SEPTEMBER • 1954

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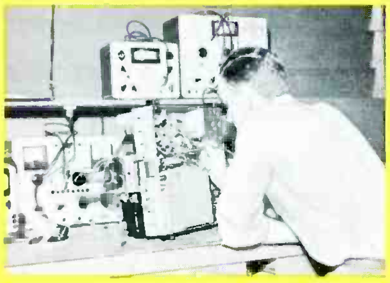
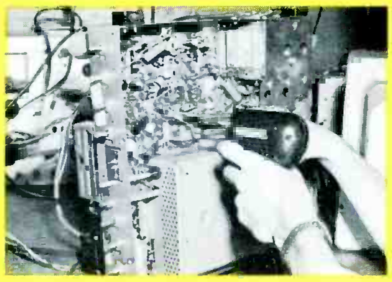
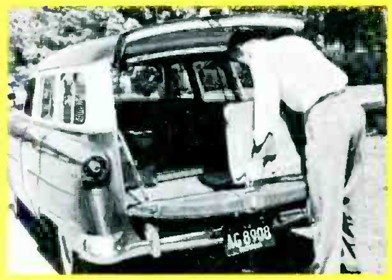
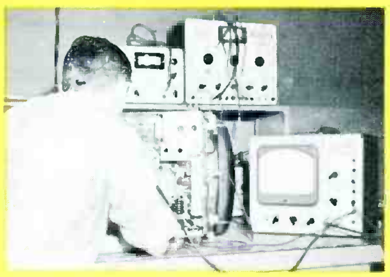
Howard W. Sams

PF INDEX

the monthly REPORTER for the Electronic Service Industry

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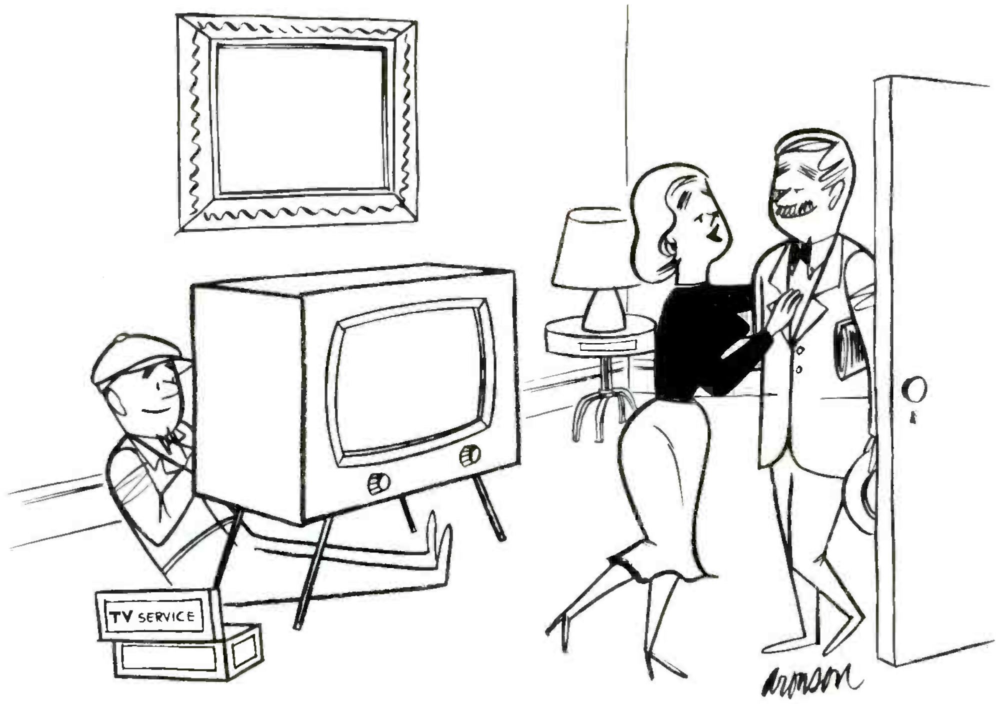

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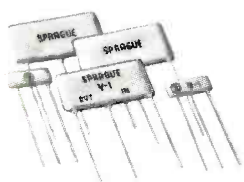

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PF INDEX

the monthly **REPORTER** for the Electronic Service Industry

VOL. 4 • NO. 9 SEPTEMBER • 1954

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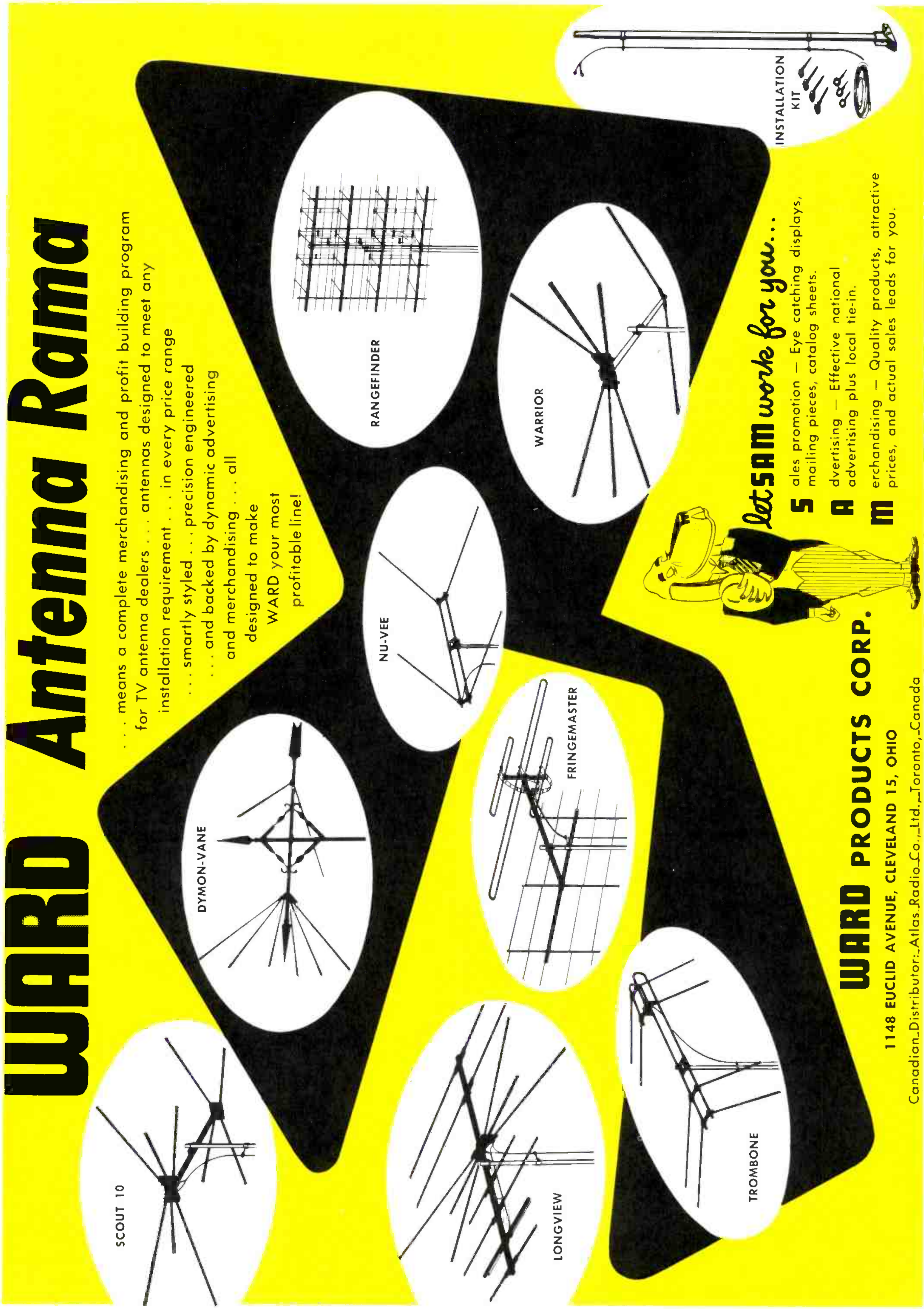
SUBJECT REFERENCE

The PF INDEX is published monthly by Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 5, Indiana. The PF INDEX is on sale at 25¢ a copy at 1093 jobbers of Electronic Parts throughout the United States and Canada. (In Canada 30 cents.) When available, back numbers may be obtained by sending 35¢ for each copy desired. Acceptance under Section 34.64 P. L. & R. authorized at Indianapolis, Indiana

SUBSCRIPTION DATA: For those desiring the convenience of delivery to their homes or shops, each issue of the INDEX will be mailed direct, promptly upon publication. The subscription charge is $4.00 annually in the United States and U. S. possessions.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Shop Talk

MILTON S. KIVER

President, Television Communications Institute

In last month's column, we discussed the electrical and mechanical troubles that a service technician encounters in his work on television tuners. Generally, the visual effect of one of these gross impairments is readily apparent to a trained observer, such as a service technician, so that he is quite aware that something is amiss.

There is, however, a more subtle difficulty that one encounters with tuners, and that is the problem of improving the sensitivity of a tuner which is already operating normally. This is frequently undertaken in weak-signal areas.

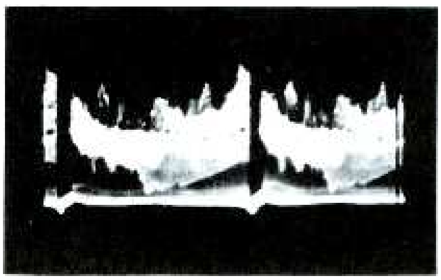
The sensitivity of a tuner, or its ability to amplify signals, is based upon three factors over which the service technician can exercise some form of control. These are: the AGC voltage, the RF amplifier tube, and the B+ voltage. Let us consider each in turn.

The AGC Voltage

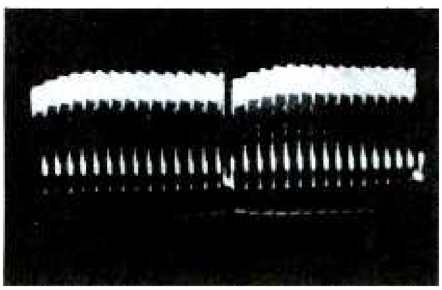
The AGC voltage is designed to regulate the gain of a stage through the variation of grid bias. The more negative the bias, the lower the stage gain. Thus, to increase the gain, the AGC voltage should be made as low as possible; and this line of attack can be followed to increase the sensitivity of a tuner. Each step must be taken carefully, otherwise set reception may be harmed rather than helped.

The following is one of the ways that has been found useful. Set up the receiver at the customer's location so that the signal strength there can be used during the adjustment. Connect an oscilloscope through a 10,000-ohm isolating resistor across the load resistor of the video detector. At the same time, connect the antenna to the receiver and tune in a local station. The video signal should appear on the scope screen as well as on the picture tube screen. Slowly lower the AGC bias which is fed to the RF stage, and keep an eye on the video-signal pattern appearing on the scope screen. Be particularly watchful of the sync pulses to make certain that they are neither compressed nor eliminated altogether. See Fig. 1. If compression should occur, stop reducing the AGC voltage. On the other hand, if there is no signal compression or distortion even when the AGC voltage is reduced to zero, then it is safe to remove this voltage completely and operate the RF amplifier without it.

The foregoing procedure should be carried out with the set tuned to the strongest signal it will receive. Suppose that you encounter a situation where there is one station which is noticeably stronger than the other or others; suppose you find that there are several stations, each with a considerably different level of input signal. What then?



(A) Sync Pulses Compressed.



(B) Sync Pulses Completely Removed.

Fig. 1. Video Signal Indicating Overloaded RF Amplifier.

The best solution is to tailor the operating bias separately to each signal, and this can be done by installing a small selector switch on the rear apron of the set. Then, for each selector position, a network can be installed which will bring the AGC bias for the RF stage to the desired level. The job is not particularly difficult to carry out, and it works rather well.

One word of caution: due to the vagaries of television reception, it is best not to lower the AGC bias to the exact point where sync pulse compression commences. Leave some leeway by maintaining the bias about 10 per cent above the critical value.

The next question is: "How do you go about reducing the AGC voltage applied to the RF amplifier?" This will vary to some extent with each different set, but a general method that has proved successful is to start with a 1-megohm resistor connected between the AGC line leading to the RF amplifier stage and ground. See Fig. 2. Then gradually lower the value of this resistor while watching the effect on the video signal appearing on the scope screen. Set the resistor value at the point where the signal amplitude is greatest without distortion.

In some circuits, there is no isolating resistor in the AGC line between the point where it leaves the IF system and where it enters the

* * Please turn to page 81 * *

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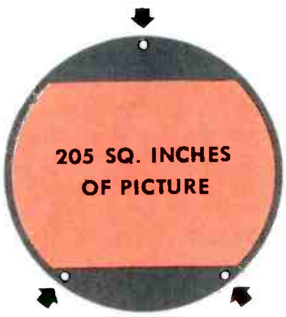

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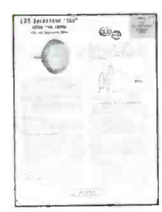

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COLOR TV TRAINING SERIES

PART IV COLOR RECEIVER CIRCUITS

by C. P. Oliphant and Verne M. Ray

Introduction

The preceding sections of this Color TV Training Series were devoted to studies of colorimetry, the development of the color television system, and the make-up of the color television signal. These subjects, together with a working knowledge of black-and-white receivers, are essential before attempting to understand the operation of color receiver circuits. The following material is intended to provide the reader with a fundamental knowledge of the way in which a color receiver operates.

The study of color receiver circuits has been divided into two categories. The first deals with the color receiver sections which are similar to those used in monochrome receivers. In this respect, the material presented deals mainly with the changes which have been made in these sections in order to achieve color reception. If a particular color receiver circuit is quite similar to its counterpart in the black-and-white receiver, very little discussion is given to it since the reader already has an understanding of its operation from his past experience with black-and-white television.

The second category has to do with color receiver sections that are specifically designed for the chrominance portions of the composite color signal. These circuits are not used in monochrome receivers; therefore, a detailed discussion of them will be presented. The discussions which follow resulted from examinations of color receivers made by several manufacturers. The circuits discussed are selected from individual receivers, and they are intended to serve as representative circuits which perform a given function. In some cases, two or more circuits which accomplish the same function are shown; but this is done only when different methods of operation or design are used.

Rapid developments in color television are being made; however, these developments will not change the basic function of a color receiver. Therefore, any knowledge obtained from this study will be a definite aid in understanding color television and can be applied to the new circuits which may be developed in the months to come.

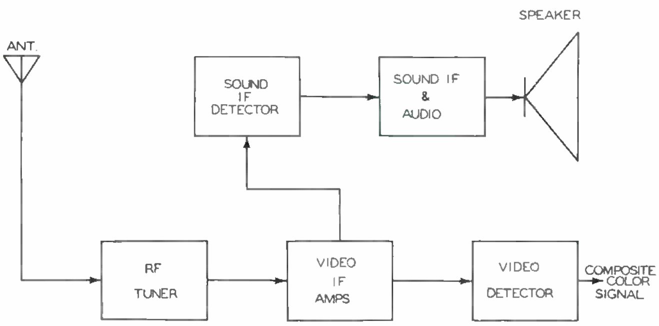

Fig. 4-1. Block Diagram of Color Receiver Sections Discussed in This Issue.

The sections to be discussed in this issue are shown by the block diagram of Fig. 4-1. It can be seen that this portion of a color receiver is not too much different from that of a monochrome receiver. With the exception of a block representing the sound detector, this drawing could represent the RF, IF, and sound circuits of any television receiver. Nevertheless, the following circuit discussions show some important differences.

RF Tuner

The function of the RF tuner in a color receiver is the same as in monochrome receivers, and the physical appearance of the unit is not changed; however, there is one requirement of the RF circuits in a color receiver

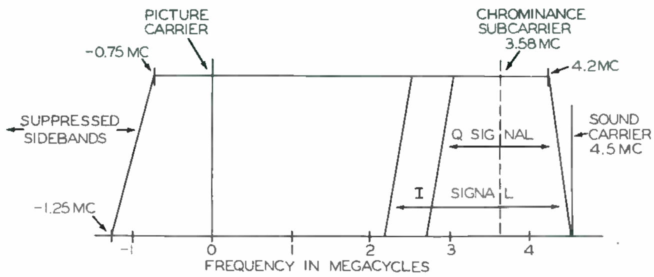

Fig. 4-2. Frequency Relationships of Color Television Signal Components.

that does not necessarily apply to monochrome operation. This concerns the allowable tolerance in the frequency response of the tuner.

It has been previously pointed out that a color television signal contains both luminance and chrominance information. As seen in Fig. 4-2, this information extends from 0.75 mc below to 4.2 mc above the picture carrier and falls to zero at 1.25 mc below and slightly less than 4.5 mc above. If a tuner designed for a black-and-white receiver were to be used in a color receiver, nonuniform amplification of all frequencies might result and cause poor color reception. Although a tilt or sag in the response of the RF tuner might be compensated for

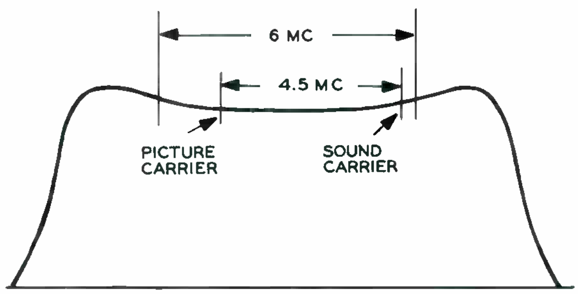

Fig. 4-3. Ideal Frequency Response of Tuner Used in Color Receiver.

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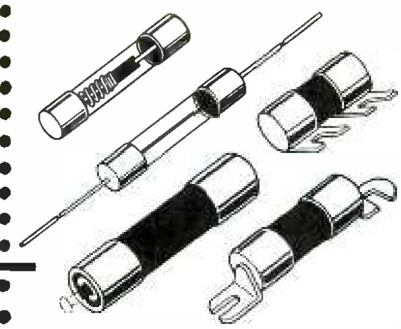

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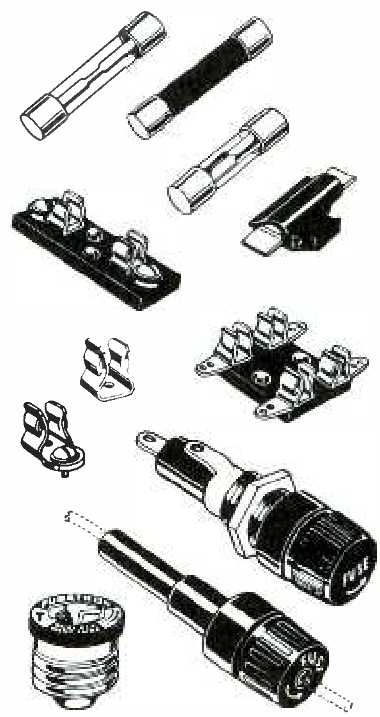

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in the IF amplifier section, it is necessary to provide uniform bandpass characteristics in the tuner in order to tune all channels properly. Fig. 4-3 shows the frequency-response curve of an RF circuit which would produce excellent results in a color receiver.

To illustrate the similarity of the circuitry in a tuner designed for a color receiver and that of a tuner designed for a monochrome receiver, a schematic of a Standard Coil tuner designed for color is shown in Fig. 4-4. Note that the circuit is very similar to Standard Coil tuners currently being used in black-and-white receivers. There is one feature, however, which warrants special note. It can be seen in the circuit drawing that the secondaries of the antenna coils for the lower channels 2 through 6 are tuned with iron-core slugs. This is done to make possible the adjustment of these coils at the lower frequencies. At the lower channels, the Q of the circuit is higher; therefore, the bandpass is narrower and the coils require adjustment to achieve flatness in the response curve over a 6-mc range.

Past experience has shown that RF tuners in monochrome receivers are quite stable and present only a moderate number of servicing problems. Tuners in color receivers will undoubtedly present additional servicing problems because they must operate more precisely than those in a monochrome receiver. A defectively operating tuner in a monochrome receiver might not be suspected, but one that is operating in a similar manner in a color receiver might result in faulty operation of the color circuits. Such a condition would obviously result in a complaint. When the tuner in a color receiver is being serviced, particularly during alignment, the requirement of the tuner must be kept in mind. Many of the compromises which are in common practice in servicing monochrome receivers cannot be made in color work.

Video IF Amplifiers and Video Detector

Although the requirements of the video IF section are more specific in a color receiver, the function is essentially the same as in monochrome receivers. Before examining the circuit design, let us consider what is required of the video IF section.

First of all, the purpose of the section is to provide amplification and selectivity to a band of frequencies. This band should extend from .75 mc below to around 4.2 mc above the picture-carrier IF in order to include all of the luminance and chrominance information. Four or five stages are needed for this function ordinarily. The video IF strip should also severely attenuate the sound IF carrier, more so than in monochrome receivers. The reasons for this will be given later in this discussion.

A curve illustrative of good over-all frequency response through the RF and IF sections of a color receiver can be seen in Fig. 4-5A. Compare this curve to the one in Fig. 4-5B which is representative of the over-all frequency response of later model monochrome receivers. It can be particularly noted that the response of the color receiver is very critical in the region of the sound carrier where the slope of the curve is very steep. Frequencies only .35 mc away from the maximum attenuation point at the sound-carrier frequency are provided with at least 90-per-cent amplification. The reason for this is that the upper sidebands of the chrominance subcarrier extend to this portion of the frequency curve. To illustrate this, the frequency limits of the color picture signal have been superimposed on the response curve of Fig. 4-5A. Although the response curve in Fig. 4-5B would produce good results on a monochrome transmission, it would severely attenuate the chrominance information contained in a color transmission. This loss of chrominance would result in poor color reproduction or complete loss of color reception.

The video detector is required to remove the luminance, chrominance, and sync signals which constitute the composite color signal. A crystal diode with an IF filter is commonly used. The video detector in a color receiver differs from that in a monochrome set by having usually a 41.25-mc sound-carrier trap in its input. This trap insures against the development of 920 kc, which is an undesirable beat between the sound carrier and the frequency representative of the color subcarrier. The sound take-off point is located ahead of this trap.

* * Please turn to page 55 * *

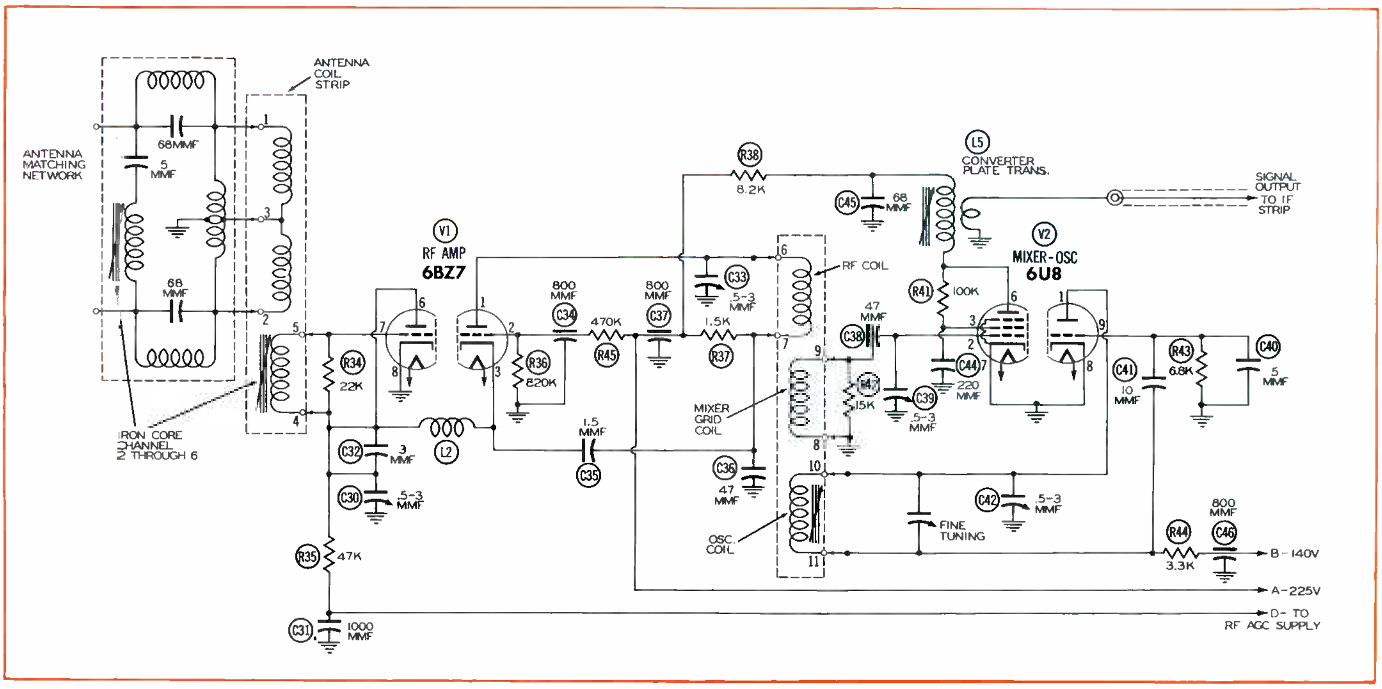

Fig. 4-4. Standard Coil Tuner Used in Westinghouse Model H840CK15 Color Receiver.

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HEADSETS for TV

by Henry A. Carter

Simple and Elaborate Circuits for Connecting Headsets

There are two primary reasons why set owners might want headsets connected to their TV receivers. The reason most often given is privacy of hearing. One person may want to watch a program while another is reading or sleeping in the same room and does not want to be disturbed by the sound from the receiver. Parents quite often desire headsets on their television receivers so that they can entertain guests at a game of bridge or the like while their children are watching and enjoying a program.

The other reason for using headsets is based upon the fact that sound is much more enjoyable to those with impaired hearing if the sound is heard directly from the receiver through the use of headsets than if the output of the speaker is reamplified by a hearing aid. The matter of acoustics and other factors that make this true will not be considered at this time.

Of these two chief reasons for desiring headsets, the use by persons with impaired hearing is the one which will require the most consideration and care in setting up satisfactory equipment. The reason for this should be quite clear. In the first place, it is almost imperative that the headset have some means whereby the volume can be adjusted to suit the hearing ability of the wearer. In addition to the volume control, it may also be advantageous to provide a means for the wearer to control the tone range of the headset.

Hookup—Should It Be Simple Or Elaborate?

There are many ways in which a pair of earphones or a headset can be connected to a TV receiver. The circuitry may be simple or quite complex, depending upon the quality of performance that the set owner desires. Many things must be considered. For instance, is the headset to be used for privacy of hearing, or is it for a partially deaf person? Is it for use in a hospital room, so that the sound will not disturb other patients, or in a noisy room, so that the headphones will shut out distracting noises? The type of hookup also depends upon the circuit of the receiver. Is the receiver an AC-DC type, or is it one of those types of sets having one side of the AC line and one side of the speaker connected to the chassis? In either of these types, there is great danger of a shock to the person who wears a headset that is improperly installed. Any chance contact with a defective electrical appliance is likely to result in a shock to the user of such equipment. This fact should be kept in mind when choosing the particular circuitry for the headset.

We must also consider the need for controlling the volume of the headset separately from that of the receiver when speaker and headset are to be used simultaneously. After all, a headset is not matched to a speaker to produce equivalent volume with the same signal applied. Therefore, a separate volume control is almost a necessity in these cases.

Generally speaking, the greater the performance requirements specified by the set owner, the more elaborate the headset installation must be. Naturally the cost of such an installation becomes greater also. Safety should be a primary consideration regardless of the type of hookup employed.

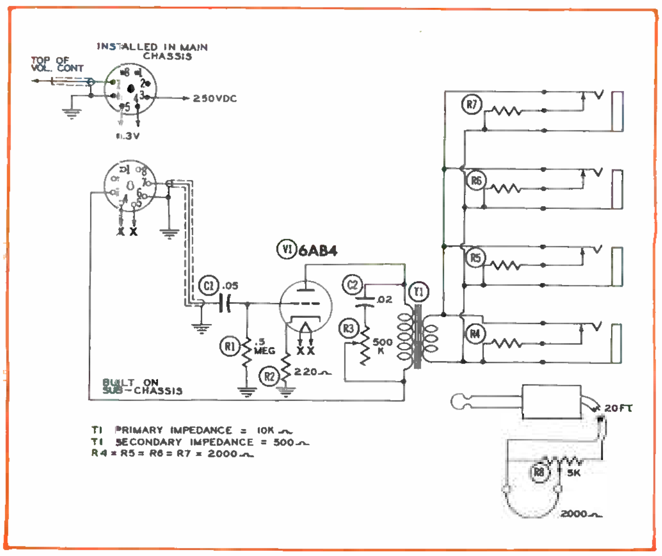

Fig. 1. A Method of Connecting Several Headsets to One TV Receiver Without Affecting Speaker Operation.

Types of Hookups

Of all the possible hookups, the method which has the most advantages is one which employs a separate audio-output tube for driving only the headsets. Fig. 1 shows a typical circuit of this type. This circuit has at least four distinct advantages over the more simple hookups.

First and foremost of these advantages is the fact that this circuit

* * Please turn to page 51 * *

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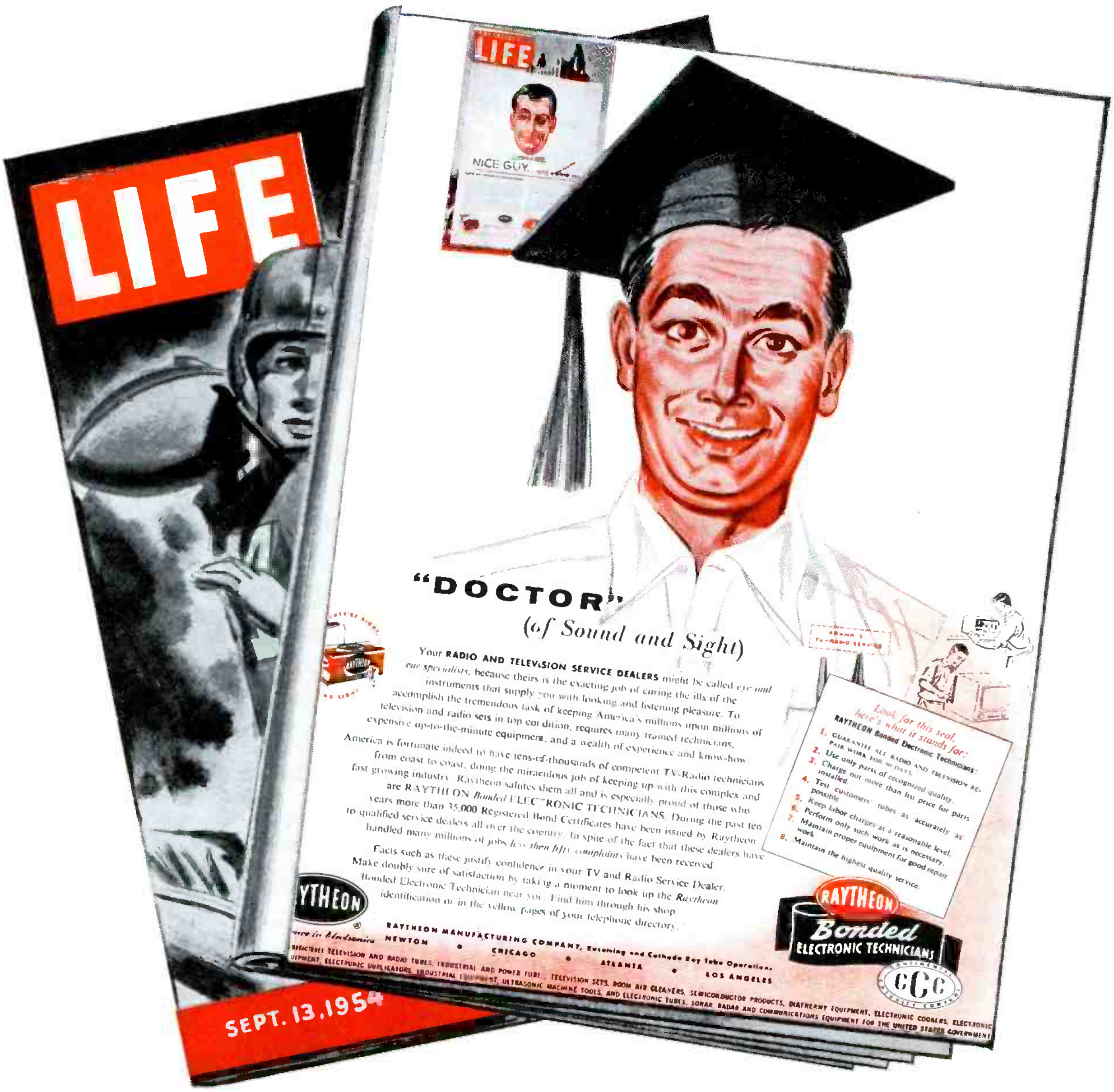

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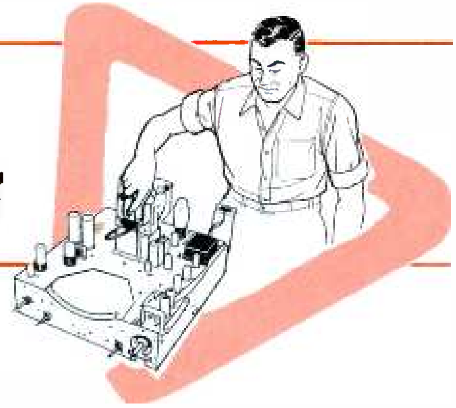

by **Henry A. Carter** *and* **Calvin C. Young, Jr.**

IN THE HOME

Effective correction of the many kinds of television interference is one of the more difficult problems encountered by the television technician during a home service call. These interference signals, although appearing in many different forms, actually may be placed in two major categories:

1. Signals generated within the television receiver in question.

2. Signals generated externally.

The interference signals generated within the receiver are usually caused by improper tuning, poor alignment, unsatisfactory shielding, or the failure or change in value of some component. Some of the internally generated interference signals encountered more often are as follows:

1. A 4.5-mc beat in the picture.

2. Bars due to horizontal-sweep radiations feeding into the video.

3. Tunable ghosts due to video IF regeneration.

4. Barkhausen oscillations.

The interference signals which are externally generated take on many different forms and have a variety of origins. A list of those more often encountered is as follows:

1. Interference from another TV station.

2. Ignition interference.

3. Interference from amateur radio equipment.

4. Interference from electric motors, lights, and other electrical appliances.

5. Ghosts due to signal reflections.

6. Local-oscillator interference from another TV receiver.

7. Interference from diathermy or industrial heating apparatus.

Figs. 1 through 4 are illustrations of the effects of interference from external sources on a transmitted test pattern or picture. The discussion which follows gives the characteristics of these interferences and the possible means of eliminating or minimizing them.

Fig. 1 is an illustration of the interference pattern produced by 4.5 mc. This pattern is usually caused by a slight detuning of the receiver or a misalignment of the 4.5-mc trap. A characteristic of a 4.5-mc beat due to receiver trouble is that the beat can be minimized by adjusting the fine-tuning control. In most cases, readjustment of the 4.5-mc trap and the receiver fine tuning will correct this trouble.

Fig. 2 is an illustration of the pattern produced by a 15,750-cps radiation being picked up from the horizontal-sweep section by the video amplifier. This trouble is usually due to improper lead dress in the video amplifier stage, to improper lead dress in the input circuit of the picture tube, or to improper shielding of the horizontal-output and high-voltage sections. Correct installations of the high-voltage cage assembly and proper lead dress of the lead to the driven element of the picture tube will in most cases eliminate this trouble.

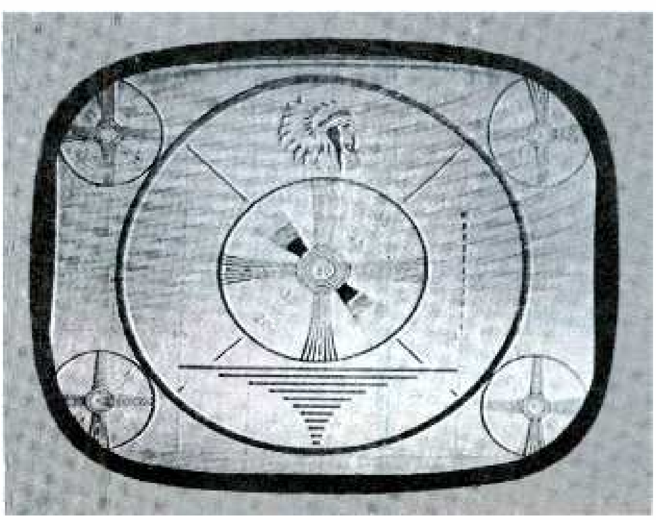

Fig. 1. A 4.5-Mc Beat Pattern.

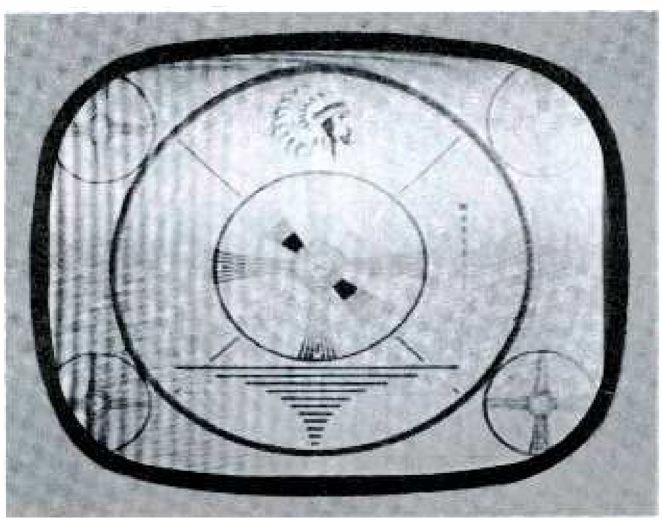

Fig. 2. A 15,750-CPS Beat Pattern.

