Howard W. Sams

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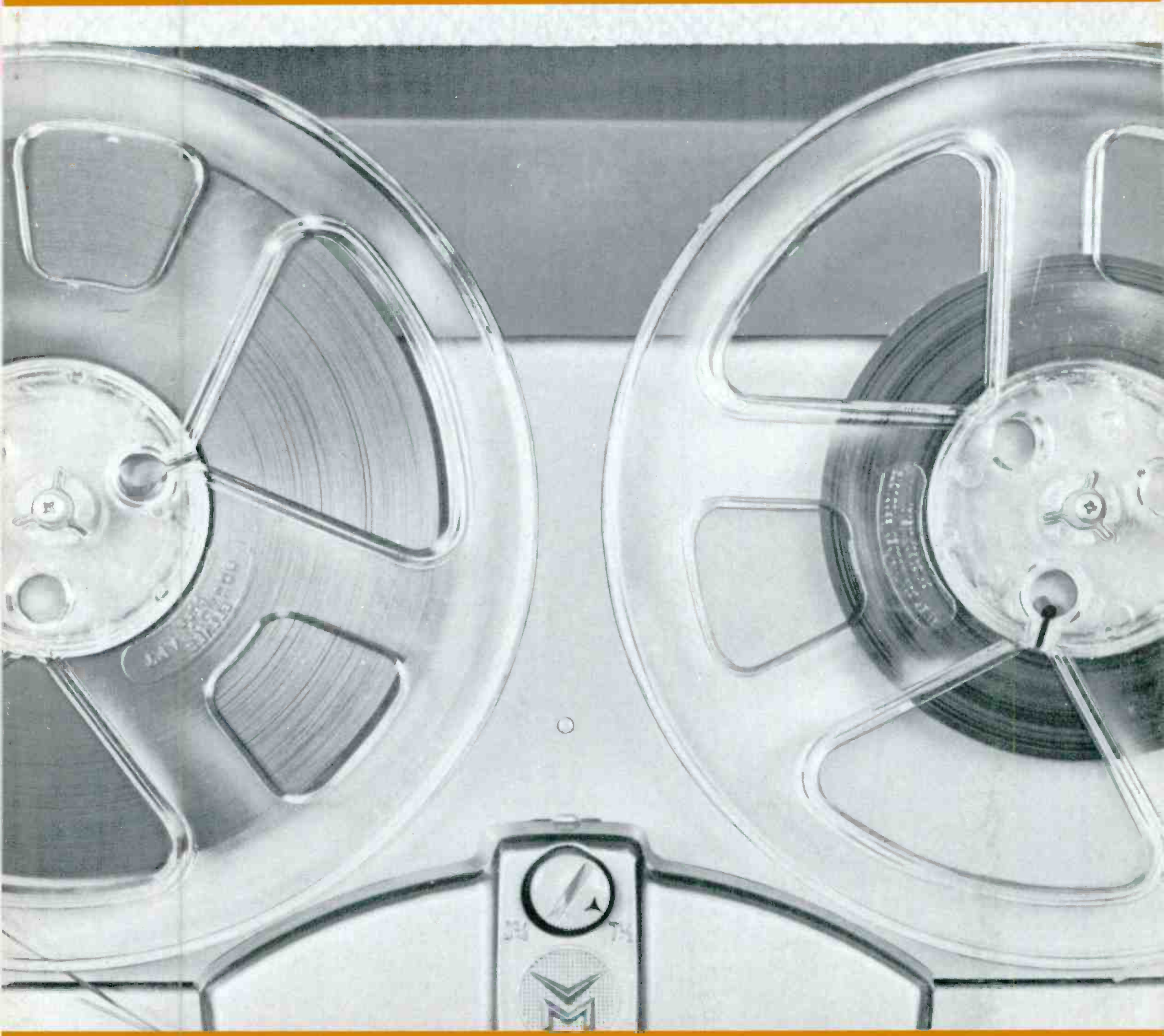
REPORTER

(formerly PF INDEX)

for the Electronic Service Industry

NOVEMBER • 1954

25 CENTS



in this issue

MAGNETIC RECORDING • UHF SERVICING

COLOR TV TRAINING SERIES PART VI

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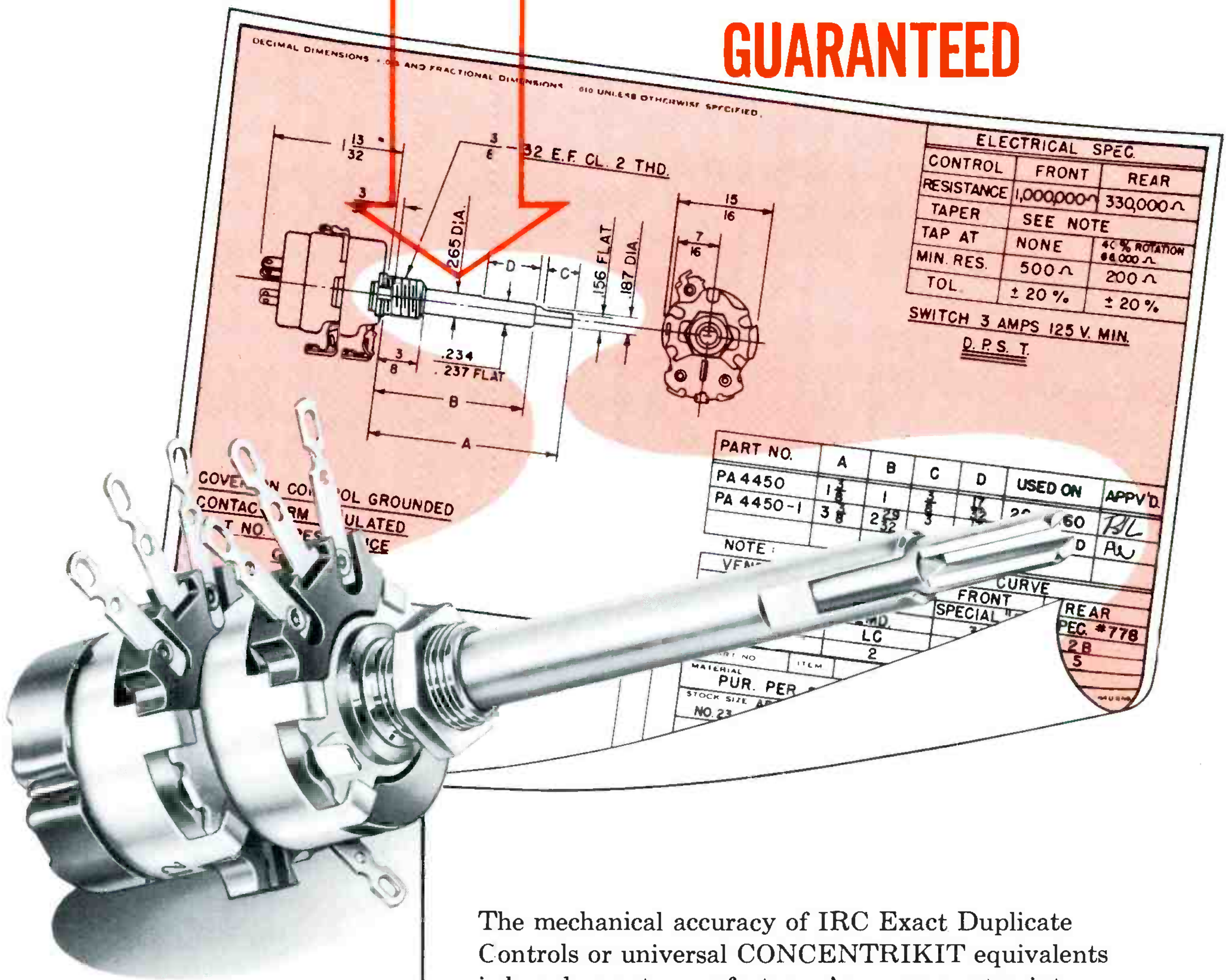

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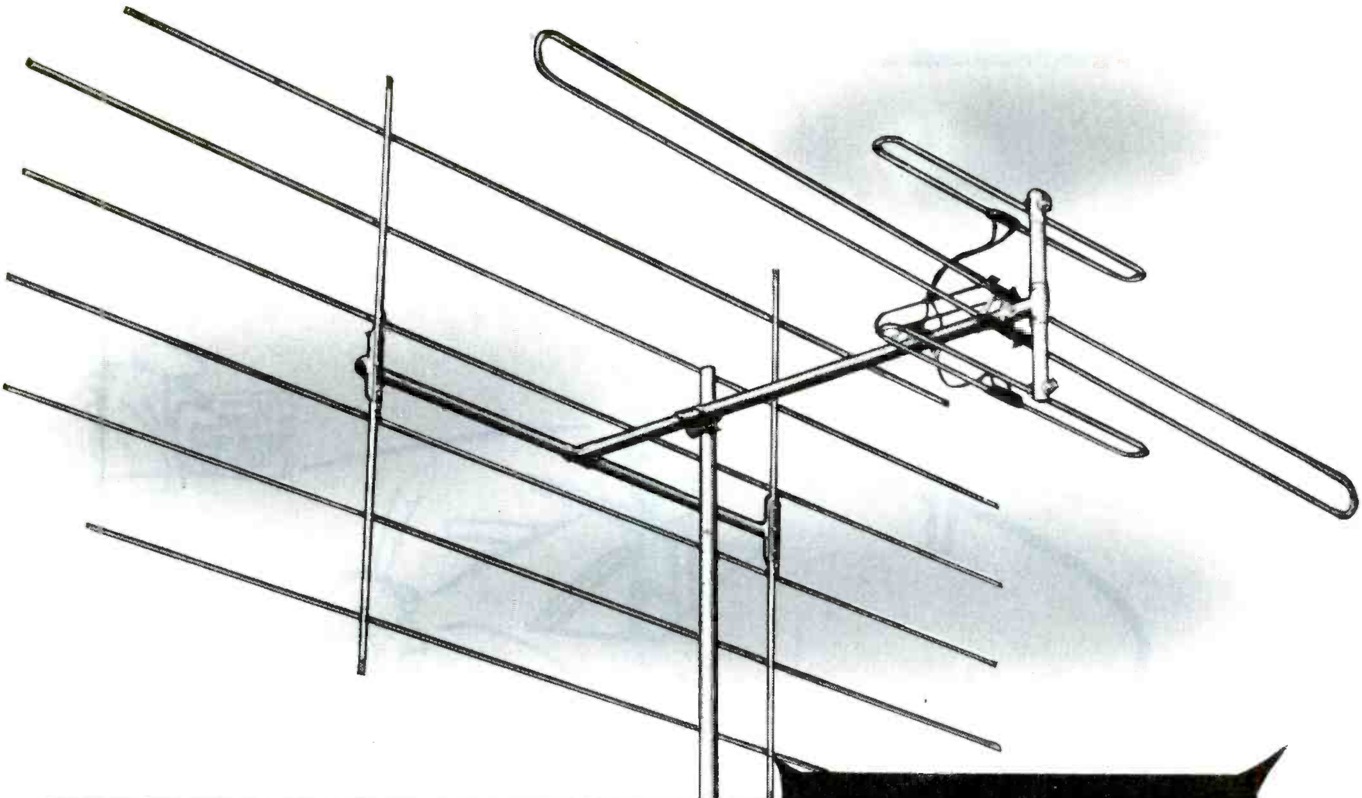

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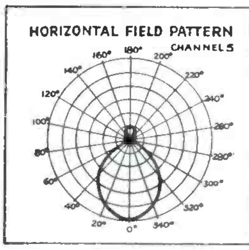

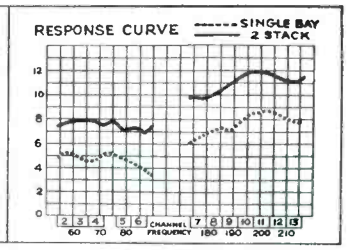

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PF REPORTER
(formerly PF INDEX) *for the Electronic Service Industry*

VOL. 4 · NO. 11 NOVEMBER · 1954

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The PF REPORTER is published monthly by Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 5, Indiana. The PF REPORTER is on sale at 25¢ a copy at 1193 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. Application for entry as Second Class matter is pending.

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In color receivers, all of the color information is contained in the region from about 2 Mc to 4.1 Mc on the over-all rf-if response curve, as shown in Fig. 1. Any loss of gain in this region will weaken the color signals. If the loss is appreciable, it may result in such effects as poor color sync, poor color "fit" (incorrect registration of color and brightness information on the kinescope), or cross-talk or color contamination between I and Q channels.

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In color receivers, there are a number of video-frequency sections, including the video amplifier, the bandpass amplifier, the demodulator channels (see Figures 2, 3, 4), and the green, red, and blue matrix networks—including the adders and output stages. A flat video sweep extending down to 50 Kc is a necessity in checking or aligning the tunable bandpass filter and the I and Q filters. *Late model RCA WR-59C Sweep Generators provide a flat video sweep extending down to 50 Kc. They also cover all rf and if ranges required for both color and black-and-white receivers.*

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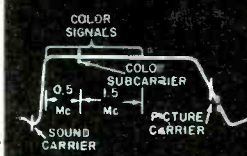

Fig. 1.
RF-IF Response

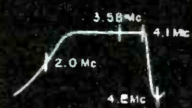

Fig. 2.
Bandpass Filter Response

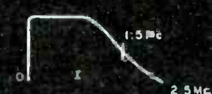

Fig. 3.
I Channel Response

Fig. 4.
R-Y, B-Y, or Q Channel Response

RCA WG-289
High Voltage Probe

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UHF Servicing

Tips on Servicing UHF Tuners and Converters

by Calvin C. Young, Jr.

Commercial telecasting on channels 14 through 83 which occupy a band of frequencies from 470 mc to 890 mc has opened a new field of service for the electronics technician.

Reception on channels 14 through 83 requires the use of an external UHF tuner. Some television receivers equipped with turret type VHF tuners may be converted to UHF reception by the installation of the proper UHF strips. These UHF strips have been found satisfactory for local reception when a strong signal is available. UHF converters, tuners, and strips have been dealt with at length in a large number of publications; but little has been said of the service problems which are peculiar to UHF reception. This article is intended to present some of these problems and their solutions.

The UHF antenna installation is of prime importance. This is true even for local reception. The propagation characteristics of UHF waves are such that misplacement of the antenna by even a very short distance may be sufficient to detract seriously from the signal or even to result in a completely unusable signal.

Before trouble-shooting procedure is started on a UHF converter or tuner, the UHF antenna system should be checked to make sure it is functioning properly. This may be done by connecting a UHF converter of known good quality between the UHF antenna and the VHF input to the customer's receiver. If the antenna is functioning properly and the VHF portion of the receiver is in proper operating condition, the UHF station should be received. Should the antenna system be found at fault, refer to PF INDEX numbers 37, 38, 39, and 41 in which problems relating to UHF antennas and their placement were covered. These articles based upon the results of UHF field surveys should answer most any question which might arise concerning UHF antennas, their location, and orientation.

