, N. Y.

What's new!

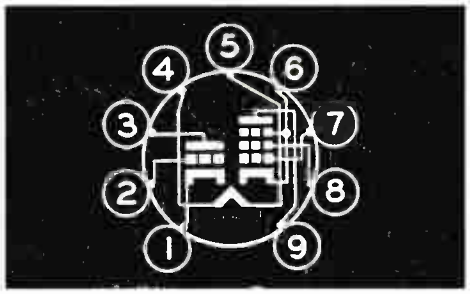
6CX8—8CX8

TRIODE-PENTODE

The 6CX8 is a miniature tube containing a sharp-cutoff pentode and a medium-mu triode in one envelope. The pentode section is intended primarily for use as a video amplifier. The triode section is suitable for a 4.5-megacycle sound IF amplifier, sweep oscillator, sync separator, sync amplifier, or sync clipper.

Except for heater ratings, the 8CX8 is identical to the 6CX8. In addition, it incorporates a controlled heater warm-up characteristic which makes it especially suited for use in television receivers with series-connected heaters.

	6CX8	8CX8
Heater Voltage	6.3 ± 10%	8.0 Volts
Heater Current	0.75	0.6 ± 6% Amps.
Heater Warm-up Time	....	11 Sec.



CHARACTERISTICS AND TYPICAL OPERATION

CLASS A_1 AMPLIFIER

	Pentode Section	Triode Section
Plate Voltage	200	150 Volts
Screen Voltage	125	.... Volts
Cathode-Bias Resistor	68	150 Ohms
Amplification Factor	....	40
Plate Resistance, app.	70000	8700 Ohms
Transconductance	10000	4600 μmhos
Plate Current	24	9.2 ma.
Screen Current	5.2	.... ma.
G_1 Volt., app. Ib = 100 ma.	−8.5	−5.0 Volts

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