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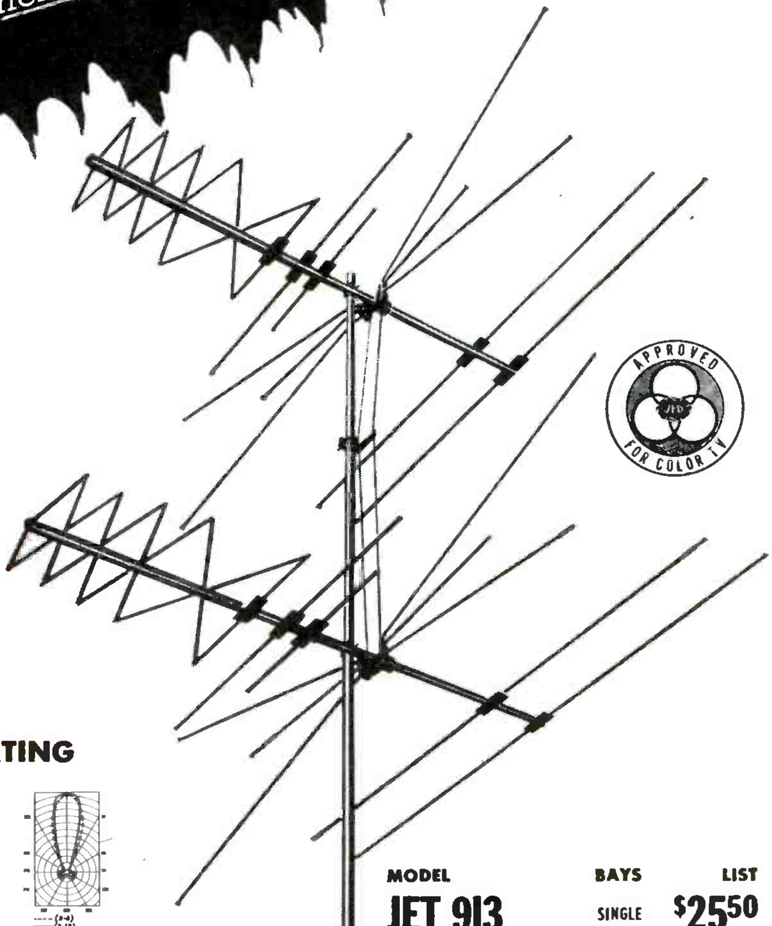

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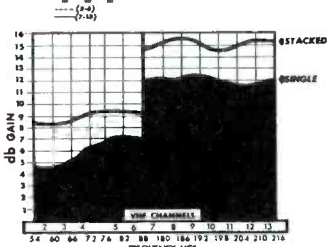

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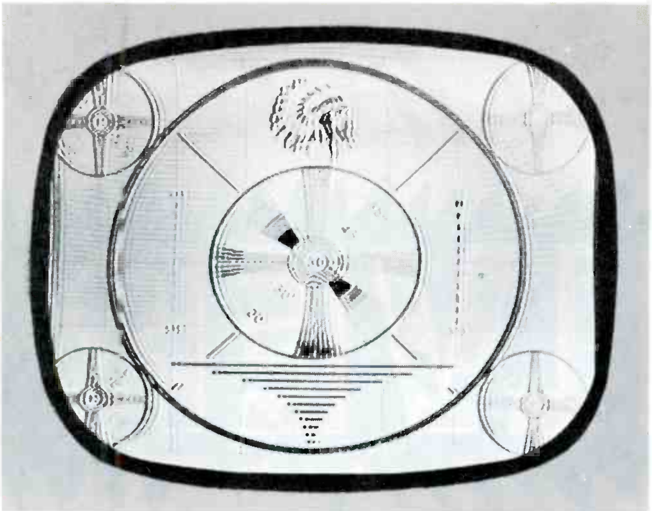

Fig. 3. Tunable Ghosts Due to Video IF Regeneration.

Fig. 4. Barkhausen Oscillations.

Fig. 3 is an illustration of tunable ghosts due to regeneration in the video IF strip. The major characteristics of this type of interference are: (1) spacing between ghosts will vary with setting of the fine-tuning control, (2) shading will vary with setting of the fine-tuning control, (3) reversing of the contrast may occur with setting of the fine-tuning control. This type of interference is usually caused by a faulty tube in the video IF stages, a faulty bypass capacitor in the video IF strip, or poor alignment of the RF or IF section of the receiver.

Fig. 4 is an illustration of Barkhausen oscillation. This type of interference is a spurious oscillation generated in the horizontal-output stage and is characterized by one or more black vertical lines in the left portion of the picture. The interference is most noticeable on weak signals where receiver gain is at or near maximum. Readjusting the horizontal-drive control or replacement of the horizontal-output tube will in most cases correct this trouble. In some extreme cases, it has been necesssry to replace the horizontal-output or flyback transformer. Poor connections on the plate cap leads of the horizontal-output tube and high-voltage rectifier tubes may also cause this trouble.

Some of the externally generated interference signals which are frequently encountered are illustrated in Figs. 5 through 13. A discussion of the characteristics of the possible cures for each type of interference is presented in the following paragraphs.

Fig. 5 is an illustration of interference from another television station transmitting on the same channel. This type of trouble is usually found in areas between two television stations operating on the same frequency where the signal strength from either is sufficient to obtain a picture. The installation of a highly directional antenna with a high front-to-back ratio should correct this trouble.

Fig. 6 is an illustration of ignition interference. This type of interference is most noticeable in weak-signal areas. The effect of this type of interference may be minimized by relocating the antenna away from the street or highway and rerouting the antenna lead-in wire to the side of the house away from the traffic. In some cases, using shielded lead-in wire will also help. There are available filters which are said to eliminate ignition interference. The black specks in the picture, incidentally, are the ignition pulses; and the white specks are interruptions of the horizontal-scanning line.

Fig. 7 is an illustration of interference from amateur radio equipment. The frequency of the interfering signal is approximately 28 mc. This type of interference can in most cases

* * Please turn to page 63 * *

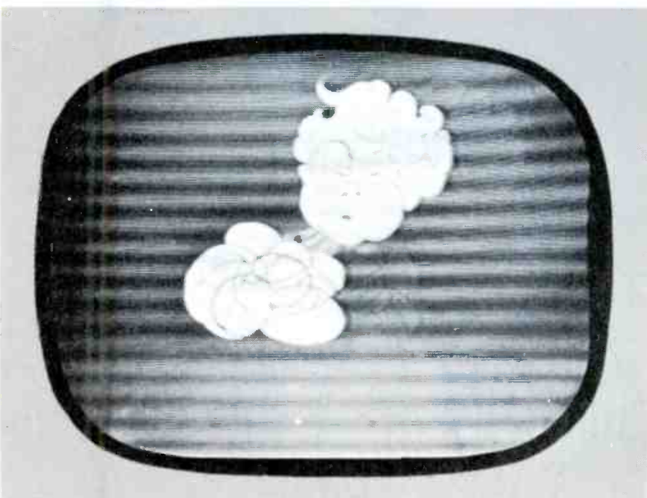

Fig. 5. Cochannel Interference.

Fig. 6. Ignition Interference.

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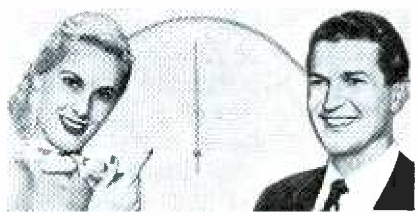

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Notes On TEST EQUIPMENT

Presenting Information on Application, Maintenance, and Adaptability of Service Instruments

by Paul C. Smith

Test-instrument manufacturers are very prompt in meeting the needs of the service technician as new developments arise in the fields of monochrome and color television. The result is that almost before a new device is in the hands of the public, instruments for its proper adjustment and servicing are available for the service technician. So he is not subjected to the frustration of an unsuccessful search for proper test instruments — rather, he is faced with the alternate problem of making the best choice of instruments to suit his needs from the array which is set before him.

This choice will be influenced by a number of factors, not the least of which is cost. The latter item may be anything from under $50 for a good multimeter to over $300 or $400 for a sweep generator, a color-bar generator, or an oscilloscope. At first glance this looks like a considerable outlay of money for instruments, especially when a technician is just starting up in business and must obtain a complete line of equipment. When the cost of an instrument is rated over a period of time corresponding to its useful life, the picture does not appear so discouraging. For example, if we figure that a $300 instrument will be used for a period of about six years (and many are still operating satisfactorily for a longer period than that), then the service technician is paying approximately one dollar a week for the use of the instrument during that time.

It should also be considered that the purchase of equipment can be viewed as a form of operating expense as much as rent and utilities; in fact, it is good business to prorate such expense over a period and include it when calculating rates for servicing charges. In locations where regulations permit, a certain percentage of equipment cost may also be taken as depreciation for tax-calculation purposes; and naturally, the equipment owner will wish to avail himself of this privilege where it is extended. This privilege makes the picture even less discouraging in regard to the original heavy investment.

Several questions which naturally occur both to the beginning technician and to the seasoned veteran are these: How much test equipment is needed? What is the minimum equipment necessary to do the job efficiently and profitably? Generally, how long should test equipment be expected to last?

The answer to some of these questions will depend to a great extent upon the natural ability or the acquired skill of the service technician himself. Some who are able to utilize instruments to their fullest possibilities because of a complete understanding of the theory of their operation can perform a satisfactory service job with the minimum of test instruments. At the same time, these same technicians are the ones who benefit most from the addition of new equipment. We believe that it is not possible for technicians to know too much about the theory of operation of their instruments. The time spent in learning the use of a new piece of equipment is not lost; the principles involved are electronic, just as with the electronic devices that are brought in for servicing; and any knowledge picked up by a study of test-instrument operation may prove useful in solving servicing problems.

A technician should be so familiar with his test equipment that its use becomes second nature to him much as an expert driver pilots his automobile through thickest traffic without conscious effort. Such expertness is not acquired overnight in either case.

The minimum test equipment required will depend not only upon the ability of the user but upon the service to be performed. If a technician services only radios (and some still do), he can get by with very little equipment. For servicing TV receivers he must add a few more instruments, and for color receivers he needs still more. The following would probably be the minimum for servicing a color receiver: a VTVM, a sweep generator, a crystal-controlled marker generator, a wide-band oscilloscope, and a color-bar generator. A white-dot generator would prove extremely useful, also. We are not recommending that the technician limit himself to these; but they are probably the absolute minimum necessary to perform satisfactory color TV servicing.

Over a period of use, there will be a certain percentage of failures among test instruments. Most of these will probably be normal tube failures: capacitor leakage or opens, resistance changes, and the like. Test leads will become frayed or broken with usage. Many repairs can be ef-

* * Please turn to page 76 * *

NEW TUBES *for* *Series Strings*

by JAMES M. FOY

Minimizing Voltage Surges and Tube Burn-Outs in Series-Connected Filaments

The vacuum tube is the unit around which practically all of our electronic circuits are built. By exercising control of electron flow, tubes can be made to produce oscillations and to rectify and amplify voltages; in fact, the tasks they perform are so many and so varied as to be almost innumerable.

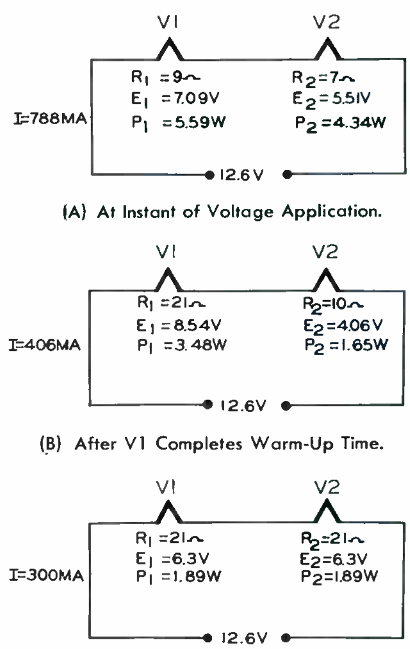
The design and manufacture of these tubes is an exact science, with the manufacturer constantly striving to meet current requirements. Any attempt to cover all the phases of this complex business in one short article would be next to impossible. Therefore, we will confine ourselves to only one of the problems with which the tube industry has been confronted. This problem has to do with the voltage surges and tube burn-outs in series-connected filament strings. Tube manufacturers have been working on this problem, and new tubes have been recently developed in an effort toward a solution.

For reasons of cost, ease of construction, weight, and other such practical factors, set manufacturers would prefer to use series-filament circuits instead of parallel-connected filaments which require transformer windings as voltage sources. The disadvantage of series-string operation has been that surges of current and voltage occur in the filaments of some of the tubes in the circuit. These surges momentarily increase the filament temperature and materially reduce the tube life.

Series Operation

To raise the temperature of a directly or indirectly heated cathode, power must be dissipated. This power should be enough to produce the desired rate of emission in the cathode, and tube heaters are designed to meet this requirement. When excessive power is dissipated, the usable life of the heater and cathode in the tube is shorted.

If a transformer winding furnishes voltage to heat the filaments and the tubes are connected in parallel, no particular difficulty is presented since the transformer voltage is the same as the rated heater voltage. The correct voltage and therefore the correct power is available to the tubes at all times. This does not hold true when the filaments of a number of tubes are connected in series.



(A) At Instant of Voltage Application.

(B) After V1 Completes Warm-Up Time.

(C) After Both Tubes Complete Warm-Up Time.

Fig. 1. Voltage, Current, and Power in a Two-Tube Series String During Warm-Up Period.

In a series string, there may be surges of voltage across some of the tubes in the circuit. These surges are directly related to the fact that a difference exists in the initial or cold resistance and the final or hot resistance of a tube filament. The results of a variation of hot and cold resistances can be seen if we apply Ohm's law. For the purpose of illustration, let us consider two tubes with their filaments connected in series. The filament in each tube is rated at 6.3 volts and 300 milliamperes. If 12.6 volts are applied to these tubes and if a 300-milliampere current flows after they warm up, the hot resistance ($R_1 + R_2$) of the two tubes in series can be computed as:

$$R_1 + R_2 = \frac{12.6}{.300} = 42 \text{ ohms.}$$

Moreover, if the voltage drop across each tube is the same, the hot resistance of each filament is equal to 21 ohms.

Let us now consider what happens when these same tubes are cold. We know that the cold resistance of a filament is less than its hot resistance; however, the value of the cold resistance may vary from tube to tube. The warm-up time will also vary in different tubes. Fig. 1A shows the voltage, current and power values which exist at the instant of voltage application to the series string. The cold resistance of tube V1 is 9 ohms, and that of tube V2 is 7 ohms. By Ohm's law the values of voltage, current, and power can be computed; and they are listed in the illustration.

* * Please turn to page 93 * *

A Method of Eliminating Interference of Specific Channels

Traps for Standard Coil Tuners

by DONALD R. HOWE

Continual improvement in the tubes and circuit designs employed in RF amplifiers has resulted in increased sensitivity for television receivers. This increased sensitivity together with the growing number of stations coming on the air has given rise to new problems in television interference. In order to alleviate these problems, manufacturers have incorporated in their receivers features that are consistent with good design practices. Among these features are high-pass filters and various forms of traps. In spite of these devices, interference problems continue to arise. A great number of these problems are the result of RF interference at a frequency of one of the channels. The interfering signal may be a harmonic from a transmitter, a beat between two transmitted signals, a signal on an adjacent channel, or the like. In this article, we are concerned with this type of signal that lies within the television band.

Upon consideration of the characteristics of this kind of interference, a trap would seem to be a logical solution to the problem. The reason for this conclusion can be shown by reviewing the action of a trap.

Traps are usually composed of inductance-capacitance (LC) circuits which are resonant at the frequency of the interfering signal. These LC circuits may be either series or parallel resonant, depending upon the manner in which they are used. The operation of a trap is based upon a fundamental principle of resonant circuits. A parallel-resonant circuit will offer a high impedance to a signal at the resonant frequency. The selectivity, or sharpness of response, of the resonant circuit is a function of the Q of the circuit. A very sharp response curve is characterized by a circuit possessing a high Q.

A series-resonant circuit offers a low-impedance path at the resonant frequency. The Q of this circuit will also affect the response. A series trap inserted across the antenna terminals of a receiver, as shown in Fig. 1A, causes a vertical short circuit at the frequency to which the trap is tuned. Signals at other frequencies are passed with very little loss. This series trap becomes a simple but very effective way to eliminate undesired signals.

A series trap may also be placed between each antenna terminal and ground. Refer to Fig. 1B. When properly tuned, these traps will shunt the interfering signal to ground. At the same time, the traps provide a high impedance to ground for signals at frequencies other than at the resonant point.

An alternative to this method is to insert a parallel trap in each leg of the transmission line. This system offers a high impedance at the resonant point and results in a rejection of the interfering signal. This arrangement is shown in Fig. 1C.

In cases where the interfering signal is strong when compared to the desired signal, a combination of series and parallel traps may be necessary. An arrangement similar to the one shown in Fig. 1D can be used.

When traps are used to eliminate interference on one specific channel, it is quite possible that they will result in degraded performance on some of the other channels. It then becomes necessary to employ a method of removing the trap from the circuit when the trap is not required. This is ordinarily accomplished by installing an auxiliary switch on the receiver. The trap may then be switched in or out of the circuit as required. This may become annoying to the viewer, particularly if the channels are changed frequently; therefore, it would be extremely beneficial if a system could be devised to eliminate the auxiliary switch.

Another point to be considered is the proximity of the trap to the tuner input. The length of the transmission line from the trap to the tuner should be as short as possible. This is done to minimize the interference picked up in the line between the trap and the tuner. When the trap is placed close to the tuner, the trap will produce its maximum effect.

In many instances, a single series-resonant trap will be sufficient to remove the interference. If this is true, a very novel method may be employed to eliminate the extra switch, provided that a Standard Coil tuner is used in the receiver.

* * Please turn to page 74 * *

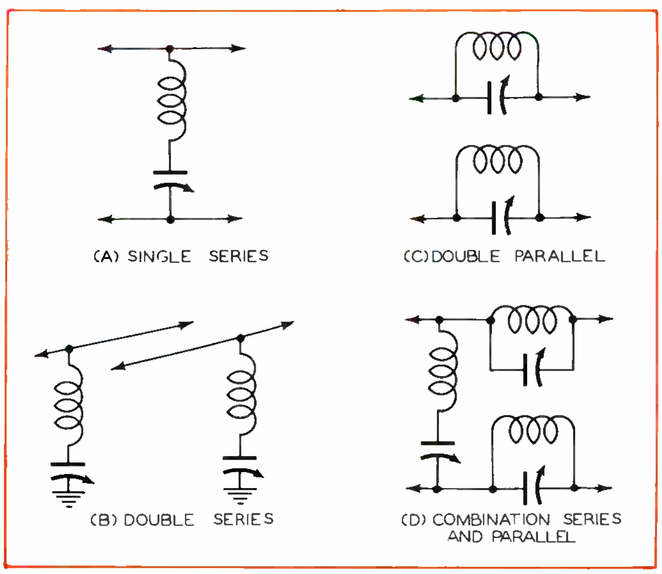


Fig. 1. Various Types of Traps.

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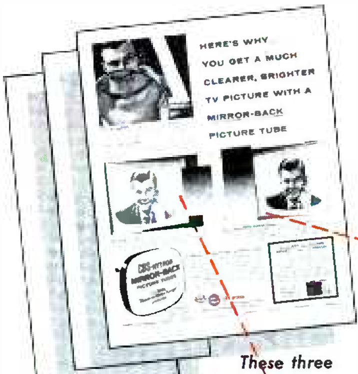

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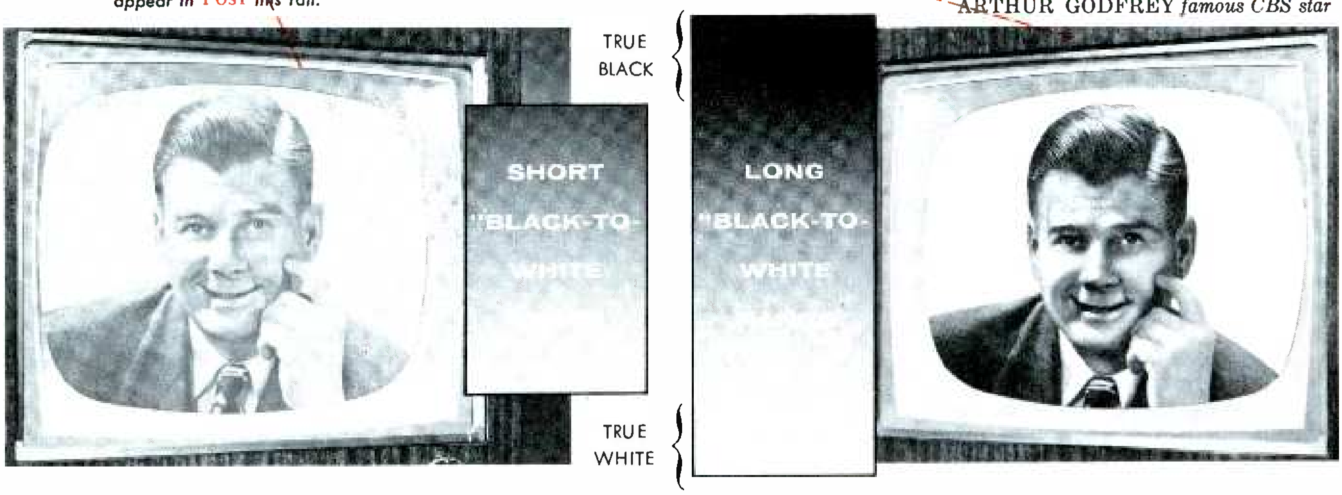

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TV COLORMATH

by HAROLD E. ENNES

The Mathematical Foundations Upon Which the Color TV System Operates

PART V

TYPICAL CIRCUITS AND COLOR FAULTS

Let us examine in detail typical color receiver circuits that differ from those used in the conventional monochrome receiver. It will be pertinent during the discussions to point out on a theoretical level the effects that circuit faults have on the results obtained in reproducing color images.

Delay Lines

A defective delay line is ordinarily replaced as an entire unit. It is important, however, to point out the importance of terminal impedances.

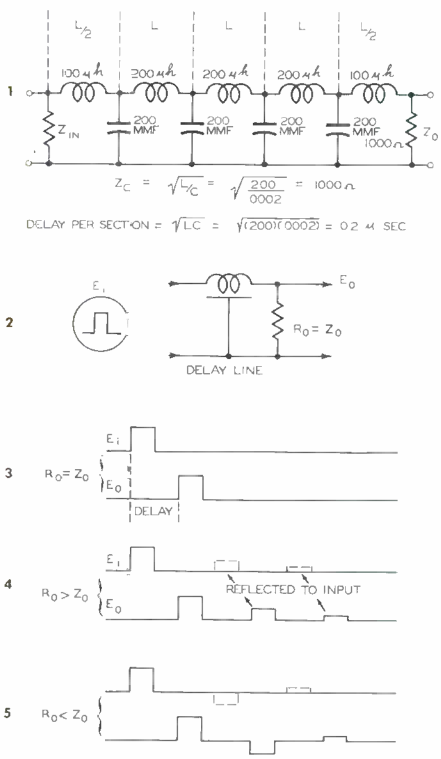

Fig. 14A. Typical Delay Line As Used in the Luminance Channel. Waveforms Illustrate the Effect of Proper and Improper Termination.

Fig. 14A, section 1, shows the schematic and characteristics of one type of delay line that is used in the luminance channel. The value shown for the amount of delay per section was calculated without taking into account any effects of mutual coupling. Since some mutual coupling exists in practice, the delay is usually somewhat greater than calculated from the square root of LC. Attenuation is negligible when the line is properly terminated in its characteristic impedance Z_O.

With proper termination of the delay line as shown in Fig. 14A, section 2, an input pulse will appear in the output as a delayed pulse of practically the same amplitude. This action is illustrated in section 3 of Fig. 14A. In this case, all the energy is properly absorbed in the characteristic impedance constituting the delay-line load. When not properly terminated, energy is reflected back and forth between terminal points.

When the terminating impedance is higher than the characteristic impedance, spurious-pulse trains occur at an amplitude that depends upon the degree of mismatch. For an open circuit, amplitudes are reduced only in time by line attenuation and input resistance. For resistive termination of a finite value higher than Z_O, spurious pulses are attenuated on each reflection. Fig. 14A, section 4, illustrates this action.

When the terminal impedance is less than Z_O, reflections are inverted in polarity and attenuated by an amount determined by the low-load resistance. Section 5 of Fig. 14A illustrates this polarity reversal. Obviously, a short circuit would kill reflections and the entire signal.

When the termination of the line is correctly loaded, the input resistance is unimportant except for gain considerations for the amplifiers concerned, since no reflections can occur. When the line is not properly loaded, the input resistance influences the amount and polarity of the signal reflections.

Fig. 14B is a partial schematic of a typical receiver and illustrates terminations and associated circuits of the delay line.

Bandpass Amplifier and Color Killer

Fig. 14C shows the first stage of the chroma section. R2 of the chroma input is ganged as a second section of R1 of the luminance input. R1 and R2 make up the over-all picture-contrast control. Since the proper ratios of Y-channel gain to chroma-channel gain must be maintained throughout the system, these controls operate together. Proper balance of respective channel gains may then be adjusted by individual gain controls later in the chroma channels.

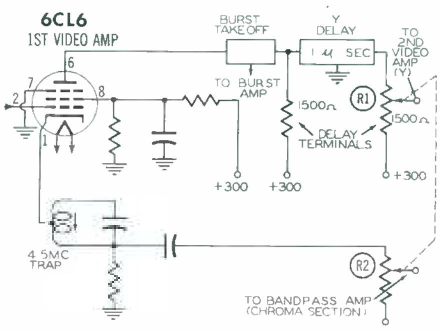

Fig. 14B. Location and Terminal Points of Y-Delay Line.

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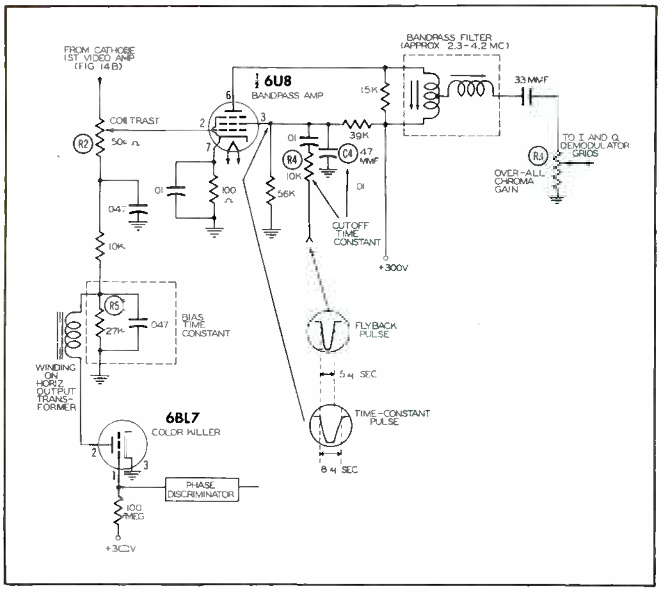

Fig. 14C. Bandpass Amplifier and Associated Circuits.

The amplified composite signal appears in the plate circuit of the bandpass amplifier where it is loaded by a filter which restricts the band-pass to approximately 2.3 to 4.2 mc. The color-carrier sidebands along with the higher Y-signal frequencies are passed, but the lower frequencies which include H and V sync pulses are eliminated.

The grid return of this amplifier is through R5 and C5. This network constitutes a bias time constant and is shunted by the color-killer triode through a separate winding on the horizontal-output transformer. The grid of the 6BL7 is returned to a plus 300 volts and to a point on the color-sync phase discriminator. During monochrome transmission, no color burst is transmitted. The phase-discriminator circuit is inoperative, and no negative voltage is supplied to the grid of the color killer. The color killer will conduct because of the positive pulses which are applied to the plate of the tube. This conduction results in the charge of C5. The time constant of C5 and R5 is such that a negative voltage which is sufficient to cut off the bandpass amplifier will be maintained between conduction periods. By cutting off the bandpass amplifier, the possibility of spurious chroma response during monochrome transmission is eliminated.

For color signals in which the color sync burst is transmitted, the grid of the color killer is held negative by a potential developed in the phase discriminator from APC (automatic phase control) action. Since the tube then cannot conduct even with a positive plate, C5 is not charged, and the bandpass amplifier functions normally.

It is recalled from earlier discussion that it is advantageous to eliminate the color sync burst from the I and Q demodulation circuits and subsequent chroma amplifiers. This is shown, in the case of Fig. 14C, to be accomplished by feeding a negative pulse at H-flyback time to the screen of the 6U8. Since the flyback pulse is only approximately the duration of H-sync (5μ sec), it is necessary to delay or widen the keying pulse so that the negative screen holds past the occurrence of the color sync burst. In this circuit, R4 and C4 constitute a time constant sufficiently long so that the charge of C4 through R4 holds the screen negative until slightly after the end of the color burst when active line scanning starts.

Burst Separator and Amplifier

It is necessary to separate the color sync burst from the composite video signal in order to drive the synchronizing section of the chrominance circuits. One method for doing this is illustrated by Fig. 14D.

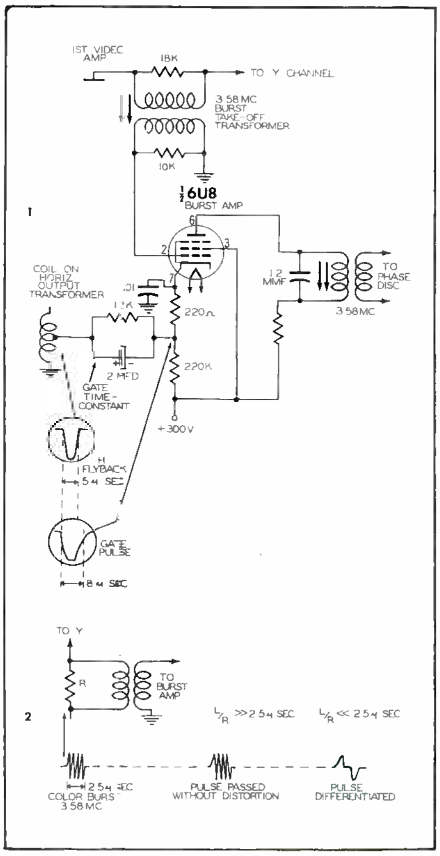

Fig. 14D. A Gated Burst Amplifier.

The control grid of the burst amplifier receives the color burst through the tuned take-off transformer in series with the plate of the first video amplifier. Amplification of only the burst is assured by gating the cathode of the 6U8 at the proper time during the blanking interval. During the positive interval of the flyback pulse, the cathode remains too far positive to allow conduction of the tube. During flyback time, the pulse is negative and intercepts the conduction potential just before burst time. The cathode is held negative by the gate pulse (hence the tube is conducting) until just after the end of the burst interval. The gated color burst is amplified and fed to the phase discriminator through the tuned plate transformer.

* * Please turn to page 41 * *

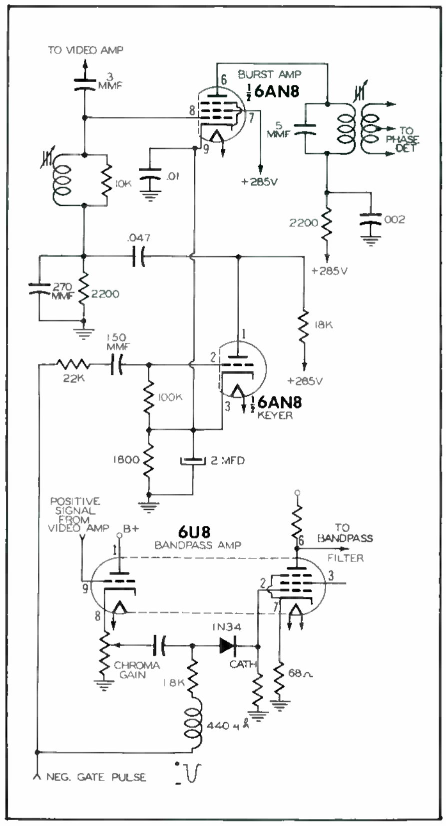

Fig. 14E. Gating Circuits for a Burst Amplifier and a Bandpass Amplifier.

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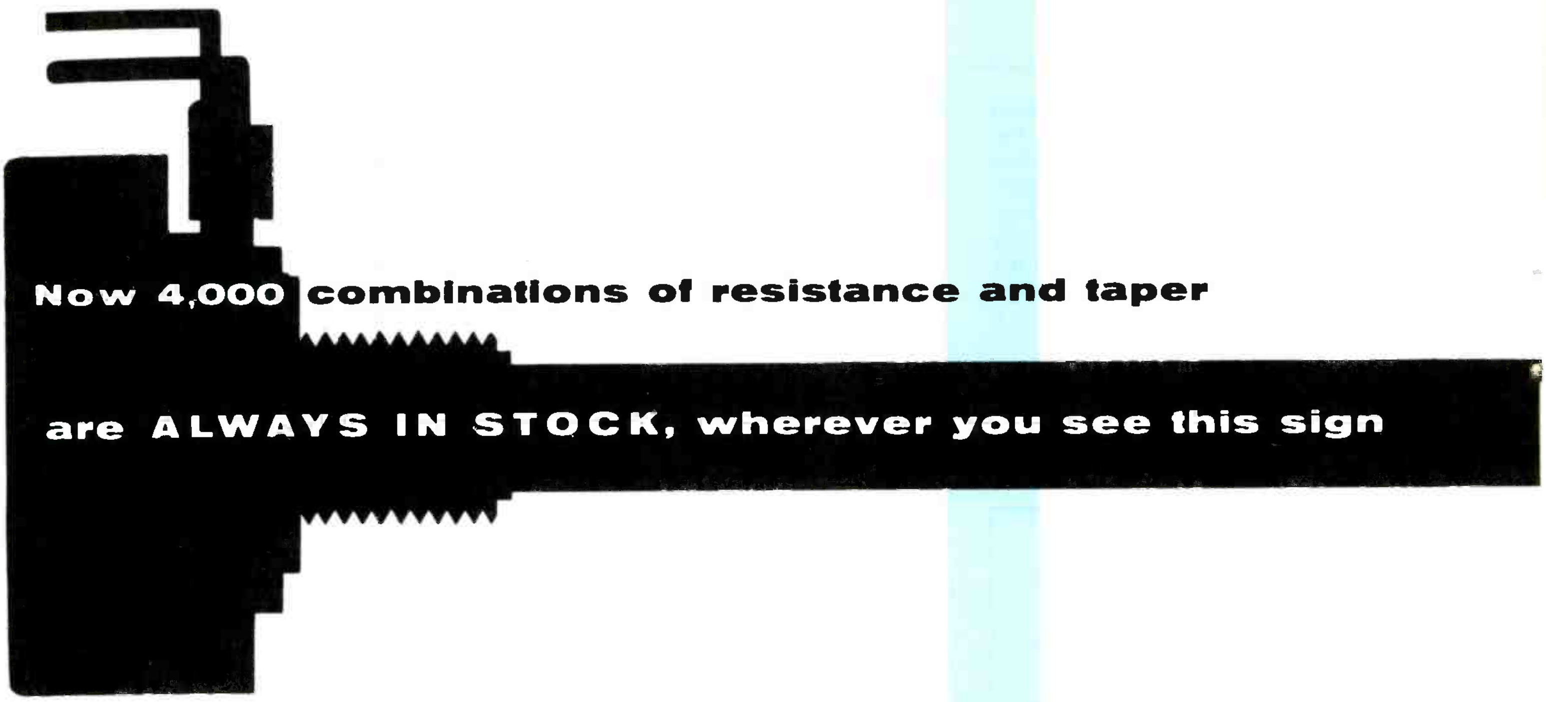

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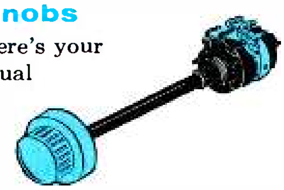

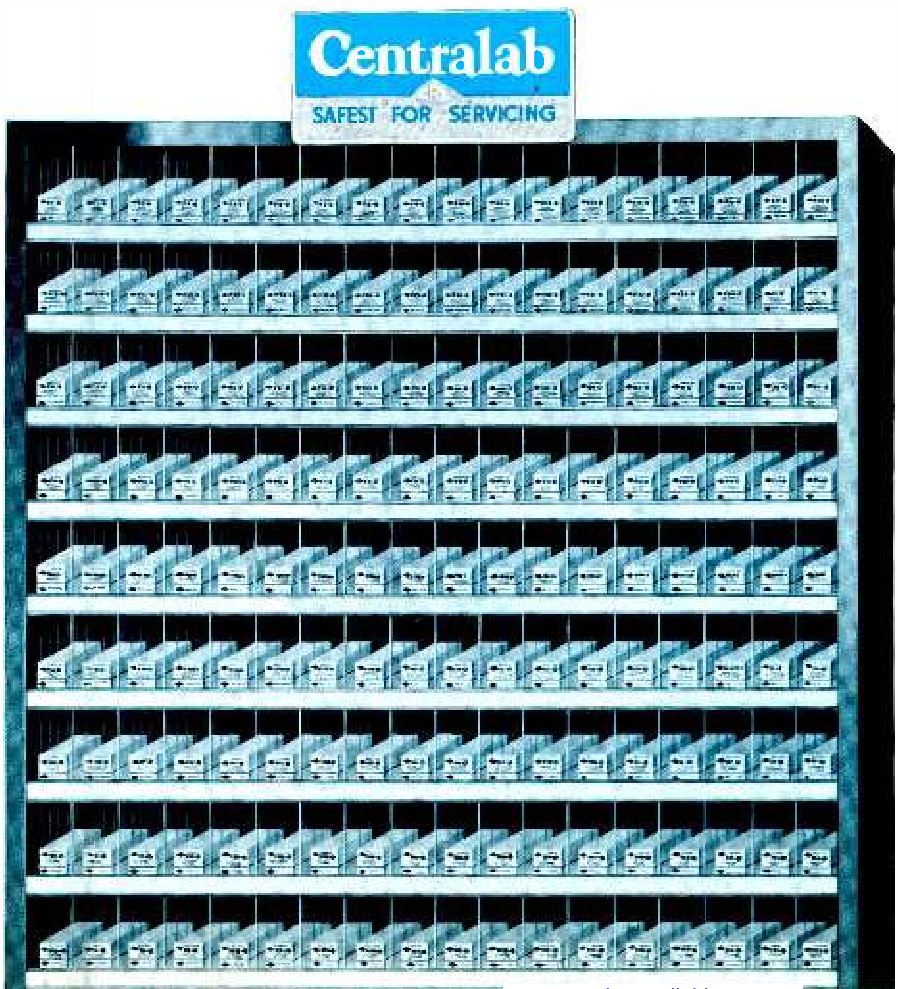

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Part IV

The Gruen Circuit

by **William E. Burke**

This article which is the fourth of the series covers the operation of a phase detector, a capacitive reactance tube, a sine-wave oscillator, and a discharge tube when the combination of these stages is used to generate and control the horizontal sweep in a television receiver. The circuit which will be described is illustrated in the schematic of Fig. 8-25. Waveform numbers on the schematic identify points at which significant waveforms can be observed. The operation of the system may be explained through an analysis of these waveforms and the phase relationships between them.

The connection of the equipment for this analysis has been given in previous articles in this series, but it will be repeated here for the convenience of the reader who desires to follow the analysis by direct observation of the waveforms. In order to provide a suitable means of comparison between the various waveforms, the oscilloscope was synchronized externally with the saw-tooth voltage which is present at the grid of the horizontal-output tube. A 500,000-ohm resistor was included in series with this external sync connection so that the receiver operation would not be disrupted by loading of the circuit. By synchronizing the scope in this manner and by maintaining the frequency and amplitude of the horizontal sweep of the scope at constant values, we obtained all the waveforms with reference to approximately the same time base. Then, by the placement of associated waveforms one above the other, any change in either the frequency or the phase of these waveforms is made apparent. In addition, an isolation probe was used in the vertical-input lead to prevent the input capacity of the scope from affecting the receiver performance.