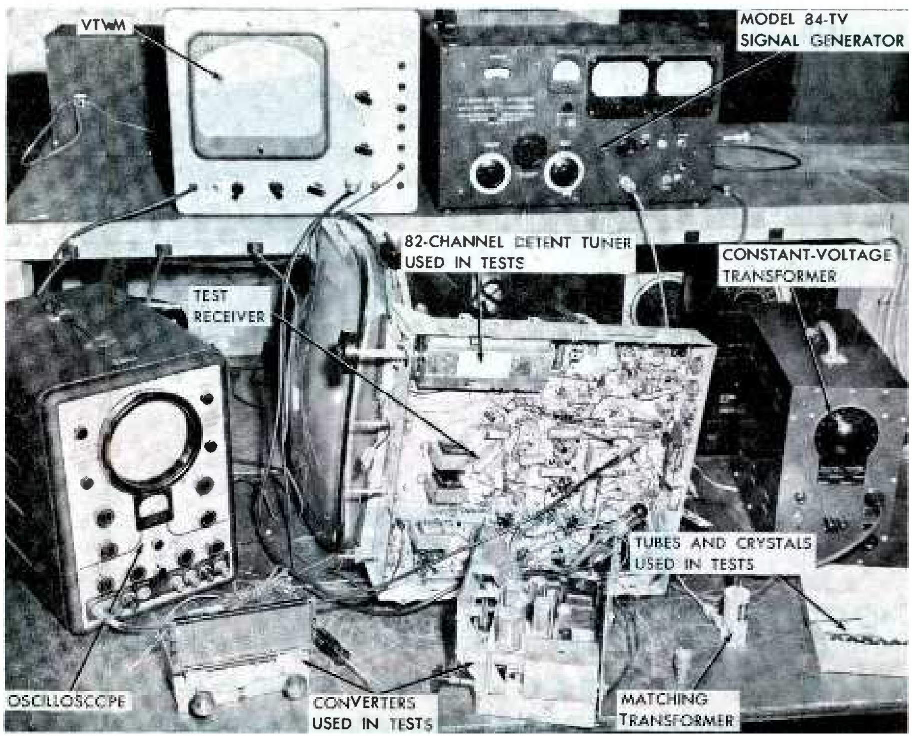

Fig. 1A. Equipment Setup Used in Tests.

In order that some of the problems peculiar to UHF converters and tuners might be more clearly understood, the following procedure which is often used in servicing VHF tuners is outlined for comparison with procedures for UHF servicing.

1. In servicing a VHF tuner for frequency drift, the usual procedure is to replace the oscillator tube with a tube of known good quality. If the original oscillator tube is defective, its replacement will in most cases correct the trouble. As a rule, no tuning or alignment will be required as a result of replacing the oscillator tube.

2. Should low sensitivity of the VHF tuner be the complaint, the usual procedure is to replace the RF amplifier tube with one of known good quality. If the original tube is defective, the trouble will usually be corrected. As in the case of the oscillator tube replacement, no alignment is usually necessary.

3. In the event that replacement of the local-oscillator tube does not correct the frequency drift or the replacement of the RF amplifier tube does not restore the sensitivity to a normal level, further procedure will be necessary. In most cases, normal trouble-shooting procedures will reveal the defective component or components. Replacement of such components requires only that reasonable care should be taken to return the components to approximately their original position. In most cases, no alignment is required.

Reports from the field have indicated that the two most common complaints concerning UHF converters and tuners are frequency drift and low sensitivity. Defective local-oscillator tubes are usually the cause of excessive frequency drift; whereas, improperly operating crystals are generally the cause of low sensitivity. In many cases, the replacement of these units will remedy the trouble. There are times, however, when such replacement necessitates further procedure such as partial realignment or in some extreme cases complete realignment. Slight variations in interlectrode capacity and in other tube characteristics may result in a change in the total capacity of a tuned circuit. Since only a small value of capacitance and inductance is required to tune across the entire UHF band, the small change of capacity caused by changing a tube may cause the circuit to be detuned

* * Please turn to page 81 * *

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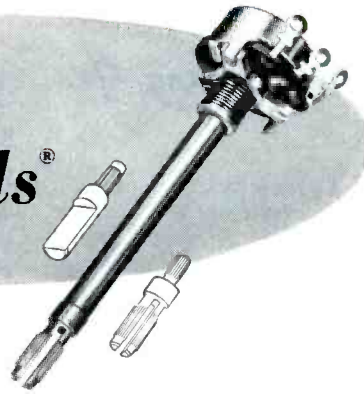

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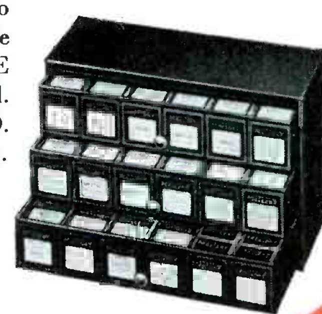

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COLOR TV TRAINING SERIES

PART VI
COLOR RECEIVER CIRCUITS

by C. P. Oliphant and Verne M. Ray

Up to this point in the Color TV Training Series, we have discussed the color-receiver stages which are necessary for the reception of both color and monochrome signals. These stages correspond very closely to those found in a conventional monochrome receiver. Minor differences in the two types of receivers are present, and those differences have been discussed.

We are now ready to enter the discussion about those stages which extract the color information from the composite signal and which prepare this information for application to the color picture tube. These stages have nothing to do with the luminance portion of the composite signal. As has been shown, the luminance signal is handled in the luminance channel of the receiver. Refer to Fig. 6-1 for the layout of the sections which have been discussed and of those which are to be covered in this part.

In order to be utilized by the picture tube in the color receiver, the color information which is in the form of a 3.58-mc signal must first be separated from the luminance portion of the composite color signal. A bandpass amplifier and a filter network are used for this purpose. Then, the 3.58-mc color signal is fed from the bandpass amplifier to two demodulators (not shown in Fig. 6-1) which extract two color-difference signals from the 3.58-mc signal. In order for the latter function to take place, two continuous-wave (CW) signals are required by the demodulators. These CW signals are generated and controlled by a section referred to as the color-synchronization section of the receiver. A burst amplifier, a keyer, a 3.58-mc oscillator, and a control circuit are used in the color-synchronization section.

During the reception of a monochrome signal by the color receiver, a means of cutting off the chrominance channel is provided. This function is performed by the color-killer section, the operation of which automatically disables the chrominance channel when there is no color signal being received.

These three sections of the receiver — the bandpass amplifier, the color-synchronization section, and the color killer — are the sections which will be discussed in this part of the training series. First, we will trace the color information up to the input of the demodulators; then, we will show how the CW signals are developed by the color-synchronization section. Since the color killer is controlled by the color-sync section and since it affects the operation of the bandpass amplifier, this stage will be discussed after the bandpass amplifier and the color-sync section are covered.

Bandpass Amplifier

The purpose of the bandpass amplifier (sometimes referred to as the chroma amplifier) is to separate the color information from the composite signal and feed it to the color demodulators. At the signal take-off point for a typical bandpass-amplifier section is the composite color signal which includes the color signal, the luminance signal, the color burst, the sync, and the blanking. The signal is usually taken off at the first video amplifier.

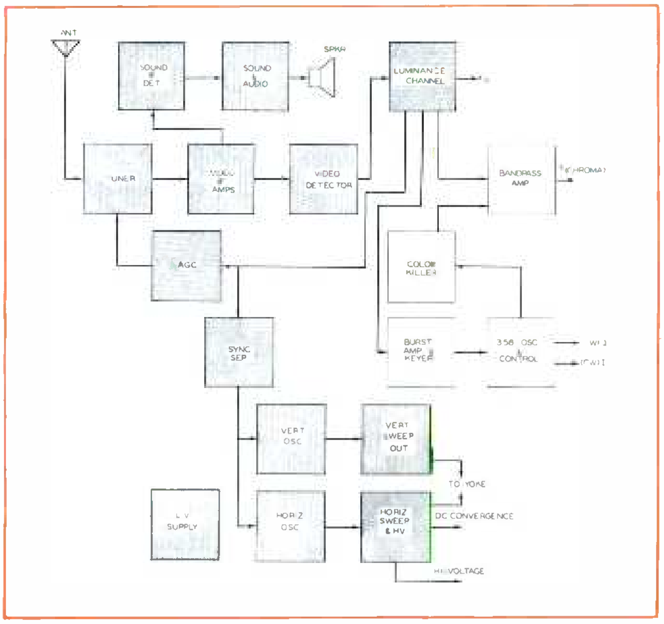

Fig. 6-1. Partial Block Diagram of a Color Receiver Showing Sections Previously Discussed and Those to Be Covered in This Issue.

Only the color portion of the composite signal appears at the output of the bandpass-amplifier circuit. Between the signal take-off point and the input of the demodulators, any remaining 4.5-mc signal has been attenuated, the luminance signal has been blocked, and the color burst and sync have been keyed out.

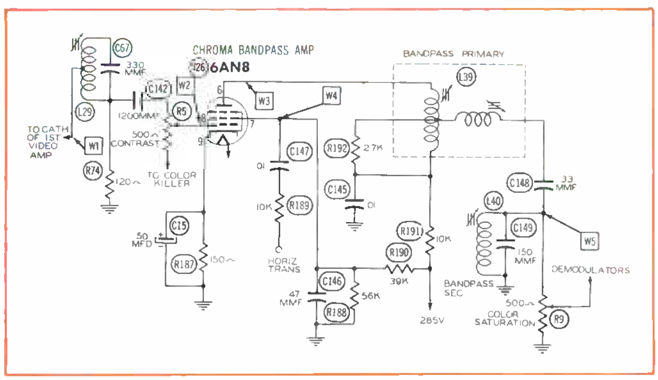

Fig. 6-2. Chroma-Bandpass-Amplifier Circuit in RCA Victor Model CT-100 Color Receiver.

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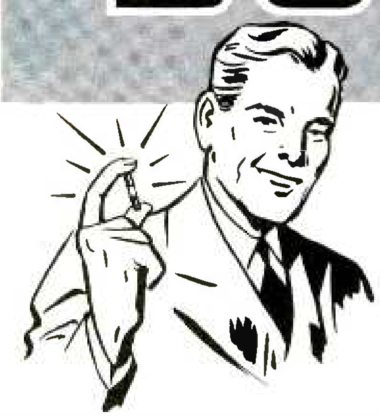

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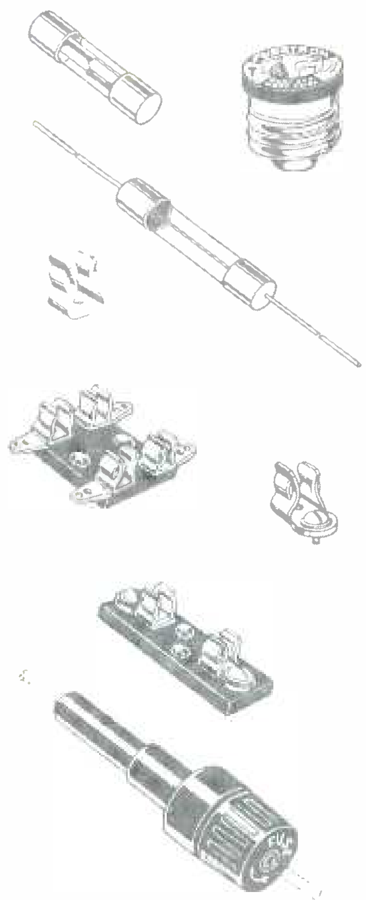

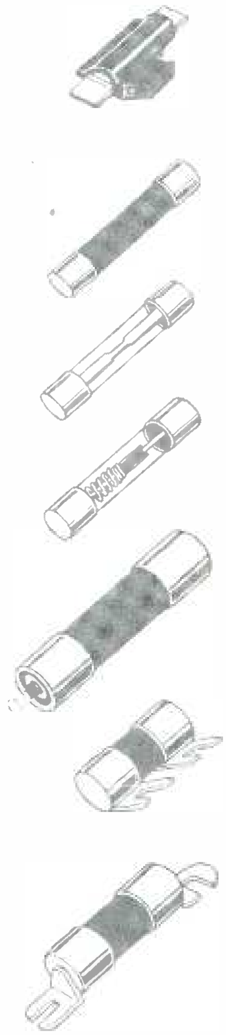

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Shown in Fig. 6-2 is one method of obtaining the chrominance signal from the composite color signal. This circuit is the one used in the RCA Victor Model CT-100 color receiver. It employs one stage of amplification and is referred to as the chroma-bandpass amplifier. The name specifies that this stage passes and amplifies the chrominance portion of the video band of frequencies. Let us see how this is accomplished.

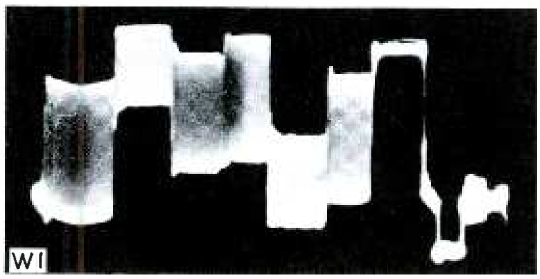

Fig. 6-3. Signal at the Cathode of the First Video Amplifier in Fig. 6-2.

The composite color signal is taken off at the cathode of the first video amplifier. Waveform W1, the signal that appears at the cathode of the first video amplifier, is shown in Fig. 6-3. The combination of L29 and C67 in the cathode circuit forms a 4.5-mc trap which removes any remaining sound signal. Up to the coupling capacitor C142, we have a signal which consists of chrominance and luminance, sync and blanking, and color burst.

The small value of capacitor C142 results in the removal of most of the luminance or Y component, but its reactance is sufficiently low at 3.58 megacycles that the chrominance signal is efficiently coupled to the grid of the bandpass amplifier. Waveform W2 in Fig. 6-4 shows the signal as it appears on the right side of C142. This is the signal that is present at the grid of V26. Notice that the center of each color bar is on the same level. The contrast control R5 varies the level of the input signal of the bandpass amplifier. It is ganged with the contrast control in the grid circuit of the second video amplifier. This provides proper tracking of the luminance and chrominance signals. The correct ratio of luminance to chrominance must be maintained so that the saturation of the colors will be correctly reproduced.

The input signal of the chroma-bandpass amplifier is developed across the contrast control R5. As shown on the schematic of Fig. 6-2, the bottom terminal of R5 goes to the color-killer stage. The operation of this stage will be discussed later.

The output of the chroma-bandpass amplifier V26 contains the chrominance portion of the transmitted signal. Waveform W3 in Fig. 6-5 represents the signal at the plate of V26. When comparing this waveform with the one shown for the input signal in Fig. 6-4, it can be seen that the sync, blanking, and color burst have been removed. This is accomplished by keying off the stage during horizontal-retrace time. A horizontal pulse from

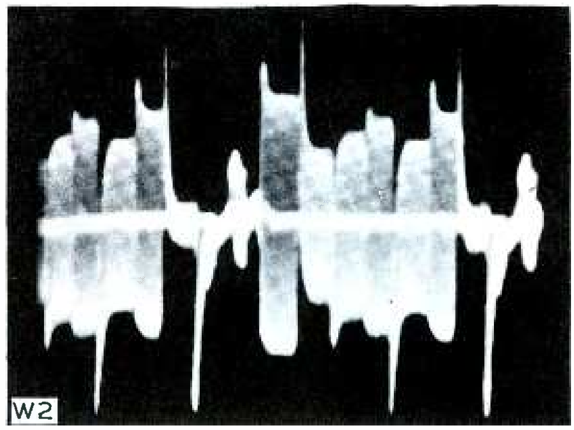

Fig. 6-4. Signal at the Grid of the Chroma-Bandpass Amplifier in Fig. 6-2.

a winding on the high-voltage transformer is coupled to the screen grid by C147 and cuts off the tube during horizontal-retrace time. Resistor R189 isolates the transformer from the screen grid. The horizontal pulse is slightly integrated by the capacitor C146. In this way the sync pulses and color burst which are not required in the chrominance section are keyed out, leaving only color information in the output of the bandpass amplifier. R187 provides cathode bias for this stage, and bypass capacitor C15 prevents degeneration at the horizontal-scanning rate. Thus, a constant bias is provided. The pulse which is present on the screen grid is waveform W4 shown in Fig. 6-6.

The frequencies which are passed by the bandpass amplifier are limited by the filter network L39. Frequencies in the range of 2 to 4.4 megacycles are allowed to pass to the demodulators. Shown in Fig. 6-7 is the response curve of the bandpass amplifier. The capacitor C148 couples the color information to the input of the demodulators. Waveform W5 in Fig. 6-8 shows the signal after it has passed through the coupling capacitor C148. Any luminance information that might get through the bandpass circuit is filtered out by the bandpass

* * Please turn to page 41 * *

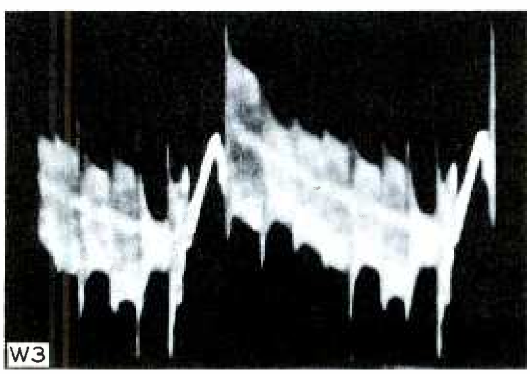

Fig. 6-5. Signal at the Plate of the Chroma-Bandpass Amplifier in Fig. 6-2.

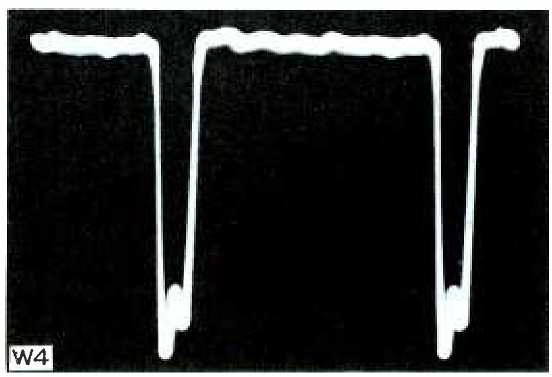

Fig. 6-6. Keying Pulse at the Screen of the Chroma-Bandpass Amplifier in Fig. 6-2.

Shop Talk

MILTON S. KIVER
President, Television Communications Institute

The television antenna plays a large role in determining the quality of the picture developed on the screen. The problem involves more than just signal strength, although this is undeniably a most important factor. The matter of ghosts is also to be considered, and this can be resolved only through careful antenna positioning.

To those whose experience with antennas is limited, many apparently confusing statements about antennas are frequently found in technical literature. For example, one well-known television text states that the formula for computing a half-wave antenna is given by:

$$\frac{\lambda}{2} = \frac{468}{f},$$

where

λ = wavelength in feet,

f = frequency in megacycles.

In another reference, the statement is made that a half wavelength is represented by the formula:

$$\frac{\lambda}{2} = \frac{492}{f},$$

where

λ = wavelength in feet,

f = frequency in megacycles.

The difference between these two formulas is about five per cent; yet, in terms of actual feet or inches, the amount is not negligible. The service technician is left to wonder why there should be two different formulas for the same half wavelength.

To answer this and many other related questions, let us start at the beginning. A wavelength is equal to the velocity of travel of a wave divided by its frequency. Thus,

$$\lambda = \frac{V}{f},$$

where

λ = wavelength in feet,

V = velocity in feet per second,

f = frequency in cycles per second.

We can use 984,000,000 feet per second for the quantity V, because the velocity of the electromagnetic wave is the same as that of light. Hence, the initial formula becomes:

$$\lambda = \frac{984{,}000{,}000}{f}, \qquad (1)$$

where

λ = wavelength in feet,

f = frequency in cycles per second.

If the frequency is given in megacycles instead of in cycles, then equation 1 becomes:

$$\lambda = \frac{984}{f}, \qquad (2)$$

since there are one million cycles in one megacycle. Half of this figure gives the length of a half-wave:

$$\frac{\lambda}{2} = \frac{492}{f}, \qquad (3)$$

where

$\frac{\lambda}{2}$ = half wavelength in feet,

f = frequency in megacycles.

This, then, is the basic formula for the computation of the length of a half wavelength in air or free space, where the velocity of travel is 984,000,000 feet per second. On a wire, such as an antenna wire, the velocity is less. This means that during 360 degrees, or one cycle, the distance covered by the same wave will be less. Consequently, a half wavelength of wire is not correctly given by equation 3 but by a new equation as follows:

$$\frac{\lambda}{2} = \frac{468}{f}. \qquad (4)$$

Since 468 is five per cent less than 492 and since this five per cent corresponds to the difference in velocity between wave travel in free space and wave travel on the antenna wire; therefore, equation 3 should actually be written as:

$$\frac{\lambda}{2} = \frac{492}{f} \times k, \qquad (5)$$

where

k = constant that depends upon the medium through which the wave travels.

For air or free space, k is 1.00. For a thin dipole rod such as that used to arrive at equation 4, k is .95. If we used a thick dipole rod, k is .90; and equation 3 then becomes:

$$\frac{\lambda}{2} = \frac{492}{f} \times .90 = \frac{443}{f}. \qquad (6)$$

Thus, half-wave antennas designed for the same frequency may have several different lengths, depending upon the type of material used for the antenna rods.

The following explanation for this behavior was advanced by RCA in one of their service-clinic textbooks.

If the resonant frequency of a tuned circuit is measured, it will be

* * Please turn to page 58 * *

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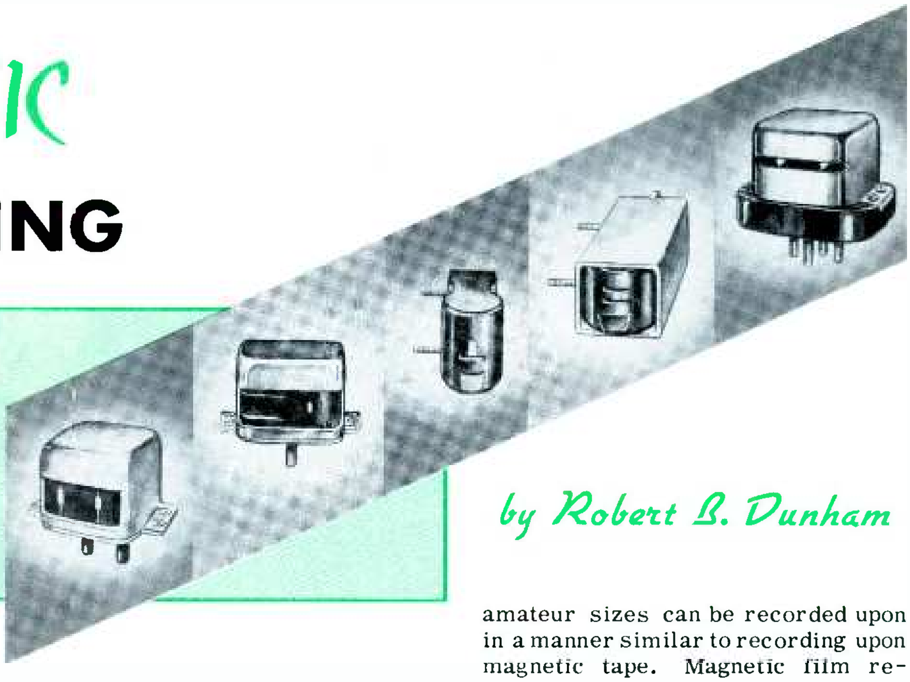
MAGNETIC RECORDING

PART—1

General Information About the Development and Basic Features of Magnetic Recorders



by Robert B. Dunham

Magnetic recorders have been developed and improved in recent years to such an extent that they now bear little resemblance to the "Telegraphone" invented by Valdemar Poulsen in Copenhagen, Denmark, in 1898.

The Telegraphone, a wire recorder designed for use as a phonograph and as a recorder of telephone conversations, was manufactured and put into service in limited numbers. A few of these pioneer magnetic recorders were used in the United States, but the results obtained with them left much to be desired. No doubt the failure to obtain high quality recordings was due to the lack of amplifiers, lack of suitable wire upon which to record, and lack of many of the mechanical refinements now being incorporated in modern mechanisms.

Very little was done about developing magnetic recorders until in the 1930's when renewed activity was started here in the United States and in Germany. Since the end of World War II, magnetic-recording equipment has been developed and improved so much that magnetic recording has become the most popular and the most widely used method for both professional and amateur sound recording.

Fig. 1. Ampex Model 600 Professional Quality Tape Recorder.

Fig. 2. Crescent Steno Wire Recorder.

Present-day magnetic recorders record on tape, wire, movie film, and coated discs. Some representative recorders are shown in Figs. 1, 2, and 3. Those using tape are the most popular by far at the present time. Wire recorders had a period in which they were popular as all-purpose recorders; but they have lost out in favor of tape recorders, particularly for high quality recording of music.

Most of the current models of wire recorders and the instruments that record on discs coated with magnetic material are specialized pieces of equipment designed for dictation applications. Figs. 2 and 3 show machines coming under this category.

When provided with a magnetic coating, the base material for movie film in any of the professional or amateur sizes can be recorded upon in a manner similar to recording upon magnetic tape. Magnetic film recorders are usually designed for certain professional and scientific purposes. Film, on which a narrow strip of magnetic material is deposited along one edge beside the picture frames for use as a sound track, is becoming more and more popular in both amateur and professional movie work.

All of the instruments mentioned, although differing in mechanical make-up, operate on the same basic principles of magnetic recording. Some explanation and discussion of these principles which make magnetic recording possible; of the electrical circuits needed to handle the signal; and of the mechanical systems required to move the tape, wire, film, or disc should prove to be very interesting and helpful to anyone operating, adjusting, or repairing this type of equipment.

Since tape recorders are the most popular type and are used by

* * Please turn to page 84 * *

Fig. 3. Brush Mail-A-Voice Magnetic Disc Recorder.

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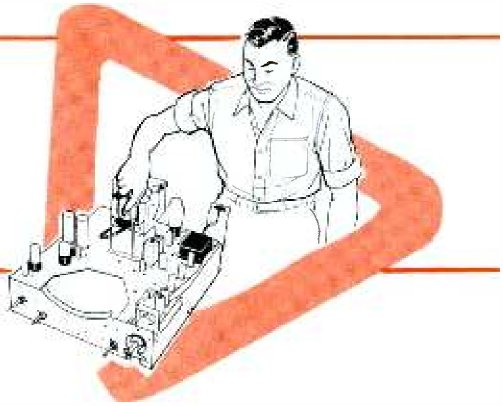


by **Henry A. Carter** *and* **Calvin C. Young, Jr.**

IN THE HOME

Service literature has always been considered a must for servicing in the television shop, but many technicians and service organizations have ignored the possibilities of service literature for service calls in the home.

In the beginning, the circuits in most television sets were patterned from those used in the original RCA 630 chassis; and after mastering the tube layout and circuits used in this basic type of receiver, the technician might attain reasonable success in home servicing without using service literature.

Since that time, many new circuits which are currently being used in television receivers have been developed. These sets for the most part employ circuits, tube layout, and component placement which may vary in some respect from most of the other television sets.

If the correct model or chassis number is known, service literature may be obtained for most TV receivers. In order to have this printed material with you in the home on the first service call, it will be necessary to have the customer supply the model or chassis number of his receiver when he makes his phone call for service.

Experience has shown that the many different types of numbers usually found on the back of a television receiver have a tendency to confuse the customer. For this reason, Chart I (page 63) has been prepared. The information contained in this chart includes the location of model and chassis numbers and a representative type of each for the major manufacturers. By using this chart, the service organization can direct the customer to the proper numbers.

Numbers supplied by the customer should be verified by the service technician on the first call. This information, if added to the service organization's master card, will make future reference to model and chassis numbers possible.

Since model numbers are not always on the chassis and since some companies do not use chassis numbers, such information should be properly and faithfully recorded on the master card at the shop in order to eliminate that occasional recall just to find out the correct model number.

Using service literature for home service calls can in many cases speed repairs and even make possible some repairs that would otherwise have been possible only in the shop. The following is one case in which the use of service literature speeded up a repair job.

On a recent call to service a GE Model 17T10 for which the complaint was no sound and no picture, it was noticed that the filaments of the tuner tubes were of an apparently normal brightness. Careful inspection finally determined the filament of the tube V4 had a faint glow. No other tubes could be detected as having any filament voltage. A copy of the filament-string layout is shown in Fig. 1. Referring to the PHOTOFACT Set No. 196, Folder No. 3 (which was obtained before leaving the shop), the technician noticed that tube V4 was in one branch of the series-parallel filament string but that the tuner-tube filaments were supplied from a small filament transformer. The fact that V4 was illuminated indicated that V12, V14, V15, V4, V5, V6, V8, V7, and the picture tube were all right as far as the filaments were concerned. This isolated the trouble to one of the following tubes: V18, V17, V13, V19, V9, V10, V11, or V16. In this case, the trouble was narrowed from 21 tubes down to 8. Further examination of the schematic showed that V9, V10, V11, V13, and V16 used 6.3-volt heaters; whereas, the others used heaters that required 12 volts or more. The 6.3-volt tubes were therefore checked first by using an ohmmeter which is one of the basic tools of the tool box. This check showed the filament of V10 to be open. Replacement of this tube cured the trouble. The 6.3-volt tubes were checked first, since they have lower resistance filaments and would be subjected to greater surge currents. This repair job which might have taken an hour or longer was completed in about 15 minutes through the use of service literature in the field.

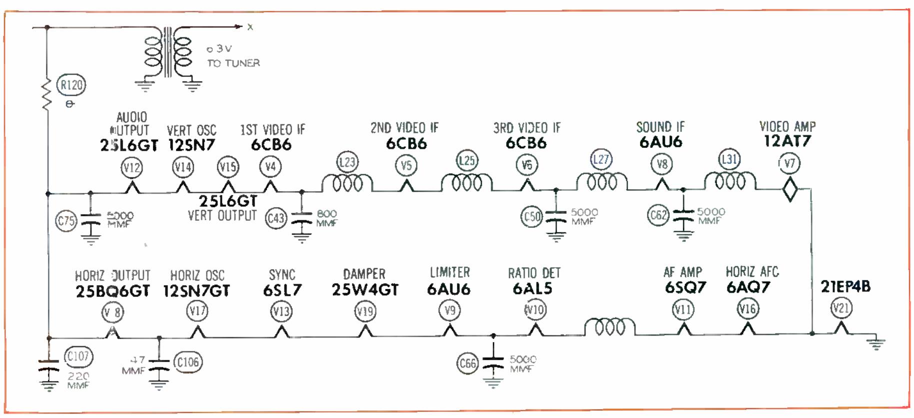


Fig. 1. Filament Connection in G. E. Model 17T10 Receiver.

* * Please turn to page 62 * *

Typical Examples Taken From Three Receivers Which Are Used for Communication Work

Special Circuits in COMMUNICATIONS RECEIVERS

BY DON R. HOWE

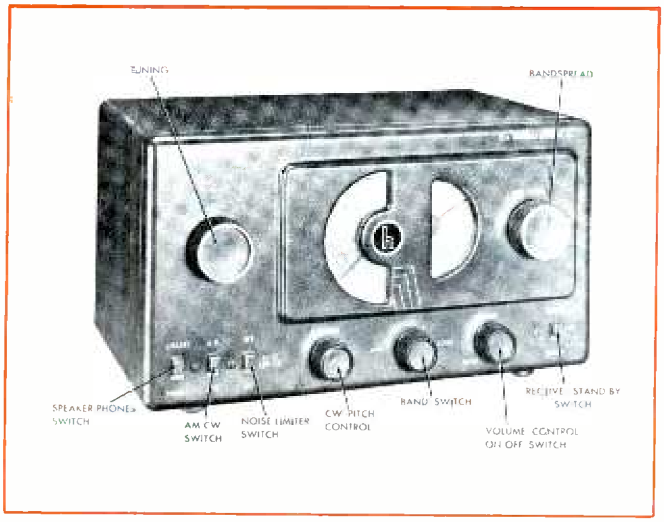


Fig. 1. The Hallicrafters S-38 Receiver.

Radio receivers capable of short-wave reception have become increasingly popular. As a result of this increased popularity, an excellent opportunity is afforded the service technician for servicing them. Although the superheterodyne principle is employed almost exclusively, these receivers incorporate many refinements not ordinarily found in the average receivers used for reception on the standard broadcast band. Great care is needed in alignment and trouble-shooting procedures because of the number of tuned stages and additional circuits. These receivers may range from multiband AC-DC models to a very elaborate communication type of receiver. They may be of the general-coverage type with a tuning range from the low end of the broadcast band to a frequency near 30 megacycles, or they may be special-purpose receivers covering either a single frequency or a specific band of frequencies.