This system, like all other AFC systems, performs a comparison between the received sync pulses and the horizontal-oscillator signal; and it controls the frequency and phase of the oscillator signal so that the signal will always be in the correct relationship with the sync pulses. The phase detector performs the comparison action and produces a DC voltage which is applied to the reactance tube. This tube then controls the frequency and phase of the oscillator. The oscillator output is applied to the discharge tube which generates the correct waveform for application to the horizontal-output tube.

Phase Detector

The phase-detector tube, V1 on the schematic of Fig. 8-25, requires two applied signals for its operation. These are a sync-pulse signal from the sync separator and amplifier and a feedback signal from the horizontal-output stage. The two signals are

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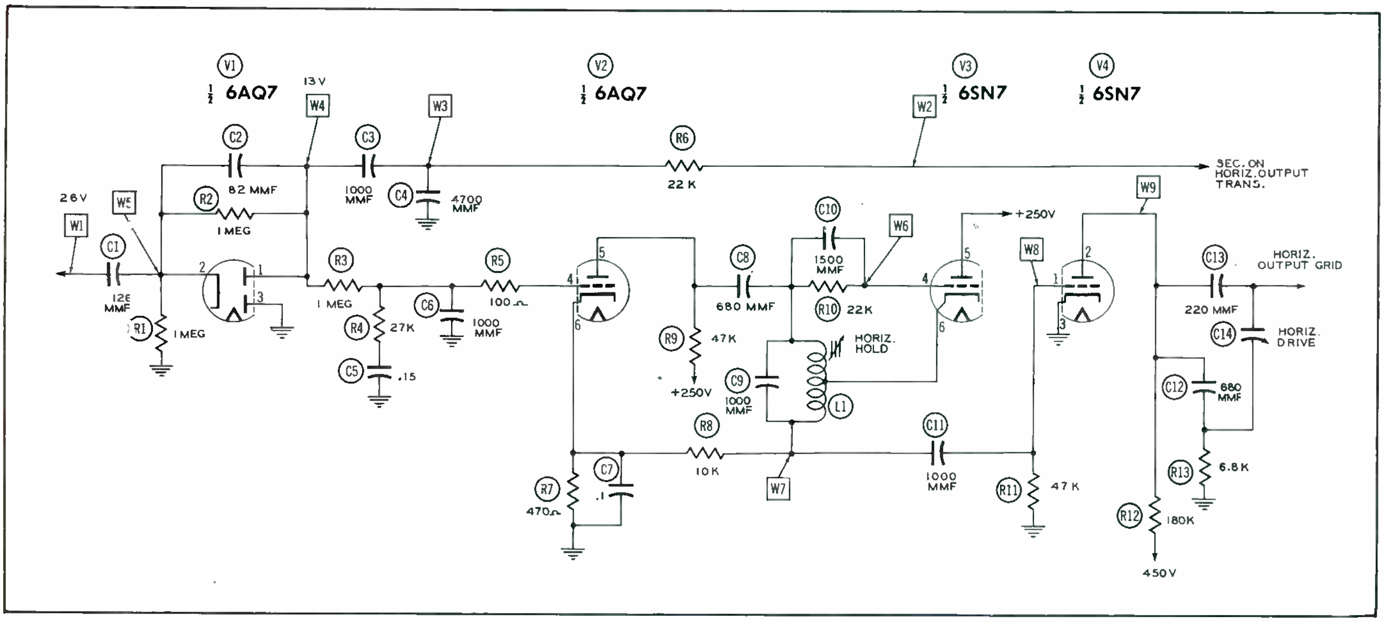

Fig. 8-25. Schematic of Gruen AFC Circuit.

Audio-Facts

The Capehart High-Fidelity Radio Phonograph Model RP-154

by ROBERT B. DUNHAM

The Capehart "Concert Hall" Model RP-154 (Fig. 1) is a complete high-fidelity unit designed for use as a high quality music system for the home. The front view reveals that an AM-FM tuner is included as well as a high quality record changer equipped with a triple-play magnetic pickup. The left half of the cabinet is utilized as the enclosure for a woofer-and-tweeter loudspeaker system.

A more detailed description of the equipment used in the Model RP-154 will show how carefully it has been designed to make it a complete system housed in one cabinet.

The large chassis (Fig. 2) combines the AM-FM radio tuner, the amplifier, and the power supply into one unit. The tuning dial, volume control, channel-selector switch, concentric tone controls, and tuning control are mounted on the front of the chassis.

The compensated volume control consists of dual potentiometers which aid in maintaining tonal balance at all levels of loudness. The ON-OFF switch is actuated by the volume-control shaft.

The independent bass and treble tone controls which are mounted concentrically provide a wide range of boost or droop for both the low and high frequencies. The amount of equalization made possible by the use of these controls is very useful because of the great variations in frequency balance encountered in records and other program material.

The four-position channel-selector switch permits easy selection of FM or AM radio reception, phonograph operation, or reception on an auxilliary channel marked SS (Special Service). This auxilliary channel provides for signal inputs from such sources as TV receivers and tape recorders.

The tuning control is used to tune the FM or AM receiver, depending upon the channel which is being used.

A ratio detector is used in the FM section of the conventional AM-FM receiver. Radiation from the FM oscillator is kept down to a very low level. Terminals are provided for an FM antenna, whereas a ferrite-rod type of antenna is featured in the AM section.

A 10-kc filter is included in the AM detector circuit to eliminate the 10-kc whistle (the beat between adjacent AM stations) which can be so annoying when one is listening with a high-fidelity AM receiver such as this.

Negative feedback is employed in the amplifier which uses two 6V6GT tubes in the output stage. The output is rated at 12.5 watts maximum power output. Distortion is held down to a very low percentage, and the extended frequency response is very smooth.

The three-speed record changer is a high quality unit featuring a weighted turntable, heavy four-pole motor, and a die-cast metal arm fitted with a plug-in magnetic cartridge. To avoid damage to the idler wheel while the changer is standing idle, the speed selector can be turned to its neutral position. This action disengages the idler wheel and removes the heavy pressure from its rim.

Incidentally, the control circuit in the amplifier is wired in such a manner that when the channel-selector switch is turned to the phono position, the supply of power to the complete system is controlled by the ON-OFF switch on the record changer. When the record changer automatically turns off at the finish of the last record (or is manually turned off) while the selector is set on phono, the complete system is turned off.

The phono preamplifier (Figs. 2 and 3) supplies the gain and equalization for correct operation of the magnetic pickup, which in this case

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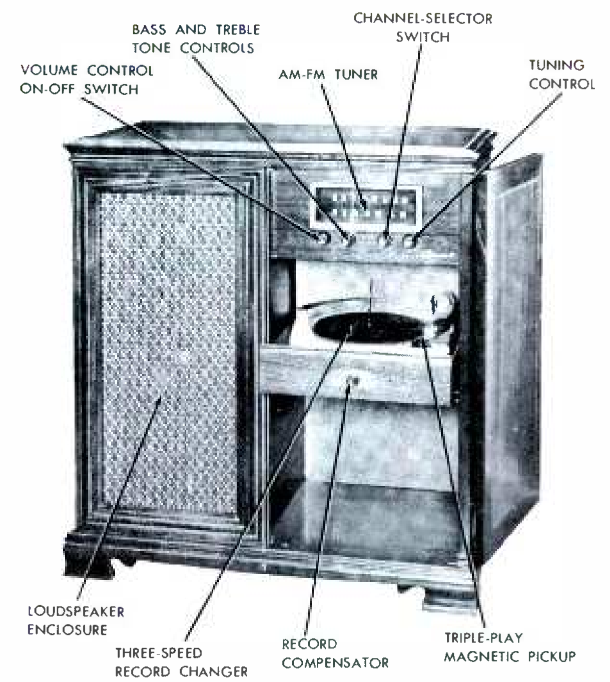
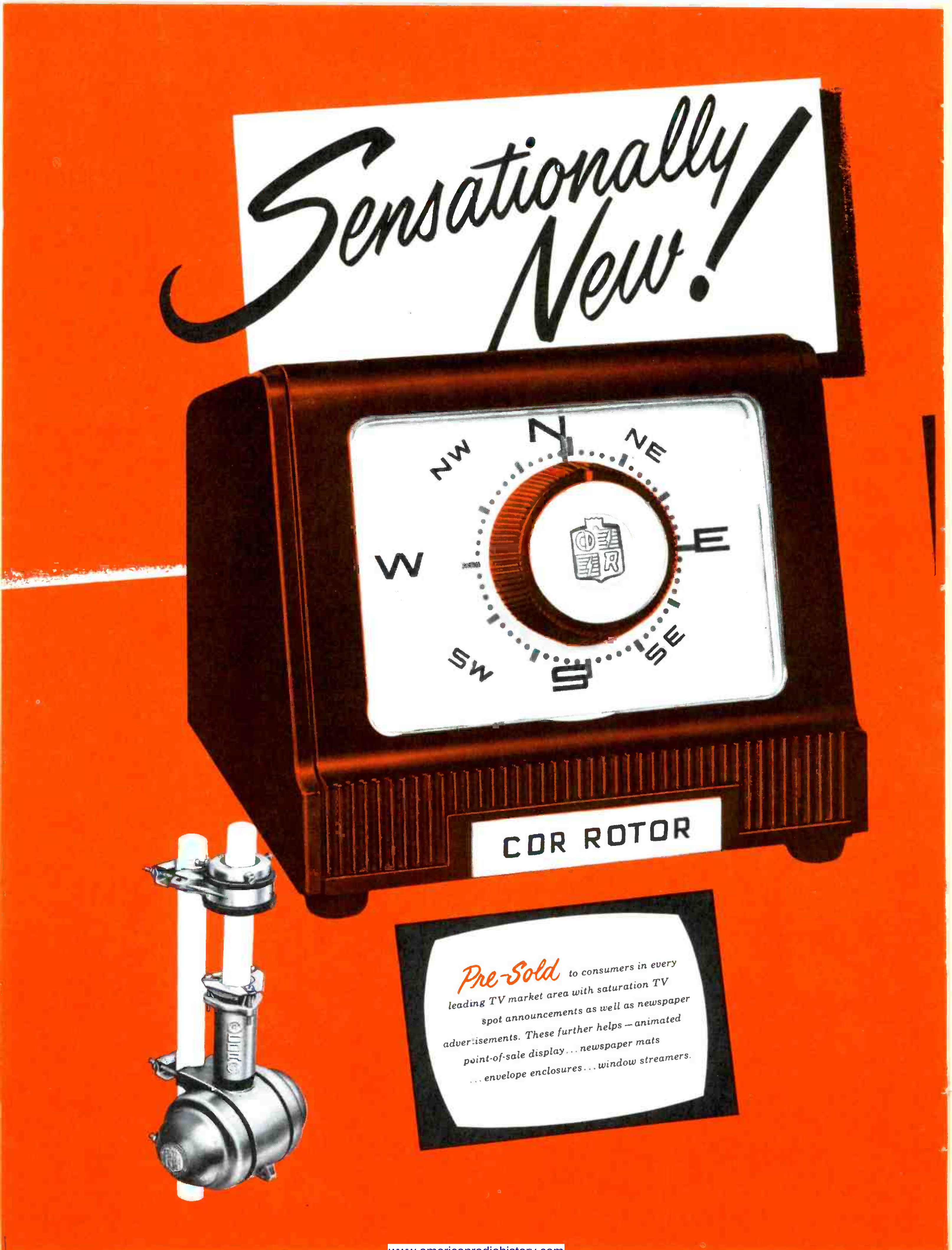


Fig. 1. Front View of Capehart Model RP-154.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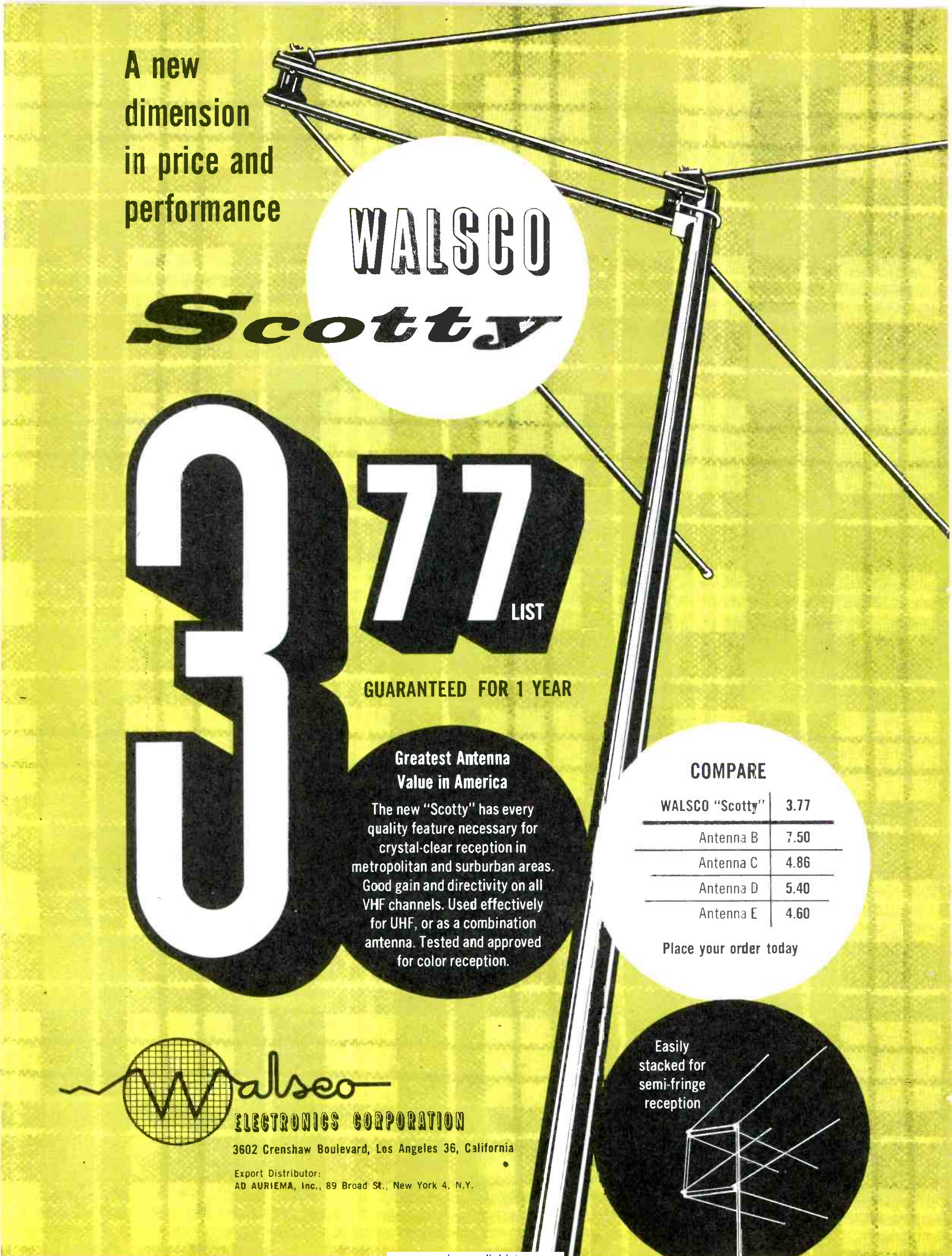
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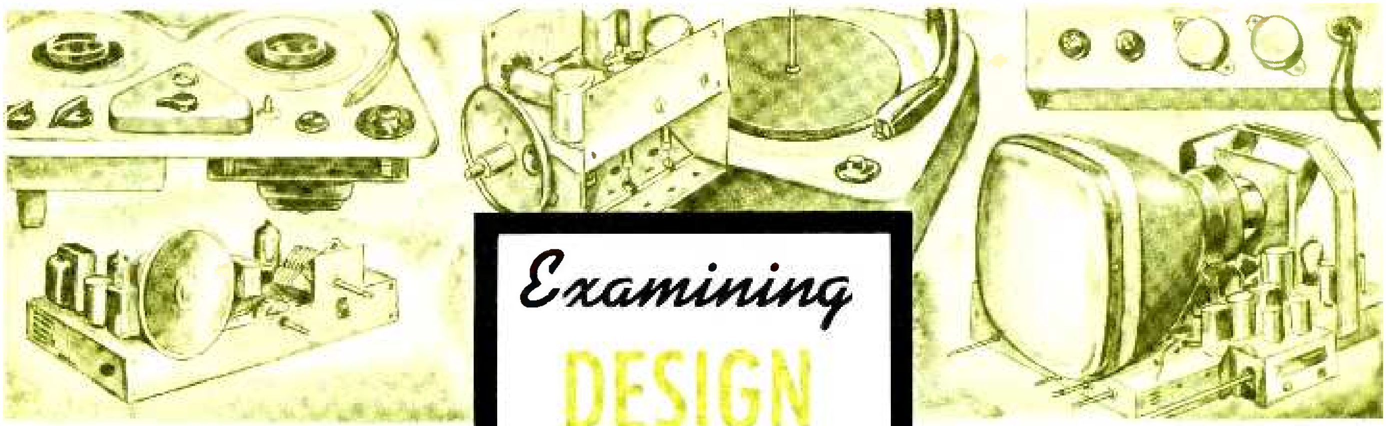

Examining DESIGN Features

GENERAL ELECTRIC MODEL 21C240

by DON R. HOWE

Recent trends in the General Electric line of receivers are exemplified by the Model 21C240. By investigating this model in detail, the service technician may become more familiar with current General Electric television receivers and consequently better prepared to service them.

The first feature that becomes readily apparent upon viewing the chassis is the familiar dip-solder method of assembly used in General Electric receivers. This may be seen in Fig. 1 which shows the chassis of Model 21C240. This receiver has a complement of nineteen tubes, exclusive of the 21AP4B picture tube. The video carrier IF is 45.75 megacycles, and the sound carrier IF is 41.25 megacycles.

The picture tube is mounted separately from the chassis by support brackets attached to the receiver cabinet. This permits the two units to be removed from the cabinet individually.

VHF Tuner

The RJX-062 is supplied for reception of the VHF channels 2 through 13. This is a switch type of tuner and has an input designed for 300-ohm lead-in. An IF trap is included at the input of the tuner to eliminate interference from signals in the IF range. The adjustment for this trap is located on the top of the tuner. Proper adjustment is accomplished by tuning the trap for minimum interference. Care should be taken to see that the trap is not tuned into the range of channel 2.

The RF amplifier consists of a 6BQ7A dual triode connected in a cascode circuit. The grid bias of the first triode section is controlled by the AGC voltage.

The triode section of a 6X8 functions as the oscillator for the tuner. Individual frequency adjustments are provided for each channel. These adjustments are accessible without removing the chassis from the cabinet. The fine-tuning control is on a separate shaft connected to the tuner by a dial-cord arrangement.

The converter stage utilizes the pentode section of the 6X8. The output of the converter is fed to the first IF amplifier.

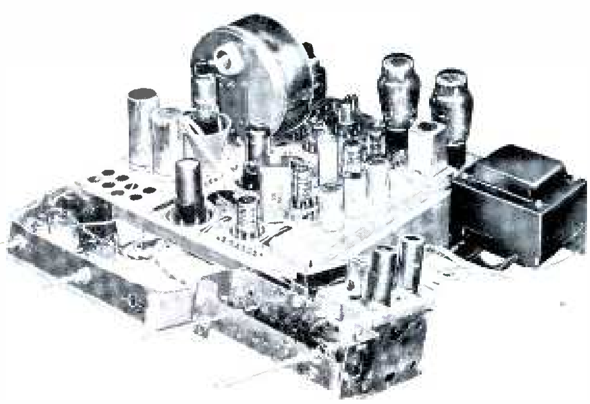

Fig. 1. The General Electric Model 21C-240.

Video IF

Two traps are contained in the grid circuit of the first IF amplifier which is a 6CB6. One of the traps is tuned to 47.25 megacycles to provide attenuation of the sound signal in the adjacent channel. The sound signal in the tuned channel is attenuated by the other trap which is resonant at 41.25 megacycles.

The second and third IF amplifiers are also 6CB6 tubes. Interstage coupling is accomplished by single-tuned transformers. In addition, these transformers are stagger tuned to achieve the desired bandwidth. The output signal from the third IF stage is transformer coupled to the video detector. The circuitry employed in the IF stages is conventional. The main difference between this IF strip and those used in some of the previous General Electric receivers is the tube complement. Some of these earlier receivers used lower-gain tubes with four IF stages in place of the present three stages which employ 6CB6 tubes.

Video

Video detection is accomplished by a Y151 crystal diode which is connected as a series detector. The output of the detector is fed to the 6CL6 video amplifier. Several video peaking coils are contained in the circuit linking the detector and the video amplifier. The cathode of the 6CL6 is returned to ground through a potentiometer which serves as the contrast control.

The plate circuit of this stage contains a 4.5-megacycle trap and two video peaking coils. The video signal is then fed to the cathode of the 21ZP4B picture tube. The cathode

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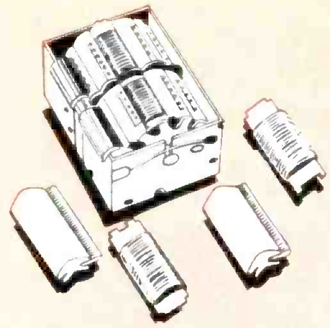

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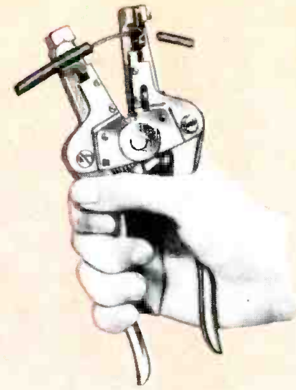

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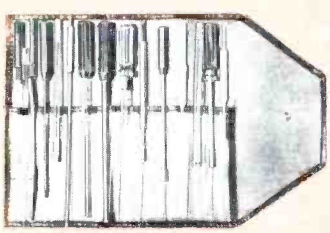

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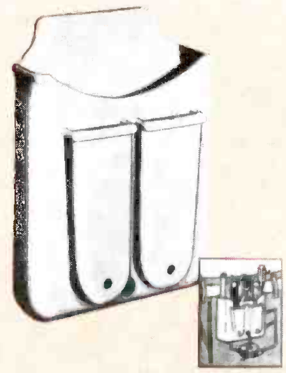

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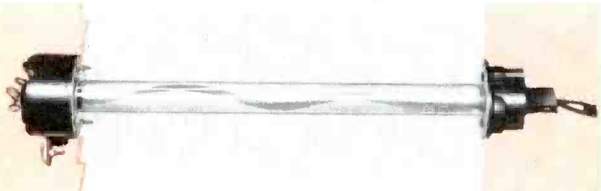

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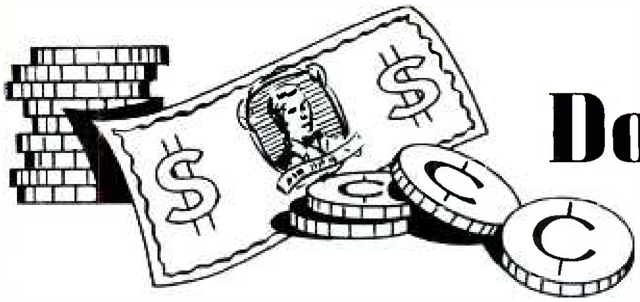


Dollar and Sense Servicing

by *John Markus*

Editor-in-Chief, McGraw-Hill Radio Servicing Library

WHALES. Down in Antarctic waters where whaling is a science, the catcher ship of a whaling fleet will shoot an explosive harpoon into a whale. Then they play the mamal with the three-inch nylon rope till it gives up and can be reeled in. If the catch is a blue whale that sinks after death, the next step is poking an air pipe into the whale and inflating it with thousands of cubic feet of compressed air. A tiny battery-operated radio transmitter is then shot into the whale's carcass, and the catcher goes off in search of another whale. The follow-up buoy boats are equiped with radio direction finders so they can go straight to the whale, even in darkness or fog. Then they tow it to the factory ship. For more of the story of how modern machinery operates today at the loneliest end of the earth, read the new book by R. B. Robertson, "Of Whales and Men."

ENIGMA. Round and round the wheel goes, and where it stops nobody knows. Such is roulette, and such is color television today. RCA announced it's stopping production of its 19-inch color tube, with intimations that something still better is in the offing.

SALES. The drop in radio sales for the first half of 1954 was baffling to manufacturers who'd learned to live right up to the 1952 and 1953 boom-year sales, but actually the change is far from world-shaking. Available figures for retail radio sales show 1,330,000 sets sold in the first four months of 1954, as compared to 1,850,000 for the same months of 1953 and 2,150,000 for those months in 1952.

Radio set inventories totaled about 3.5 million at the end of April this year, with 1.4 million of these on dealers shelves, 1.1 million in distributor storerooms, and about one million still stuck at the factories. This probably means you'll be seeing liquidation sales and price-cutting deals this fall, particularly among slower-moving models in the higher-priced brackets.

CHOPPER. One of the cutest new components we've seen lately is a photoelectric chopper which breaks up a weak and slowly varying DC signal into an AC signal that can be amplified more easily. All there is in the housing is a U-shaped neon flash tube and a tiny selenium photoelectric cell. The flash tube is connected to any 60-cycle power source of appropriate voltage, and the photocell is connected in series with the DC signal circuit. The repeated flashing changes the resistance of the cell 120 times a second to give the desired chopping action, and the AC signal is picked off across the cell. It's designed chiefly for use in guided missiles, in place of the vibrator type of choppers that don't always withstand the high-G shock of launching and the vibrations of flight. Avion Instrument Corporation in Paramus, N. J., is the manufacturer.

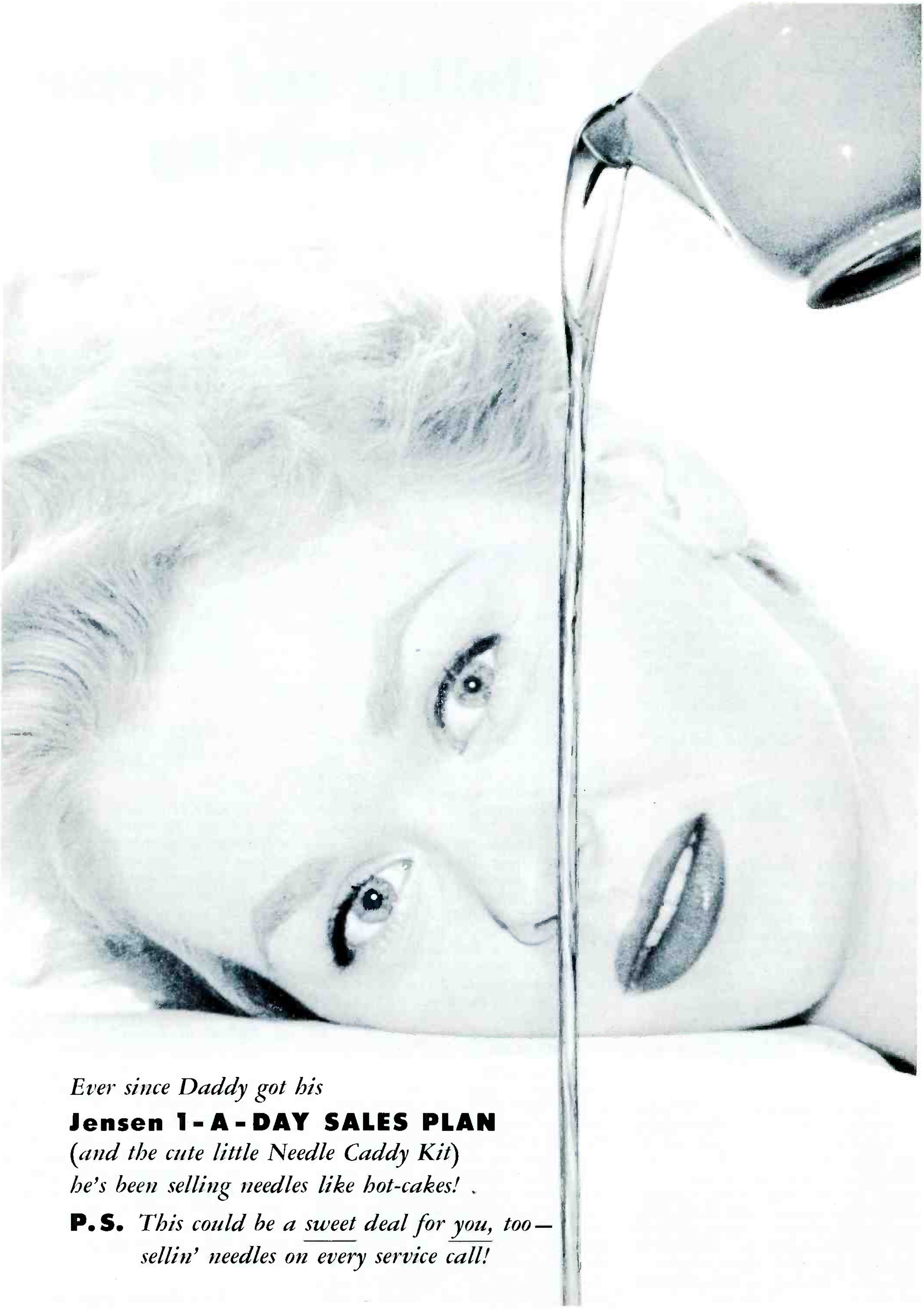
Incidentally, this firm has an ingenious array of desks for its engineers. They're made from flush panel doors, with one end resting on a two-section metal filing cabinet and the other end having feet made from 1 1/2-inch wood dowel rods fitting into drilled holes at a slight angle. Total cost is only a fraction of that of a new desk. Try one for your shop; oftentimes an odd-sized door can be picked up at a bargain. At a Chambers Street surplus store in New York City last year, you could take your pick from hundreds of them for $10.95 each.

SCRAMBLER. For those who want to scramble up a telephone or radio conversation, the MX 595-6SQ-1A Speech Scrambler can be bought on the surplus market for $45. It uses numbered code cards to insure complete privacy. It'll take another $45 for a companion unit to unscramble the jibberish at the other end. These scramblers were advertised in June Electronics by V & H Radio & Electronics, 2033 W. Venice Blvd., Los Angeles 5, Calif.

Kinda reminds us of the IFF unit we spent twenty bucks for right after the war. It looked so pretty with its acorn tubes and other cute UHF components that we did not have the heart to break it up to salvage the parts.

PRIVATE EYES. Latest trick for getting the evidence needed for extracting a divorce from an errant spouse is industrial television. The private eye gets into the room somehow when no one is around and installs the TV camera of cigar-box size behind some concealing plant or behind a one-way mirror on a closet door, runs the wires to an adjoining room having the monitor receiver, then sets up a camera to snap shots off the screen. The detective can then relax in leisure in a comfortable chair, glancing occasionally at the screen to see how the action is coming, and reaching up at appropriate moments to snap the camera and rewind the film. Being in a separate room the click, of the camera can't be heard by the performers. The TV camera is of course completely silent. Already two contested divorce actions have been settled out of court as a result of TV photos. Thus does television invade still another phase of our way of life.

* * Please turn to page 60 * *



TV Colormath

(Continued from page 27)

Fig. 14D, section 2, shows some waveforms which illustrate the effect that proper burst-transformer time constant L/R has on the pulse-passing characteristic. So long as L/R is much greater than the pulse duration, which is 2.5 microseconds, the color-burst envelope will be passed without distortion. Should L/R becomes less than this duration, with a radically increased R or decreased L, the envelope will be differentiated; and the color burst is lost.

Another method for extracting the color burst is shown in Fig. 14E. In this example, a negative gating pulse is fed to the grid of a keyer, is amplified, and is inverted in polarity. The resultant signal is fed to the grid of a burst-amplifier stage. The cathodes of the burst amplifier and the keyer are connected together. The heavy conduction of the keyer tube during scan time produces at the cathode a positive voltage which is sufficient to cut off the burst amplifier. The positive pulse which is fed to the grid of the burst amplifier is sufficient to overcome the bias voltage applied to the cathode, and the tube conducts. Thus, the color burst is extracted from the composite video signal and is passed to the phase-detector circuit.

Fig. 14E also illustrates a circuit which can be used to kill the color sync burst in the bandpass amplifier. The triode section of the 6U8 is employed as a cathode follower to feed the grid of the pentode section through a 1N34 diode. For the duration of the negative gating pulse, the positive terminal of this diode is held too far negative to allow conduction; and grid No. 1 of the pentode receives no signal. During intervals between gating pulses, the video which is of positive polarity at this point is passed and amplified. Since the gating pulse is usually taken from the horizontal-deflection system, it should be realized that the stability of the horizontal AFC is of great importance for color receivers. The phase of the gating pulse must not radically change over the normal range of the horizontal-hold control.

Color Sync and Phase

The output of the burst amplifier feeds a phase-detector circuit which also receives a signal from the local 3.58-mc oscillator. The phase detector has an output voltage which indicates by changes in polarity and magnitude any difference in phase of the two signals. This correction voltage is fed to a conventional reactance-tube circuit which locks the local oscillator on frequency and at a specific phase relationship with the transmitted color burst.

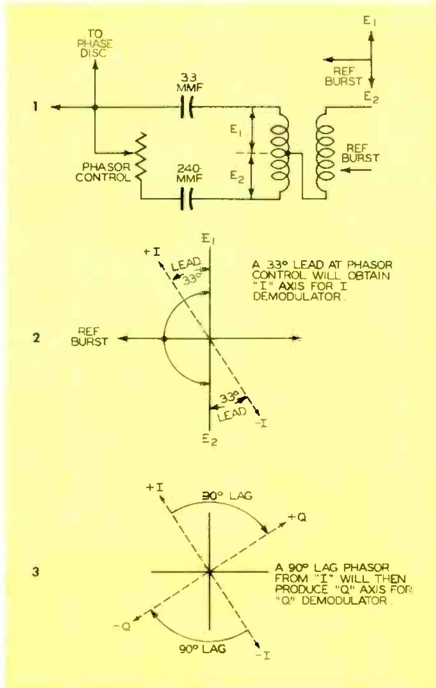


Fig. 14F. Phasing Requirements for the CW Signals to Enable Demodulation on the I and Q Axes.

Before looking at typical circuits in this section of the color receiver, let us review system requirements for the I and Q circuits. Fig. 14F aids in this review. Remember that a definite phase relationship is necessary so that I (wideband color) lies along the orange-cyan axis of the color triangle.

The voltage induced in the secondary of the transformer shown in section 1 of Fig. 14F will lag the primary reference-burst current by 90 degrees. This is conventional transformer action. Since this secondary is center tapped, voltages at opposite ends are 180 degrees apart. Thus, E1 and E2 are 180 degrees apart and in quadrature to the reference burst as shown in the phase diagram.

We may now see that (in Fig. 14F, section 2) if the voltages E1 and E2 are exactly in quadrature to the color-burst phase, adjustment of the phasor control (R-C combination which produces a leading phase angle) to 33 degrees will cause the output voltage to lie along the I axis. If E1 and E2 are not exactly in quadrature to the reference burst (as is usually the case due to leakage reactance), the phasor control covers an adequate range to provide proper phasing. This voltage is fed to the phase discriminator which compares it with the reference burst. A correction voltage will then hold the local oscil-

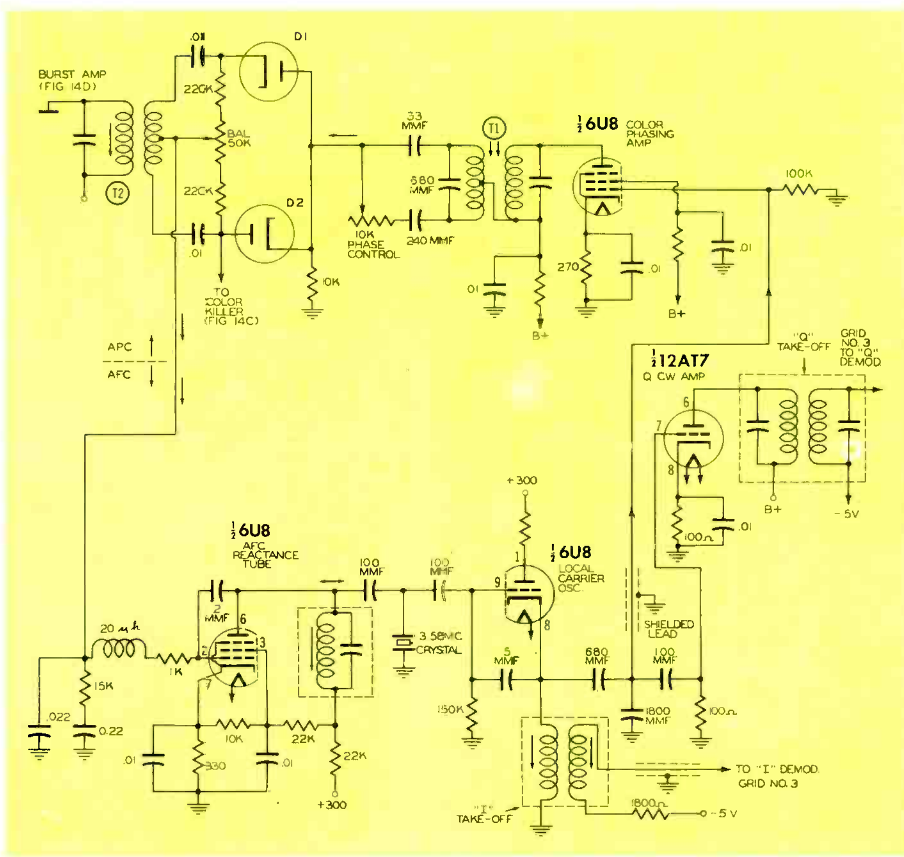


Fig. 14G. A Color-Synchronizing Circuit.

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lator at this phase angle (I axis), as described in the following.

Observe in Fig. 14F, section 3, that a 90-degree lag phasor from the I axis will supply a carrier along the Q axis. The importance of this lies not so much in practical adjustment of receiver circuits but in the fact that it enables a more accurate visualization of the system function. A phasing control, ordinarily on the front panel, properly phases the local oscillator so that the locally injected carriers fall on the I and Q chrominance-signal axes. Improper adjustment causes inaccurate color reproduction such as reds going blue, blues going green, and the like.

Fig. 14G shows one type of APC loop for color synchronizing. Diodes D1 and D2 constitute the phase-discriminator circuit for comparison of the local-oscillator signal through T1 with the transmitted burst signal through T2. Note that the diodes are connected to conduct on the same half-cycle of the signal. No conduction will occur without voltage from the burst amplifier.

Under conduction, the plate of D2 will go negative with respect to ground. This point connects to the color-killer grid (Fig. 14C) to prevent that tube from conducting during color telecasts.

Transformer T1 containing the phase control serves the function described in the foregoing. The discriminator will then act to supply a correction voltage for the reactance tube so that any deviation from the I axis is corrected as in conventional AFC circuits.

The inphase I carrier is taken off from the secondary of the transformer in the cathode circuit of the crystal oscillator. The Q amplifier feeds from the cathode of the oscillator.

Actually, APC circuits will vary widely. Some receivers use lumped resistance-inductance circuits for the quadrature phasing. Principles, however, remain the same.

The receiver which demodulates on the R - Y and B - Y axes differs from the one just described in that no 33-degree phase relationship with the reference burst is necessary. The B - Y signal lies along the sine axis. It is then only necessary to feed the R - Y demodulator through a 90-degree phasor to demodulate the red color-difference signal. This particular feature does not aid in simplification, since 33-degree networks are very simple (Fig. 14G); and

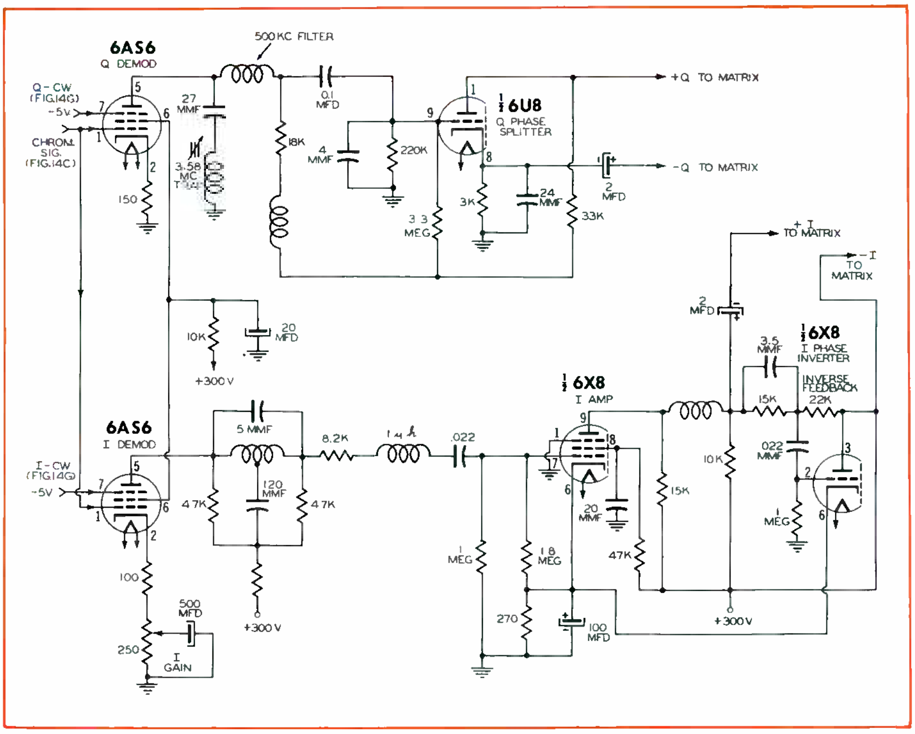

Fig. 14H. Demodulators and Phase Inverters for the I and Q Signals.

whether this 33-degree phasor is used or not, a phasing control must be used for accurate placement of the local-carrier phase.

Synchronous Demodulators

Fig. 14H illustrates one method of feeding the synchronous demodulators and the matrixer. The chrominance signal is fed to the control grids of the demodulators. The suppressor grid of the I demodulator is driven by the inphase CW, and the suppressor grid of the Q demodulator is driven by the quadrature CW. The chrominance signal, of course, contains both I and Q color information.

In the I demodulator, the output contains a vector sum of the I-signal sidebands from the chrominance channel and the inphase CW. The Q-signal sidebands in the chrominance signal, since they are in quadrature to the I sidebands, produce zero output in the I demodulator. This is the action of a synchronous demodulator; the output is zero for components 90 degrees apart from the CW drive.

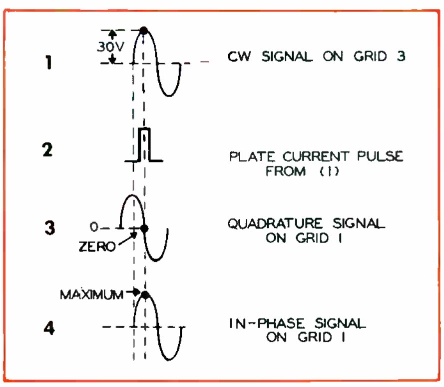

Fig. 14I. Synchronous Demodulator Action.

The output of the Q demodulator contains the vector sum of the quadrature CW and the Q-chrominance sidebands. The single sidebands of the I signal above 500 kc produce a quadrature component which will therefore crosstalk into the Q-demodulator output. This is the reason for the 500-kc filter in the plate load of the Q demodulator shown in Fig. 14H.

Note that the I demodulator has a gain control and an extra amplifying stage. Since the Q sidebands are equal (double sidebands), Q gain will be twice that of the I channel above 500 kc. The extra I amplifier compensates for this difference, and the gain control allows exact adjustment for proper gain ratio.

Fig. 14I illustrates the basic operation of a synchronous demodulator. Note from Fig. 14G that the suppressor grids (grid No. 3), which receive the CW signals, are biased at a negative 5 volts. The peak voltage of the CW signals may be approximately 30 volts. Parameters of the circuits are such that the tube conducts heavily on peak regions of the CW signal even though there is no chrominance modulation on grid No. 1.

The CW signal is shown in section 2 of Fig. 14I. Corresponding tube

* * Please turn to page 47 * *

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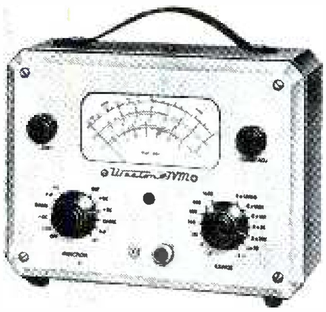

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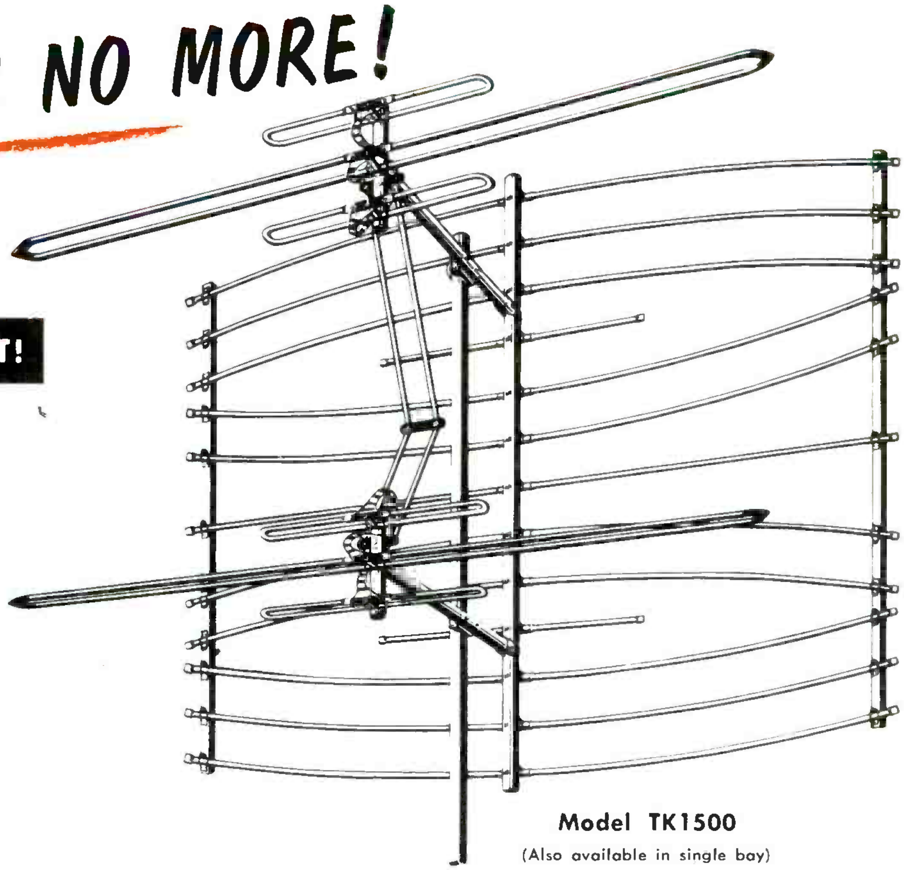

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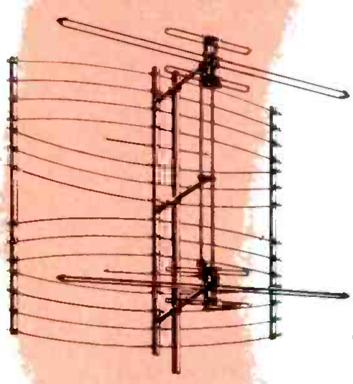

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TV Colormath

(Continued from page 43)

conduction with no chrominance signal is shown in section 2 of Fig. 14I. Any instantaneous signal voltage on grid No. 1 will determine the amount of that current that reaches the plate. Thus, the instantaneous voltage on grid No. 1 is multiplied by the instantaneous voltage on grid No. 3. This action is sometimes referred to as product demodulation.

On grid No. 1, signals that are inphase will go positive when grid No. 3 goes positive. This results in heavy plate current on the positive peaks. The pulses will follow modulation on grid No. 1.

A quadrature signal on grid No. 1 (section 3 of Fig. 14I) will be zero at the time of plate current pulse, therefore no signal is produced in the output. An inphase signal (section 4 of Fig. 14I) will add vectorially to the CW signal.

If the CW signal is not the same frequency and phase as the chrominance signal, the usual superheterodyned beat frequency results. This undesired beat component will be modulated by the amplitude variations on grid No. 1, and as a result there will be spurious products in the output circuit. The fact that these signals pass through the low-pass filters into the chrominance amplifiers emphasizes the importance of proper APC loop-phasing adjustments.

Note that the plate of the Q phase splitter (Fig. 14H) is DC coupled to the matrixer while the cathode is AC coupled. This is necessary to isolate plate and cathode DC voltages in the matrix. Similarly, the +I signal is AC coupled and the -I signal DC coupled to isolate these separate voltages. The I phase inverter contains negative feedback which holds the output amplitude equal to the +I amplitude. Thus, the tube acts only as a polarity inverter.

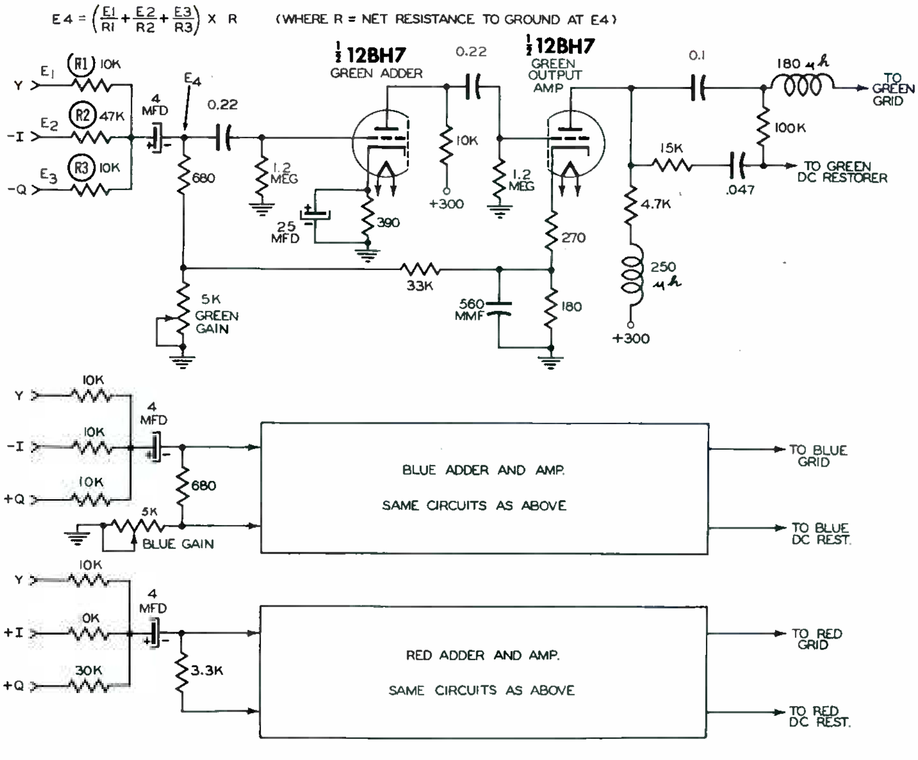


Fig. 14J. Color Matrix, Adder, and Output Circuits.

Matrix and Adder Circuits

Fig. 14J illustrates typical matrixer and color-adder circuits. Identical circuits are employed in this example for the red, green, and blue adders and amplifiers. The three output circuits are employed to obtain unequal signal drives which are necessary to compensate for phosphor efficiencies. Red phosphors require maximum signal drive, green less, and blue the least. The green and blue gains can be adjusted so that the proper signal drive is obtained.

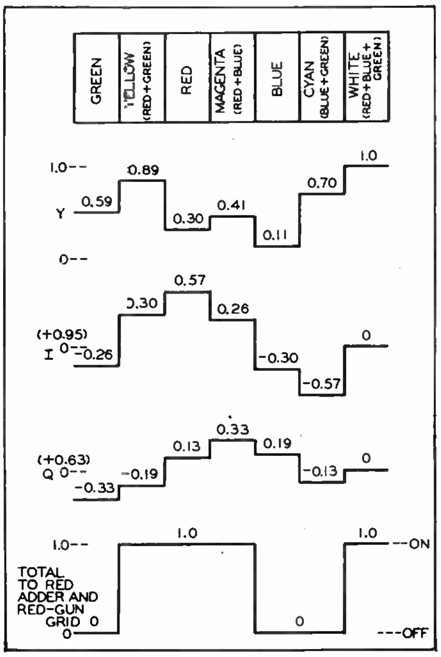


Fig. 14K. Voltages at Red Matrix for Indicated Bar Pattern.

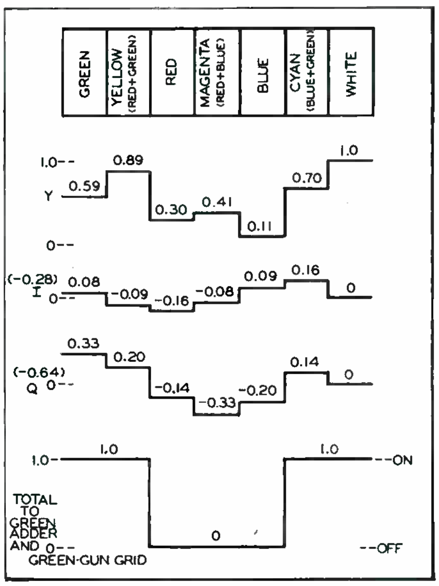


Fig. 14L. Voltages at Green Matrix for Indicated Bar Pattern.

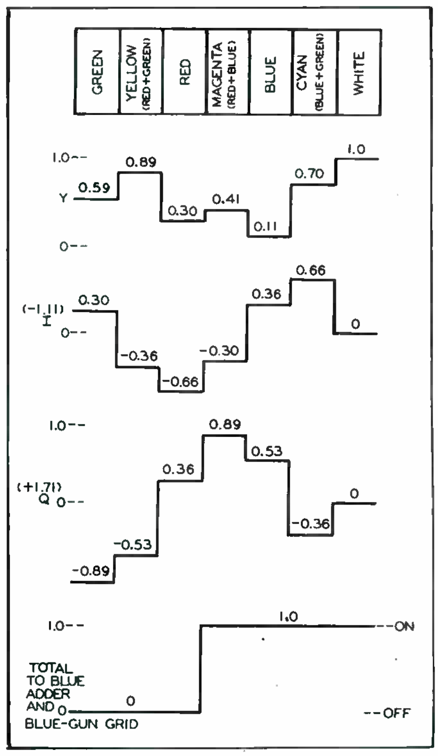


Fig. 14M. Voltages at Blue Matrix for Indicated Bar Pattern.

TABLE II

EFFECTS OF LOSS OF THE I SIGNAL

	Green Bar		Yellow Bar		Red Bar		Magenta Bar		Blue Bar		Cyan Bar	
	Values Existing in the Color Channels											
	Normal	Without I	Normal	Without I	Normal	Without I	Normal	Without I	Normal	Without I	Normal	Without I
Red Channel	0	0.26	1	0.70	1	0.43	1	0.74	0	0.30	0	0.57
Green Channel	1	0.92	1	1.09	0	0.16	0	0.08	0	-0.09	1	0.84
Blue Channel	0	-0.30	0	0.36	0	0.66	1	1.30	1	0.64	1	0.34
	Effects Caused by the Foregoing Conditions											
Red Channel		0.26		0.70		0.43		0.74		0.30		0.57
Green Channel		0.92		1.09		0.16		0.08		0		0.84
Blue Channel		0		0.36		0.66		1.30		0.64		0.34
Colors Reproduced		Contaminated yellow-green		Yellow-green		Desaturated magenta		Purple		Purple at low bright-ness level		Yellow-green

Note, however, that the red channel has no gain control. Adjustment of the red channel is not required, since the proper ratio can be obtained through adjustment of the green and blue gains.

To enable a clear visualization of matrixer action, the graphs of Figs. 14K, 14L, 14M, and 14N are presented.

Observe Fig. 14K, which is a graph showing voltages at the red matrix (and red-gun grid) for the indicated bar pattern. For example, we know that the red phosphor will be biased off for a green signal. Note that on the green bar (indicated at top of graph), Y is 0.59; I is -0.26; and Q is -0.33. The total is zero, as indicated on the bottom curve. Also note that for the red bar and for bars which combine red with another color, the totals add to give unity. The values for the green and blue matrixers are shown similarly by Figs. 14L and 14M.

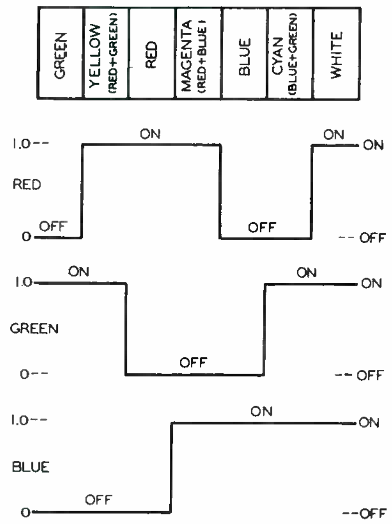


Fig. 14N. Combined Action of the Three Primary Channels for Reproduction of Indicated Bar Pattern.

The combined action is shown by Fig. 14N.

From observation of these graphs, we have prepared Tables II and III to note the results of loss of I or Q signals. Other tables could be constructed to show the effect of loss of any single color channel, change in values of matrix resistors, or the like.

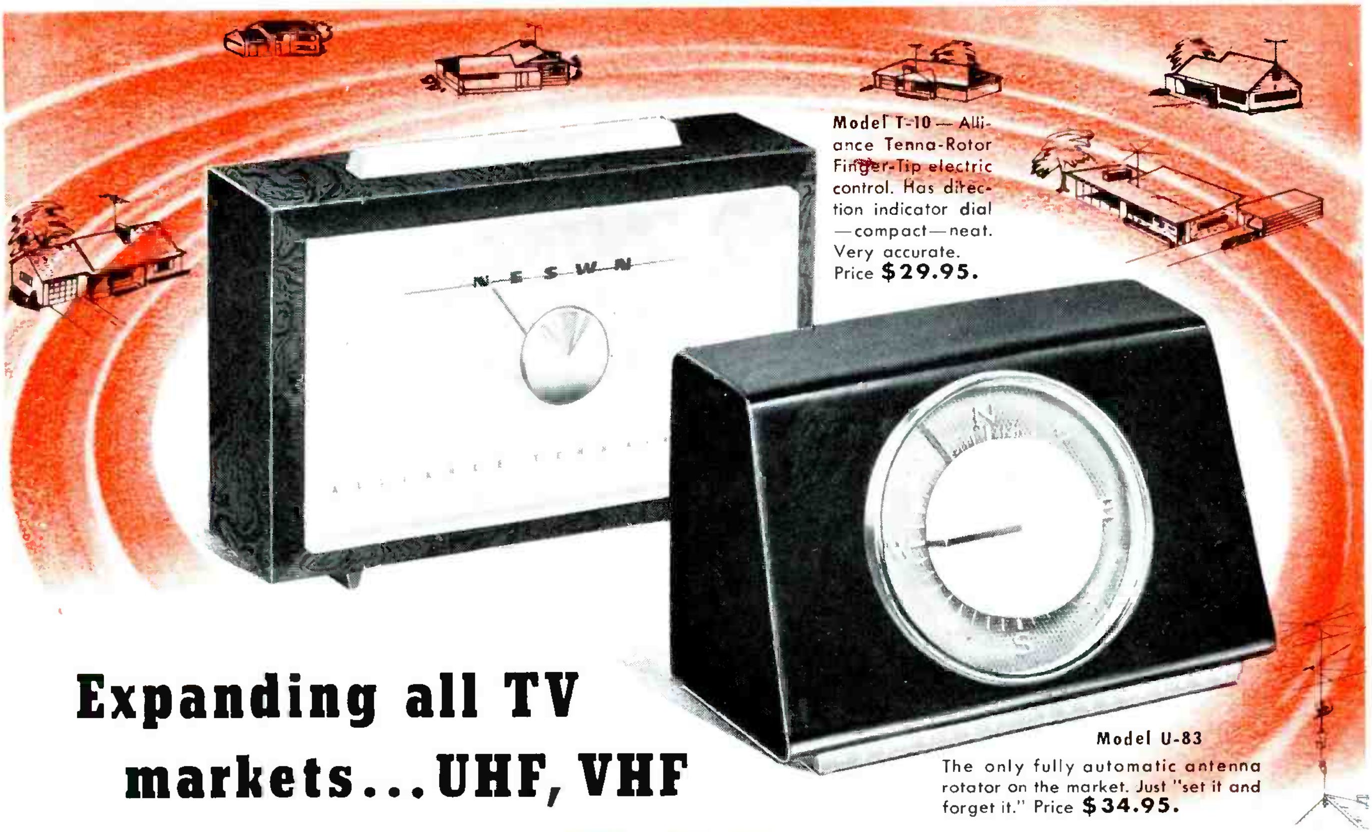
As an example of use of the tables, note Table II for loss of I signal. The reader should check back through the graphs to see how these values are derived. Note that green without the I signal gives a final value of 0.26R, 0.92G, with blue biased off. The normal value is 1G, with red and blue biased off. Since some red is mixed with green in this example, the green bar will be reproduced as a contaminated yellow-green.

It is important that all amplifiers be as nearly linear as possible.

TABLE III

EFFECTS OF LOSS OF THE Q SIGNAL

	Green Bar		Yellow Bar		Red Bar		Magenta Bar		Blue Bar		Cyan Bar	
	Values Existing in the Color Channels											
	Normal	Without I	Normal	Without I	Normal	Without I	Normal	Without I	Normal	Without I	Normal	Without I
Red Channel	0	0.33	1	1.19	1	0.87	1	0.67	0	-0.19	0	0.13
Green Channel	1	0.67	1	0.80	0	0.14	0	0.33	0	0.20	1	0.86
Blue Channel	0	0.89	0	0.53	0	-0.33	1	0.11	1	0.47	1	1.36
	Effects Caused by the Foregoing Conditions											
Red Channel		0.33		1.19		0.87		0.67		0		0.13
Green Channel		0.67		0.80		0.14		0.33		0.20		0.86
Blue Channel		0.89		0.53		0		0.11		0.47		1.36
Colors Reproduced		Purplish blue		Reddish yellow		Orange		Orange-red		Cyan		Blue-purple



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Model Genie-1

ALLIANCE MANUFACTURING COMPANY, Alliance, Ohio

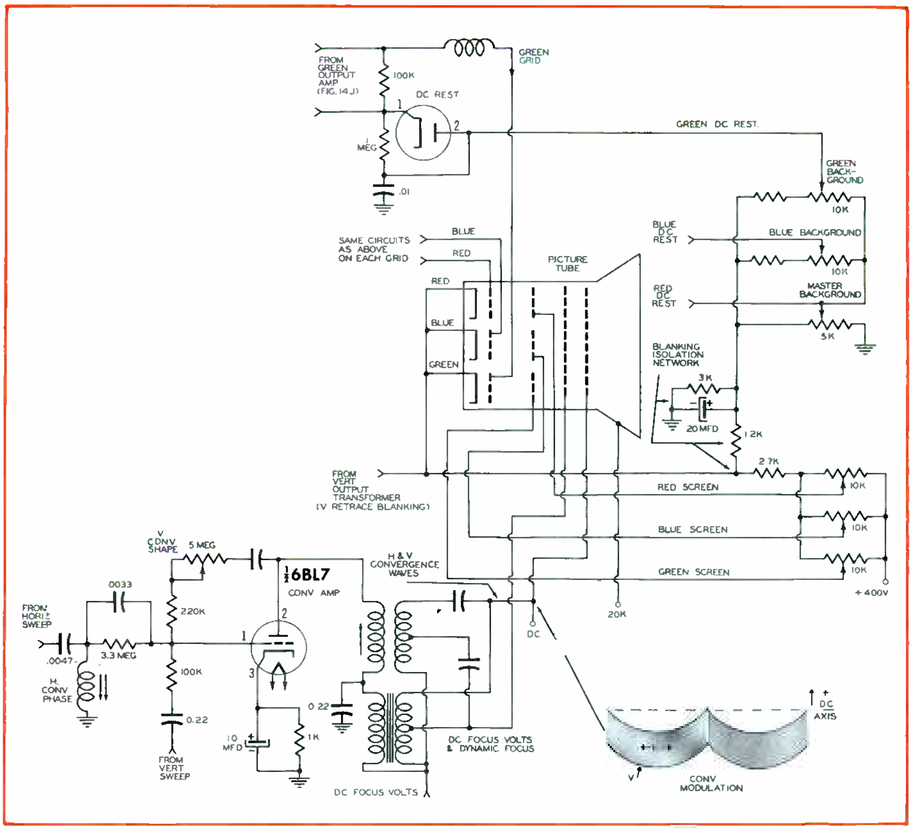


Fig. 14-O. Dynamic-Convergence Circuits, Screen and Background Controls.

Remember that the actual signals received are gamma-controlled to compensate for phosphor power-law characteristics. Should the amplifiers depart from linear amplification, the gamma-corrected signals will be distorted either to nullify or to overemphasize the correction.

Color Picture Tube Circuits

Fig. 14-O designates the circuits associated with a three-gun color picture tube.

Each grid receives excitation from its specific video channel (Fig. 14J), is DC controlled, and is returned through individual background controls.

The cathodes are driven positive during vertical-blanking intervals by pulses from the vertical-output transformer. This assures complete retrace blanking.

Each screen can be adjusted in DC voltage by individual controls to aid in balancing phosphor efficiencies.

The convergence-amplifier grid receives horizontal and vertical waveforms from the cathodes of horizontal and vertical-deflection amplifiers. Shapes of the waveforms at these points closely approach a parabola. The controls that are shown shape the applied voltages properly to any correction necessary. The amplified output modulates the DC applied to the convergence electrode. Since the distances from the guns to the top, bottom, left, and right regions of the screen are greater than the distance to the center of the raster; the beams from the three guns would not properly register without correction. Dynamic convergence corrects the applied voltage in step with the scanning position of the beams.

DC applied to the focusing electrode is adjustable for optimum control of the scanning-spot size from each gun. The focusing electrode also receives a portion of the parabolic waves to maintain focus during scanning.

The picture-tube high voltage is regulated by a shunt-regulator tube across a flyback voltage-doubler power supply. During a black picture and blanking intervals when no beam current is drawn, the regulator becomes the power-supply load. For a maximum white picture, the kinescope becomes the load and the regulator tube absorbs very little power. This method maintains constant load on the high-voltage power supply and allows good regulation for the picture-tube anode.

Harold E. Ennis

Headsets for TV

(Continued from page 11)

has no effect upon the sound being produced by the speaker. Second, the circuit uses a separate volume control, the setting of which has no effect on the speaker circuit. Third, it contains a tone control which also does not affect the speaker circuit. Fourth, the circuit will provide enough drive to operate several pairs of headsets. This makes it ideal for use in a hospital room where more than one person may want to watch a show without disturbing others and for home use where more than one child will want to enjoy the afternoon cartoon without disturbing mother's afternoon bridge party. Safety for users of the headsets is assured because the headsets are isolated from the subchassis and from ground by the output transformer T1.

A 6AB4 high-mu triode is used as the audio amplifier. The input to this tube is obtained through a socket connector from the high side of the volume control in the receiver. Filament and B+ voltages are also provided through the socket connector. The input impedance of the 6AB4 is sufficiently high that it places a negligible load on the volume-control circuit in the reciever. A tone-control circuit consisting of capacitor C2 and potentiometer R3 shunts the plate load of the tube. The transformer T1 should have a primary impedance of 10,000 ohms and a secondary impedance equal to 500 ohms. The latter specification is based on the assumption that four jacks are incorporated and that the impedance of each headset is approximately 2,000 ohms. The jacks are the closed-circuit type.

The circuit in Fig. 1 may be modified to provide a constant output impedance by using a 2,000-ohm T-pad in place of the volume control on the headset. If closed-circuit jacks are not available, open-circuit jacks may be used. In this case, a 500-ohm resistor is connected across the

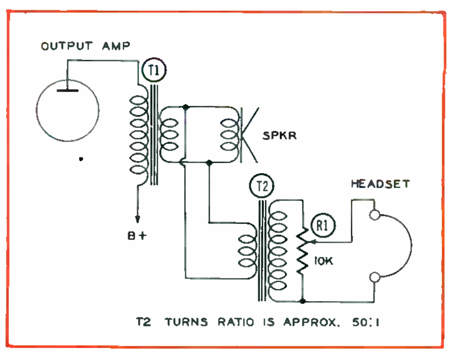
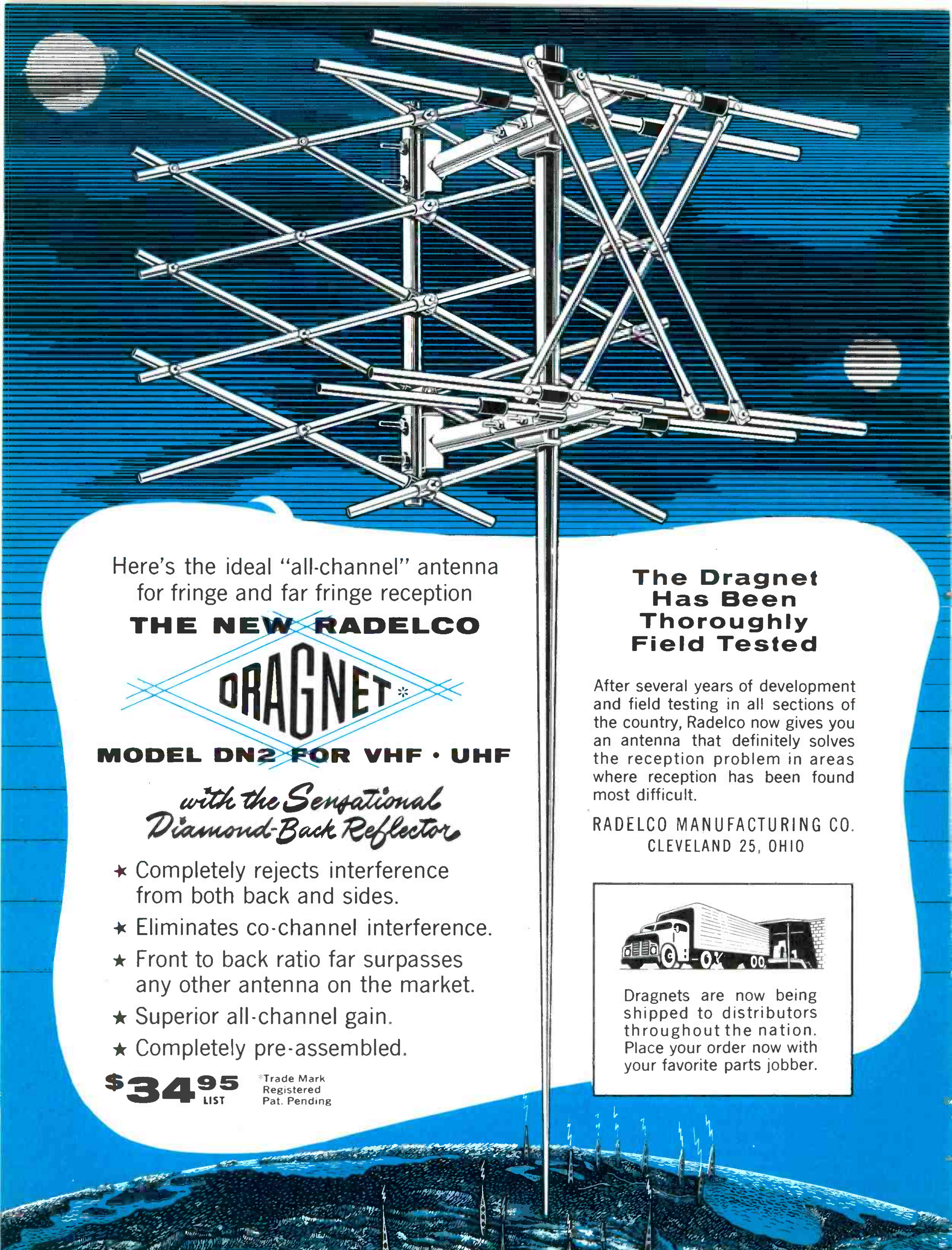


Fig 2. Connecting a Headset to a Speaker by Means of a Second Transformer.



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secondary of T1 to replace resistors R4, R5, R6, and R7.

Fig. 2 illustrates a circuit hookup which has proved very satisfactory as a simplified circuit; however, there is still the expense of an output transformer. This circuit, too, contains a volume control which has very little effect upon the volume of the speaker output because of the relatively high impedance in the secondary circuit of transformer T2. This hookup is a fairly good one for a family which has one member who has difficulty in hearing over most of the audio range.

The circuit of Fig. 2 merely consists of a second transformer connected in such a manner as to step up the amplitude of the audio so that enough audio is available to be controlled. The transformer used for this purpose should have one winding of approximately 50 ohms in impedance. The second winding should have an impedance of approximately 10,000 ohms. There are certain inexpensive transformers having their principal applications in transceivers and inter-communication devices that will function satisfactorily as transformer T2. Since the headset circuit in Fig. 2 is isolated from the receiver by transformer T2, shock hazards to the user are eliminated.

A method of installing headsets in a case where they are to be used solely for the purpose of hearing in privacy is shown in Fig. 3. This circuit contains a closed-circuit phone jack in the plate circuit of the audio-output tube. When the headset is plugged in, the lead to the speaker transformer is broken and the headset transformer becomes the sole plate load on the output tube. If a family has more than one person who will be using headsets at the same time, these headsets could be connected in much the same manner as the secondary portion of the circuit in Fig. 1.

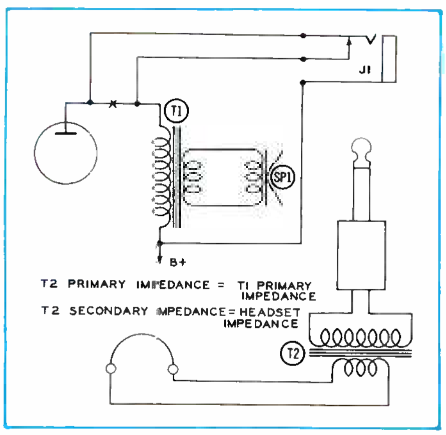

Fig. 3. A Method of Substituting a Headset for the Speaker.

The primary impedance of the headset transformer should be the same as that of the speaker transformer. The secondary will depend upon the number and impedances of the headsets. For instance, if four pairs of headphones are to be used and each pair has an impedance of 2,000 ohms, the secondary of the transformers should be 500 ohms.

Fig. 4 illustrates one of the less expensive hookups for operating a headset. The chief advantage to this circuit is its low cost. The disadvantages are more numerous. For example, changing the volume of the headset causes a change in the tone of the speaker, and the tone in the headset also changes with different volume settings. Furthermore, this circuit cannot be safely used with sets which have one side of the AC line connected to the chassis ground; there is a shock hazard because one side of the headset is also grounded. Finally, only one headset can be used with this circuit since the addition of

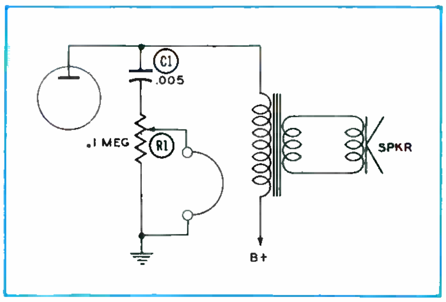

Fig. 4. A Transformerless Headset Connection.

others in parallel would require a higher setting of volume control R1 with a consequent reduction in the plate load on the output tube and a very pronounced effect on the volume and tone of the audio output. By the same reasoning, it would not be advisible to use a pair of very low-impedance earphones in a circuit of this type, because the tone of the speaker would be too greatly affected.

Of all the different ways in which a pair of headphones may be connected to a set, probably the least desirable is that shown in Fig. 5. This is especially true if the headphones have a fairly large impedance. For instance, if the equipment were to be used by a person who is partially deaf, a headset with an impedance of 2,000 ohms would produce such low volume that in order to hear satisfactorily, the wearer would have to turn up the receiver volume to such a point that it would be annoying to others who might be trying to listen to the speaker. Such a hookup is also a shock hazard if the secondary of the audio-output transformer is grounded and one side of the line is connected to the chassis ground.

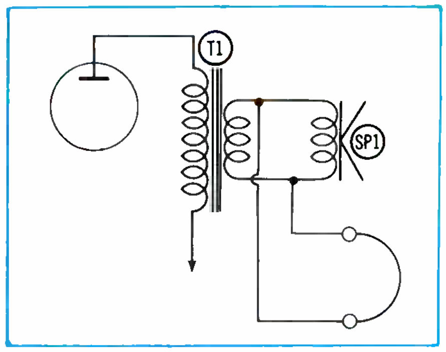

Fig. 5. The Simplest Method of Connecting a Headset.

What Type Headsets?

There are many types of headsets from which the set owner can choose. The choice will depend upon a number of things: the cost, how the set is to be used, the quality desired, and the wearing comfort and freedom of movement desired by the customer. Because there are so many from which to choose, it would be a good idea for the service technician either to carry several types in stock or to have some literature that the set owner might study to make his selection.

There are several types of light-weight headsets available; two of these are the Monoset and the Twinset manufactured by Telex, Inc. The Monoset is an inexpensive under-the-chin type with very small and light earphones which place very little pressure on the ears. The Twinset is also a very light unit and has the added feature of not placing any pressure on the ears. Instead, the receivers rest lightly on the temples, and two small tubular arms pipe the sound directly into the ears.

High-fidelity headsets are available and provide a very good quality of reproduction. However, they are quite expensive and are impractical for TV use by the average set owner.

Length of Lead

From an electrical standpoint, the length of lead is not critical. It should be made long enough that it will reach the point normally used for viewing without being stretched. It should not be so long, however, that it becomes cumbersome and a nuisance to put away when not in use.