A Multiband AC-DC Receiver

An example of the multiband AC-DC receiver is the Hallicrafters S-38 shown in Fig. 1. In addition to the controls on an ordinary receiver, the S-38 also has the following controls:

1. AM-CW switch for the reception of amplitude-modulated (AM) signals or continuous-wave (CW) signals.

2. CW pitch control which adjusts the pitch.

3. Speaker — Phones switch which provides for the use of either the speaker or phones.

4. Band switch to select the range of frequencies desired.

5. Receive — Stand-by switch for instantaneous on-off operation.

6. Noise-limiter switch which introduces noise limitation.

7. Bandspread control for fine tuning.

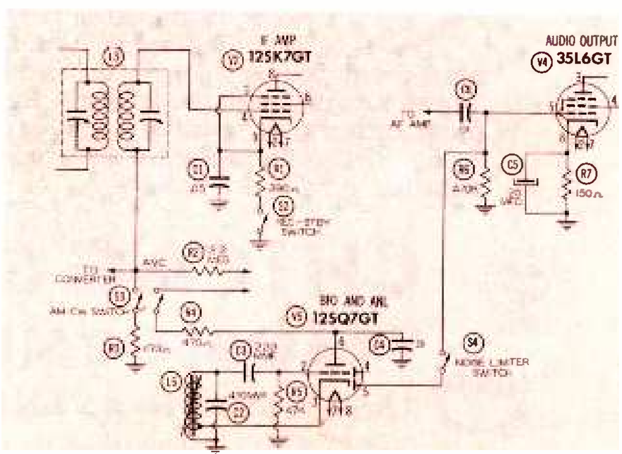
The position of these controls in the receiver circuitry is shown in the block diagram of Fig. 2.

The AM-CW switch is normally placed in the AM position. When it becomes desirous to receive continuous-wave signals, the switch is placed in the CW position. This places the beat-frequency oscillator (BFO) into operation. A schematic diagram of the BFO consists of a conventional RF oscillator operating at a frequency slightly removed from the intermediate frequency. Usually, the difference in frequencies is approximately 1,000 cycles and is variable over a small range by the CW pitch control.

Since the incoming CW signal contains no modulation, it is hetero-

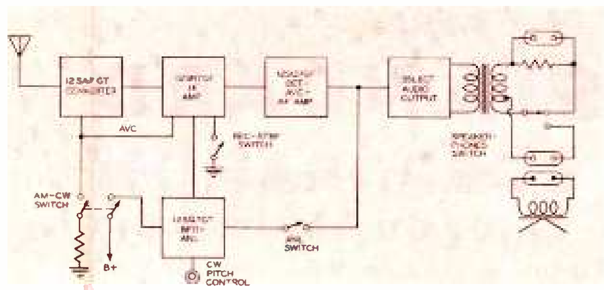
(right)

Fig. 3. A Partial Schematic of the Hallicrafters S-38 Receiver.



(below)

Fig. 2. A Block Diagram of the Hallicrafters S-38 Receiver.



dyned with the signal from the BFO after being converted to the intermediate frequency. The result is an audible signal corresponding to the difference in frequency between the two signals.

In addition to controlling the operation of the beat-frequency oscillator, the AM-CW switch also removes the effect of the automatic-volume-control (AVC) voltage when receiving CW signals. This is desirable because the signal from the BFO may overload the AVC and reduce the sensitivity of the receiver.

The Receive — Stand-by switch is located in the cathode circuit of the 12SK7GT intermediate-frequency amplifier. This is also shown in Fig. 3. By placing the switch in the stand-by position, the ground return for the 12SK7GT is removed and the receiver is silenced. This switch is incorporated for use when a transmitter is used in conjunction with the receiver.

A schematic of the circuit associated with the automatic noise limiter (ANL) is included in Fig. 3. When the noise-limiter switch is closed, a diode is connected between the grid of the audio-output tube and ground to form a shunt limiter. A strong noise pulse appearing on the grid causes the diode to conduct and shunt the noise pulse to ground. The noise limiter is particularly useful during reception on the higher frequencies.

The bandspread tuning provides a method of fine tuning for ease in selection of the desired station. This is accomplished by a set of single rotor plates to provide a variable capacitor in parallel with the main tuning capacitor. Rotation of the variable capacitor changes the tuning very little so that fine tuning is obtained.

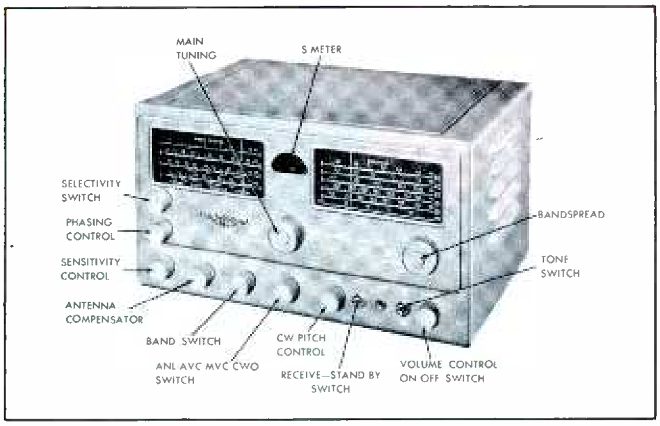


Fig. 4. The National NC-98 Receiver.

A General-Purpose Receiver with Refinements

An example of the medium-priced communication receivers is the National NC-98 shown in Fig. 4. This receiver incorporates several features not found in the low-priced models. By reference to the figure, it may be seen that the receiver has a calibrated bandspread and an S-meter. The S-meter is useful in determining the strength of the received signal. In addition, there are the following controls not previously discussed:

1. Selectivity switch for choosing various degrees of selectivity.

2. Phasing control for use in conjunction with the selectivity switch.

3. Sensitivity control which provides a method of varying the receiver sensitivity.

4. Antenna-compensator control which compensates for different types of antennas.

5. ANL-AVC-MVC-CWO switch for selecting the desired mode of operation.

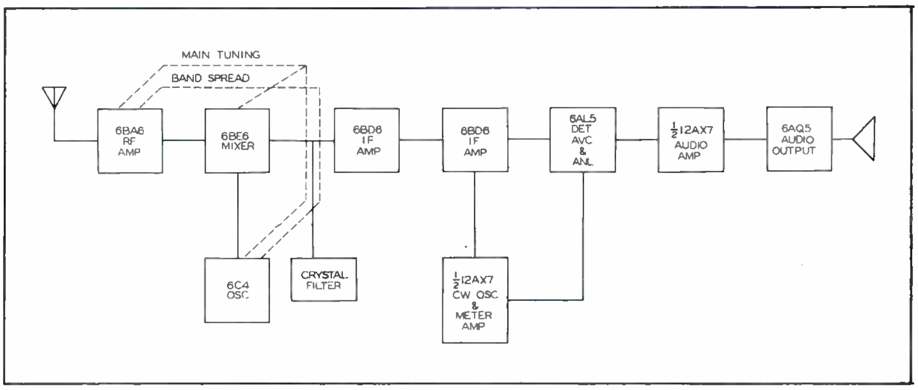


Fig. 5. A Block Diagram of the National NC-98 Receiver.

An over-all picture of the receiver is most easily obtained by first referring to the block diagram of Fig. 5. A comparison with the block diagram of the previous receiver will show that several additional stages are present in the higher-priced receiver. In addition to the gain contributed, the RF amplifier also provides a higher degree of selectivity and image rejection.

The selectivity switch and the phasing control are associated with the crystal filter shown in the diagram. The crystal filter provides a method of varying the bandpass of the receiver so that the degree of selectivity may be chosen by the operator. This system is extremely beneficial in the bands where the stations are very close together. The highest degree of selectivity is usually useful only when receiving CW signals. This is true because the extremely narrow bandpass does not pass the

* * Please turn to page 35 * *

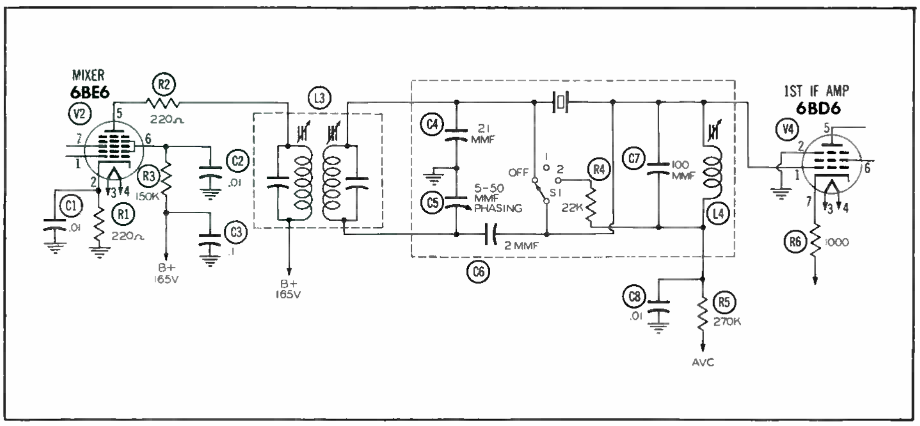


Fig. 6. A Schematic Diagram of the Crystal-Filter Section in the National NC-98 Receiver.

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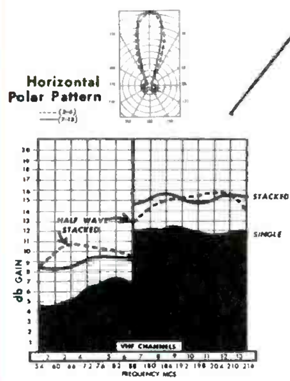

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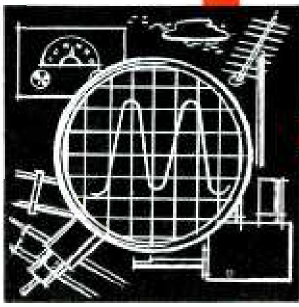

by Calvin C. Young, Jr.

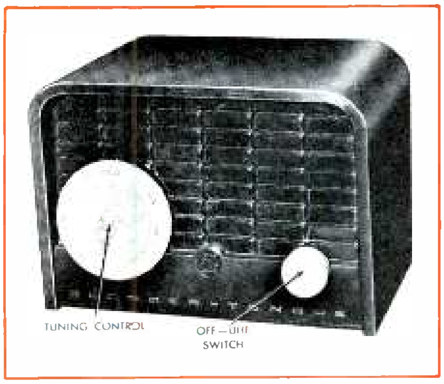

Fig. 1. The Blonder-Tongue Model 99 UHF Converter.

BLONDER-TONGUE MODEL 99

The Blonder-Tongue Model 99 UHF converter shown in Fig. 1 is manufactured by the Blonder-Tongue Laboratories, Inc., of Westfield, New Jersey. The manufacturer states that this unit was designed for reception in class-A signal areas.

The Model 99 UHF converter employs two front-panel controls. The tuning control serves as the channel indicator. The On-Off switch connects the VHF antenna to the TV receiver when in the Off position. In the On or UHF position, the VHF antenna is disconnected and grounded so that no interference from this source will result.

A high-pass filter is incorporated into the UHF antenna-input circuit. This circuit passes frequencies which are higher than 450 megacycles and will greatly attenuate any frequency which is lower. A schematic diagram is shown in Fig. 2. Following the high-pass filter is a tuned input circuit which uses one section of the tuned line. The selected output from this tuned circuit is capacitively coupled to the crystal mixer and heterodyned with signal energy from the 6AF4 local oscillator. This heterodyne action produces a beat frequency which is of the frequency of TV channels 4, 5, or 6, depending upon the setting of the tuning control. The crystal mixer used in this converter is of the low-noise type. In installation, one lead of the crystal was left long and was run physically close to the local oscillator. This functions as a gimmick coupling which provides injection voltage for the oscillator, as mentioned earlier. In replacing the crystal, care should be exercised not to disturb this lead because detuning or insufficient injection might result.

The oscillator used may be either a 6T4 or a 6AF4, and its frequency is varied by changing the electrical length of its associated tuned line.

TV channels 4, 5, or 6 may be used in conversion, depending upon which is unoccupied in the particular reception area.

The power supply uses an auto-transformer which has a 6.3-volt tap for the filament of the 6AF4 or 6T4 oscillator tube.

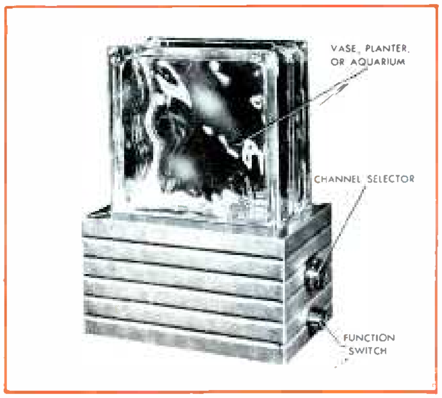

Fig. 3. Front View of Fen-tone Model C1.

FEN-TONE MODEL C1

The Fen-tone Model C1 UHF converter shown in Fig. 3 is manu-

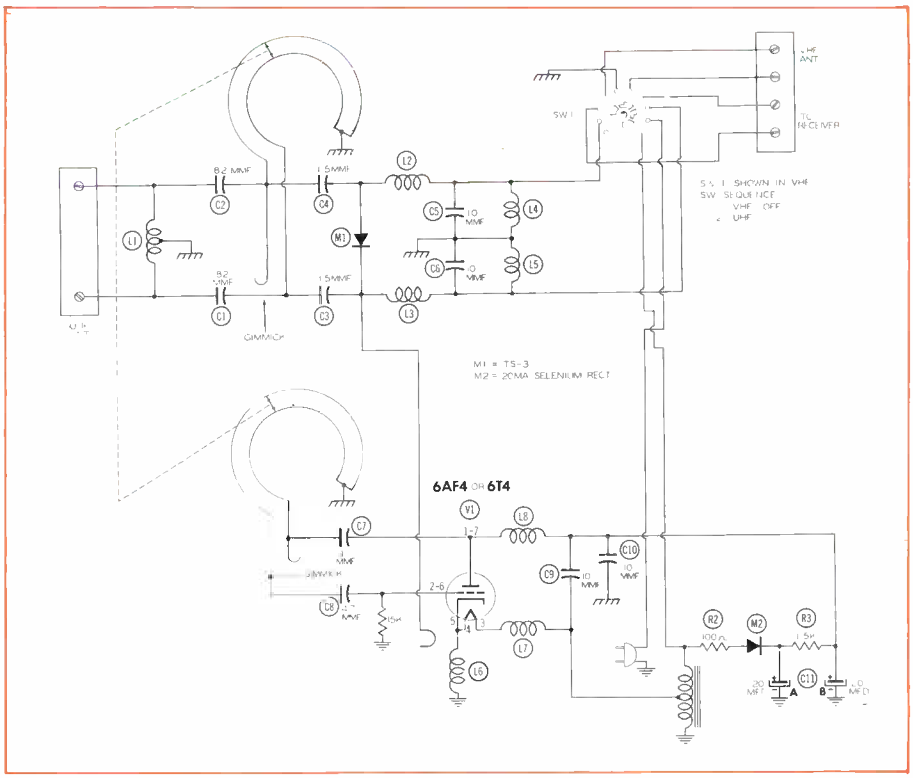

Fig. 2. A Schematic Diagram of the Blonder-Tongue Model 99 UHF Converter.