HENRY A. CARTER

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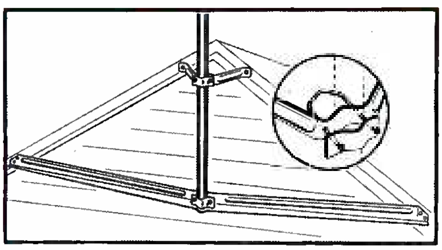

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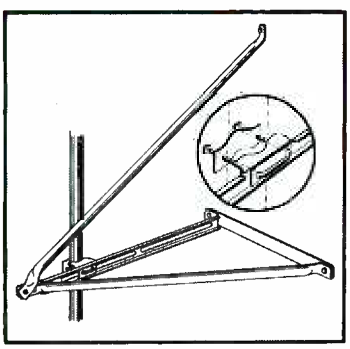
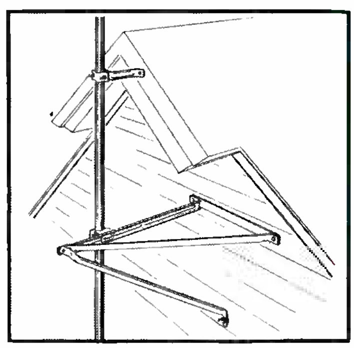


ALL STEEL ADJUSTABLE WALL BRACKET

Model ST-18A

2 heavy-gauge embossed steel, fully adjustable, rugged braced brackets permit an 18″ clearance under eave. Bottom bracket includes steel bracing leg. Features unique "U" bolt and plate sliding-type mast clamp. Hot-dip galvanized to prevent corrosion and rust-streaking. Hardware includes lag screws for mounting.



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Same lower bracket as Model ST-18A. Utilizes a rugged 3″ embossed steel upper bracket. Useful in many applications where mounting is required under peak of a house. Complete with necessary hardware and lag screws.

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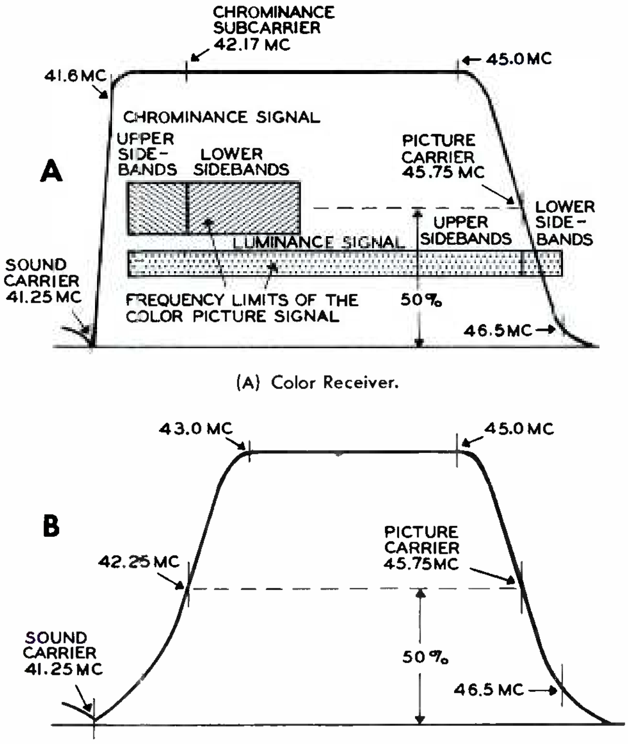
Color TV Training Series

(Continued from page 9)



(A) Color Receiver.

(B) Late-Model Monochrome Receiver.

Fig. 4-5. RF and IF Frequency Response Curves.

With these requirements in mind, let us examine the video IF section and the video detector used in one make of color receiver. Fig. 4-6 shows a schematic diagram of this part of the RCA Victor Model CT-100. It can be immediately noticed that a greater number of tubes and tuned circuits are employed than are commonly found in black-and-white receivers. This seems reasonable, considering the stringent bandpass requirements of the circuit.

Five stages provide IF amplification. Following the first video IF amplifier, L18 and L20 form a bridged-T bandpass circuit that is M-derived. Frequency rejection is accomplished through the use of two series traps. These are tuned to 40.7 mc and 47.25 mc, the latter being the frequency of the sound IF carrier in the adjacent channel. The second, third, and fourth picture IF transformers are stagger tuned to produce a flat response over the desired range. L21 is tuned to the high side of the frequency band; whereas, L25 is tuned to the low side. L24 is tuned about midrange to produce an over-all flat response. Further frequency rejection is provided by the 47.25-mc absorption trap coupled to the plate circuit of the fifth picture IF stage.

The video IF signal contains a frequency representative of the chrominance subcarrier. This frequency appears approximately 920 kc away from the sound IF signal. If both frequencies were allowed to reach the video detector stage at sufficient levels, a 920-kc beat frequency would be developed. As a result, an annoying interference at this frequency of 920 kc would appear in the picture. In order to prevent this, one of these signals must be severely attenuated before reaching the video detector. In the receiver circuit shown in Fig. 4-6, the sound IF carrier is the signal which is attenuated.

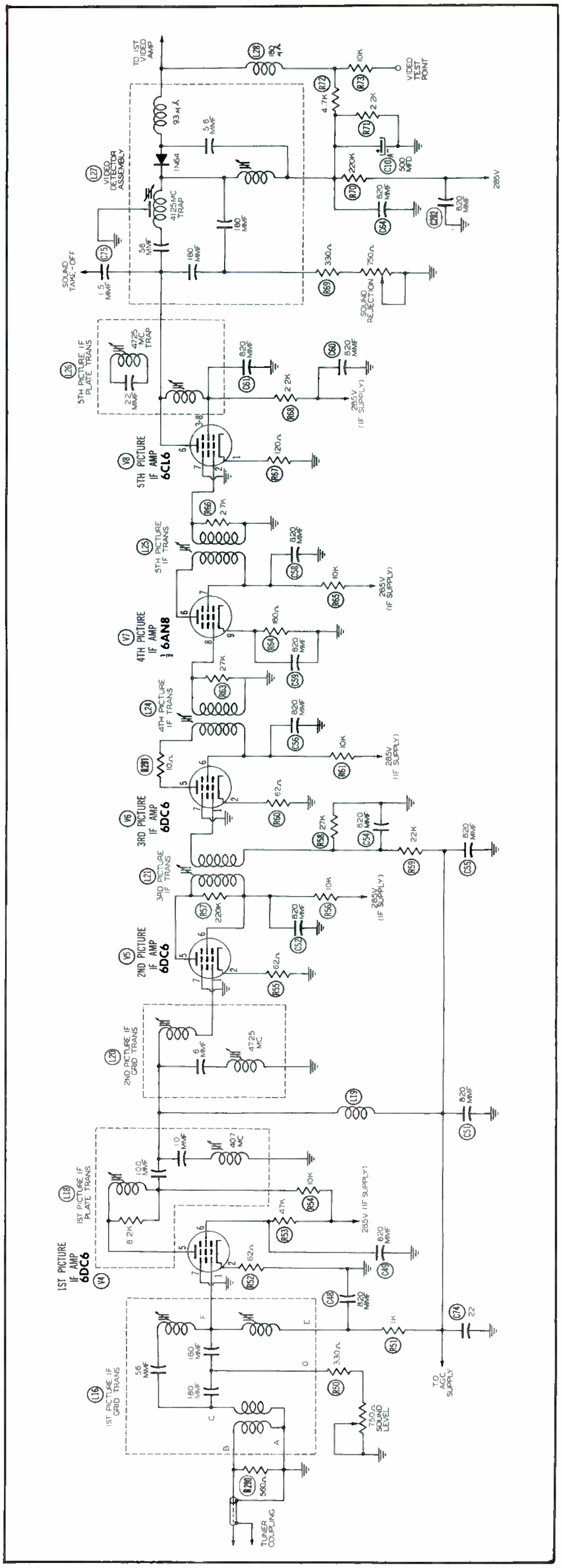


Fig. 4-6. Video IF and Detector Circuits in RCA Victor Model CT-100 Color Receiver.

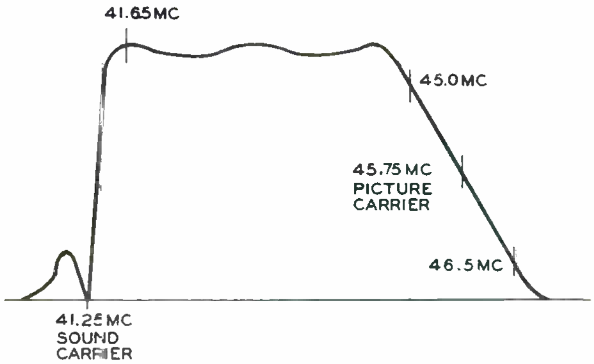


Fig. 4-7. Over-All Response of RF and IF Sections in RCA Victor Model CT-100.

This attenuation is provided through the use of traps. A bridged-T trap in the grid circuit of the first video IF amplifier provides the initial sound attenuation, which yields about the same 15 to 1 ratio of picture-to-sound carrier level that is employed in most intercarrier receivers. The use of the sound-level control in the resistive portion of the trap provides the necessary adjustment to obtain the desired ratio. Although bridged-T traps are not uncommon, the use of a variable resistance in connection with the trap in this part of the circuit is unusual. Before the sound IF carrier is further attenuated, it is taken off and fed to the sound IF detector. The take-off point is shown at the plate of the fifth video IF amplifier.

Preceding the video detector, a second bridged-T trap further attenuates the sound IF carrier. The adjustment procedure for this receiver specifies that the sound-rejection control should be adjusted for maximum attenuation of the sound IF signal. At this setting, an attenuation of 60 db below peak response is provided. Thus, the sound carrier is practically eliminated before the signal reaches the video detector.

The over-all IF response of the receiver from the mixer to the video detector conforms with the drawing in Fig. 4-7. Note that this response fulfills the bandpass

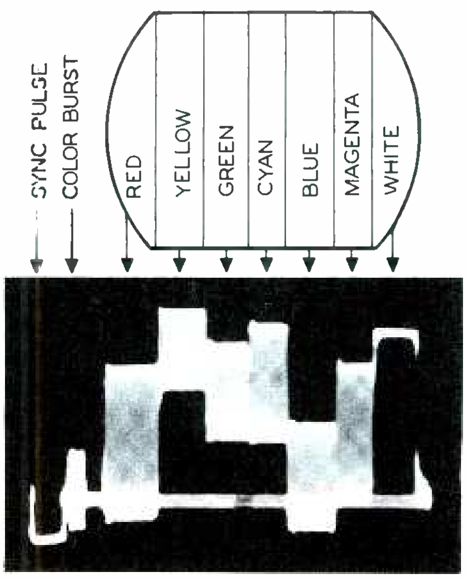


Fig. 4-8. Color-Bar Pattern and Associated Composite Color Signal at Output of Video Detector.

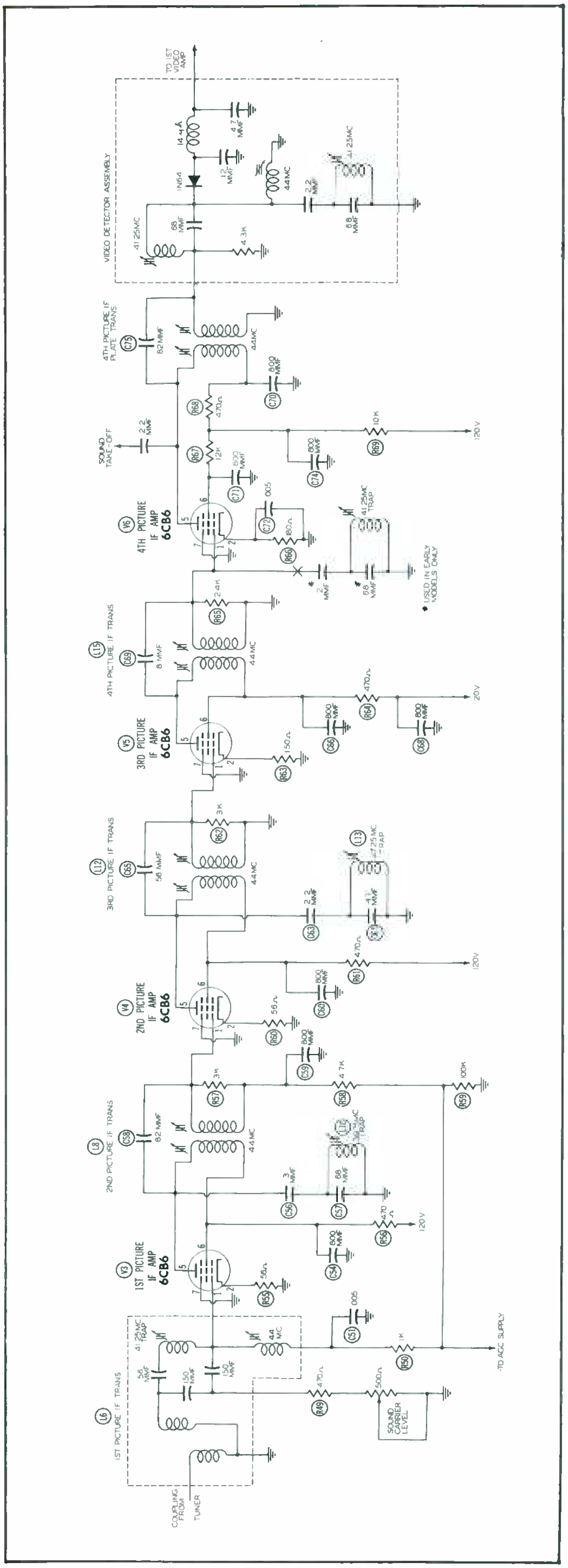


Fig. 4-9. Video IF and Detector Circuits in Westinghouse Model H840CK15.

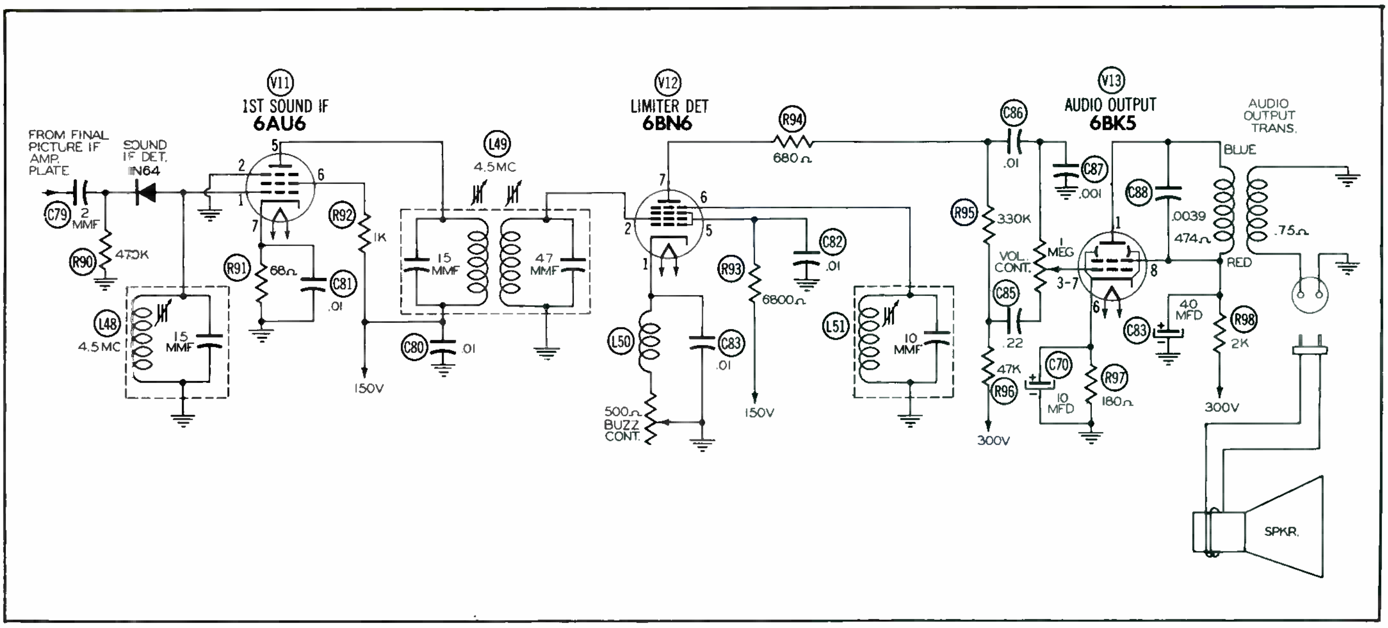


Fig. 4-10. Sound Circuits in Arvin Model 15-550 Color Receiver.

requirements for good color reproduction. These requirements are illustrated by the response curve shown in Fig. 4-5A.

An interesting design feature of the five-stage IF strip in Fig. 4-6 is the use of a 6CL6 as a fifth video IF amplifier. This tube is a power pentode which would not be used normally in this application. The signal level at the input of this stage is quite high, however; and this tube is used to provide the necessary signal-handling capabilities.

The video signals appearing at the output of the video detector consist of luminance, chrominance, horizontal and vertical sync pulses, and the color burst. The photograph reproduced in Fig. 4-8 shows the waveform of this output signal for the period of one horizontal line. The drawing above the waveform depicts the color-bar picture on the screen at the time the waveform was taken.

The RCA Victor Model CT-100 uses five stages of IF amplification as do models by several other manufacturers. Still other manufacturers have designed their color receivers with four IF stages. A partial schematic of the Westinghouse Model H840CK15 is presented in Fig. 4-9. Four 6CB6 pentodes are used; and except for the location of the sound take-off point and the numerous 41.25-mc traps, the circuitry is much like that used in many monochrome receivers.

Sound IF and Audio Sections

With the exception of the separate sound IF detector, the sound IF and audio sections of color receivers follow conventional monochrome design. If the reader knows the theory of intercarrier operation, he should have little difficulty in understanding and working with these sections in color receivers.

It has been mentioned that the sound IF carrier is severely attenuated in the video IF strip; consequently, the output of the video detector contains virtually no 4.5-mc beat signal. Sound information must be obtained from a point ahead of the video detector. This take-off point is usually the output of the final video IF amplifier. The signals available at this point are in the IF range; and in order to obtain the 4.5-mc sound signal, a detector is necessary.

The sound IF and audio circuits used in the Arvin Model 15-550 can be seen in Fig. 4-10. A 1N64 crystal diode at the input of the first sound IF amplifier is used as the sound IF detector. The load impedance provided by L48 is tuned to 4.5 mc. Since the picture and sound IF carriers are the input signals, the action of the diode and its load results in the production of the 4.5-mc sound signal. From that point on, the sound information is handled as in monochrome receivers.

In the next issue, we will continue the discussion of the color receiver circuits which follow the video detector.

In order to give the reader an opportunity to test himself on the material in this issue, we are including a few questions that are answered in this discussion.

1. What is the basic requirement of a tuner which is used in a color receiver? Why?

2. What are the upper and lower bandpass limits of the video IF section in a color receiver? How does this compare with the IF response of an average black-and-white receiver?

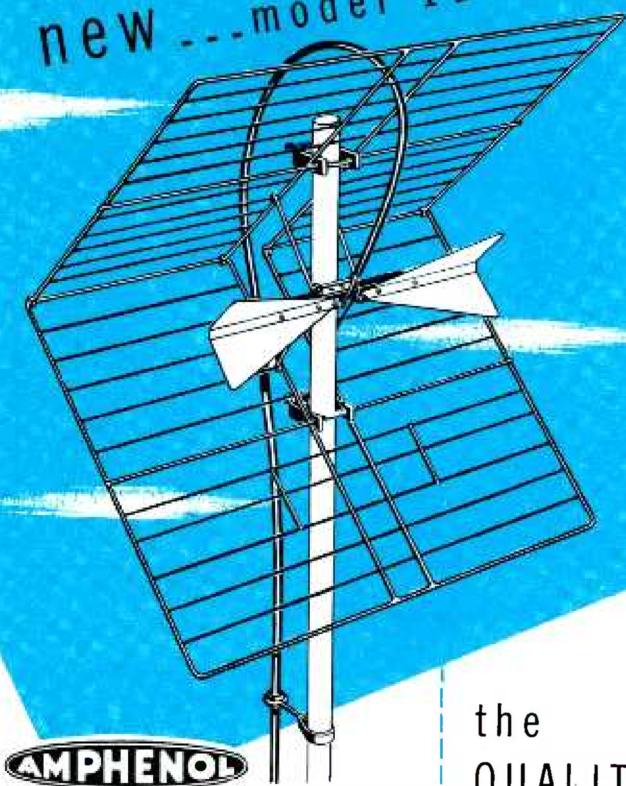
3. Why is the sound IF carrier severely attenuated in the video IF section?

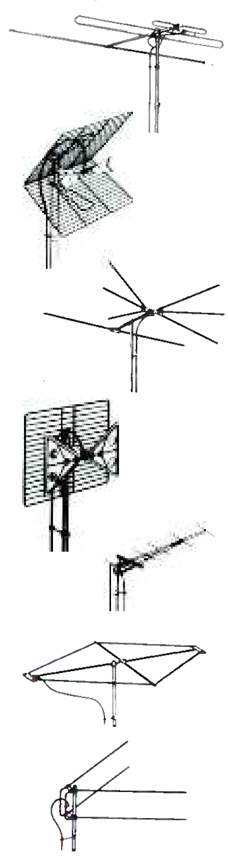
4. Why is a sound IF detector employed in a color receiver?

C. P. Oliphant

and

Verne M. Ray





Dollar and Sense Servicing

(Continued from page 39)

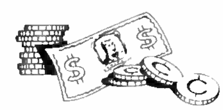
SIDELINES. One neighbor of ours uses television to get her mending and ironing done. Seems as how darning of socks goes faster when she listens to some program and looks occasionally at the picture to give her eyes a rest from the cross-stitches.

Our own daughter writes letters to Australian Brownie Scouts or sews doll clothes while watching the daily dose of westerns and glances up at the screen only when the action becomes irresistible.

A Connecticut housewife paints in oils right in front of her TV set. According to columnist Jack Gould in the New York Times, she says, "You can get lots of painting done during the commercials. There are many programs where you don't miss anything by not watching them . . . Best for painting," she goes on to say, "are programs of the What's-My-Line type, where you can take a quick look at the guest contestant and go on about your work."

If painting in front of TV sets catches on, program producers will have a new challenge to meet. When you're trying to concentrate on something else, these working televiewers say, you're more conscious than ever of a bad program.

Thus is TV unwittingly meeting the criticism of die-hard radio fans that you can't work while you watch. And thus has this country taken one more revolutionary invention in its stride, for better rather than for worse.



SOUND. Professional quality of sound accompaniment for home movies, the goal of practically all 8-mm and 16-mm amateur enthusiasts, has until recently been too costly for all but a few. Magnetic striping on the back of developed film attracted interest but cost as much as 3 1/2 cents per foot, which is real money for a 400-foot reel that lasts about 20 minutes. Striping doesn't work out too well, either, because temperature and humidity often combine to crack off the coating and thus make the sound track noisy. Laminated striping cures this trouble; but its cost is still high, as also are projectors equipped for magnetic sound. Best hopes lie with a radically new approach to the sound problem.

An electronic control system now being patented by Eugene Anthony (formerly television and radio service manager for General Electric Supply Corp., in New York City) permits use of any standard two-track magnetic tape recorder and standard magnetic tape with any movie projector to achieve synchronized sound. No extra processing whatsoever is involved. Synchronization is always accurate to within the spacing between adjacent sprocket holes. The simple attachments required on the recorder and projector can be put on by a service technician in a few minutes and connected to the electronic control chassis. Installed cost of the control unit and accessories is expected to be about $100.

The user feeds commentary and background recorded music conventionally to the microphone or other inputs of the recorder while watching the projected film. Control signals for controlling projector speed during playback are recorded automatically on the other track of the film. For lip synchronization of sounds recorded during filming, such as baby's first words or the scream of Aunt Nellie as a spider is dropped down her neck, a simple sprocket-tooth switch device is added to the camera.

CLASSICAL. Don't comment disparagingly about high-brow music lovers, because they account for about 30 per cent of all records sold today. This means they buy at least that proportion of the phonographs sold, generally in the most expensive high-fidelity models, and they contribute more than that proportion to servicing income from audio amplifiers, radio-phono combinations, and phonographs.

The golden rule for success in servicing is — if you can't say something nice about a topic, don't say anything. You can never tell when a casual comment may offend and thereby cause loss of a customer.

HAUNTING. Sounds of footsteps going up and down stairs when nobody is there offer potential business to service technicians, according to Leo Connor in a recent issue of NRI's National Radio-TV News. To haunt stairways of recreation rooms, Leo says, you merely have to mount a solenoid-operated striker under each stair tread and connect them all up to contacts mounted on a motor-driven drum. By arranging contacts properly or providing an extra set of contacts, you can even make the ghost go halfway up the stairs and then come back down again at your call. The firm of Herbach and Rademan in Philadelphia is suggested as a source for the motor, solenoid coils, and plungers. For construction details, write editor Lou Menne at National Radio Institute in Washington and ask for a copy of his June-July 1954 issue.

INTERFERENCE. If you get auto-radio service job where conventional techniques fail to cut down ignition interference, try measuring continuity between the brass cap at the end of a spark-plug lead and the cable itself. In some new models of cars of a well-known make, as many as half of the spark-plug cables are open. The spark jumps across all right, so the performance of the car isn't noticeably poor; but what that spark does to operation of the auto radio equipment is really terrific. These caps are just crimped on, and lately the crimp hasn't been deep enough to pierce the insulation and make contact with the inner conductor.

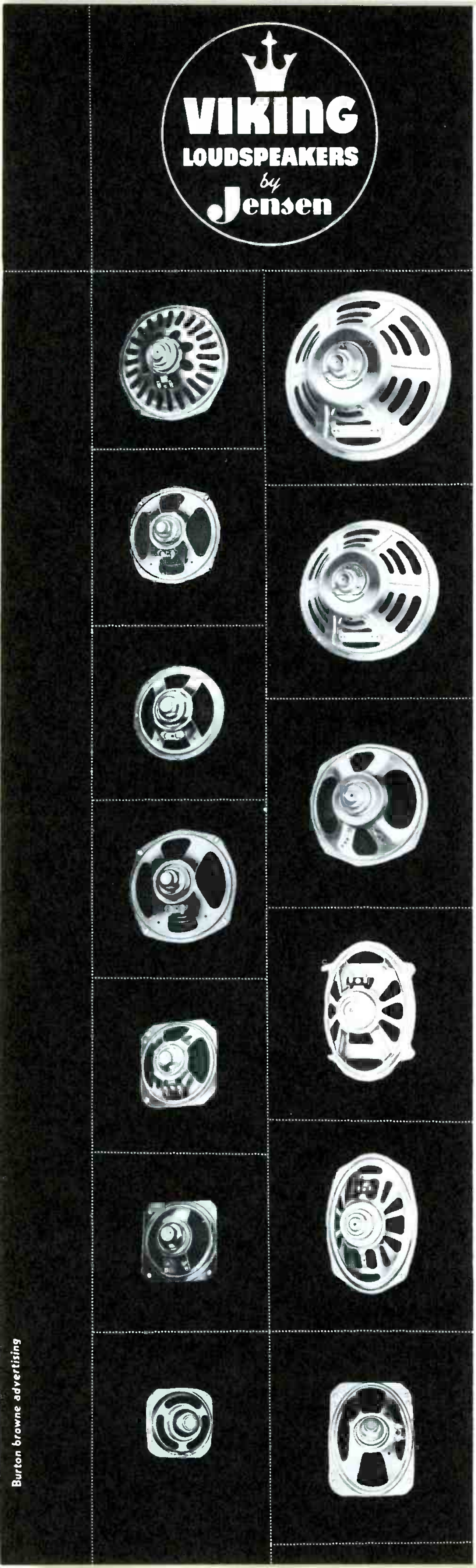
BANKS. Selling techniques of TV-radio dealers affect profits of banks, according to a speech by Pennsylvania banker W. F. Kelly before the National Association of Electrical Distributors. Dealers using high-pressure or unethical sales techniques were warned to improve their business practices if they expect banks to continue accepting their credit paper.

When people are rushed into buying something they can't afford or don't really want, they often neglect to make payments. The bank then has to send out men to collect or hire lawyers to force payment in court — both costly practices. Passing the buck to the banker is thus no way to stay in business. Much better is a good honest selling job using every persuasive technique given in books on salesmanship. Unfortunately, we know of no really good books written directly for TV and radio selling, so you'll have to translate the general recommendations yourself. Here's a wide-open field for a TV salesman to become an author.

REPORTING. Two TV sets in the news room of the New York Times were hooked up to automatic sound recorders while the sets were watched by reporters during the Army-McCarthy hearings this spring. Accurate quotes of the proceedings were thus obtained by playing back the sound recordings for incorporation in news stories that were set in type long before the actual text came over the news teletype wires conventionally. Other important news events are being covered more and more in this manner, so that TV sets are becoming an essential part of the modern newspaper office.

STRETCHER. We highly admire the shiny new Sylvania dolly for transporting TV chassis, but the question that keeps rumbling around in our head is: Should the "Corpse" go out head first or feet first?

JOHN MARKUS



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In the Interest of Quicker Servicing

(Continued from page 15)

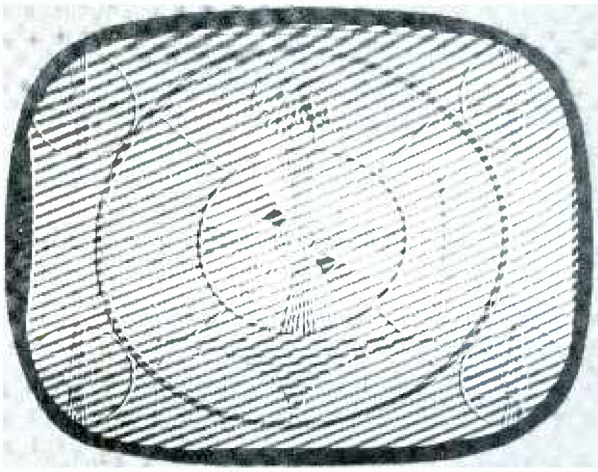


Fig. 7. A 28-Mc Beat Produced by Amateur Transmitter.

Fig. 10. Ghost Due to Reflected Signal.

be eliminated by the installation of a high-pass filter in the antenna-input circuit of the television receiver. This filter should be installed as close to the tuner as possible. Fig. 8 is the diagram of a typical high-pass filter. Any of the commercially available high-pass filters which are made for this purpose should be satisfactory.

The installation of a high-pass filter will eliminate any interference from the fundamental frequency on which an amateur may be operating. If the amateur's transmitting equipment should be generating harmonics, the installation of a high-pass filter will not correct the interference. In this case, the offending amateur should be notified that his equipment is radiating harmonics. Usually the amateur operator will cooperate and either not transmit when such transmissions might interfer with television, or he may take steps to eliminate the harmonic radiation from his transmitter.

Fig. 9 is an illustration of interference from a small electric hand drill. This type of interference may also be caused by electric motors,

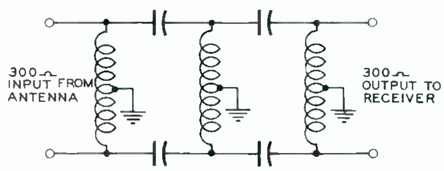


Fig. 8. A Typical High-Pass Filter.

fans, air-conditioning units, refrigerators, and other electrical appliances. The installation of commercially available line filters between the interfering device and the AC line or between the television set and the AC line will do much toward eliminating this type of interference.

Fig. 10 is an illustration of ghosts due to signal reflections. A major characteristic of this type of interference is that the ghost does not change with a change of receiver tuning. In many cases, reorientation of the antenna will correct this trouble. If the ghost should still exist after reorientation of the antenna, it may be necessary to change the location of the antenna or the lead-in wire. Ghosts may also be caused, as in the case of a long lead-in wire, by improper matching at one or both ends of the antenna lead-in.

Fig. 11 is an illustration of interference caused by radiation from the local oscillator of another television receiver. This is a mild case of radiation. In some instances, radiation from the local oscillator of a

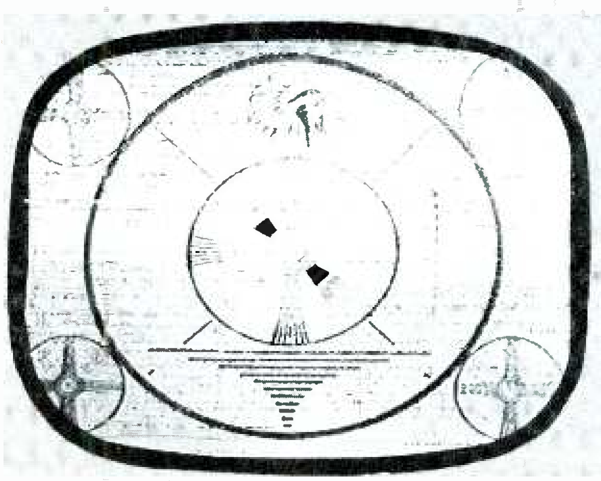


Fig. 9. Interference Caused by Small Electric Drill.

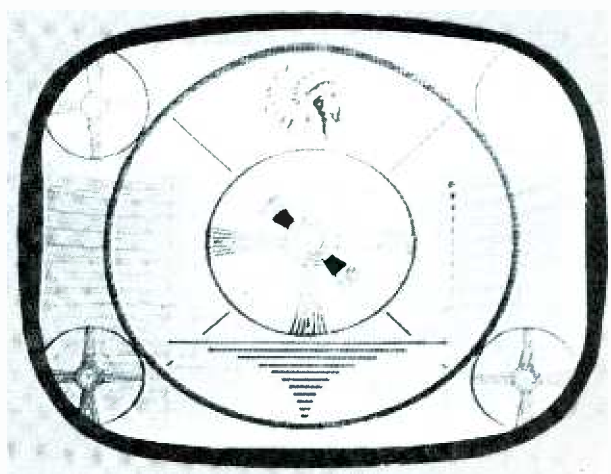


Fig. 11. Local-Oscillator Interference From Another TV Receiver.

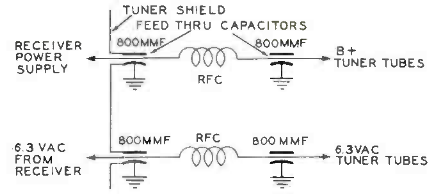


Fig. 12. Bypass System for the Power Leads to Tuner.

TV receiver is of sufficient amplitude to overload another nearby receiver. The safest cure for this type of interference is to find the offending receiver and by the use of approved methods to install a bandpass filter in its antenna-input circuit. This will prevent its antenna from radiating the interfering signal. It may be necessary to install a line filter between the receiver and the AC line. In some extreme cases, RF filter units should be installed in all power leads to the tuner. Fig. 12 is an example of the latter type of installation. If used along with the aforementioned antenna and line filters, the filter system in Fig. 12 will keep the oscillator radiations from charging the chassis and thus will keep the chassis from radiating.

Fig. 13 is an illustration of one type of diathermy interference. This is rather a mild case, and in most cases may be effectively eliminated by the installation of a high-pass filter at the antenna input and by the use of a line filter between the AC line and the TV receiver.

Some of the older types of diathermy and industrial heating equipment were built using little or no filtering in the power supply, and interference from these machines will show up with one or two black bars. Most of these old machines have been located, and steps have been taken to make them TVI proof.

Although this discussion may not have covered every type of interference, most of the principal kinds have been illustrated. The reader may recognize some of them from his past experience and may encounter new ones in his future servicing work. If the foregoing material can be used by him as an aid in diagnosing and curing interference problems, it will have served its purpose and well.

IN THE SHOP

Bench Picture Tube

After receiving many requests for information on setting up a picture tube for use on the bench, we decided to try one ourselves to see just what the problems were and what would be

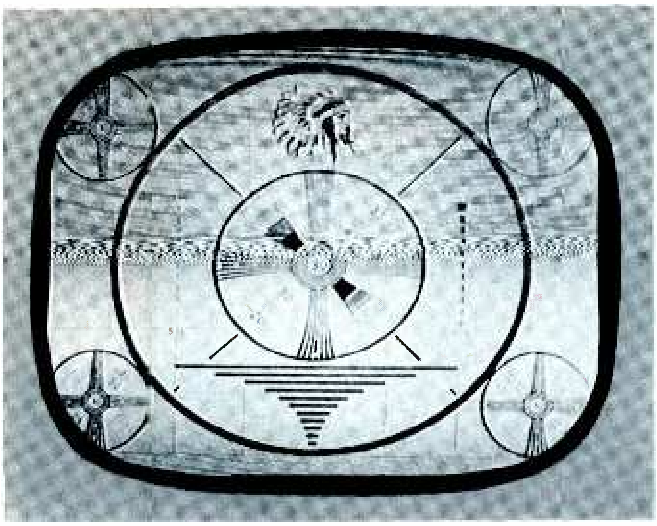


Fig. 13. One Type of Diathermy Interference.

needed. We came up with the following ideas and suggestions which we thought might be of interest. Although this setup may seem to be quite expensive, it will probably pay for itself in time saved. For instance, consider how long it takes to remove the picture tube from a cabinet when it is mounted separately. Another thought to consider is the ever-increasing size of picture tubes. They are becoming more and more difficult to handle safely — hence this is another point in favor of a test picture tube on the bench.

First of all, it must be understood that no one particular yoke can take the place of all types which are in use. In other words, there is no such thing as a completely universal yoke which will suffice for all applications. Therefore, the biggest problem is to determine what yokes should be used for this project.

The yokes selected must have inductances in the horizontal and vertical coils relatively close to the inductances required by the sets under test. Since most of the yokes in use have very nearly the same inductance (50 mh) in their vertical-deflection coils, principle concern should be given to the horizontal-deflection coils. Inductances in horizontal-deflection coils vary anywhere from about 8.5 mh to 30 mh. Therefore, if three 70-degree yokes are selected with approximately 10-, 20-, and 30-mh inductances respectively, in the horizontal-deflection coils, they can be used with all the 70-degree sets except those sets using a low-inductance, vertical-deflection coil. The latter sets would necessitate the use of a yoke with a 30-mh horizontal coil and a 3.5-mh vertical coil.

Chassis which are used in sets employing 90-degree deflection systems will require a separate unit in order to obtain a proper raster for trouble shooting sweep circuits. At the present time, one 90-degree yoke will suffice for all the sets being manufactured for wide-angle deflection. This yoke should have approximately 12 mh in the horizontal coil and 45 mh in the vertical coil.

To service practically all the sets now in use, it is necessary to set up two picture tubes for bench use — one for 70-degree sets and one for the larger 90-degree sets. As stated before, this increases the cost of such a setup; but the arrangement will probably pay for itself in a short time if the shop has enough work to warrant its use.

Another item that this setup requires is about four focus coils for the sets that use them. Most of the sets which use focus coils incorporate them as a part of filter networks. That is an additional reason for including them as part of this bench setup. The most commonly encountered focus coils have the following ratings:

240 ohms (for use in circuits having approximately 200-ma drain),

360 ohms (for use in circuits having approximately 140-ma drain),

470 ohms (for use in circuits having approximately 100-ma drain),

1,000 ohms (for use in circuits having approximately 75-ma drain).

These coils will cover the large majority of applications; however, you may find it necessary to keep on hand one other type of focus coil, the combination electromagnet and permanent-magnet focus coil which seems to be gaining in popularity.

Fig. 14 illustrates a simple but functional method for mounting the test picture tube. The rear upright board is permanently mounted. The front tube rest is also attached to the base. After the picture tube is in position, the front piece with the safety glass in it is put into place and attached with screws to the picture-tube rest. The diagonal brace is then put in place and held with screws to keep the front piece vertical.

On the rear of the base board can be seen a small chassis which contains a female octal socket. From four of the pins of this socket, wires run to four female pin sockets. Each yoke selected for this test setup is wired to a male socket which can be plugged into the socket on the small chassis. The pin jacks are coded so that they can be identified. Two sets of test leads are prepared for use with this arrangement. One set of leads has alligator clips; the other set contains pins for connecting to chassis which have plugs on their yokes.

It is not necessary to mount the deflection yokes on a bracket, for they will hold their position fairly well. However, the focus magnet must be mounted on a bracket, because it will move much too easily. The focus coils must likewise be mounted on brackets. The bracket which holds the focus magnet or focus coil can be mounted on a small board wide enough to prevent it from tipping over. This eliminates any need for fastening it to the base of the picture-tube mount.

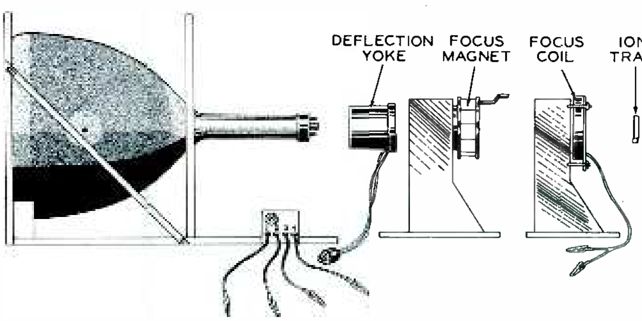
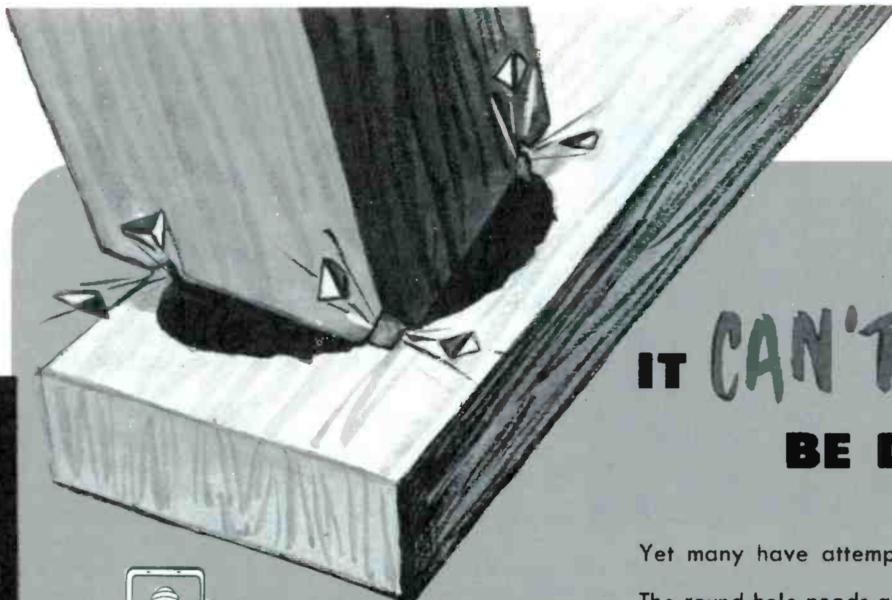


Fig. 14. Suggested Layout for a Bench Picture Tube.

Sync Separator and Amplifier

Because the sync section of a TV receiver can give rise to puzzling



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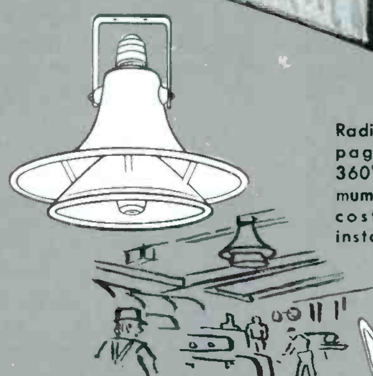

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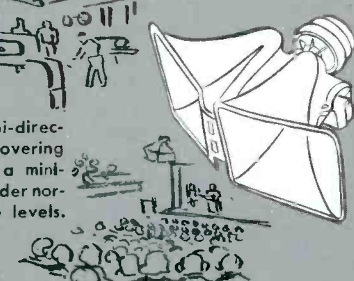

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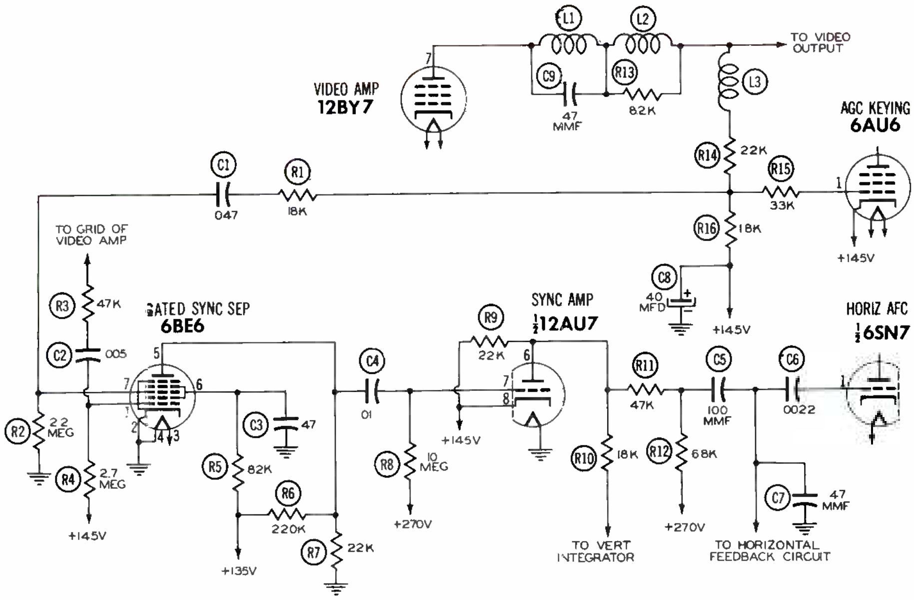


Fig. 15. Partial Schematic Diagram of Receiver Discussed in Text.

symptoms if troubles occur in it, we are presenting in narrative form a few typical problems and their solutions. A partial schematic of the receiver which we are using as a reference is shown in Fig. 15.

Problem No. 1.

The picture in the set had a twitch and waviness which appeared to be caused by incomplete action of the sync separator. The technician suspected that there was video in the sync signal arriving at the AFC circuit and that the presence of this video was causing improper action of the circuit.

In order to prove or disprove this theory, the scope lead was placed on the plate lug of the sync separator and the waveform was observed. There were two things wrong with the signal. A great deal of video signal was present, and the amplitude of the waveform was much lower than it should have been. Instead of the eight-volt peak-to-peak signal required, there were only two and a half volts.

Next, the signals were checked at the two input grids (pins Nos. 1 and 7) of the sync separator. The waveforms of these signals proved to be proper in form as well as in amplitude. As a result of these indications (weak signals on the plate and correct signals on the grids), voltage checks were undertaken on the basis that the loss of gain was probably caused by incorrect operating voltages. A vacuum-tube voltmeter was used for the checks. All measurements were satisfactory except the plate voltage which measured 13 volts instead of the 9 volts called for in the service literature.

An open screen-bypass capacitor could cause a loss of gain; therefore, the next step was to check C3. The quickest and easiest method to do this is by checking the screen with a scope. If there is a strong signal present, the capacitor is probably open. Bridging the capacitor with a new one would be the final check. When the technician investigated capacitor C3, he found that it was open; and after replacement of this capacitor, the set functioned normally.

Notice that the technician deserted his scope in favor of his voltmeter at one point in this troubleshooting procedure. Actually, he could have found the source of trouble more quickly if he had continued using his scope to check screen waveform while he was conducting his preliminary tests.

Problem No. 2.

This problem proved to be not only very interesting but quite puzzling as well. The set would not lock in horizontally and was very difficult to stabilize vertically. With everything considered, this indicated a loss of sync. However, when the scope lead was placed on the plate of the sync amplifier, a signal was found. This signal was not too good — besides being somewhat distorted, it was reduced considerably in amplitude. The signal on the grid was then checked on the scope and found to be good in both shape and amplitude. This indicated that the tube might be operating on improper voltages. Therefore, the VTVM was used to measure the grid, plate, and cathode voltages. These voltages all seemed to be satisfactory. By this time, the technician was completely nonplused and decided that perhaps there was something wrong in the plate circuit of the sync amplifier and that whatever it was was having a very strong effect on the signal but not on the DC voltage. Hence, every component in the plate circuit was then checked with an ohmmeter and a capacitor checker. Still, nothing could be found defective.

The technician decided to backtrack, so he applied the scope lead once again to the plate of the sync amplifier. Then came the realization that a gross error had been made. Subconsciously, the technician had accepted what he had seen on the scope as being the horizontal sync pulses; but on this second check, he noted the frequency of the scope and saw that it was set for 30 cps instead of for 7,875 cps!

A quick look at the schematic then brought about the conclusion that the signal being seen on the scope was undoubtedly being fed back from the vertical oscillator; therefore, the next step was to disable the vertical oscillator by grounding the grid and to turn down the brightness so that the picture tube would not be damaged.

With the vertical oscillator disabled, the sync-amplifier plate was again checked on the oscilloscope. Not a sign of a signal of any kind was present.

Putting all the facts together brought about the only possible answer to the question. Either the cathode was open between the socket and the actual element or the plate circuit was open in a like manner, since both the cathode and plate voltages at the socket were measured and found satisfactory. Therefore, two more tubes were tried. When these failed to help, the socket was examined and found to have a great deal of corrosion in the cathode pin socket. It was cleaned out by inserting a sharp-ended wire to scrape the corrosion loose, and it was then washed with carbon tetrachloride to remove any loose particles. After the vertical oscillator was restored to operation, the set operated normally.

The stumbling block in this trouble-shooting experience arose from a misinterpretation of a scope waveform. The moral is: check test equipment before and during its use to guard against such mistakes.

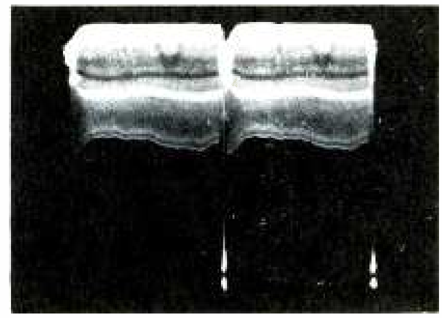


Fig. 16. Normal Signal on Plate of Sync Separator.

Problem No. 3.

A loss of sync was the first symptom noticed in the receiver. When the horizontal- and vertical-hold controls were manipulated, the picture stood still long enough that one could see what it looked like; but the picture was not completely locked in. In addition, the picture had too much contrast and appeared to be slightly negative.

From these symptoms, the conclusion was drawn that there were at least two and maybe even three stages being affected by the trouble. These stages were the video amplifier (because of the strong contrast), the sync separator and amplifier (because of no sync), and the AGC (because it could cause either excessive contrast and sync loss or both).

Since the lack of sync was the first thing noticed, the sync section was considered a good place to start checking. So, the scope probe was first placed on the plate of the sync separator. Instead of finding a normal waveform resembling that of Fig. 16, one that was more like that of Fig. 17 was found.

This excessively distorted output indicated that the signal was probably being distorted at the separator; hence, voltage readings were taken. The voltage on pin No. 7 of the sync separator (see Fig. 15) was

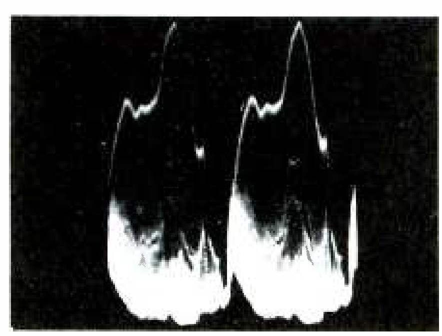


Fig. 17. Signal on Plate of Sync Separator With Leaky Input Coupling Capacitor.

greatly out of proportion. Instead of measuring -0.5 volts, it measured +2 volts. This positive grid voltage indicated that the coupling capacitor C1 probably was leaky. A continuity check with an ohmmeter soon substantiated this theory with a reading of 220,000 ohms.

Since the leakage resistance in the coupling capacitor together with resistors R16, R1, and R2 forms a voltage-divider network and since the bias on the AGC tube is tapped from this network, the bias was affected by the leaky capacitor. This caused a change in the output of the AGC tube and a resulting overload condition in the RF circuits of the receiver. Hence, a negative picture was produced as one of the symptoms.

Problem No. 4.

Once in a while a technician can be lucky and have an easy job of locating a trouble. This was one of those times. The symptom was a complete loss of horizontal sync. Vertical sync was apparently good. A new AFC tube and an oscillator tube were tried, but to no avail.

The trouble was somewhere after the take-off point for the vertical sync, since the vertical sync was all right. Accordingly, the first checks were made in the horizontal oscillator and AFC circuits with an oscilloscope. The waveforms on the oscillator were satisfactory; however, when the scope lead was moved to the grid of the AFC tube, no signal was found.

One of three items could be at fault and cause this. C5 or C6 could be open and thereby interrupt the signal, or C7 could be shorted and thereby ground the signal. The scope lead was moved to the junction of C5, C6, and C7; still there was no signal. A check with the ohmmeter soon disclosed that the signal was not being grounded by a short in C7. A scope check at the junction of R11 and R12 showed the presence of a signal; so capacitor C5 was replaced, and the set resumed normal operation.

The tests in this problem were so simple and straightforward that much less time was needed to make them than to tell about them. If all TV troubles were found this easily, there would be fewer discouraged service technicians.

Problem No. 5.

Here was one of those jobs that make technicians "tear their hair." The symptoms were confusing. The set had horizontal tearing the pulling;

and when new tubes were tried in the sync, AGC, and horizontal-oscillator sections, they were of no help. When the contrast control was turned up, a Christmas-tree effect would occur in the picture.

With these facts to go on, it was apparent that the amplitude of the video in the output circuit was affecting the operation of the oscillator or the AGC in some manner. In order for this to occur, it was probable that the video was getting into the AFC circuit or into the oscillator in some way. First, the scope lead was placed on the horizontal-oscillator coil. The waveform appeared to be normal. The input of the AFC circuit was checked with the scope and showed considerable distortion. The plate of the sync amplifier was then checked, and some video signal was noted. Next, the grid waveform of the sync amplifier was checked and found to be clean. As a matter of course, the scope lead was then placed on the cathode of the sync amplifier where a very strong video signal was seen.

An examination of the circuit schematic showed that the cathode of the sync amplifier was connected to the 145-volt line. Since the filter capacitor C8 was the only filter in this line and since the video output tube was supplied from this line, the technician reasoned that a logical suspect was the filter capacitor C8. If this capacitor opened, there would be no filtering of the video signal which was developed in the plate circuit of the video output tube. A check of capacitor C8 confirmed the fact that it was open; and upon replacement of this component, the set functioned properly.

The oscilloscope proved to be an invaluable aid to the technician in each of these problems. Remember its usefulness the next time you encounter troubles in the sync amplifier and separator.

Figs. 4, 5, 6, and 10 were taken from telecasts by WFBM-TV, Indianapolis, Indiana. The pictures do not in any way reflect upon the quality of the transmitted signal, since all picture defects were introduced at the receiving site. We wish to express our thanks to WFBM-TV for permitting us to use these photographs.

Henry A. Carter and Calvin C. Young, Jr.

Examining Design Features

(Continued from page 37)

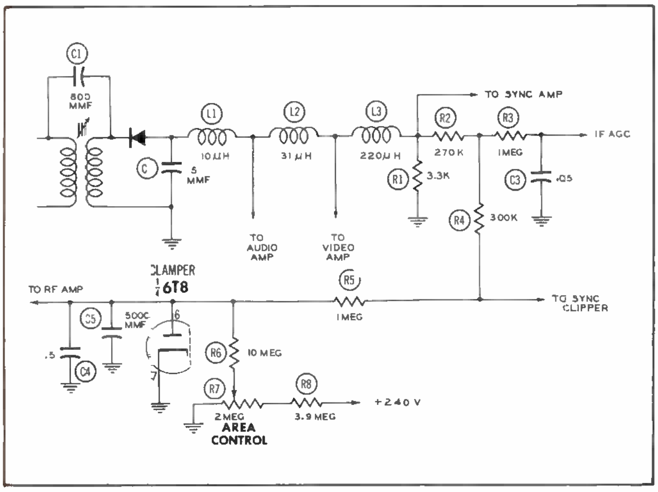


Fig. 2. The Circuit Which Provides the Tuner AGC Voltage in the General Electric Model 21C240.

circuit also contains the brightness control.

Sound

The scund take-off point is located at the output of the video detector. The signal from this point is coupled to the grid circuit of the sound IF amplifier which consists of the pentode section of a 6U8. The amplified signal is then fed to the 6AU6 limited by a 4.5-megacycle IF transformer.

Detection is accomplished by a conventional ratio detector employing two diode sections of a 6T8. The resultant audio signal is RC coupled to the grid of the audio amplifier which is the triode section of the 6T8. The setting of the volume control determines the level of signal applied to the latter stage.

A 6V6GT and its associated components constitute a conventional audio output stage.

AGC

The output of the video detector serves as the source of AGC voltage in this receiver. The detector output is filtered and isolated before being applied to the grids of the IF amplifiers. The AGC voltage that is applied to the RF amplifier is controlled by the circuit shown in Fig 2.

A positive bucking voltage is applied to the tuner AGC line by the voltage-divider network consisting of resistor R8 and potentiometer R7. The potentiometer is termed the "area control" and serves to set the level

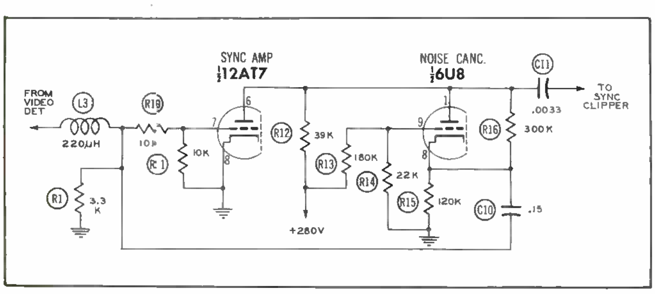


Fig. 3. A Schematic of the Noise-Cancellation Circuit in the General Electric Model 21C240.

of the bucking voltage. A clamper on the AGC line prevents the potential from becoming positive.

A switch ganged to the area-control potentiometer is normally closed. In the case of a very strong signal, the area control may be rotated toward the strong position until the switch is actuated. The switch opens and removes the B+ voltage from the RF amplifier. The strong signal is then coupled through the RF stage by the interlectrode capacitance of the tube, and the inoperative tube functions very much like an attenuator.

Sync

As shown in Fig. 3, a composite video signal of negative polarity is fed from the video detector to the grid of the sync amplifier. A negative signal is also fed to the cathode of the noise-cancellation tube through capacitor C10. A positive bias is applied to the cathode by the action of resistors R12, R16, and R15. A positive potential is also applied to the grid of this stage by the divider formed by resistors R13 and R14. The combined effect of these two voltages is to keep the noise-cancellation tube normally cut off. This stage does not affect the operation of the sync amplifier under these conditions.

When a strong noise pulse appears in the video signal, it is sufficient to overcome the bias on the noise-cancellation tube and the tube conducts. The result is a negative-going signal at the plate. This signal cancels the positive signal appearing at the plate of the sync amplifier. A "hole" then appears in the signal from the sync amplifier for the duration of the noise pulse. By this means, the strong noise pulses are prevented from being fed to the sync clipper and false triggering of the sweep circuits is avoided.

The composite signal from the output of the sync amplifier is coupled to the grid of a sync clipper. This stage employs one triode section of a 12AT7. A small negative bias is supplied to the grid from the AGC line.

The sync signals occurring in the plate circuit of the sync clipper are fed to the grid of a phase splitter. This stage uses a triode section of a 12AU7. The sync signals from the plate of the phase splitter are fed to an integrator network and then to the vertical-sweep section. The signals from the cathode of the phase splitter are coupled to the horizontal phase detector.

Vertical Sweep

The sync signal occurring at the plate of the phase splitter is fed

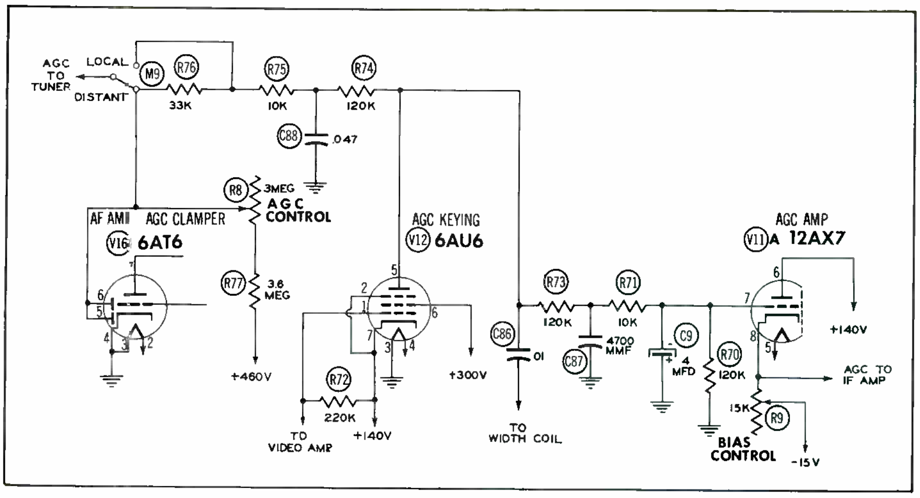


Fig. 4. A Schematic of the AGC System in the Arvin Chassis TE-340-1, -2.

through an integrating network and then to the grid of the vertical multivibrator, which is composed of the two triode sections in a 6BX7GT. The vertical-linearity control and the vertical-hold control are located in the cathode circuits of the 6BX7GT. The vertical-size control is contained in the plate circuit of one of the triode sections. The use of a 6BX7GT as the vertical multivibrator permits the elimination of a separate vertical-output tube because sufficient sweep output is available directly from the multivibrator.

Horizontal Sweep

The triode section of a 12AU7 functions as the horizontal phase detector in this receiver. A sync pulse from the phase splitter and a sample waveform from the horizontal-sweep output are fed to this stage. The phases of these two signals are compared, and any difference results in an error voltage. The error voltage is then coupled to the horizontal multivibrator to correct its frequency.

A positive potential is applied to the grid of the horizontal multivibrator by a voltage-divider network. The level of this voltage establishes the frequency of the multivibrator and is determined by the setting of the horizontal-hold control.

Two triode sections of a 12AT7 are connected as a cathode-coupled multivibrator to produce the horizontal-sweep signal. The horizontal-stabilization control serves as an adjustable ringing coil in the multivibrator circuitry.

The output of the horizontal multivibrator is coupled to the grid of the 6BQ6GT horizontal-output tube. There are two additional adjustments provided in the horizontal-sweep section. These adjustments are for width and for horizontal linearity.

There are two additional tubes associated with the horizontal section. For high-voltage rectification, a 1B3GT is used. The remaining tube is the 6AX4GT damper.

Low-Voltage Power Supply

The low-voltage power supply includes two 5U4G tubes to provide the necessary current by full-wave rectification. The inclusion of several dropping resistors in the output of the power supply provides the wide variety of voltages required for proper operation of the receiver. There are six voltage sources obtained in this way.

The primary winding of the power transformer has two possible connections. One is for a line voltage of 110 volts, and the other is for 117 volts. The selection of the desired connection is accomplished by placing the line fuse in either of the two fuse clips on the receiver.

UHF

There are three types of UHF tuners supplied with this line of receivers. Two of the tuners, RUX-001 and RUX-006/007, are single-conversion units. They both utilize a 6AF4 as the oscillator and a 1N82A crystal diode as the mixer.

The third type of tuner employs the double-conversion principle. In addition to the 6AF4 oscillator and the 1N82A mixer, a 6BK7A is included to act as a two-stage IF amplifier.

AGC SYSTEM IN ARVIN CHASSIS TE-340-1, -2

Strong noise pulses that are present in the video signal of a television receiver result in the appearance of black dots in the picture. These black dots are usually accompanied by white streaks immediately after them. The reason for this phenomenon is that the coupling capacitors in the IF stages become heavily charged by a strong noise pulse. Since the grid circuits normally have a high impedance to ground, the charges do not leak off immediately and may cause the white streaks to appear.

Some of the recent Arvin receivers have incorporated a circuit designed to minimize these annoying white streaks. A schematic of this circuit, as contained in Arvin chassis TE-340-1, -2, appears in Fig. 4.

A 6AU6 is utilized in a conventional keyed AGC system to develop the necessary AGC voltage. This voltage is fed to the tuner in a straightforward circuit containing a Local-Distant switch and an AGC clamper. The clamper uses the diode sections of a 6AT6.

The departure from the normal circuitry is found in the method of feeding the AGC voltage to the IF stages. This is done by using a cathode follower. The triode section of a 12AX7 is used for this application.

By reference to the schematic diagram, it may be seen that the full AGC voltage is developed across resistors R73, R71, and R70. The grid of the cathode follower is connected to the junction of resistors R71 and R70. The voltage on this grid is dependent upon the AGC voltage. Bias on the stage is determined by the setting of the bias control R9. The arm of this control is returned to a negative potential.

The AGC voltage for the IF stages is taken directly from the cathode of the cathode follower V11A. As the AGC voltage becomes more negative, the cathode also becomes more negative. Since the potential of the cathode follows in step with the AGC voltage, the IF stages are effectively controlled by this voltage.

When strong noise pulses charge the coupling capacitors of the IF stages, the capacitors may become quickly discharged through the low-impedance offered by the cathode circuit of V11A. The quick discharge of the coupling capacitor minimizes the formation of the white streaks that follow the black dots caused by noise pulses.

Don R. Howe

Traps for Standard Coil Tuners

(Continued from page 23)

In the Standard Coil tuner, the antenna-input circuit for each channel is contained on a separate strip. A schematic of this setup appears in Fig. 2. These strips provide a logical location for a trap. Since any one strip is connected to the circuit only when the set is tuned to a particular channel, the trap would also be in the circuit on only one channel. This would entirely eliminate the need for an additional switch. Another distinct advantage is offered by the use of this method. The series trap is connected directly across the antenna coil, terminals Nos. 8 and 10; consequently, there is no lead-in after the trap. A potential source of interference pickup is thereby eliminated. This complies with one of the previously mentioned criteria for trap installations.

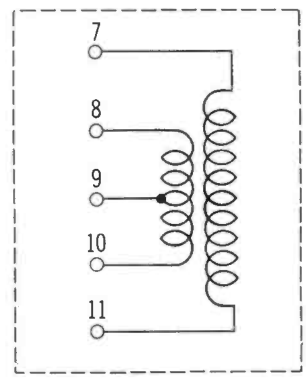


Fig. 2. Schematic Diagram of an Antenna Strip From a Standard Coil Tuner.

Several problems, both mechanical and electrical, arise because of the small space that is available inside the tuner. These problems are minimized, however, by a careful selection of component parts for the trap. Mounting of the trap is facilitated by the use of the strip terminals as tie points. The coil and capacitor which make up the trap may be soldered directly to these points. The trap then becomes self-supporting, and the physical mounting is easily accomplished and does not constitute a serious problem. Since the indi-

Fig. 3. A Series Trap Before Installation on a Strip.

Fig. 4. A Series Trap Installed on an Antenna Strip.

vidual strips are easily removed, the mounting may be done without working in the confined space of the tuner.

The capacitor selected for use in the trap is of the trimmer type. The maximum capacitance of the trimmer should not exceed 30 mmf. A maximum value of 10 mmf may prove more practical in many cases. The larger capacitors cover a wider band of frequencies but are more critical in their adjustment. Although a capacitor of lower value covers a smaller range of frequencies, it is more easily adjusted to remove the interference. It is therefore advisable to select as small a value of capacitor as possible when constructing a trap. If a capacitor of more than 30 mmf is selected, there is a danger of some shunting effect at the higher frequencies.

The inductance may be wound so that it will be resonant at the desired frequency when used with the selected capacitor. Because of the available space in the tuner, the length of this coil should not exceed 1/2 inch. When the trap is to be used at frequencies below 95 megacycles, a diameter of 3/8 inch is suggested. If the trap is to be tuned to a frequency higher than 95 megacycles, a diameter of 1/4 inch is a good choice. Fig. 3 shows a typical trap before it is attached to a strip.

Any combination of inductance and capacitance may be used, provided that the components resonate at the frequency of the interfering signal and that they are of the proper physical size. Some practical combinations are shown in Table I.

TABLE I

RECOMMENDED SPECIFICATIONS FOR TRAPS

Frequency Range (mc)	Capacitor (mmf)	Coil		
		No. of Turns	Diameter (inches)	Length (inches)
120 to 243	1.5 to 10	5	1/4	3/8
106 to 216	1.5 to 10	5	1/4	1/4
94 to 185	1.5 to 10	7	1/4	1/2
88 to 170	1.5 to 10	7	1/4	5/16
66 to 123	1.5 to 10	7	3/8	1/2
71 to 178	2 to 20	7	3/8	7/16
60 to 176	2 to 20	7	3/8	3/8
50 to 178	2 to 30	7	3/8	7/16

Before installing the trap on the strip, it is advisable to check the frequency range. This is done by temporarily connecting the coil and capacitor in a parallel-resonant circuit and by employing a grid-dip meter to determine its resonant frequency. Although this step is not essential, it may eliminate a time-consuming trial-and-error procedure.

When the coil is permanently affixed to the strip, it should be installed so that its axis is perpendicular to the axis of the antenna coils on the strip. This method of mounting minimizes the mutual coupling that may exist between the coils and results in a more satisfactory performance of the trap.

One end of the coil is soldered directly to terminal No. 8 of the antenna strip. The other end of the coil is soldered to one lead of the trimmer capacitor. The other lead of the trimmer is soldered to terminal No. 10. A trap is shown installed on an antenna strip in Fig. 4.

The capacitor should be tilted slightly when it is mounted. This permits tuning adjustments to be made without the shaft, which extends through the tuner being in the way of the alignment tool.

After installing the strip and the trap in the tuner, it is necessary to tune the trap. This is accomplished by utilizing the following procedure. One or two strips opposite the trap are removed, thus providing access to the trimmer capacitor. The receiver should be turned on and tuned to the channel where the trap is installed. An alignment tool is then inserted through the opening provided by removing the strips. The trimmer is adjusted for an indication of minimum interference. Fig. 5 shows how this adjustment is made.

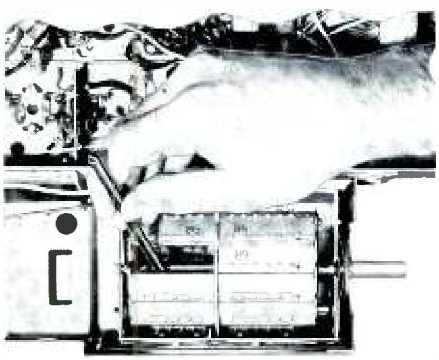


Fig. 5. Making a Tuning Adjustment on a Trap.

Before making this adjustment, it is often convenient to set the trimmer at maximum capacity. This permits the lowest frequency of the trap to be used as a starting point. A reference is established in this manner, and the operator can identify the point or points at which the trap is effective in eliminating the interference. If more than one point is found, the trap should be set at the point where maximum results are obtained. If necessary, a small degree of tuning is possible by adjusting the over-all length of the trap coil. If the coil is compressed to lower the frequency, care should be taken that none of the turns are shorted.

After the tuning adjustments have been made, the response curve of the channel should be observed. This may be done by using a sweep generator and an oscilloscope connected in the same manner as for visual alignment of the tuner. This check assures that the trap will not result in inferior performance on the channel containing the trap. At this time, the adjacent channels should also be checked to make certain that the trap has not affected them.

Installation of a trap in a tuner is not a panacea for all problems of television interference. It does, however, satisfy a definite need in several types of interference. A trap of this kind is not difficult to construct or install, and the results are very satisfactory.

Don R. Howe

Notes on Test Equipment

(Continued from page 19)

fected by the technician himself, but replacement of some components in complex circuits may make it necessary to return the instrument to the manufacturer for realignment or adjustment.

The actual time spent in making such repairs and in routine maintenance would be only a small percentage of the useful life of the equipment, and so we believe that the technician is in no danger of eventually devoting all his attention to his test equipment to the exclusion of his service work.

It would be difficult to set an actual figure for the expected life of any test instrument. Short of actually being demolished through accident, test instruments can be kept operating with minor repairs until the service technician feels that they should be replaced with equipment of more recent design. Consider a multimeter, for example. The ohmmeter battery needs replacement only after a long period of time; switch contacts might possibly wear and need replacement; perhaps the greatest repair required would be the replacement of a burnt-out meter movement. After these repairs, the meter should function as well as a new one; therefore, the expected life of this type of instrument is very long indeed. Actual mechanical wear in any test instrument would be restricted to moving parts such as switches, dial drive mechanisms, sweep-generator drives, and attenuators. These can be replaced at much less cost than that of a new instrument. The result is that the instrument itself can hardly be considered to wear out; but it may be retired in favor of a newer design, as was previously stated.

One factor in determining the number of test instruments that a technician may acquire is a more or less natural aversion to tackling something strange, as he might be required to do when learning to operate a new instrument. The array of knobs, meters, and switches which appear on some instruments may actually be dismaying to some. However, the reverse can also be true inasmuch as many persons welcome the opportunity to work with a new instrument; and the more adjustments it has, the more intrigued they become.

Simplicity of operation is a virtue, but the usefulness of the instrument should not be sacrificed in the interest of simplified operation.

Our association with test instruments has given us a healthy respect for the performance of modern high quality equipment. All things considered, we would be inclined to make the following recommendations: select your equipment with care and get as much as your space and budget will stand. In the last analysis, the test instrument is a tool; and the better a workman's tools, the better he can render his services.

The Hickok 655XC Color-Bar Generator

The new Hickok 655XC color-bar generator provides a wide variety of color signals suitable for checking, adjusting, and servicing color receivers. The horizontal-line frequency, the sound intermediate frequency, and the color-subcarrier frequency are all crystal controlled thus insuring utmost accuracy of these important functions. A photograph of this instrument appears in Fig. 1. The RF carrier may be conveniently set to either of channels 4, 5, or 6 with the aid of a crystal-controlled calibrator such as the Hickok Model 690.

The following output signals are available at connectors on top of the chassis: video (with either positive or negative polarity), RF, and 3.58-mc signals.

A function selector switch permits selection of three types of color-bar patterns, all with colors that are 100-per-cent saturated. These are: (1) a 5-bar pattern containing green, yellow, red, magenta, and blue bars; (2) two bars produced by positive signals on the I and Q axes; and (3) two bars produced by positive signals on the R - Y and B - Y axes. This choice of signals makes the instrument extremely suitable for checking receivers of either the I and Q type or the R - Y and B - Y type.

Fig. 1. The Hickok 655XC Color-Bar Generator.

A number of other control switches are provided and have the following functions:

POWER	Turns the power on or off.
MOD	Applies modulation to RF carrier, depending upon the setting of other switches.
SOUND	Applies unmodulated sound carrier to signal.
Y	Applies the Y or luminance component to the signal.
CHROMA	Applies color modulation to the signal.
I and R - Y	Applies I or R - Y component to the signal, depending upon the setting of the function-selector switch.
Q and B - Y	Applies Q or B - Y component to the signal, depending upon the setting of the function-selector switch.
VIDEO POLARITY	Allows choice of either positive or negative polarity of the video signal available at video-output connector or as modulation to the RF signal.

In addition, a variable attenuator controls the amplitude of the video signal at the video-output connector but does not control the video modulation of the RF signal. An RF attenuator controls the amplitude of the RF signal.

Eighteen tubes are used and include the following types:

1 — 5U4G

1 — 6BJ7

4 — 6U8

5 — 12AT7

4 — 12AU7

3 — 12AV7

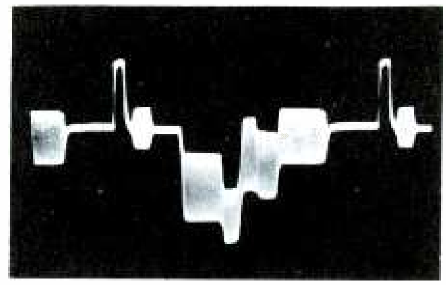


Fig. 2. Video Output Signal of the Hickok 655XC With Control Switches Set for Five-Color-Bar Pattern. The Signal Has Positive Polarity.

The instrument is housed in an attractive carrying case with a removable lid.

Several photographs of waveforms were taken to show the variety of signals available and the manner in which some were used in our laboratories for checking and adjusting a color receiver. Figs. 2 through 7 are the results of applying the video output directly to a wide-band oscilloscope. Fig. 2 is the video-output signal of positive polarity with the function-selector switch set for the five-bar pattern. At the left, the narrow peak appearing above the axis is the horizontal sync pulse followed immediately on the right by the color burst. The next pulse to the right is the signal which represents the green bar; and the succeeding pulses are for the yellow, red, magenta, and blue bars. The Y or luminance information is represented in this signal by the displacement of each pulse below the blanking level. The yellow bar has a comparative luminance value of .89 which is the greatest of the five color bars and is the result of adding the luminance of the red bar (.30) and that of the green bar (.59). The blue bar has the least value of luminance (.11) and the magenta luminance value of .41 results when the blue and red luminance values are combined.

With the generator set up as just indicated, the chroma switch was then thrown to the OFF position. This action removed the chrominance

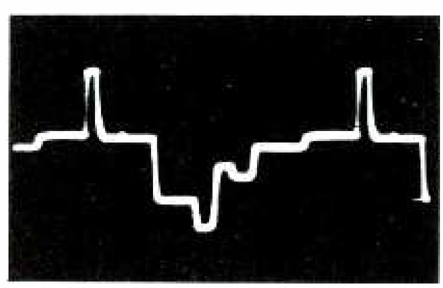


Fig. 3. Same Signal As in Fig. 2 Except That the Chroma Switch Is at the OFF Position. The Y Signal Remains.

information from the output signal. The waveform of Fig. 3 resulted and is an indication of the relative luminance levels just mentioned for the five color bars.