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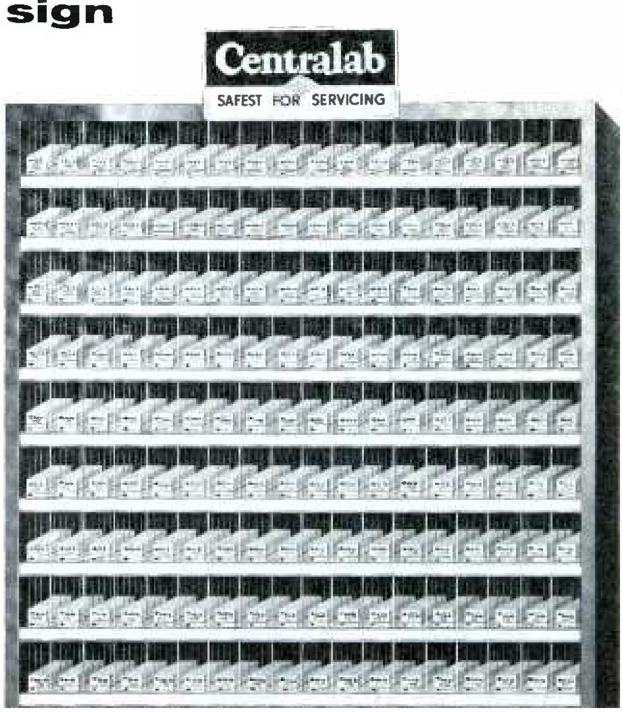

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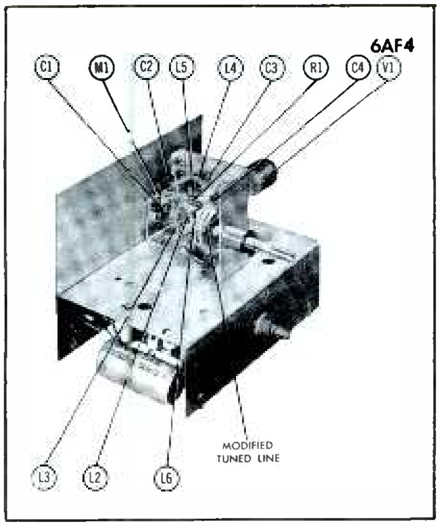


Fig. 4. Preselector and Oscillator Components in Fen-Tone Model C1.

factured in New York, N. Y., by the Fenton Company.

In addition to its primary function as a UHF converter, this unit has several other interesting functions. The glass bowl shown in Fig. 3 can be used in several ways. The manufacturer's suggestions are listed as follows: (1) illuminated plant vase, (2) illuminated aquarium, (3) lamp. The 7 1/2-watt light used to illuminate the bowl is controlled by a separate switch so that the light may be turned on or off as desired, and it is independent of the ON-OFF switch of the converter.

The AC outlet on this converter is "hot" as long as the converter is plugged into the AC power line.

The major portion of the circuit components, with the exception of the power supply and the antenna switch, are shown in Fig. 4. The modified tuned line may be clearly seen and is so constructed that it is continuously variable through a full 360 degrees of rotation. Also visible is the low-noise 1N72 crystal mixer which is mounted in clips for ease of replacement. A schematic diagram of the tuner appears in Fig. 5.

Output from this converter is such that any one of the VHF channels 2 through 13 may be used for conversion. However, the manufacturer suggests that channels 5 or 6 be used if possible.

The locations of the power-supply components and antenna-selector switch are shown in Fig. 6. A fully isolated AC transformer is employed for maximum safety.

There are two operating controls located on the right end of this converter. One of these controls is the tuning control which also serves as the station indicator, and the other is the function-selector switch. The function switch has three positions which are listed as follows: OFF, VHF, and UHF. The switch which operates the 7.5-watt lamp is located on the left end of the converter.

REGENCY MODEL RC53

The Regency Model RC53 converter shown in Fig. 7 is manufactured in Indianapolis, Indiana, by the Regency Division of I. D. E. A., Inc.

There are two operating controls for the converter. One is a direct-acting channel selector which also serves as the channel indicator. The other is a function-selector switch which has three positions: UHF, VHF, and OFF.

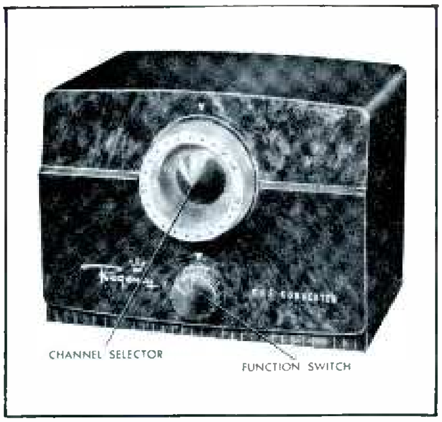


Fig. 7. Front View of Regency Model RC53.

In addition to functioning as a UHF converter, this unit acts as a control device for the TV receiver. The inclusion of an AC outlet and an antenna-switching system which are controlled by the function-selector switch makes this possible. See Fig. 8 for layout details.

In the VHF position, the filament of the 6AF4 oscillator is heated. This keeps the UHF converter in a stand-by condition and makes rapid changes to UHF operation possible.

In the circuit diagram of Fig. 10, notice the high-pass filter system which is included in the UHF antenna-input circuit. This circuit will pass frequencies of 450 mc or higher and will severely attenuate any frequency lower than 450 mc. This action effectively eliminates interference from VHF TV, FM, and other types of broadcast operation.

The crystal mixer used is of the low-noise type. The TS-2 crystal

* * Please turn to page 53 * *

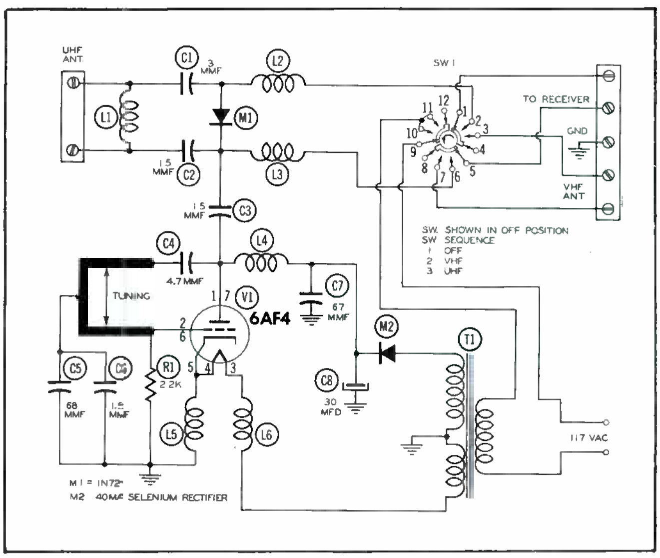


Fig. 5. Schematic of Fen-tone Model C1.

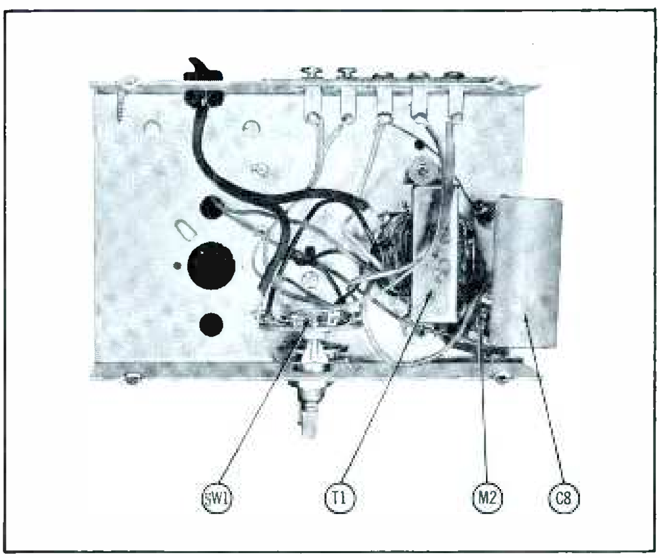
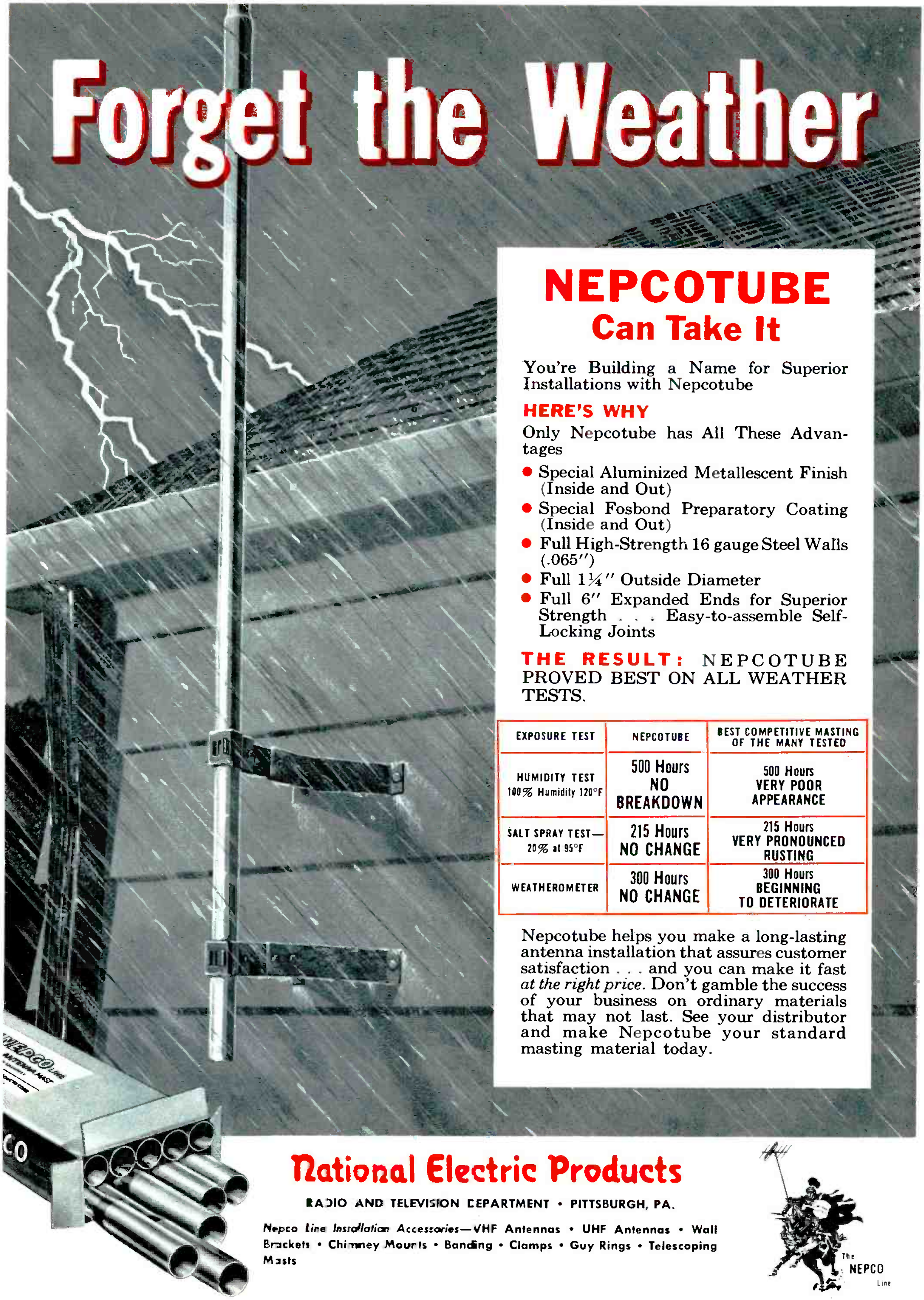


Fig. 6. Function Switch and Power-Supply Components in Fen - tone Model C1.



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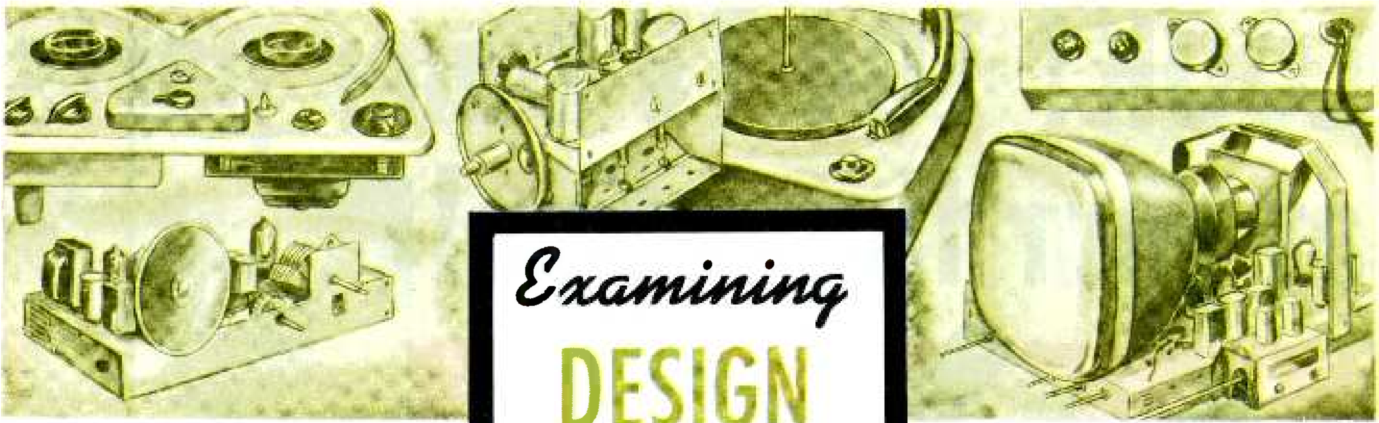

Examining DESIGN *Features*

by **DON R. HOWE**

EMERSON CHASSIS 120205-B

The 120205-B chassis provides an excellent example of the recent Emerson line. A total complement of 23 tubes is utilized in the chassis. This figure is exclusive of the 27RP4 or 27EP4 picture tube. The entire picture-tube assembly is mounted on a subpanel which is separate from the chassis. See Fig. 1. This arrangement permits either the chassis or the picture tube to be removed from the cabinet with a minimum of difficulty. The use of a separate assembly for the picture tube also provides a convenient system for bench servicing of the equipment. This receiver is of the intercarrier type and employs a video IF of 45.75 megacycles.

VHF Tuner

A type 470696 VHF tuner is employed in this chassis and is a 12-position turret tuner covering channels 2 through 13. The RF amplifier is connected in a conventional cascode arrangement. The output of the tuner is coupled to a straightforward three-stage video IF strip utilizing 6CB6 pentodes. The first two stages of this strip are controlled by the AGC voltage.

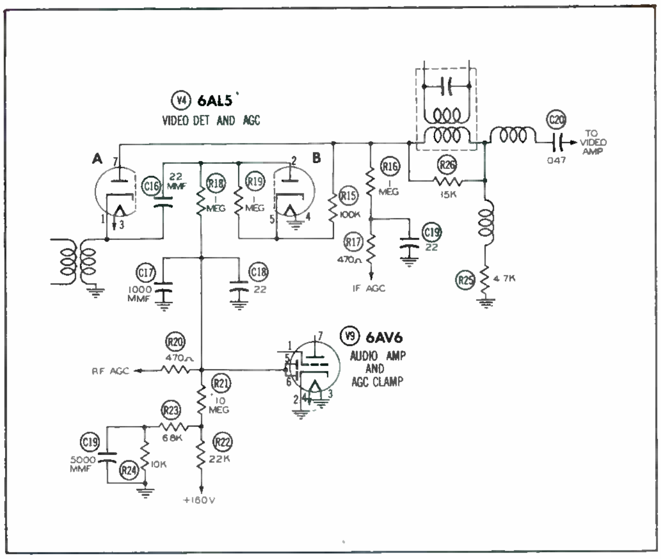

Fig. 2. Schematic of the Emerson AGC System.

AGC Circuit

Video detection and AGC action are accomplished by a 6AL5. A rather unique system is employed in developing the AGC voltage. Separate AGC voltages are used for the IF stages and for the RF amplifier.

Fig. 2 is a schematic diagram of the AGC system. Section A of V4 is used for video detection and for development of the AGC voltage for the IF stages. This AGC voltage is obtained from the diode load in a conventional manner.

Section B of V4 is used only for the development of AGC voltage for the RF amplifier. A voltage-doubler circuit is employed for this function.