Fig. 4 is identical with Fig. 2 except that the video-polarity switch was thrown to the negative position for Fig. 4. This feature is useful in obtaining the correct polarity of signal when the video signal is introduced to different stages of a color receiver.

The waveform of Fig. 4 was further changed by throwing the Y switch to the OFF position. This action removed the Y component from the signal and left the chrominance information only. The resultant waveform appears in Fig. 5.

When the function-selector switch is set at the Q and I position, the waveform of Fig. 6 is obtained; and when it is set at the R - Y and B - Y position, Fig. 7 is obtained. These figures appear to be exactly alike; however, there is a relative phase difference of 33 degrees between the 3.58-mc portions of the two signals, and this is sufficient to produce the required color differences. With the function-selector switch in either of these two positions, either or both of the two color-bar signals can be removed by throwing the I and R - Y control switch or the Q and B - Y switch.

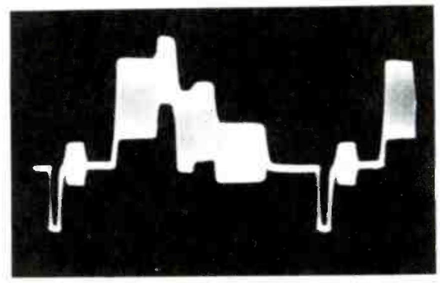


Fig. 4. Five-Color-Bar Signal of Fig. 2 But With the Video Polarity Switch Set at the Negative Position.

Figs. 8 and 9 will serve to illustrate how the color-bar generator may be used to check and adjust the hue phase control and the quadrature transformer of a color receiver. The waveforms in these figures were obtained during the procedure described as follows: The RF output of the 655XC color-bar generator was connected to the antenna input terminals of a color receiver through a suitable matching network such as the Hickok 75, and the generator controls were set to provide an I and Q signal since this particular receiver was of that type. An oscilloscope was connected to a test point at the cathode of the Q-channel phase splitter. The operating controls of the color receiver were set as for normal operation

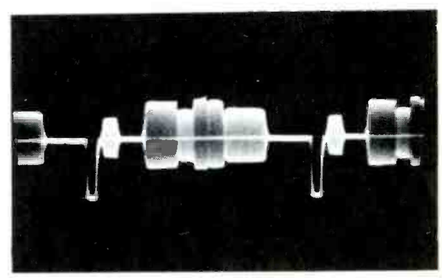


Fig. 5. Five-Color-Bar Signal of the Hickok 655XC With the Y Switch at the OFF Position. The Chrominance Signal Remains.

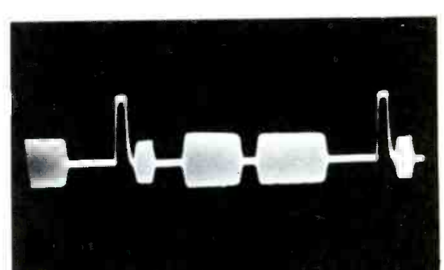


Fig. 6. The I and Q Signal Output From the Hickok 655XC.

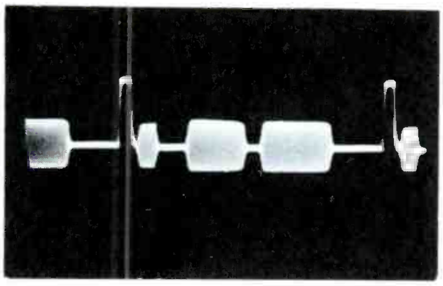


Fig. 7. The R-Y and B-Y Signal Output From the Hickok 655XC.

when viewing a color transmission. The generator supplies both I and Q signals; but with proper functioning of the receiver, only the Q-bar signal would be evident at the test point mentioned. The I bar would fall on the zero axis, as in Fig. 8. If the hue phase control were misadjusted, the I bar would fall above or below the axis, as shown in Fig. 9. Proper adjustment of the hue phase control would then cause the I-bar indication to move toward the axis and disappear there.

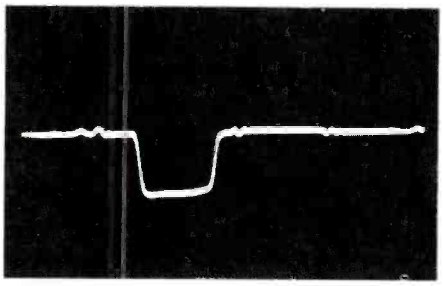


Fig. 8. Waveform Obtained at the Q Phase Splitter of a Color Receiver When I and Q Signal Output From the Hickok 655XC Is Applied to Receiver Input. The Waveform Indicates Correct Adjustment of the Hue Phase Control of the Receiver. A Signal of Negative Polarity Is Obtained at This Point.

After making the hue phase adjustment as indicated, the scope was moved to a corresponding point at the I-channel phase splitter to check for correct adjustment of the quadrature transformer. Correct quadrature adjustment would be indicated by an I-bar signal only, with the Q bar on the axis. Under these conditions, the I and Q channels would be demodulating the color subcarrier with a relative phase of 90 degrees or in quadrature with each other. If the Q bar were visible, the quadrature transformer should then be adjusted to make the bar disappear on the axis. When both bars are visible, there may be some question in the technician's mind as to which is the I or Q bar. This can be easily determined by throwing either the I or Q toggle switch and noting which bar disappears.

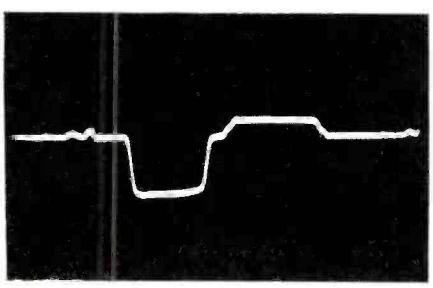


Fig. 9. Waveform Obtained As in Fig. 8 But With Incorrect Adjustment of the Hue Phase Control of the Receiver.

The foregoing adjustments are easily made with the aid of the oscilloscope and color-bar generator, and they take less time than it does to describe them. Although the effect of such adjustments could be noticed on the screen of the color tube, innumerable combinations could occur; and it is highly improbable that the technician could ever arrive at the correct adjustment by observing the color screen alone. The use of the scope and the color-bar generator affords a positive indication.

Inasmuch as the Hickok 655XC color-bar generator also provides R - Y and B - Y signals, the same type of adjustments that have just been described could also be performed on a receiver which demodulates on the R - Y and B - Y axes.

Figs. 10 and 11 show the response of the I and Q channels, respectively, to the 5-color-bar signal. The oscilloscope was connected to the same test points previously mentioned. Starting from the left in each waveform, we see first on the zero axis a small disturbance which indicates the position of the horizontal sync pulse. This is followed by the relative step levels of the green, yellow, red, magenta, and blue bars in that order. It is interesting to note that these levels and polarities correspond to the specified relative amplitudes and polarities for these colors, as recorded in Table I of Mr. Ennes's article "TV Colormath" in the June issue of the PF INDEX. (Allowance must be made for the fact that the Q-channel test point was located at a point of negative Q signal; and therefore, all the polarities of the Q-channel waveform must be reversed for proper interpretation.)

To quote from the table just mentioned, the relative amplitudes in the Q channel should be green -0.525,

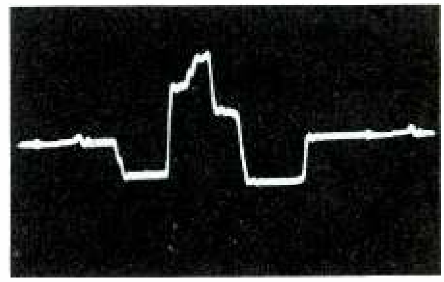


Fig. 10. Waveform Obtained at the Cathode of the I Phase Splitter When the Five-Color-Bar Signal Output From the Hickok 655XC Is Applied to the Receiver Input Terminals.

yellow -0.31, red +0.21, magenta +0.525, and blue +0.31. For the I channel, the relative amplitudes would be green -0.28, yellow +0.32, red +0.60, magenta +0.28, and blue -0.32.

If any marked deviation from these relative amplitudes or polarities is observed in the waveforms, some malfunction or misadjustment of the I or Q channel is indicated.

Another interesting feature to note in Figs. 10 and 11 is that the

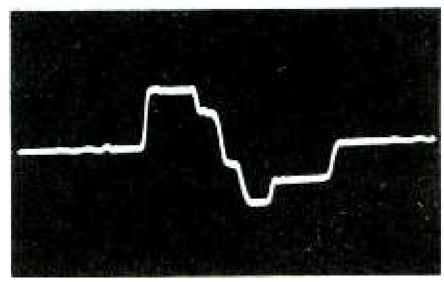


Fig. 11. Waveform Obtained at the Cathode of the Q Phase Splitter When the Five-Color-Bar Signal Output From the Hickok 655XC Is Applied to the Receiver Input Terminals.

square-wave response of the I channel appears to be better than that of the Q channel. This is to be expected since the I channel is designed for a bandpass of about 1.5 megacycles, whereas the Q channel is designed for a bandpass of only about 500 kc.

The preceding examples should give some indication of the usefulness and application of a test instrument such as the Hickok 655XC color-bar generator when servicing or adjusting color receivers.

Paul C. Smith

Shop Talk

(Continued from page 5)

tuner. If this is so, insert a 470,000-ohm, half-watt resistor in the line before carrying out the foregoing test.

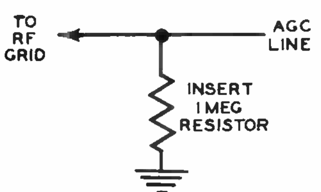
The RF Amplifier Tube

A second factor in the sensitivity of a television tuner is the RF amplifier tube. Improvement from this angle can be achieved in one of two ways — either by using another stronger tube of the same type or by substituting a tube with a different type number. The latter tube should have a higher mutual conductance but otherwise similar characteristics. Let us consider the first approach.

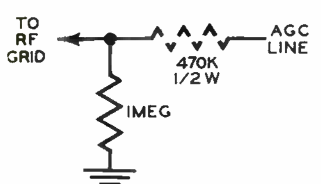
A. Choosing the Hottest Tube. In any group of similar tubes, measurements with a tube checker will reveal that some are hotter than others. The best test for this is with a transconductance (g_m) type of tube checker. When you find the tube with the highest g_m, use it in the RF stage of the tuner. The mere use of this tube, however, does not assure better performance because of the presence of interelectrode tube capacitance. This may vary enough from the capacitance of the original tube that the RF circuits will be detuned, and thereby any gain increase brought about by the rise in mutual conductance will be nullified. Hence, to obtain full benefit from a hot tube, the circuit should be carefully realigned. It is recognized that this procedure is not something which is carried out readily; moreover, in moderate and strong signal areas, any decrease in stage gain will frequently have no noticeable effect. But when you are fighting for every ounce of stage gain, the foregoing procedure will pay off.

The question of RF tuner alignment and how important it is will be found, in the final analysis, to depend upon how much signal you have. In a strong signal area, there is considerable leeway available before the picture is noticeably affected. The RF response curve can be peaked, double-humped, or even skewed off to one side; yet to most observers no apparent change will be visible. (This test was made using trained service technicians who were carefully instructed to look for picture degradation, smearing, interference, and background noise.) The situation changes markedly, however, when the signal level drops. It is toward the latter condition that this discussion is directed.

B. Substituting Other Tubes. Increased tuner gain can also be achieved by substituting other closely related tubes which inherently have a higher g_m. The 6AG5, 6BC5, and 6CB6 tubes offer an excellent illustration of this. With a plate voltage between 200 and 250 volts, the 6AG5 has a g_m value of 5,000 micromhos, the 6BC5 has a g_m value of 5,700



(A) IF-to-RF Isolation Already Provided.



(B) A 470K-Ohm Resistor Inserted For IF-to-RF Isolation.

Fig. 2. Shunting the AGC Line to Ground With a 1-Megohm Resistor.

micromhos, and the 6CB6 has a g_m value of 6,200 micromhos. Since amplifier gain is directly proportional to g_m, a stage using the 6CB6 will provide roughly 24 per cent more gain than the same stage using a 6AG5. This, then, is an excellent reason for using 6CB6's in place of 6AG5's. Precautions to observe in this exchange are: (1) that circuit realignment should also be carried out and (2) that the suppressor grid of the 6CB6 is not internally connected to the cathode as it is in the 6AG5. Hence, a check should be made to insure that the socket pin for the suppressor grid is properly connected when a 6CB6 is substituted for a 6AG5.

The B+ Voltage

The gain of an amplifier is also governed by the value of B+ plate and screen voltage used. In general, the higher the plate voltage, the greater the gain. In the 6AG5, for example, a g_m of 4,500 micromhos is obtained when the screen and plate voltages are both 100 volts. If we raise these to 125 volts each, the g_m value rises to 5,100 micromhos, or an increase of about 14 per cent. However, it is interesting to note that further increase to 250 volts for the plate (and 150 volts for the screen) does not give any high g_m figure. As a matter of fact, there is a slight decrease to 5,000 micromhos. Therefore, the best voltage value to use would be 125 volts; anything beyond this is wasteful of power.

The source of much of the preceding data is any receiving-tube manual. This will tell you how much mutual conductance a certain value of plate voltage will produce. In addition, maximum ratings are also given, and these are important in making certain that the voltages you use do not cause the tube to exceed its dissipation wattage. Running a tube too hot will lead to shortened life and frequent replacement. The wattage being dissipated at the plate is computed by multiplying the voltage at the plate by the plate current. Screen dissipation is determined in a similar manner using screen-grid voltage and current.

If a change in grid bias is indicated when the plate voltage is raised, be sure to follow this recommendation. Most of the time, it simply means using another cathode resistor.

In very weak signal areas, boosters are often used ahead of the receiver. If this is the case, the proper procedure is to connect the booster to the set and observe the picture produced. After this if additional gain is still desired, the procedures discussed can be followed. A hot booster with a "souped-up" set can lead to sync-pulse compression or clipping or, worse still, to oscillations. With the use of cascode tuners and with the higher operating power of many stations, the need for boosters is not so pressing now as it was several years ago; however, boosters can still be useful in many situations.

REVIEW. The higher we go in frequency, the more important it becomes to arrange the various circuits in a receiver so that undesired interaction via stray fields is kept at an absolute minimum. Ordinarily, we might classify this as the engineer's problem and forget about it. However, service work frequently calls for parts replacement; and in high frequency circuits, altering lead dress or the placement of parts can have a noticeable deteriorating effect on receiver operation.

A companion subject to lead dress and circuit layout is shielding. While most of us know in a general way what shielding does, few of us really appreciate the underlying principles involved. Yet the theory (if we wish to call it that) is quite simple and excellently presented in an article that appeared in the June 1950 issue of "Wireless World." This is an English publication that is produced monthly by Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E. 1, England.. Yearly subscription rates to Americans is $4.50.

The article in question was entitled "Screening," which is the English equivalent of our "Shielding." The author is listed as "Cathode Ray" and is apparently a staff member who discusses some general topic each month.

There are two basic methods for preventing the field of one circuit from affecting any other circuit: either by diverting the course of the field or by cancelling it out with an opposing field. An illustration of the former method is given in Fig. 3. The magnetic lines of flux which the coil develops are kept within the coil enclosure by the high permeability of the container. The magnetic flux simply finds it easier to travel through the magnetic material than through air.

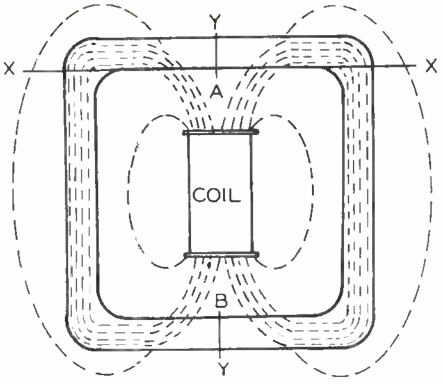


Fig. 3. Magnetic Shielding Afforded By a Metal Can of High-Permeability.

An electrical analogy to this magnetic behavior is shown in Fig. 4. The electromotive force of the battery E corresponds to the magnetomotive force of the current-carrying coil. The two high-valued resistances R1 and R2 correspond to the rather high magnetic reluctances of the air spaces at the ends of the coil. Before the low resistances of R3 and R4 are connected across the circuit, the full battery voltage appears across the ends of R1 and R2. When R3 and R4 are shunted across the circuit, their resistances are so low that the voltage difference between the ends of R1 and R2 is reduced to a very low value.

Let us now reconsider the coil in Fig. 3. When the high-permeability shield is placed over the coil, its low reluctance reduces to a very small value the magnetomotive force available for driving flux through the surrounding air. Consequently, there is very little flux in the air either immediately surrounding the coil or beyond the shield.

To carry the electrical analogy one step further, any break in R3 and R4 would remove their shunting effect and permit the full voltage of the battery to appear across the ends of R1 and R2. By the same token, any break or gap in the shield around the coil would permit some of the magnetic flux to escape and thereby nullify some of the shielding action of the can. The only place a gap is permissible is along such flux lines as YY in Fig. 3.

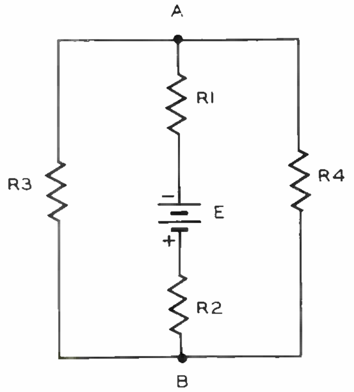


Fig. 4. Electrical Analogy of Fig. 3.

A high-permeability shield, such as one made of mumetal, will function admirably at the low frequencies. When the frequency increases, the permeability drops; and at the radio frequencies, a shield of this type is not of much help. The problem can be better met at high frequencies by using a copper shield. The permeability of copper is about the same as that of air, and so it cannot divert the flux. However, copper does function as a shorted secondary turn wherein the current set up in it produces a field which opposes the field of the coil.

If the copper shield were placed very close to the coil, much of the field of the coil would be nullified, reducing the inductance of the coil to a very low value. This would reduce its usefulness in the circuit. If the shield is made large and roomy, however, its effect on the coil is small; yet at the same time, it neutralizes practically all of the coil field reaching it by developing an opposing field of its own. The lower the resistance of the copper shield to current flow, the more effective the shielding action becomes.

It is interesting to note in connection with a copper shield that the direction of current flow differs considerably from the direction of the flux lines shown in Fig. 3. Current flows in a continuous ring parallel to the turns in the coil. Hence, a gap along line XX in Fig. 3 would be permissible; but one along YY perpendicular to the turns in the coil would interrupt the shield currents and render the shield useless.

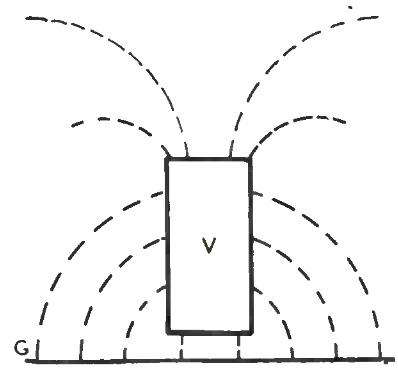
Electric Shielding

Thus far nothing has been said about grounding the shield; and indeed, so far as magnetic shields are concerned, grounds are of no particular consequence. A ground connection does become important in preventing electric (as distinguished from magnetic) fields from extending beyond their immediate area.

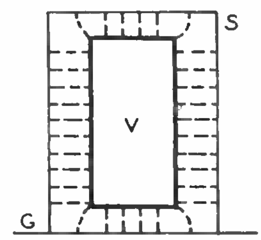
In Fig. 5A, V represents some component which has a large potential with respect to ground. The electric field is indicated by the dotted lines which indicate that every point in the surrounding space is under the influence of this electric field.

If we take a metal box and place it over V, the electric lines of force from V travel to the nearest surface of the metal box. See Fig. 5B. In this way, all the lines are returned to ground, and no portion of the field appears outside the metal box or shield.

For most effective shielding, the electrical resistance of the metal box should be quite low. For high



(A) Unshielded.



(B) Shielded by Metal Box or Screen of Low Resistance.

Fig. 5. An Electrical Field Produced by Potential V.

frequencies or where the shielding is critical, two shields may be used, one inside the other. It is also possible to achieve excellent shielding by using mesh screens instead of a completely enclosed surface. The lines of force will terminate on the screen wires, if they are grounded; and very little of the electric field will extend out between the wires. Straight, vertical screen wires are

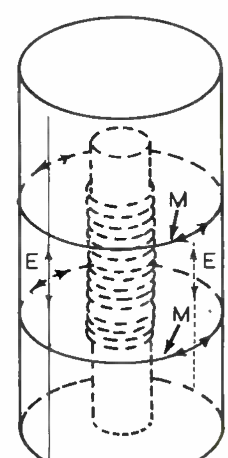


Fig. 6. An Electromagnetic Shield Showing Directions of Magnetically Induced Currents M and Electrically Induced Currents E.

best. A vertical spiral or coil of wire is not very effective because it would place a comparatively large resistance and inductance between the upper part of itself and ground.

As with magnetic screens, an electric shield should not be too close-fitting. Such a screen increases the capacitance to ground of whatever it is shielding; it also increases the currents flowing in the screen and raises the potential difference over the screen surface. Shielding is most effective when the over-all surface is all at ground potential.

Frequently, it is necessary to shield both the electric and magnetic fields of a component. For this we can use a grounded metal can which has a low resistance to current flow. See Fig. 6. The lines marked M indicate the current flow set up by the magnetic field, while the E-lines indicate typical current paths established by the electric fields. If the can must contain seams or joints, it is better to have them affect E than M.

If it is desired to stop electric (capacitive) coupling without interfering with magnetic coupling, say in a transformer, then the proper approach is shown in Fig. 7. The shield between primary and secondary windings does not form a complete circular path; the insulating strip between the overlapping edges of a grounded, nonmagnetic metal sheet prevents any current flow due to magnetic lines of flux; and this, in turn, cannot establish a counteracting magnetic field. At the same time, the metal strip is grounded and effectively prevents electric fields from passing.

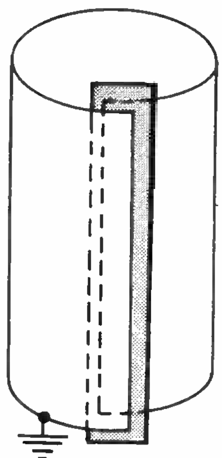


Fig. 7. Shield Which Allows Magnetic Coupling But Provides Electric Shielding.

If magnetic shielding is desired without affecting an electric field, it can be accomplished with a set of insulated rings parallel to the turns in the coil like hoops around a barrel.

In summary, the requirements for various types of shielding can be given as follows:

Magnetic shielding for DC or low-frequency AC requires the use of high-permeability metal which provides a continuous low-reluctance path for magnetic flux.

Magnetic shielding for high-frequency AC requires the use of high-resistance path for induced currents at right angles to the flux paths.

Electric shielding requires low-impedance conduction paths to ground and may be easily accomplished except at the highest frequencies.

Electromagnetic shielding requires a combination of both electric and magnetic shielding.

Milton S. Kiver

Audio Facts (Continued from page 33)

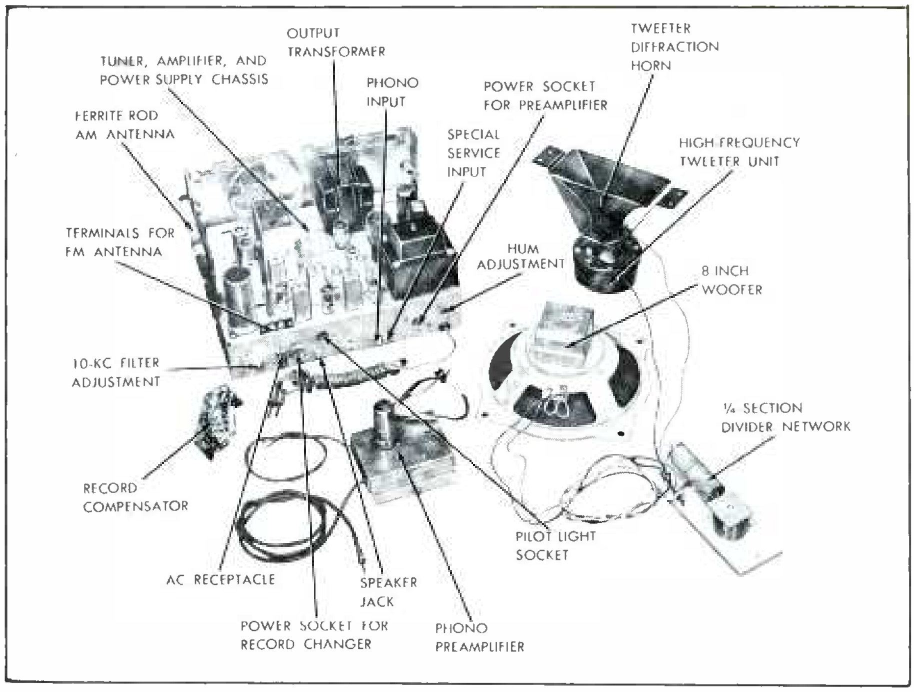


Fig. 2. View of Equipment Used in Capehart Model RP-154.

is a GE triple-play variable-reluctance cartridge. This separate preamplifier provides equalization by virtue of the feedback circuit around the second section of the 6SC7 tube and draws its power from the main chassis. The output cable connects to the phono input on the tuner amplifier chassis, and the input cable connects to the output of the record compensator.

The record compensator (Figs. 1, 2, and 4) is inserted between the pickup and preamplifier to equalize and compensate for the characteristics of the record being played. Its five positions are marked as follows:

Position No. 1	LP
Position No. 2	AES
Position No. 3	FLAT
Position No. 4	HC1
Position No. 5	HC2

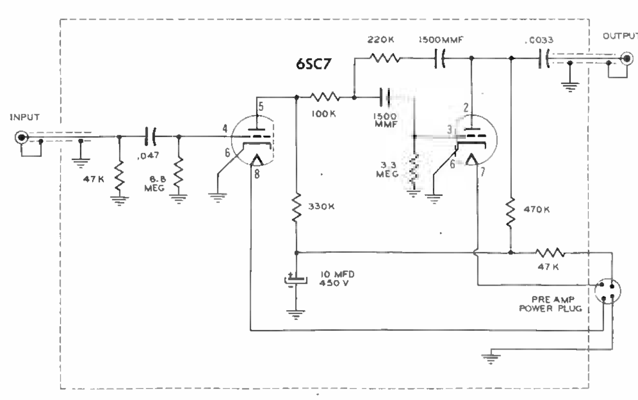
Positions 1, 2, and 3 are self-explanatory; positions 4 and 5 provide high-frequency roll-off in sufficient amounts to reduce the surface noise of records with poor or worn surfaces.

Enough flexibility of control is available in all modes of operation so that it should not be difficult to obtain satisfactory tonal balance.

All of the foregoing items are very important in a high-fidelity system, but the importance of the loudspeaker upon the results to be obtained from the system deserves special consideration. The loudspeaker performs the critical function of converting the electrical signal fed to it into an acoustical signal which can be recognized by the ear as being a faithful reproduction of the original sound.

A loudspeaker system composed of multiple units, a divider network, and a suitable enclosure is usually required if smooth, clean, and wide-range musical reproduction is to be

Fig. 3. Schematic of Phono Preamplifier.



enjoyed. This pattern has been followed in the Model RP-154, and the desired high quality of reproduction has been obtained because of the good design and careful selection of the components used — namely, the woofer, tweeter, divider network, and enclosure.

The 8-inch woofer, high-frequency tweeter, and the divider network are shown in Fig. 2. These mount in the left half of the cabinet which is enclosed on all sides. The cubic content of the resulting enclosure is sufficient for good matching with the 8-inch woofer. No sound-deadening material is used on the interior surfaces of the enclosure.

The high-frequency tweeter is an efficient smooth-operating unit which matches very well with the 8-inch woofer. The diffraction horn fitted to it distributes the high frequencies over a wide area; otherwise, they would be heard only in a narrow concentrated beam.

Frequency division and smooth response at the crossover point are provided by: (1) a simple quarter-section divider network (Figs. 2 and 5) employing a 4-mfd capacitor and a 0.47-mh coil, (2) the rather sharp

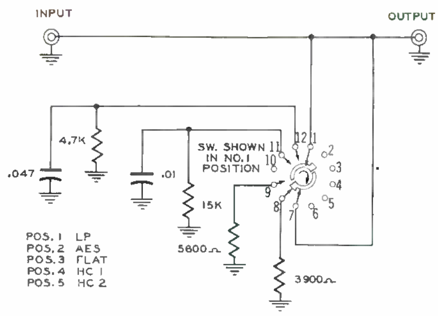


Fig. 4. Schematic of Record Compensator.

low-frequency cutoff of the horn-loaded tweeter, and (3) the high-frequency roll-off of the woofer.

The Model RP-154 was designed for use as a music system in the home.

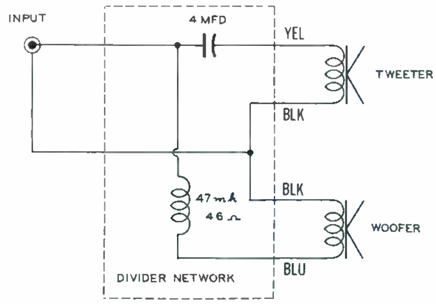


Fig. 5. Schematic of Loudspeaker System.

Consequently, best results are to be realized when listening is done under conditions similar to those found in the usual parlor or living room. The carpet, rugs, drapes, and upholstered furniture with which the room is furnished cut down on reverberation and are responsible for a deadening effect. The amount of brilliance or tonal balance suitable for such conditions would not be at all suitable in a "live" room possessing an empty-hall effect.

Most listening rooms in the home are not really large; and since comparative quiet usually reigns, very little audio power is needed to fill them. The reserve power of the Model RP-154 is more than sufficient to take care of the occasional peaks found in most musical selections.

The Capehart Model RP-154 is an interesting example of the present design trend to packaged, "all-in-one-cabinet" units for the high quality reproduction of music.

Robert B. Dunham

Horizontal AFC Circuits

(Continued from page 31)

shown as waveforms W1 and W2 in Fig. 8-26. For proper operation of the phase detector, it is necessary to change W2 into a saw-tooth waveform; and this is done by the integrating action of resistor R6 and capacitor C4. The resulting saw-tooth waveform is W3 in Fig. 8-26. Waveform W4 is this saw-tooth signal as it is applied to the phase detector by means of capacitor C3.

The action of the phase detector depends upon the simultaneous application of the aforementioned signals, but its operation can best be explained by considering the application of the signals separately. Let us start with the sync pulses as they are applied to

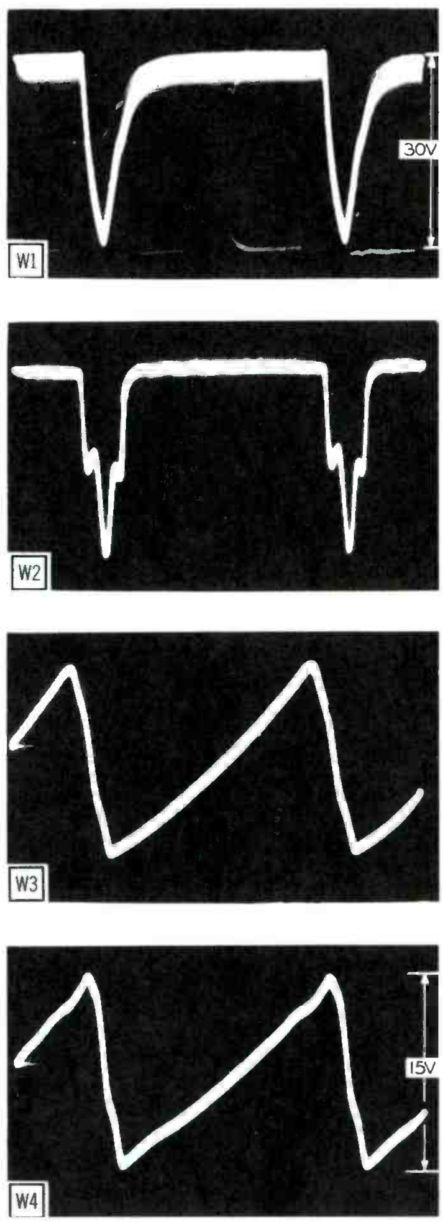
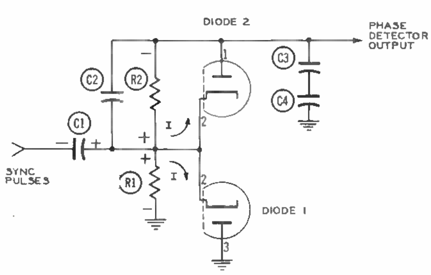


Fig. 8-26. Waveforms Applied to the Phase Detector.

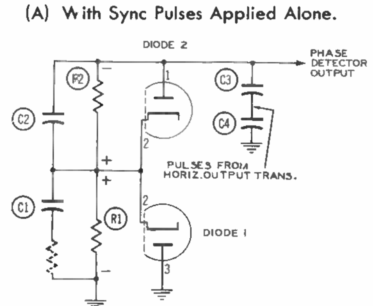
the circuit of Fig. 8-27A which shows a redrawn version of the same phase-detector circuit that appears in Fig. 8-25.

The negative sync pulses applied to the diode cathodes have the same effect as positive pulses applied to the diode plates, and the pulses will cause current to flow in both diodes. During conduction, electrons flow out of the right side of C1 to the common cathode of the diodes where the electron flow divides between diode 1 and diode 2. If we first consider diode 1, the electrons flow from cathode to plate, through ground, and through the sync-amplifier tube to the left side of C1. In diode 2, the electrons flow from cathode to plate and into the top plate of the capacitor combination of C3 and C4. This displaces electrons from the lower plate of C4, and they flow through ground and through the sync amplifier to the left side of C1. Because of the excess of electrons on the left side of C1, this capacitor becomes charged in the polarity shown.

Between sync pulses, the diodes are not conducting and some of the charge on C1 leaks off through resistors R1 and R2. The electron flow during the discharge of C1 has two paths. Electrons flow from the left side of C1, through the power supply to ground, and from ground through resistor R1 to the right side of C1. This flow establishes across R1 a DC voltage which is approximately equal to the peak amplitude of the sync pulses. Electrons also flow from the left side of C1, through the power supply to ground, and from ground to the lower plate of the capacitor combination of C3 and C4. This displaces electrons from the top plate of this



(A) With Sync Pulses Applied Alone.



(B) With Saw-Tooth Voltage Applied Alone.

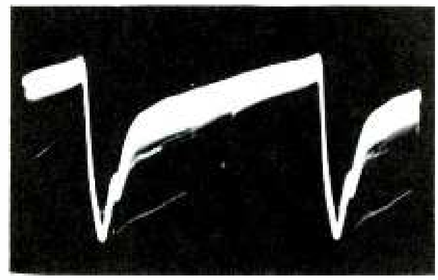
Fig. 8-27. Phase-Detector Action.

capacitor combination, and the electrons move through R2 to the right side of C1. A DC voltage is developed across R2 in this manner. The voltages across resistors R1 and R2 are of equal values but opposite polarities, hence the voltage from the top of R2 to ground is zero. Since the top of R2 is also the output of the phase detector, no voltage is produced by the detector when the sync pulses are applied alone.

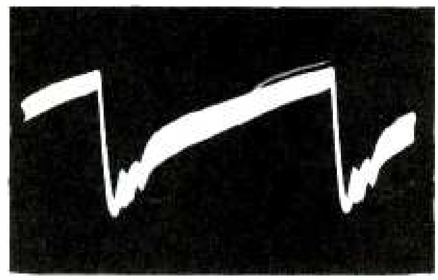
Let us consider the action of the phase detector when only the saw-tooth voltage is applied to the detector circuit. For this purpose, the circuit has been redrawn in Fig. 8-27B. The pulses from the horizontal-output circuit are applied to the junction of C3 and C4. Capacitor C4 integrates the pulses to form a saw-tooth waveform, and C3 couples this saw-tooth waveform to the plate of diode 2. Waveform W4 at this point has an amplitude of approximately 15 volts. The two diodes are connected in series to ground, thus a saw-tooth waveform of 7.5 volts appears across each of the diodes. To insure that these voltages are equal, the effective impedance of diode 2 is shunted by capacitor C2 in order to match the shunting effect of capacitor C1 on diode 1. In this way the impedances of the two circuits are made approximately equal, and hence the proper voltage division occurs when the saw-tooth signal is applied.

Due to the fact that the two diodes are connected back to back, diode 2 conducts on the positive half-cycle of the saw-tooth voltage and diode 1 conducts on the negative half-cycle. Each diode conducts while the other one is nonconductive. Conduction in diode 1 will develop a voltage across R1, and conduction in diode 2 will develop a voltage across R2. The polarities of these voltages are indicated in Fig. 8-27B. As with the sync pulses, these voltages are equal but of opposite polarities, and the detector produces no voltage in the output.

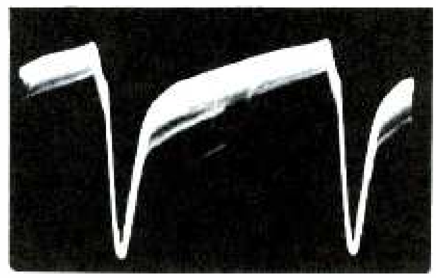
At this point, the reader may understandably ask, "If the sync pulses do not produce an output from the phase detector and if the saw-tooth feedback voltage does not produce an output, how can any control voltage be developed?" The answer to this question lies in the fact that when the two different signals are both applied to the detector circuit the instantaneous value of the saw-tooth voltage at the time of sync-pulse application acts to unbalance the total voltages across the two diodes in such a way that the DC voltages across R1 and R2 are also unbalanced. This unbalanced condition creates the control voltage.



(A) Horizontal Oscillator Operating at Sync-Pulse Frequency.



(B) Horizontal Oscillator Too Slow.



(C) Horizontal Oscillator Too Fast.

Fig. 8-28. Waveform W5 Under Various Operating Conditions.

The observation of the waveforms representing the combined sync-pulse and saw-tooth signals across each diode is hampered by the fact that both the cathode and the plate of diode 2 are above ground potential. Both electrodes have a high impedance to ground; and when the ground lead of the scope is connected to the cathode, a considerable amount of hum is injected into the phase-detector circuit.

For this reason, in Fig. 8-28 we can show only waveform W5 which is the voltage on the cathode of diode 1 with respect to the plate of diode 1. The reader should use his imagination to visualize the plate voltage with respect to the cathode on this diode. The easiest way to do this is to think of a downward excursion of the waveform as being a positive voltage on the plate and an upward excursion as being a negative voltage.

It was stated previously that the charge on C1 between sync pulses was about 30 volts. An inspection of the circuit should reveal that this voltage is of such polarity that the diodes are biased in the nonconductive direction. This charge diminishes as C1 discharges; and by the time the next sync pulse arrives, the charge is just low enough to allow the diodes to conduct on the peaks of the pulses. This action is necessary to insure that only that portion of the saw-tooth waveform which occurs during the sync pulse has any effect on the output of the phase detector. The sync pulse applied to a circuit of this type should always have an amplitude about twice that of the saw-tooth waveform.