When a strong signal is received, the AGC for the IF stages is obtained from the voltage developed across the load resistor R25 of diode V4A. An IF signal is also coupled through capacitor C16 to the diode V4B and causes conduction to occur in V4B. This action produces a voltage across the load resistor R19 of V4B. The voltages across R19 and R25 are in series and add so that the total voltage is made available to the RF amplifier as AGC voltage. A delay is applied to this AGC line by a voltage divider consisting of resistors R22, R23, and R24. The delay permits maximum amplification to be obtained in the RF stage when a weak signal is received. The AGC line is prevented from assuming a positive potential by the clamping action afforded by the diode section of V9.

This system of AGC permits the RF amplifier to range from a near cutoff condition for very strong sig-

* * Please turn to page 37 * *

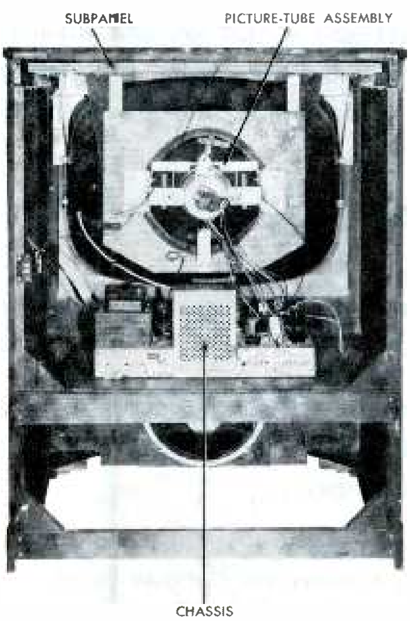

Fig. 1. Rear View of Emerson TV Receiver Having Separate Picture-Tube and Chassis Assemblies.

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Notes On TEST EQUIPMENT

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

by Paul C. Smith

A Tube-Tester Trouble of Unusual Nature

The construction of a tube tester is such that long periods of trouble-free operation may be expected. The number of tubes in the instrument is usually few; the circuit consists mainly of a collection of switches for selecting the proper tube pins and applying the necessary voltages. Consequently, when some trouble appears, the operator is "flabbergasted" to think that something has finally gone wrong with the old reliable tube tester.

As it was finally determined in this case history, the trouble was not in the tube tester itself but was due to a human element — the failure of some operator to understand properly the instrument. (Obviously, he did not read the instruction manual!) It is very unlikely that this same trouble would occur in any other case, but the story is told here mainly for the element of human interest involved; and it does illustrate a point that this writer made in a previous article — that sometimes the instruction manuals do not receive the attention which they deserve.

The technician who discovered the trouble was engaged in checking a series of tubes and noticed that an unusual number of hot tubes were in the group. Ordinarily, tubes that have been in use for some time do not get stronger but get weaker. So, the technician carefully checked all the switch and bias settings of the tube tester and retested the tubes, but with the same results. "Two heads are considered better than one," therefore another technician was called in. He obtained the same results. Then the tube-tester instruction manual was consulted, and an item was found which pointed immediately to the possible source of trouble. A quick check verified this indication, and using a screwdriver cured the trouble in a few seconds.

The tube tester used was a Simpson Model 1000 plate-conductance tester. Among the various controls used in setting up this instrument for operation is a bias-control knob which is set to the value indicated on the roll chart for the particular tube in question. This control is calibrated with equal divisions that read from zero to 100; however, the control also operates a switching function for checking rectifier tubes. With the control at zero position, a current-limiting 400-ohm resistance is placed in the testing circuit. As the control is rotated clockwise, a switch is thrown to short across this resistor. The switch operation requires 7 divisions of the scale; therefore, no bias values between zero and 7 are listed in the chart.

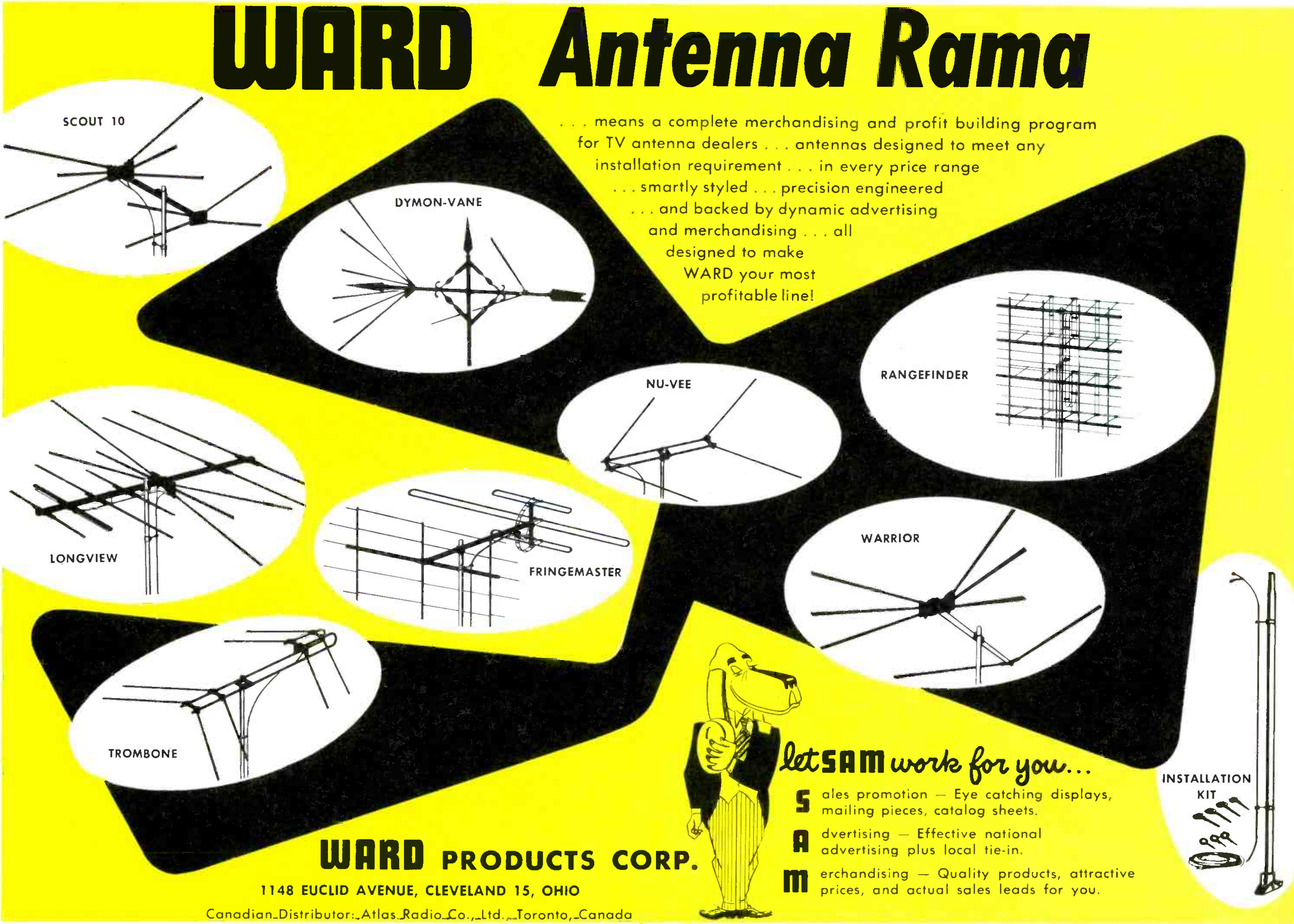
Apparently, what had happened was that some previous operator had had occasion to reduce the bias-control setting from some higher value to zero; and upon reaching the physical opposition to rotation offered by the switch, he had assumed that he had reached the limit of counterclockwise rotation. Then, seeing that the control knob was at 7 rather than at zero, he had loosened the knob on its shaft and reset it to zero. Thereafter, any bias setting that was made would actually be 7 divisions higher than that indicated on the dial, and a plate-conductance reading would be considerably higher than that obtained under correct settings for that tube. In some cases, the meter needle would go all the way off the scale and quiver against the stop.

As pointed out previously, the trouble was not due to a defect in the instrument but to a human failure — an error in judgement brought about by lack of familiarity with the instrument. The technician who uses his test equipment day after day will probably never be a victim of an error of this sort; but during the short period of time when a new piece of equipment is strange to him, he should become familiar with it by using it as often as possible and by studying the manual.

Jackson Model 711 UHF Television Signal Generator

The Jackson Model 711 UHF signal generator is pictured in Fig. 1. This instrument is designed to be operated in conjunction with the service technician's present VHF sweep and marker generators (such as the Jackson Model TVG 2) to provide a UHF sweep signal suitable for servicing and aligning UHF converters and VHF-UHF receivers. The output of the Model 711 will cover the entire range of UHF channels 14 through 83 with continuous tuning and no band switching. The signal level and the sweep width are controlled by the settings of the attenuators and sweep-width controls of the associated VHF sweep generator.

* * Please turn to page 69 * *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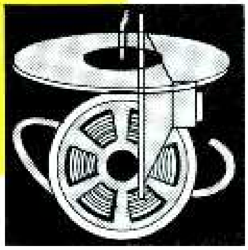
Audio-Facts

Hints on Restoring Good Performance in Audio Systems



BY ROBERT B. DUNHAM

It is fortunate that a well-designed and well-constructed high quality audio system will operate over a long period of time without developing serious troubles; however, it is also true that the quality of reproduction may deteriorate after the system has been used for some time. A loss in sound quality may not always be noticed, because the conditions which cause the change in quality often develop so gradually that the loss is not apparent to the listener. On the other hand, trouble can appear suddenly; and the resultant abrupt change in the reproduced sound can be unmistakable. The following discussion is intended to furnish the reader with a few helpful suggestions for reconditioning an audio system so that it will operate at its best.

Most high quality audio systems are used by very critical listeners; and careful work is required in a system to reduce or eliminate distortion, hum, and unwanted noise to the satisfaction of the listener. Some touching up of the adjustments which were made originally when the system was put into service may be all that is required to bring the system back to normal operation. In other cases, it is possible that some trouble shooting will have to be done and that some tubes or parts may have to be replaced.

It is difficult to decide where to start a discussion such as this, because we know that the quality of reproduction from a good audio system depends upon satisfactory operation of every part or section of the system. Probably the power amplifier is a good unit with which to begin, since every system uses one to drive the loudspeaker.

POWER AMPLIFIER

Such an obvious difficulty as a burnt-out tube which causes an amplifying system to become inoperative will not be dwelled upon here. Troubles and conditions that are responsible for an increase in distortion, noise, or hum or troubles that cause reduced output will receive the most consideration.

There seems to be a common tendency to suspect the power amplifier when something goes wrong with the sound. There is a logical reason for this, since in the past the power amplifier was often the only amplifying equipment used other than a tuner. Present-day audio systems have become more complicated than this.

Tubes in the Power Amplifier

When something is thought to be wrong with the power amplifier, the tubes are first to be blamed — particularly the power-output tubes.

Tubes can be checked in a good tube tester, and any defective ones that are responsible for a loss in signal output or an increase in noise or distortion can be discarded. The actual substitution of a good tube for a suspected one while the amplifier is in operation is an excellent procedure to follow when tracing the source of noise, hum, and other disturbances in low-level stages. Such effects are most noticeable when they are caused by trouble in these low-level stages.

The tube or tubes in a push-pull stage should provide balanced operation. For instance, distortion can be caused by the unbalanced operation of a dual triode in a push-pull driver stage when one section of the tube is weak. Since balanced operation of the output stage is important, most high quality amplifiers are provided with one or more balance controls. After an amplifier has been operated for some time, the balance of the output stage should be checked by using the method recommended for the amplifier in question. If balance cannot be obtained by adjustment of the balance controls (if such controls are provided), a pair of tubes with similar characteristics should be selected for the output stage.

Resistors in the Power Amplifier

Symptoms very similar to those produced by defective tubes can be caused by resistors that have deteriorated or changed in value for some reason. Noise can originate in any resistor, but it is most likely to develop in carbon or composition resistors and in controls. Of these types, low-wattage units that have been overheated by overloading or by a soldering iron are the greatest offenders.

Resistors can change value after a period of use, and this change in value can alter the operating conditions of the circuit involved. Distortion usually develops when such a change occurs. When noise (either a frying or a scratching sound) becomes objectionable, the plate loads in low-level high-gain stages are the most common offenders. A noisy resistor can cause a disturbance in any stage, but the disturbance is more noticeable when the faulty resistor is in the first or low-level stages. If a resistor becomes unstable and varies in value with the modulation of the signal flowing through it, the distortion that can be generated by such unstable action can well be imagined.

Capacitors in the Power Amplifier

Noise, distortion, and reduced power output can result from the effects of leaky, open, or shorted capacitors. A change in a capacitor will change the normal operating conditions of the circuit and will produce degrading effects similar to those created by a defective resistor.

A leaky or intermittent capacitor can be a source of noise; however, in the case of a coupling capacitor, a leaky condition usually introduces distortion because it allows enough B+ voltage to be impressed on the grid of the following stage to change the bias on that stage and to upset normal operating conditions.

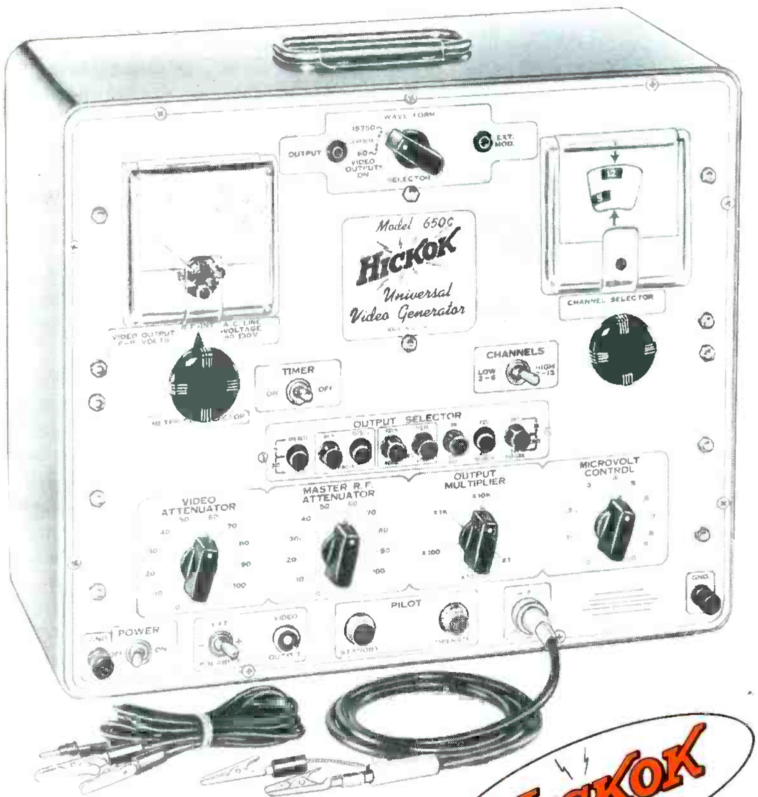
An open cathode bypass capacitor can reduce the gain of a stage, especially at the lower audio frequencies. If the cathode bypass capacitor should become shorted, the bias on the tube would be reduced. This would change the operation of the tube and distort the signal.

Of course, decoupling and filter capacitors can become shorted and make the complete system inoper-

* * Please turn to page 74 * *

New 650 C WHITE DOT *Generator*

COMPATIBLE FOR COLOR or BLACK and WHITE



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The Model 650C is another example of HICKOK pioneer engineering and originality in test equipment design to meet the practical necessities of TV maintenance.

NOTE FOR VALUE . . .

To the thousands of you who already have a Model 650, you will appreciate knowing that its design is so complete that only a simple conversion is necessary for color use. This conversion assembly, completely wired, is available from the factory for $5. You can add this assembly to your present 650 in a matter of minutes and thus convert to provide all features of the latest Model 650C White Dot Generator for Color TV, as well as retain the black dots for black and white receivers.

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You can always count on HICKOK engineers to make special efforts to keep your present equipment up to date and operating to full specifications. It is interesting to note that due to HICKOK engineering cooperation many HICKOK testers, well over 25 years old, are still delivering top performance in everyday use. It is policy such as this that has contributed a great deal to the present HICKOK position of "First in Preference".

See the complete HICKOK line at your nearest Radio Parts Jobber . . . and write today for the new HICKOK Equipment Catalog No. 29.

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From SPLIT SOUND to INTERCARRIER

CONVERSIONS BASED ON FIELD EXPERIENCES

by Henry A. Carter

The principal disadvantage in using a nonintercarrier receiver for reception of UHF is that frequent retuning may be required because of local-oscillator drift. There are definite reasons why a nonintercarrier receiver may be subject to the effects of local-oscillator drift. The sound IF signal is taken off at the output of the tuner in most of these receivers, and it is fed to amplifiers that accept only a narrow range of frequencies. Thus, if the local-oscillator frequency were to shift, the sound IF carrier will be displaced from the center frequency of this narrow passband. The result is either distorted, weak, or no sound.

Drift of local-oscillator frequency is particularly objectionable in the UHF range of television channels. At these higher frequencies, a drift variation on a percentage basis amounts to an appreciable shift in frequency.

Nonintercarrier receivers can be made to receive UHF signals; as a matter of fact, large numbers of such receivers are used in conjunction with UHF tuning devices. It is important to point out to the customer prior to a UHF installation that if a nonintercarrier receiver is used, frequent retuning may be necessary. Should the customer express a desire to avoid this frequent retuning, a conversion to intercarrier operation in his receiver can be suggested. It is the purpose of this article to present some recommendations for such a conversion and to cite two cases in which conversions have been performed successfully.

CHART I

Components Available for Converting

The Radio Craftsmen Model RC200

Components	Merit Part No.	Miller Part No.	Meissner Part No.
Sound	TV-151	1469	20-1004
Interstage Transformer	TV-113	6203	16-3445
Discriminator Transformer	TV-114	6204	

CHART II

Components Available for Converting

The Olympic Model 922L

Components	Merit Part No.	Miller Part No.	Meissner Part No.
Sound Trap	TV-151	1469	20-1004
Interstage Transformer	TV-108	1466	17-1021
Discriminator Transformer	TV-109	1467	17-1023

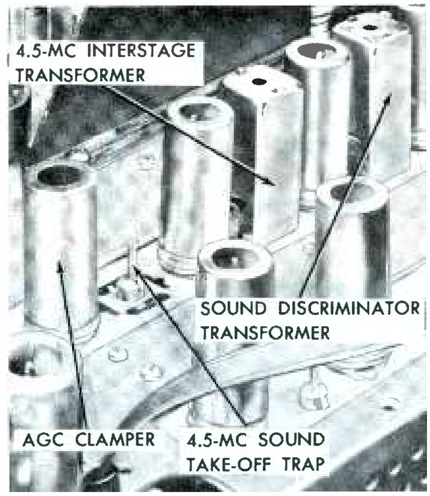

Fig. 1. Sound Strip After Conversion in the Radio Craftsmen Model RC200.

The principle of intercarrier operation provides a sound IF signal that is obtained by heterodyning the picture carrier and the sound carrier at the video detector. The bandpass of the video IF strip is designed to be broad so that both picture and sound carriers can be properly tuned. Slight oscillator shift does not impair the sound in an intercarrier receiver since both carriers remain in the passband of the receiver.

Intercarrier operation has some disadvantages, but the advantages gained from the system greatly outweigh them. One disadvantage is the fact that when a television station has trouble with its visual transmitter and the picture carrier is lost, the sound in an intercarrier receiver is also lost because of the fact that there is only one carrier present. The viewer cannot hear the announcement of trouble which is usually sent out over the station's aural transmitter, and consequently he very often thinks the trouble is in his receiver.

Converting a receiver from split-sound to intercarrier operation may sound like an expensive process at first thought; however, it is neither expensive nor particularly time con-

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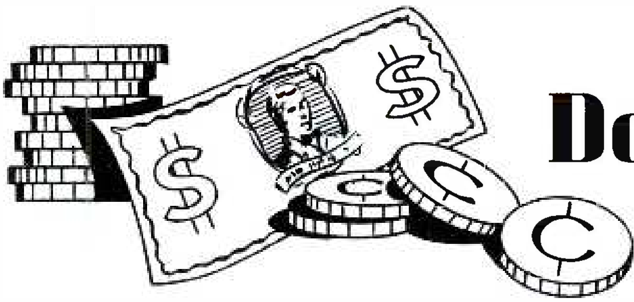

Dollar and Sense Servicing

by *John Markus*

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

ODE TO AN INTERMITTENT. In the July 1954 issue of Radio Times of India is service engineer T. Gilding's elegy of elation at finally repairing a set that had been fixed by six different dealers:

"A set came in the other day,
'Twas quite a good one in its way.
The fault was only something small,
A fault which could occur in all —
IT CRACKLED!

"I stood it up upon a bench
And pried the knobs off with a wrench;
I swept the chassis clear of fluff,
Then switched it on and sure enough
IT CRACKLED!!

"I turned it o'er and cleaned the switch,
I thought perhaps that there's the hitch,
Although it looked too clean to blame,
I tried anew but just the same —
IT CRACKLED!!!

"The iron was hot, the joints looked dry,
I thought at least I could but try.
I soldered here, I soldered there,
I soldered darn near everywhere.
IT CRACKLED!!!!

"I changed the tubes, I tried the coil
And smoothed the gang with drops of oil,
I switched it on and probed about;
One thing for sure I did find out —
IT CRACKLED!!!!!

"I racked my brains, I tore my hair,
I beat the bench in mad despair,
I screamed aloud and swore my fill,
I raved and cussed and stamped, but still
IT CRACKLED!!!!!!

"I checked the wiring piece by piece,
And found a part all splotched with grease,
The joint had arced and dropped the fat,
So little wonder was it that
IT CRACKLED!!!!!!!

"I took it back and plugged it in,
The owner tuned in with a grin,
Handed over a handsome fee,
I won't say what, but gosh! Oh, Gee!
IT CRACKLED!!!!!!!!

ELECTROSTATIC SPEAKERS. Be on the lookout, in the fall lines of home phonographs and possibly even in the hi-fi models of radios and television sets, for speakers without magnets or coils. Both Philco and Columbia Records are using electrostatic tweeters, and others are considering them. Manufacturing cost is reported to be around $4 per unit, which is attractively low in comparison with conventional tweeters.

With no air gap but instead just a thin plastic-dielectric sheet between a solid electrode and a stretched gold-foil electrode serving as diaphragm, there just isn't much chance for movement of the diaphragm. This means that the unit responds only to very high frequencies. When hooked to an ordinary radio or phonograph, chances are that nothing will be heard because no highs are there. Likewise, old records with all the high notes gouged out won't give any tweeter output.

Besides all this, the efficiency of an electrostatic tweeter is low, so that circuit tricks are sometimes needed to produce highs. One way is to leave the highs pre-emphasized at the input of the amplifier and balance the amplifier response with the tweeter response to get the desired frequency response.

JOB HUNTING. If a service technician in search of a job could just see the assortment of letters an average firm receives in response to a help-wanted ad, he'd think twice before snitching a sheet out of his son's school tablet to answer an ad. The great majority of applications are so carelessly planned and prepared that they rate nothing better than the wastebasket.

A good job obtained through an employment agency costs a week's salary at the very least. If you're going to apply directly yourself, use for the purpose at least some of the money you save. Get a few sheets of the most expensive bond or heavy parchment paper you can find. Plan your presentation so that each different type of information is neatly centered on its own sheet. Thus, personal data concerning name, age, marital status, address, and telephone number can be on the first page; education and qualifications on the second; former employers, references, and experience on the third; a good clear photograph of yourself neatly pasted on the fourth; and a description of the type of job you would like and the salary expected on the fifth page. Even more pages can be used if desired by dividing the material still further.

Try out the typing yourself a few times on cheap paper, then get a really good typist — even a public stenographer if you have to — to do the final job on parchment. Take this to a print shop or stationery store, have it punched for an attractive spiral plastic binding, and get attractive hard covers punched the same way. You then have an application that will get careful attention and consideration no matter how many others answer that ad. Of course, mail it in a large envelope and use corrugated cardboard sheets for protection; put on a special delivery stamp to show that you consider your application important.

If the job you want is worth anything, it's worth paying for.

NEW HOBBY. Taking snapshots of TV programs right off the screen is growing into a new fad for camera fans. Stations are even running contests with prizes for the best shots made of certain programs.

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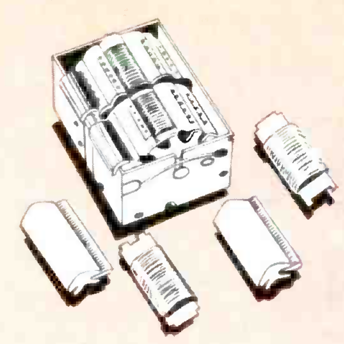

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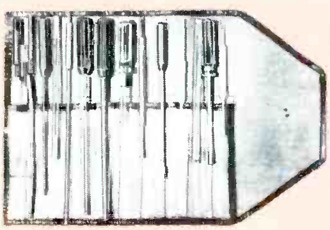

G-C DELUXE ALIGNMENT TOOL KIT Handy roll type case with 16 most-used tools. Tool tips are extra thin, of best grade hardened spring steel for long useful service. Value of tools sold separately $15.00.
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G-C GENERAL SCRATCH STIK Easy to use, in handy carry-with-you case. Removes scratches on walnut, mahogany, oak—all shades and colors. Avoid embarrassment on the job . . . wipe Skratch Stik on that accidental scratch!
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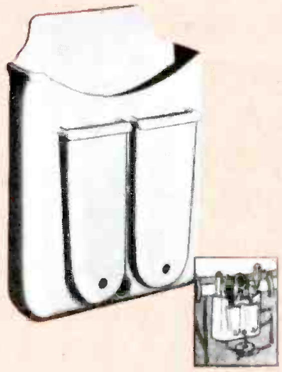

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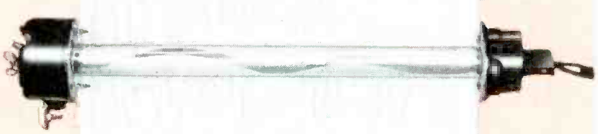

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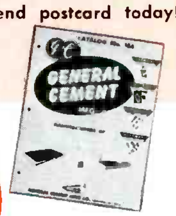

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Special Circuits in Communications Receivers

(Continued from page 19)

sidebands of the AM signal; therefore, the signal becomes unreadable.

A schematic diagram of the crystal-filter section appears in Fig. 6. When the selectivity switch is in the OFF position, the crystal is shunted and has no effect upon the receiver bandpass. In position No. 1, the crystal is in the circuit and will pass only those signals which are very near its series-resonant frequency. The phasing control may be rotated to balance out the capacitance of the crystal holder. The point where this balance occurs provides the highest degree of selectivity.

If more selectivity is desired, the switch may be placed in position No. 2. This shunts a resistor across the tuned circuit of C7 and L4 and consequently lowers its impedance. The lower impedance in series with the crystal has the effect of producing a higher Q for the crystal filter. The over-all response curve of the crystal filter is then sharpened. When a receiver with a crystal filter is aligned, the IF stages must be aligned at the exact crystal frequency.

The control that is labeled "Antenna" is a variable capacitor (5 to 10 mmf) connected in the input circuit of the receiver. Its function is to compensate for the detuning effects of the antenna. It is adjusted for maximum signal.

The next control to be considered is the ANL-AVC-MVC-CWO switch. In the ANL position, a noise limiter is connected in the circuit to suppress the effects of noise pulses. The noise limiter is a diode placed in series with the signal from the second detector. Its function is the same as the shunt diode discussed previously.

The AVC position provides automatic volume control in the receiver. This is obtained in a conventional manner. If the AVC action is not desired, it may be disabled by switching to the MVC (manual volume control) position.

The CWO position disables the automatic volume control, activates the continuous-wave oscillator, and disconnects the S-meter. As mentioned previously, disabling the automatic volume control is desirable during CW reception to eliminate the possibility of the CW oscillator overloading the automatic volume control.

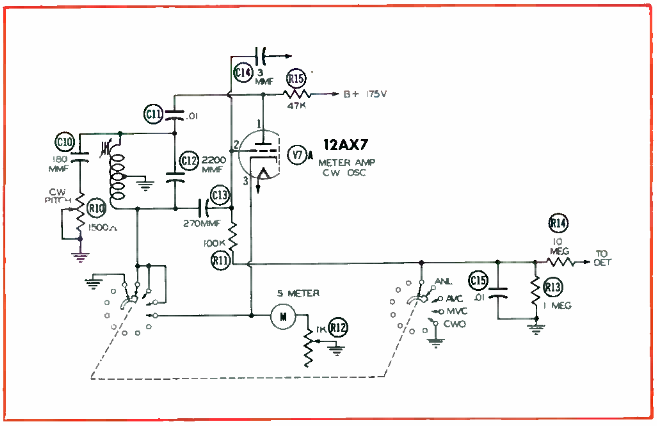

Fig. 7. A Schematic of the S-Meter Circuit Used in the National NC-98 Receiver.

The sensitivity control consists of a potentiometer in the cathode circuits of the RF amplifier, first IF amplifier, and the second IF amplifier. The sensitivity of these stages may be varied by the sensitivity control.

The S-meter provides an indication of the relative strength of the received signal. It is also of great assistance in properly tuning the station. The S-meter is calibrated in S-units from 0 to 9; above the S9 reading, it is calibrated in decibels from zero up. For example, if the indicator points to 20 db, then the actual signal strength would be 20 db above S9.

The S-meter circuitry is shown in Fig. 7. V7A which is one triode section of a 12AX7 serves a dual purpose. Since the S-meter is not used during reception of a CW signal, the tube may serve as a CW oscillator during this period and as an S-meter amplifier for other types of reception. The S-meter is a zero to 1-ma meter in series with the cathode of the meter amplifier. With no signal input to the receiver (in other words, with the antenna terminals shorted), the S-meter control R12 is adjusted for zero reading on the meter.

A signal is taken from the detector stage in much the same way that the AVC voltage is, and it is applied to the grid of the meter amplifier after proper filtering. The level of this signal is proportional to the strength of the incoming signal; consequently, the current through the S-meter will also be proportional to the strength of the received signal.

The National NC-98 receiver is equipped with a calibrated bandspread. This is of great assistance in determining the frequency of the incoming signal. It is also beneficial in setting the receiver to a predetermined frequency. This particular receiver may be obtained with either of two calibrated bandspreads. One of these is calibrated in the amateur bands of 10, 15, 20, 40, and 80 meters. The other choice is a bandspread for the short-wave bands with ranges of 17, 18, 25, 31, and 41 meters.

A Deluxe Communication Receiver

Further refinements in receiver design are available in the higher-priced receivers such as the Collins 75A-1 shown in Fig. 8. This receiver is designed specifically for reception on the amateur bands. There are four bands one megacycle wide and two bands two megacycles wide.

A single rotation of the tuning knob provides a coverage of 100 kilocycles on the lower bands and 200 kilocycles on the higher bands. The supplementary dial is calibrated in one-kilocycle divisions for the lower bands. Two-kilocycle divisions are provided for the higher bands. Extreme accuracy in frequency calibration is therefore possible.

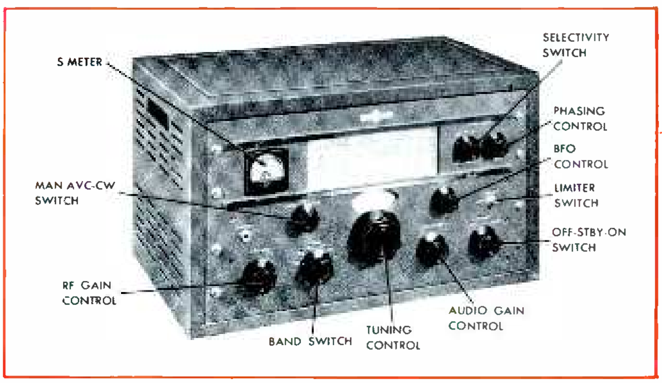

Fig. 8. The Collins 75A-1 Receiver.