To explain the action of the phase detector when both signals are applied, we shall first assume that the sync pulses and the saw-tooth voltage are in phase. The waveform W5 which occurs in this case is shown in part A of Fig. 8-28. The sync pulse appears at the time when the retrace portion of the saw-tooth waveform is passing through the AC axis; this is a point of zero voltage for the saw-tooth waveform. The saw-tooth voltage neither adds nor subtracts from the sync-pulse voltage, and the diodes have equal applied voltages. Both diodes will conduct equally, and no DC voltage can appear in the output of the phase detector.

The sweep oscillator in the receiver can run either faster or slower than the frequency of the sync pulses. If it were to run slower, the sync pulses would arrive at the phase detector before the saw-tooth waveform crossed the AC axis. The sync pulse would appear on the positive portion of the saw-tooth voltage across diode 2, and the two voltages would add. The sync pulse would appear on the negative portion of the saw-tooth voltage across diode 1, and the two voltages would subtract. Waveform W5 in part B of Fig. 8-28 shows the reduced voltage across diode 1 under this condition. The missing waveform across diode 2 would have a higher amplitude. Since diode 2 has the most applied voltage, it would conduct more than diode 1 and produce a higher voltage across its load resistor. This voltage is negative, and so the detector output voltage is also negative. This is the AFC or control voltage, and it is applied to the grid of the reactance tube which then alters the oscillator frequency to conform with that of the sync pulses.

If the oscillator tends to run faster than the frequency of the sync pulses, the sync pulses would appear at the phase detector after the saw-tooth waveform crossed its AC axis. Now the sync pulses would be superimposed on the negative portion of the saw-tooth voltage across diode 2, and the voltages would subtract. Across diode 1, meanwhile, the sync pulse would appear on the positive portion of the saw-tooth voltage, and the two voltages would add. Waveform W5 in Fig. 8-28C shows the increased voltage across diode 1 under this condition. The missing waveform across diode 2 would have a lower amplitude. Diode 1 will therefore conduct more current than diode 2, and a positive voltage will be produced at the output of the phase detector. A positive voltage applied to the grid of the reactance tube will return the oscillator to the correct frequency.

It should now be evident that frequency correction takes place from either direction. If the oscillator tends to run slow, a negative voltage which speeds up the oscillator is produced. If the oscillator tends to run fast, a positive voltage which slows down the oscillator is produced.

The output voltage from the phase detector is passed through a filter circuit before it is applied to the reactance tube. This filter is designed to remove any fluctuations in the control voltage and, especially, to minimize the effects of random noise pulses which could affect the stability of the horizontal oscillator.

Reactance Tube

The basic principle of operation for the vacuum tube is that the control grid voltage can control the plate current in the tube. If a constant plate voltage is applied to a tube and the grid voltage is varied, the tube will appear as a variable resistance to any circuit connected to the plate. This is the basis for the operation of the capacitive reactance tube V2 in the schematic of Fig. 8-25. Capacitor C8 is connected from the top of the oscillator tank coil, in series with V5 and R8, to the bottom of the tank coil. When the grid bias of V2 is varied by the phase-detector output voltage, the plate resistance of V2 is varied. Since this plate resistance is in series with C8, the effective capacity which C8 contributes to the oscillator tank circuit is also varied. In this way the oscillator frequency is varied.

If the control voltage on the grid of the reactance tube goes in a positive direction, the plate resistance offered by the tube decreases and C8 introduces more capacitance into the oscillator tank circuit. This action tends to lower the frequency of the oscillator. On the other hand, if the control voltage goes in a negative direction, the plate resistance of the tube increases. There is less capacitance shunted across the tank circuit and the oscillator frequency increases.

Resistor R9 is a voltage dropping resistor which reduces the amount of plate current drawn by V2. Resistors R7 and R8 are so proportioned that a portion of the oscillator cathode voltage is applied to the reactance-tube cathode as an initial fixed bias. If the grid of the reactance tube were not biased negatively, a positive control voltage would cause a detrimental flow of grid current in the reactance tube. In addition, the fixed bias establishes the control-grid voltage at a position on the tube curve where the control exerted by the grid is linear. This insures that equal increments of change in the control voltage produce correspondingly equal changes in plate current.

Oscillator

The horizontal oscillator V3 in the schematic of Fig. 8-25 is connected in a modified Hartley circuit and operates as a class-C, sine-wave oscillator. Grid bias for the oscillator is derived by grid rectification of the positive portions of the sine-wave voltage developed across the tank coil L1. Capacitor C10 receives a charge when grid current flows on each positive peak and discharges through resistor R10 to hold the grid below the cutoff level for about 70 per cent of the cycle. Waveform W6A in Fig. 8-29 shows the voltage at the grid of the oscillator tube. It can be seen that the negative portion of this waveform is a sine wave but that the positive portion has been distorted. This distortion is a result of the signal developed at the point indicated for W7 in Fig. 8-25. In some circuits this point is grounded, and the waveform on the grid of the oscillator more closely approaches a sine wave as indicated by waveform W6B in Fig. 8-29. In this type of circuit a different means is employed for biasing the reactance tube since R7, R8, and C7 are eliminated.

Waveform W7 in Fig. 8-29 represents the output of the oscillator. The addition of waveforms W7 and W6B results in waveform W6A. The important feature of the output waveform is the fairly sharp positive peak, which incidentally causes the distortion in the positive portion of waveform W6A. This peak is required in order to drive the discharge tube properly.

Discharge Tube

The discharge tube V4 in the schematic of Fig. 8-25 operates as a conventional discharge stage such as has been described previously in this series. The stage is driven by wave-

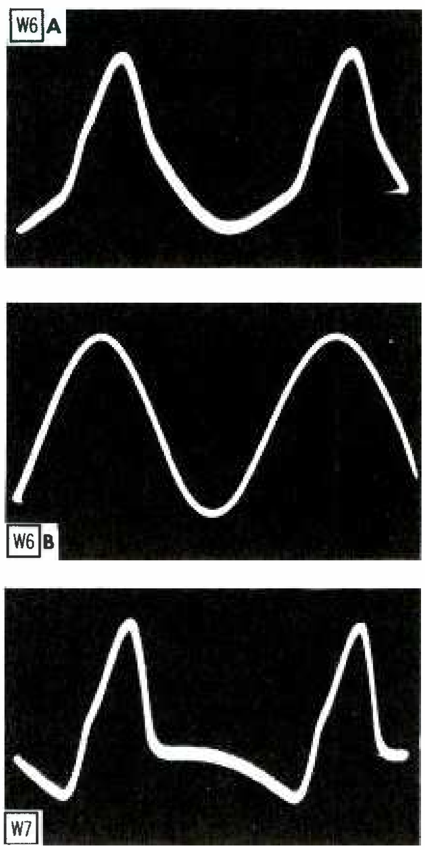


Fig. 8-29. Oscillator Waveforms.

form W8, shown in Fig. 8-30. Grid current flows during the positive peaks as shown by the flattened tops. Capacitor C11 obtains a charge during grid-current flow, and the discharge of this capacitor through resistor R11 holds the grid below cutoff except during the positive peaks. Thus, the tube acts as a switch by conducting during the positive peaks and by not conducting between these peaks.

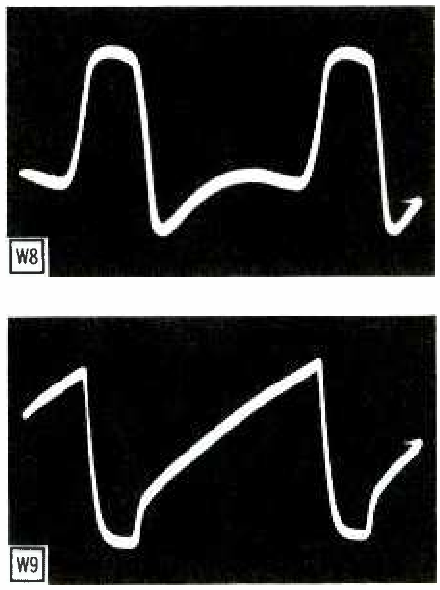


Fig. 8-30. Waveforms in the Discharge-Tube Circuit.

The saw-tooth waveform W9 in Fig. 8-30 is produced at the plate of the discharge tube. Proper shaping is achieved through the use of C12 and R13. The capacitor charges through resistor R12 while the discharge tube is not conducting and discharges rapidly through the tube when it is conducting. The trace portion of the saw-tooth waveform is formed by the charge cycle, and the retrace portion is formed by the discharge cycle. Resistor R13 is included to develop the trapezoidal waveform which is required for proper operation of the horizontal-output stage.

The Gruen circuit and many modifications of it have been used by several television manufacturers. These circuit modifications will, in many cases, cause the waveforms to be somewhat different from those shown here, and liberal interpretation will be needed in order to compare the various waveforms. The end product should always be some form of saw-tooth waveform which is applied to the horizontal-output stage.

William E. Burke

Tubes for Series Strings

(Continued from page 21)

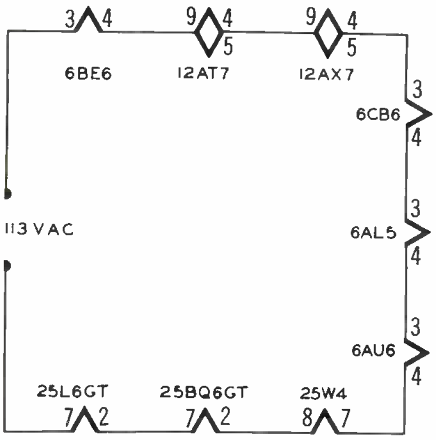


Fig. 2. Series-Filament String Composed of 300-Milliampere Tubes.

Notice particularly the power dissipation across V1 as compared to that across V2. Assume that the warm-up time for V1 is less than that for V2. Fig. 1B shows the electrical circuit values at the time when V1 completes its warm-up time and assumes its hot-resistance value of 21 ohms. V2 is still warming up; its resistance may be only 10 ohms. A marked surge of voltage appears across the filament of V1. When V2 attains its hot resistance, as in Fig. 1C, the voltages across the tubes equalize.

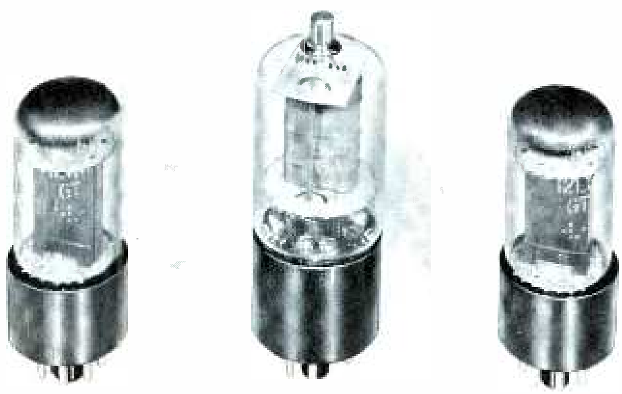
TABLE I

RESULTS FROM TEST OF 300-MILLIAMPERE STRING IN FIG. 2.

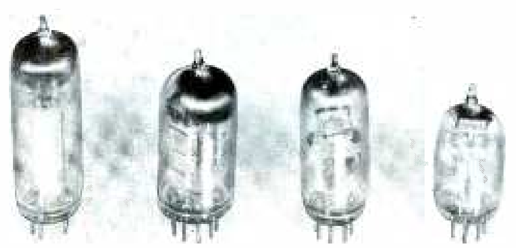
Tubes	Max. Surge (volts)	Steady-State (volts)	Time Taken to Reach Steady State (seconds)
6BE6	10.0	6.8	43
12AT7	7.0	6.2	45
12AX7	22.0	6.1	21.5
6CB6	6.4	6.4	40
6AL5	13.5	6.1	35
6AU6	8.4	6.4	56
25W4	25.5	25.5	16
25BQ6GT	21.5	21.5	59
25L6GT	34.0	28.0	52.5

Further complications are imposed when the number of tubes in a series string is increased. When several tubes are slow in reaching the full value of their hot resistance, the voltage drops across these tubes are lower than their rated values. This leaves an excess of voltage to be distributed across the remaining tubes. Surge voltages are increased still further by the additional number of tubes.

Since the heater temperature determines the heater resistance at various times during warm-up time, it is apparent that if all tubes warmed up at the same rate and if the initial resistances were in the same ratio as the final resistances, the distribution of resistance in the series string would be the same at all times. Voltage surges would be minimized under these conditions.



(A) Octal.



(B) Miniature.

Fig. 3. New 600-Milliampere Tubes. (Samples Courtesy of the General Electric Company.)

TABLE II

GENERAL ELECTRIC 600-MILLIAMPERE FILAMENT TUBES

Tube Type	Heater Rating (volts)	Heater Rating (amps.)	Equiv. Type
3AL5	3.15	0.6	6AL5
3AU6	3.15	0.6	6AU6
3BC5	3.15	0.6	6BC5
3BE6	3.15	0.6	6BE6
3BN6	3.15	0.6	6BN6
3BY6	3.15	0.6	6BY6
3CB6	3.15	0.6	6CB6
5AQ5	4.7	0.6	6AQ5
5BK7A	4.7	0.6	6BK7A
5J6	4.7	0.6	6J6
5T8	4.7	0.6	6T8
5U8	4.7	0.6	6U8
5V6GT	4.7	0.6	6V6GT
12BK5	12.6	0.6	6BK5
12BQ6GA	12.6	0.6	6BQ6GA
12L6GT	12.6	0.6	25L6GT
12W6GT	12.6	0.6	6W6GT

To demonstrate surges in an actual string, nine tubes with 300-milliampere filament ratings were selected at random and connected in a series-string arrangement. Since the drops in voltage across the combined tubes totaled 113 volts, this value of AC voltage was impressed across the string. A vacuum-tube voltmeter was used to record the largest voltage surge and also to record the final steady-state voltage across each filament. The time necessary for the voltage to level off and reach a steady value was recorded with a stop watch. Fig. 2 shows a diagram of the tubes used and how they were connected in the string. Table I shows the largest voltage surges and the steady-state voltages across the filaments. The time taken for the tube voltages to reach a steady state is also recorded.

An examination of the figures given in Table I shows that three out of the nine tubes had extremely high surges of voltage. The 12AX7, which was connected for 6.3-volt operation at 300 milliamperes, was the worst offender with a surge of 22 volts; next was the 6AL5 with 13.5 volts; and the 25L6 had 34 volts across a filament rated at 25 volts. It should be noted that the steady-state voltages were unevenly distributed among the tubes. For instance, the 25L6 had a 28-volt drop and the 25BQ6 had only 21.5 volts across it. This can be attributed to a variation in hot resistance between the tubes. In most cases, this variation is small because it is one of the features over which the manufacturer has established a control limit. Normally, even though tubes are of different types, their hot resistance will be the same as long as their filaments have equal voltage and

TABLE III

RCA 600-MILLIAMPERE FILAMENT TUBES

Tube Type	Heater Rating (volts)	Heater Rating (amps.)	Equiv. Type
3BC5	3.15	0.6	6BC5
3CB6	3.15	0.6	6CB6
5AN8	4.7	0.6	6AN8
5AT8	4.7	0.6	6AT8
5J6	4.7	0.6	6J6
5U8	4.7	0.6	6U8
12L6GT	12.6	0.6	25L6GT

current ratings. The surges in the circuit of Fig. 2 are probably greater than will be encountered in actual circuits, because no effort was made here to arrange these tubes for best results. The test was conducted only to illustrate how acute this problem can be.

Set manufacturers have tried numerous methods of tube arrangements in an effort to eliminate these voltage surges during warm-up time. Current-limiting resistors such as the Globar type are used, and in some cases the tubes are specially selected to meet the specific requirements. With all the precautions that are taken, surges sufficient to reduce tube life materially are still encountered in

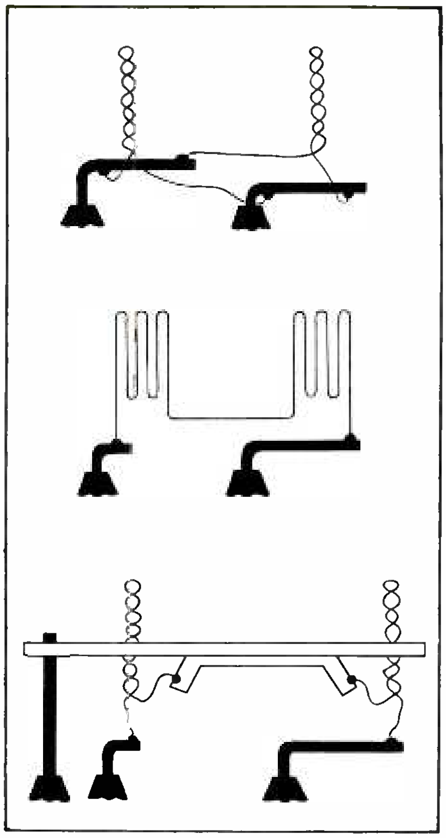


Fig. 4. Various Types of Heater Construction.

many of the series-string circuits that are in use in television sets today.

New 600-Milliampere Tubes

As a solution to this trouble, some of the tube manufacturers have announced a new line of tubes especially designed for series-string operation in television receivers. The General Electric Company, for example, will produce the tubes that are shown in Table II. This table also shows the heater ratings and the equivalent tube types. Photographs of some of these tubes are shown in Fig. 3. RCA has also announced the release of seven tube types of 600-milliampere heater operation. These types are listed in Table III. Note that the new filament-voltage ratings are indicated by the first finger in the tube-type number. With the exception of heater voltage and current ratings, electrical characteristics will remain the same as for the listed equivalent types.

We have stated that if all the tubes in a series string took the same length of time to warm up and if the initial resistances were the same ratio as the final resistances, the resistance distribution in the string would be the same and no surges could exist. This is, in effect, the approach that has been used in designing the new 600-millampere line of tubes.

The metal, the type of coating, and the structural shape of the heater are important factors in determining the length of time for warming up. In the past, several structural designs have been used in the construction of filaments. Some of these are drawn in Fig. 4. In the new 600-milliampere tubes, the manufacturers have controlled the aforementioned factors to produce heaters with uniform warm-up periods. At the same time, they have maintained the cold resistances of all the new tubes in the same ratio as the hot resistances of the tubes. For example, the hot resistances of a 3AL5 and a 12BK5 are 5.25 ohms and 21 ohms, respectively. If the cold resistance of the 3AL5 is 2.5 ohms, then the cold resistance of the 12BK5 is:

$$R = \frac{21}{5.25} \times 2.5 = 10 \text{ ohms.}$$

In the past there have not been enough tubes with equal heater-current ratings to provide a complete line of tubes for a television receiver. This meant that set manufacturers had to use 300- and 600-milliampere heaters connected in a series-parallel arrangement. Such an arrangement increased the difficulty of maintaining constant voltage drops across every tube. A complete line of the new 600-millampere tubes will make it possible to have a television set with one string of tubes (picture tube included). Total voltage drop across all tubes will probably be about 95 to 100 volts.

We should remember that the heater warm-up time will not necessarily be the time it takes for the tube to go into operation since that will be dependent upon the cathode used, its thickness, coating, and other factors. A heavier wire is used for 600-milliampere heaters, giving them the additional advantage of sturdier construction. The new tubes are less likely to be affected by shock and vibration.

To see how these new tubes react in comparison with the 300-

TABLE IV

RESULTS FROM TEST OF 600-MILLIAMPERE FILAMENT STRING IN FIG. 5

Tubes	Max. Surge (volts)	Steady-State (volts)	Time Taken to Reach Steady State (seconds)
3BE6	3.8	3.1	9
5T8	6.0	4.6	9
5T8	6.4	4.6	8
3CB6	4.0	3.2	10
3AL5	4.0	3.1	9
3AU6	3.8	3.1	10
12W6GT	12.7	12.7	11
12BQ6GA	12.6	12.6	11
12L6GT	12.7	12.7	10

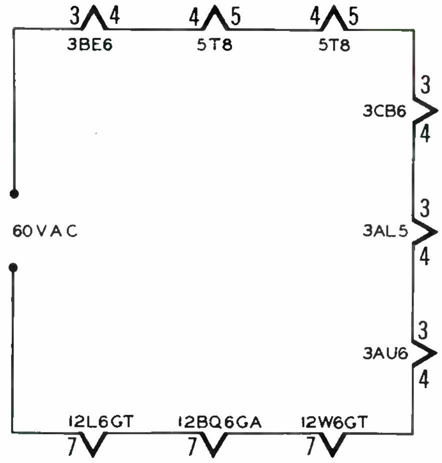


Fig. 5. Series-Filament String Composed of New 600-Milliampere Tubes.

milliampere tubes, surge-voltage readings were taken in a nine-tube string composed of one 3BE6, two 5T8's, one 3CB6, one 3AL5, one 3AU6, one 12W6GT, one 12BQ6GA, and one 12L6GT. Fig. 5 shows how these tubes were connected. The voltage readings and times are listed in Table IV. Compare this table with Table I. Although there were some slight voltage surges in the new tubes, the figures clearly indicate an improvement over the older types of tubes.

The advantages of series filaments in a television receiver are many. The transformer can be eliminated; and this means a reduction in size and weight of the chassis, a reduction in the spacing requirements of the picture tube because of the removal of magnetic fields, and a reduction in the power consumed in transformer losses. With less power dissipated, the set will operate cooler; and a cooler operating temperature will tend to reduce the failure of component parts. All of these are factors which lower the initial cost of the television receiver a matter of extreme importance to the set manufacturer.

When we consider these advantages, it is easy to predict that in all probability a large percentage of the forthcoming sets will be using these 600-milliampere tubes for series-connected filament strings. To the service technician, this will mean that he will have to stock a larger selection of tubes. Probably he will have to modify his tube tester in order to handle tests on the new tubes with their different voltage and current ratings. On the other hand, it will mean that better sets can be sold for less money. With more sets in use, the service technician will benefit by increased business.

JAMES M. FOY

PF INDEX REPORTER

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+ More or Less −

As was generally expected, color television did not become a major, direct factor in the service field immediately after the adoption of the NTSC standards by the FCC.

The development, production, and sale of color television receivers to date have not been great enough to account for any percentage of servicing. The percentage of service technicians which has been called upon to service color television receivers is close to zero. There is little doubt, however, that this situation will exist for too long.

Several factors can account for the seemingly slow pace of color television up to the present time. One of the factors has been, of course, the number of color programs available, or rather the lack of them. Network color schedules should show a considerable increase this fall and will undoubtedly continue to expand. In addition to network telecasts in color, many local programs will also be available in color. As color programming increases, so will the interest of the consumer or prospective purchaser of color television receivers.

Another major factor has been the unavailability of any quantity of color television receivers in what is termed large-screen size at prices that will be attractive to the general public. The stumbling block here has been the design, development, and manufacture of large-screen, color picture tubes that do not require a great deal of complicated circuitry. The solution to this is a necessity before color television receivers will be mass produced and sold.

Large-screen, color picture tubes have been announced, are in production, and will soon be available. Then there will undoubtedly be gradual development toward mass production, lower costs, and an increasingly greater number of people who will purchase color television receivers. As the percentage of people who own color receivers increases, so will the percentage of the service technician business be increased from the servicing of these receivers.

It will be quite some time before color receiver servicing will detract from the present or prospective amount of servicing of monochrome TV receivers, radios, audios, etc., and therefore it must be considered as an addition to present servicing business. If this color receiver servicing is to be a part of your business, then it must be included in your plans for the future.

Color television servicing is not simple. To adjust and service color television receivers, the technician will require knowledge of new terms, new circuits, and new methods. He should obtain this knowledge through study prior to the time that it becomes a factor or a part of his every-day business. This study will require time and investment.

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Circuit description, analysis, and servicing procedures will then be given from actual examination and experience obtained in the adjusting and servicing of production color television receivers.

We hope that this series becomes a part of your present planning and that it will assist you in making your future color television receiver servicing more pleasant and, above all, profitable.

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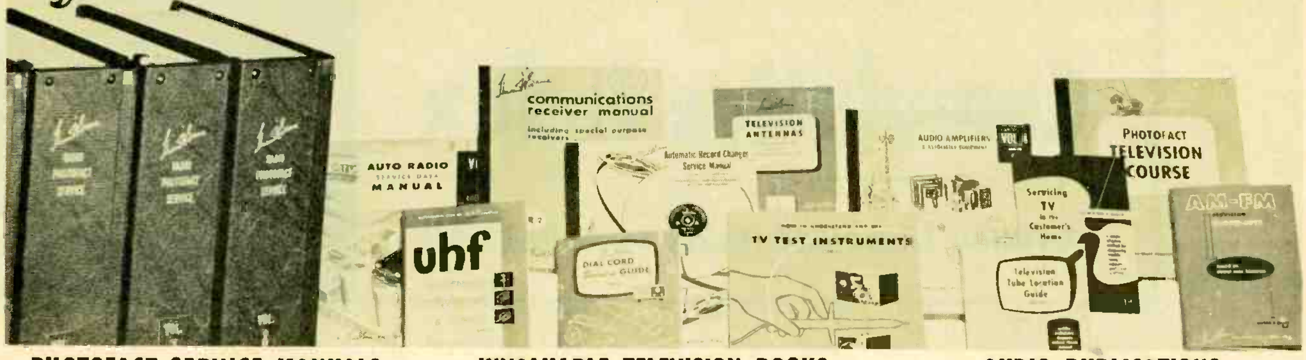

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HOW TO USE THIS INDEX

To find the PHOTOFACT Folder you need, first look for the name of the receiver (listed alphabetically below), and then find the required model number. Opposite the model, you will find the number of the PHOTOFACT Set in which the required Folder appears, and the number of that Folder. The PHOTOFACT Set number is shown in bold-face type; the Folder number is in the regular light-face type.

IMPORTANT—1. The letter "A" following a set number in the Index listing, indicates a "Preliminary Data Folder." These folders were designed to provide immediate basic data on TV receivers. Many of these were later superseded by regular Photofact Folders. In those cases where short production runs and/or limited distribution prevented availability of a sample chassis the "A" designation has been retained.

2. Models marked by an asterisk (*) have not yet been covered in a standard Folder. However, regular PHOTOFACT Subscribers may obtain Schematic, Alignment Data or other required information on these models without charge by supplying make, model or chassis number and serial number. (When requesting such data, mention the name of the Parts Distributor who supplies you with your PHOTOFACT Folder Sets.)

3. Production Change Bulletins contain data supplementary to certain models covered in previously issued PHOTOFACT Folders, and are listed in this Index immediately following the listing of the original coverage of the model or chassis. These Bulletins should be filed with the Folders covering the models to which the changes apply.

NOTE: PCB denotes Production Change Bulletin

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NOTE: PCB denotes **Production Change Bulletin**

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- 21F3Y (Ch. TS-292AY, BY, CY and Radio Ch. HS-316A) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21F5, B Ch. TS-502 and Radio Ch. HS-40°) Tel. Rec. (TV chassis only) ....237—8
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- 21K4AY (Ch. TS-292AY, BY, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K4B (Ch. TS-292A, B, C) Tel. Rec. (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1) .191—13
- 21K4BD, BDY (Ch. WTS-292A, AY, B, BY, C, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K4BY (Ch. TS-292AY, BY, CY) Tel. Rec. (See PCB 63—Set 197-1 PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K4C, CB, CBY, CW, CWY, CY, D, DY (Ch. WTS-292A, AY, B, BY, C, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K4W (Ch. TS-292A, B, C) Tel. Rec. (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1) ....191—13
- 21K4WD, WDY (Ch. WTS-292A, AY, B, BY, C, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K4WY, 21K4Y (Ch. TS-292AY, BY, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K5, B (Ch. TS-292A, B, C) Tel. Rec. (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1) .191—13
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- 21K5BY (Ch. TS-292AY, BY, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K5D, DY (WTS-292A, AY, B, BY, C, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K5Y Ch. TS-292AY, BY, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K6 (Ch. TS-292A, B, C) Tel. Rec. (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1) ....191—13
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- 21K6Y (Ch. TS-292AY, BY, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K7 (Ch. TS-292A, B, C) Tel. Rec. (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1) ....191—13
- 21K7D DY (Ch. WTS-292A, AY, B, BY, C, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K7Y (Ch. TS-292AY, BY, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C—Set 191-13)
- 21K9, Y (Ch. WTS-292A, AY, B, BY, C, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set 191-13)
- 21K10 B, BY, Y (Ch. VTS-292A, AY, B, BY, C, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214 1 and Model 21C1—Set 191-13)
- 21K11 B, BY, Y (Ch. VTS-292A, AY, B, BY, C, CY) Tel. Rec. (See PCB 63—Set 197-1, PCB 73—Set 214 1 and Model 21C1—Set 191-13)
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- 21T4EA (Ch. TS-324A, B) Tel. Rec. (Also see PCB 63—Set 197-1) ....191—13
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A-T2294 (Code 128) (Ch. 94, J-5 and Radio Ch. RT-11) Tel. Rec. (For TV Ch. Only See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
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A-UT1818 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
A-UT1856, HM, L, W (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
A-UT1858 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
A-UT2230 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
A-UT2232 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B)
A-UT2233 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
A-UT2234 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
A-UT2266, L (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
A-UT2272 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
A-UT2272 (Code 129) (Ch. 81A, D-81) Tel. Rec. 227—10
A-UT2274, W (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
A-UT2277 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
A-UT2279 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
A-UT2280 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1, and Model 53-T1853—Set 185-10)
A-UT2281 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1, and Model 53-T1853—Set 185-10)
A-UT2288 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
A-UT2289 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1, and Model 53-T1853—Set 185-10)
A-UT2292L (Code 128) (Ch. 94A, J-5 and Radio Ch. RT-10) Tel. Rec. (For TV Ch. Only See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
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C-4908 (See Mopar Model 805—Set 71-11)
C-5009 (See Mopar Model 809—Set 71-11)
C-5010 (See Mopar Model 805—Set 71-11)
C-5109 (See Mopar Model 815—Set 139-8)
C-5110 (See Mopar Model 816—Set 139-8)

NOTE: PCB denotes Production Change Bulletin

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52-T2140 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (Also see PCB 56—Set 190-1) .... 171—9
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52-T2142 (Code 122) (Ch. 35, F2) Tel. Rec. (See Model 51-T2102—Set 132-10)
52-T2144 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (Also see PCB 56—Set 190-1) .... 171—9
52-T2145X (Code 121) Tel. Rec. 159-1A
52-T2145X (Code 125) (Ch. 44, D4, D4A) Tel. Rec. (Also see PCB 57—Set 191-1) .... 181—9
52-T2150, W, 52-T2151, L (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1). 179—9
52-T2151 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2157 (Code 125) (Ch. 42, G2) Tel. Rec. 186-10
52-T2175 (Code 124) (Ch. 35, F-2 and Radio Ch. RT-6) Tel. Rec. (For TV Ch. see Model 51-T2102—Set 132-10, for Radio Ch. see Set 159-2A)
52-T2176 (Code 124) (Ch. 35, F-2 and Radio Ch. RT-6) Tel. Rec. (For TV Ch. see Model 51-T2102—Set 132-10, for Radio Ch. see Set 159-2A)
52-T2182 (Code 121) (Ch. 44, D-4, D-4A and Radio Ch. RT-6) (For TV Ch. see PCB 57—Set 191-1 and Set 181-9, for Radio Ch. see Set 159-2A)
52-T2224 (Code 121) (Ch. 41, D1, D-A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2244 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (Also see PCB 56—Set 190-1)
52-T2245 (Code 121) (Ch. 44, D4, D4A) Tel. Rec. (Also see PCB 57—Set 191-1) .... 181—9
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52-T2256 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T2106—Set 171-9)
52-T2258 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2259 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
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53-T1827, -F, -HM (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T1852 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also See PCB 83—Set 224-1) .... 201—7
53-T1852 (Code 124) (Ch. 71, G-1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
53-T1852F (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also See PCB 83—Set 224-1) .... 201—7
53-T1852HM (Code 123) (Ch. 81, H-1) Tel. Rec. (See Model 53-T1824—Set 201-7)
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53-T1852L (Code 124) (Ch. 71, G-1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)

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53-T1853, L (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) 185-10
53-T1853, L (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T1854, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
53-T1883 (Code 125) (Ch. 44, G4) Tel. Rec. 196-11
53-T1884 (Code 125) (Ch. 44, G-4 and Radio Ch. RT-9) Tel. Rec. (TV Ch. Only) 196-11
53-T1886, L (Code 125) (Ch. 44, G-4 and Radio Ch. RT-9) Tel. Rec. (TV Ch. Only) 196-11
53-T2124, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
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53-T2125, L (Code 124) (Ch. 71, G1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
53-T 2126 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
53-T2126 (Code 125) (Ch. 42, G2) Tel. Rec. 186-10
53-T2127 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) 185-10
53-T2152, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
53-T2152, L (Code 124) (Ch. 71, G1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
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53-T2227 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
53-T2228 (Code 126) (Ch. 91, J1) Tel. Rec. 185-10
53-T2228 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2255 (Code 133) (Ch. 81, H1) Tel. Rec. .... 201—7
53-T2260 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
53-T2260 (Code 125) (Ch. 42, G2) Tel. Rec. 186-10
53-T2262 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
53-T2262 (Code 125) (Ch. 42, G2) Tel. Rec. 186-10
53-T2264 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
53-T2264 (Code 125) (Ch. 42, G2) Tel. Rec. 186-10
53-T2266, L (Code 126) (Ch. 91, J-1) Tel. Rec. (Also see PCB 66—Set 203-1) 185-10
53-T2266, L (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2268 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) 185-10
53-T2269 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) 185-10
53-T2269 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-2270 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) 185-10
53-T2270 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2271 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) 185-10
53-T2271 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2272, L (Code 123) (Ch. 81, H1) Tel. Rec. .... 201—7
53-T2273 C, M (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) 185-10
53-T2273, C (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2274 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... 201—7
53-T2285, L (Code 126) (Ch. 94, J-4 and Radio Ch. RT-8) Tel. Rec. .... 213—5
53-T2285, L (Code 128) (Ch. 94, J-5 and Radio Ch. RT-8) Tel. Rec. (See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
53-T2285S (Code 126) (Ch. 94A, J-4 and Radio Ch. RT-8) (See Model 53-T2285—Set 213-5)
53-T2285S (Code 128) (Ch. 94, J-5 and Radio Ch. RT-8) Tel. Rec. (See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)

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53-T2286 (Code 126) (Ch. 94, J-4 and Radio Ch. RT-8) Tel. Rec. .... 213—5
53-T2287 (Code 126) (Ch. 94, J-4 and Radio Ch. RT-11) Tel. Rec. (TV Ch. only) .... 213—5
53-T2287 (Code 128) (Ch. 94, J-5 and Radio Ch. RT-11) Tel. Rec. (For TV Ch. See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
53-U1827, HM (Code 126) (Ch. 91, J-1) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U1827 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U1852 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)
53-U1853, L (Code 126) (Ch. 91, J-1 Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U2124 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)
53-U2125 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)
53-U2226 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)
53-U2227 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)
53-U2255 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)
53-U2260 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)
53-U2266, L (Code 126) (Ch. 91, J-1) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U2266 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U2269 (Code 126) (Ch. 91, J-1) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U2271 (Code 126) (Ch. 91, J-1) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U2271 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U2272 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)
53-U2285 (Code 126) (Ch. 94, J-4 and Radio Ch. RT-8) Tel. Rec. (See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
53-U2286 (Code 126) (Ch. 94, J-4 and Radio Ch. RT-10) Tel. Rec. (For TV Ch. Only See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
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NOTE: PCB denotes Production Change Bulletin

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NOTE: PCB denotes Production Change Bulletin

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(CM-1) indicates service data *also* available in Howard W. Sams 1947 Record Changer Manual. (CM-2) indicates service data available in Howard W. Sams 1948 Record Changer Manual. (CM-3) indicates service data available in Howard W. Sams 1949, 1950 Record Changer Manual. (CM-4) indicates service data available in Howard W. Sams 1951, 1952 Record Changer Manual. (CM-5) indicates service data available in Howard W. Sams 1953 Record Changer Manual.

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NOTE: PCB denotes Production Change Bulletin

ADDITIONAL PHOTOFACT BENEFITS

From time to time, PHOTOFACT Folder Sets include valuable "bonus" aids, as well as useful data of a special nature. The following materials are extra benefits incorporated in the PHOTOFACT Folder Sets indicated, at no additional cost.

	Set No.
1—RETMA Production Source Code (Jan. 1, 1954)	246
2—TRADE DIRECTORY— Parts Manufacturers	12
3—National Electrical Code on Antennas	88
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11—Alliance Model ATR Rotator	216
12—Alliance Model DIR Rotator	240
13—Alliance Model F-4 Rotator	250
14—Alliance Model HIR Rotator	242
15—Photofact Television Course appearing serially in	38-51, 54
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17—CR (Electromagnetic) Tube Characteristics Chart	112
18—CR Tube Interchangeability Chart	112
19—NPA maintenance and repair information	130
20—General Electric Clock Data	160

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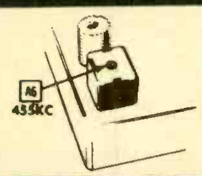
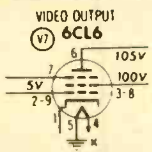
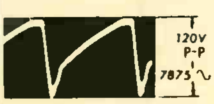


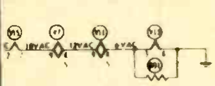
Alignment Frequencies
right on photos adjacent to adjustment number—to speed up adjustment.



Voltages on Schematics
to help speed voltage analysis for quick location of trouble.



Waveforms on Schematics
reproduced right on the diagram at vital points for rapid analysis by 'scope.



Series Filament Schematic
for quick reference when receiver employs series or series-parallel combination filament string.

Blank Pin or Locating Key
shown on each tube in placement chart (top view) to aid in substituting and replacing tubes without chassis removal.

NEW "EXTRAS"

- Tube types on chassis top photo views
- Tube failure check chart in TV Folders
- Fuse location on tube placement chart
- TV Trouble-Shooting Aids Chart
- Tips on TV servicing in the field
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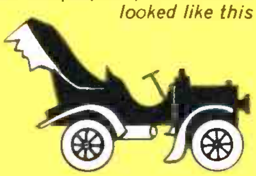

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TRIPLETT

630

Volt-Ohm-Mil-Ammeter

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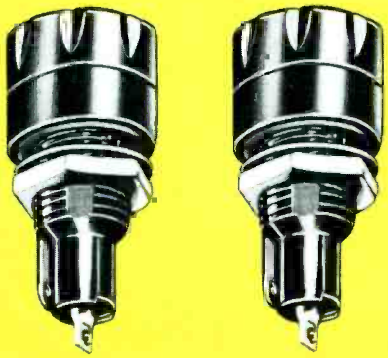

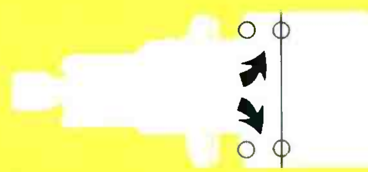

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