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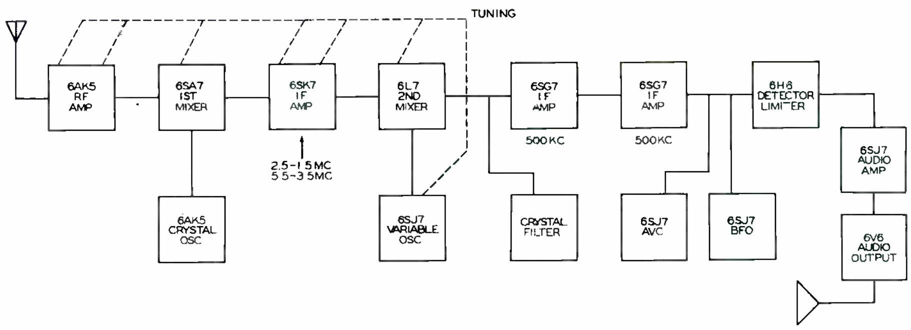

Fig. 9. A Block Diagram of the Collins 75A-1 Receiver.

The Collins 75A-1 receiver employs a principle known as double conversion. This is simply a refinement of the superheterodyne receiver. Two stages of conversion are used in place of the more conventional single conversion. This is of particular advantage in communication receivers. This system permits the use of a high IF for maximum image rejection and a lower IF for greater selectivity. Refer to Fig. 9.

The high IF is tunable; whereas, its associated local oscillator is crystal controlled. A separate crystal is used for each band. An IF of 2.5 to 1.5 megacycles is used for the four lower bands. It should be noted at this point that the one-megacycle tuning range of the IF corresponds to the one-megacycle coverage of the lower bands.

An IF of 5.5 to 3.5 megacycles is used for the two higher bands. Each of these bands covers a range of two megacycles. The shift to a higher IF for these two high bands maintains a high degree of image rejection.

The lower IF utilizes a frequency of 500 kilocycles. This is not variable. The tunable local oscillator is used in conjunction with the second mixer to convert the high IF to the 500 kilocycles necessary for the low IF. The receiver has seven tuned stages which must track.

As indicated in Fig. 9, a separate tube is used to develop the AVC voltage. The circuitry for this stage appears in Fig. 10. The cathode of the AVC tube V10 has a positive potential applied by the action of the voltage divider which consists of resistors R4 and R5. This potential is necessary for providing a delay in the AVC.

A signal from the IF amplifier is fed to the AVC tube through capacitor C5. As soon as this signal is of sufficient amplitude to overcome the delay voltage, the AVC voltage is developed across resistor R6. At the same time that the signal is being applied to the AVC tube, the detector V11A is rectifying the signal. The grid of the AVC tube is returned to the positive side of the load resistor R2 in the detector circuit. This circuit arrangement contributes to the conduction of the AVC tube, permits a rapid recovery of the AVC voltage, and still permits maximum performance on weak signals.

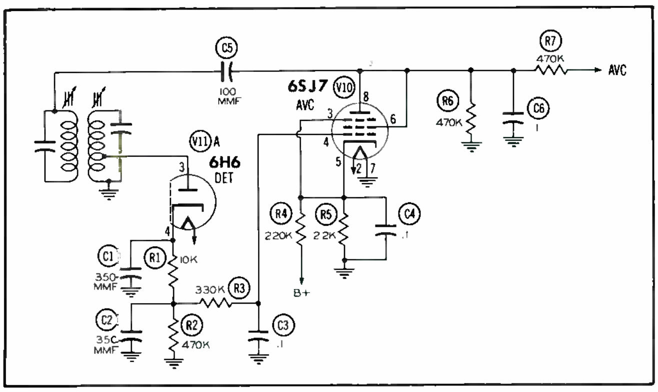

Fig. 10. A Schematic of the AVC Stage in the Collins 75A-1 Receiver.

The AVC voltage developed across R6 is filtered and applied to the RF amplifier, variable-IF amplifier, and the two fixed-IF amplifiers.

The foregoing receivers are examples of the types found in their respective categories. The circuitry will vary according to the manufacturer; however, the principles involved are basically the same. The individual user must determine which refinements are necessary for his purpose.

DON R. HOWE

Examining Design Features

(Continued from page 25)

nals to a state of high amplification for weak signals. The AGC voltage for the IF stages may then operate over the range necessary for proper performance.

Video

The video amplifier is a 6CB6 connected conventionally with video peaking in the plate circuit. The output of this stage drives the cathode of the picture tube. A 4.5-mc trap is contained in series with the lead to the picture-tube cathode. Brightness and contrast controls are included in the circuitry associated with this stage.

Noise Immunity

To provide noise immunity in the sync circuits of this receiver, a noise-inverter stage is included. A sync-clamper tube operates in conjunction with this stage. The circuitry which provides for noise immunity is illustrated schematically in Fig. 3. A portion of the bias on the noise inverter V2B is obtained from the divider network in the cathode circuit. This voltage level is adjustable by varying the fringe compensator R9. Additional bias for the noise inverter is supplied by the action of the sync clamper.

Positive pulses from the horizontal-output transformer are applied to the grid of the sync clamper. A high grid-leak bias is produced on the grid of the clamper by these pulses. A signal which contains positive sync pulses from the output of the sync amplifier V1A is applied to the plate of the clamper. This signal, together with the pulses on the grid, causes the clamper to conduct during the sync pulses. When the clamper conducts, capacitor C1 charges to a value dependent upon the level of the sync pulses. The discharge of this capacitor through resistor R8 supplies a bias on the grid of V2B. This bias is therefore dependent upon the strength of the incoming signal, and the proper operating point for the noise inverter is maintained under conditions of varying sync levels. The conduction of the sync clamper V2A prevents the sync pulses from appearing on the grid of the noise inverter which, as a result, does not conduct. This lack of conduction prevents the sync pulses from being cancelled, and they proceed from the sync amplifier to the sync separator in the normal manner.

Since the clamper is cut off between sync pulses, any noise pulses

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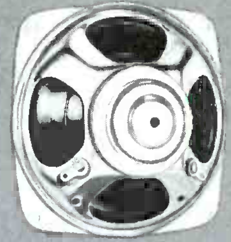

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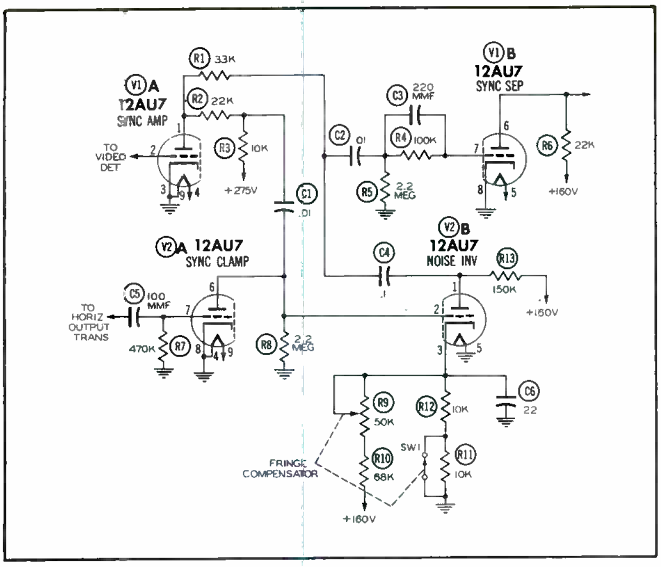

Fig. 3. Schematic of the Noise-Immunity Circuit in the Emerson Chassis 120205-B.

which appear during that time will be coupled to the grid of the noise inverter. The noise inverter will then conduct, and the noise pulses will appear with opposite polarity in the plate circuit. These pulses are fed back to the output circuit of the sync amplifier where they cancel the original noise pulses and appear as negative pulses on the grid of the sync separator. Because of their negative polarity on the grid of the sync separator, the noise pulses have no effect on the operation of the sync circuits.

If the action of the noise inverter is not desired, the fringe compensator may be fully rotated counterclockwise until the switch SW1 is opened. This increases the bias on the noise-inverter tube so that it will no longer operate.

Sweep

A sync signal from the output of the sync separator is fed to an integrator network and then to the vertical multivibrator. The vertical multivibrator is a conventional cathode-coupled type. Two controls are associated with this stage. These are the vertical hold control and the vertical size control. The resultant signal is then coupled to the grid of the 6W6GT vertical-output tube which contains the vertical-linearity control in the cathode circuit.

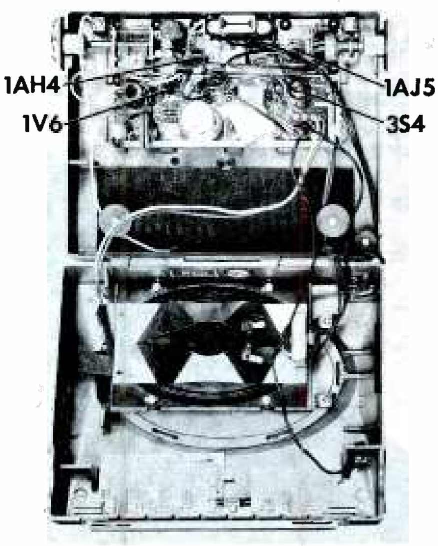

Fig. 4. Motorola Model 54L1 Portable Radio.

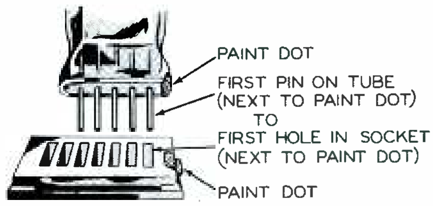

Fig. 5. Coding System Used on the Pins of Subminiature Tubes.

A signal from the sync separator is fed to the horizontal-sync phase inverter. Two signals, one from the plate circuit and one from the cathode circuit of the phase inverter, provide sync signals of opposite polarity for operation of the horizontal phase detector. Two additional signals are supplied to the phase detector. One signal is from the output of the horizontal multivibrator, and one is from the horizontal-output transformer. The control voltage from the phase detector is then coupled to the grid of the horizontal multivibrator to provide synchronization.

The 1B3GT high-voltage rectifier supplies approximately 18 kilovolts to the picture tube. If the receiver employs a 27EP4, a 100K-ohm resistor and a 500-mmf capacitor are used together as a filter network. If the receiver is equipped with a 27RP4, the filter network is eliminated because the aquadag coating on the tube acts as the filter.

Two 5U4G tubes are used for rectification in the low-voltage power supply. Three values of B+ are provided for use in the various receiver circuits.

MOTOROLA MODEL 54L1

The Motorola Model 54L1 is an AC-DC-battery portable radio containing some rather interesting design features. By reference to Fig. 4, it may be seen that the printed-circuit type of construction is used in this receiver. It is also of interest to note the subminiature tubes that are employed. Certain precautionary measures should be exercised when removing or replacing these tubes. They should be removed from their sockets by pulling them straight up. Wiggling the tube may very easily cause damage to the socket or the fragile tube pins.

In order to minimize the danger of inserting the tubes in their sockets incorrectly, the tube bases and the sockets are coded with a small painted dot. This system of coding is illustrated in the drawing of Fig. 5. The tube is always inserted so that the painted dot on the tube is adjacent to the dot on the socket.

The sockets for the subminiature tubes contain seven holes; however, the tubes may have fewer than seven pins. If the tube has fewer than seven pins, pin No. 1 (the pin adjacent to the painted dot) should always go into the hole nearest the dot on the socket.

Fig. 6. Base Diagrams for the Subminiature Tubes Used in the Motorola Model 54L1.

The base diagrams for the three types of subminiature tubes in this receiver are shown in Fig. 6.

This receiver also uses a speaker with the permanent magnet mounted within the cone, a practice which is opposite to the more conventional rear mounting. This arrangement proves beneficial in reducing the size of the portable receiver.

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Color TV Training Series

(Continued from page 9)

secondary L40. The variable control R9 picks off the correct amount of signal to be applied to the demodulators and is called the color-saturation control. When the setting of the color-saturation control is increased, the saturation of the colors is increased. When its setting is decreased, the colors become less saturated. The color-saturation control is a front-panel control which is accessible for use by the set owner.

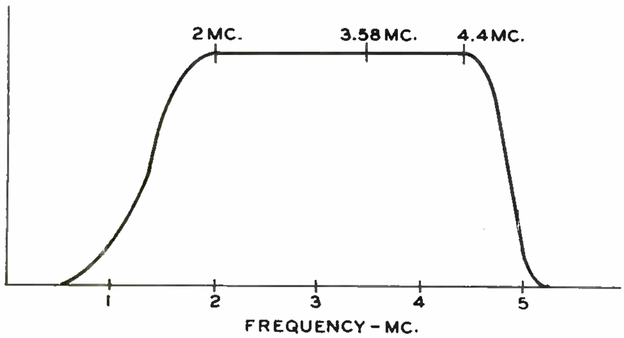

Fig. 6-7. Frequency Response Curve of Chroma-Bandpass Circuit of Fig. 6-2.

Another type of bandpass-amplifier circuit is shown in Fig. 6-9. This circuit is used in the General Electric Model 15CL100 color receiver. This circuit performs the same function as the bandpass-amplifier circuit just covered. However, the method of obtaining the chrominance information from the composite signal is slightly different.

The output of the last video IF stage is coupled to two separate detector stages. One is for the detection of the luminance signal, and the other is for the detection of the chrominance signal. In both cases, crystal detection is employed. The crystal detector for the chrominance signal is shown in Fig. 6-9. At the output of the chroma-detector circuit is the composite signal minus the luminance portion. Waveform W6 in Fig. 6-10 shows the signal that is present at this point. The signal is limited to a bandwidth of 3.0 to 4.2 megacycles by the bandpass filter L35. The sound signal is trapped out by the 4.5-mc trap L36.

After being band limited, the color signal is coupled to the input of the chroma amplifier V29. This stage employs a 6BA6 type of tube. The signal is amplified and then passed through a second bandpass filter L38. At the output of L38, the signal is coupled to two different stages. It is coupled to the input of the color-sync section where the color burst is extracted and to the input of the chroma cathode follower V30A. The signal on the grid of V30A is keyed off during horizontal-retrace time by a pulse obtained from a winding on the high-voltage transformer. This pulse is applied to the grid through capacitor C108 and resistor R108. The horizontal sync pulse and the color burst are eliminated from the signal by this method; therefore, the output signal on the cathode of

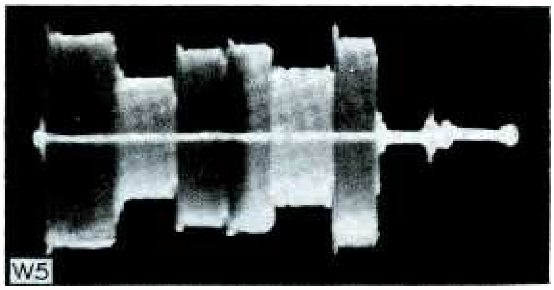

Fig. 6-8. Signal Across Color-Saturation Control in Fig. 6-2.

V30A contains only the chrominance information. Waveform W7 in Fig. 6-11 shows the signal that is present at this point. This signal is then applied to the color-demodulator stages through the chroma control R9.

As shown in the waveforms of Figs. 6-8 and 6-11, the output of the bandpass amplifier consists only of the chrominance portion of the composite signal. This chrominance signal is coupled to the demodulator stages where it is detected. The chrominance signal varies in both phase and amplitude. A difference in phase of the signal represents a change in color. A difference in amplitude represents a difference in the degree of saturation of the colors. It is the function of the demodulator stages to detect correctly the differences in phase and amplitude of the chrominance signal in order for the receiver to reproduce the proper colors.

Color Synchronization

In order to reproduce the colors of a televised image, the action applied to the color information at the transmitter in reversed at the receiver. It is recalled that the modulation process at the transmitter involves

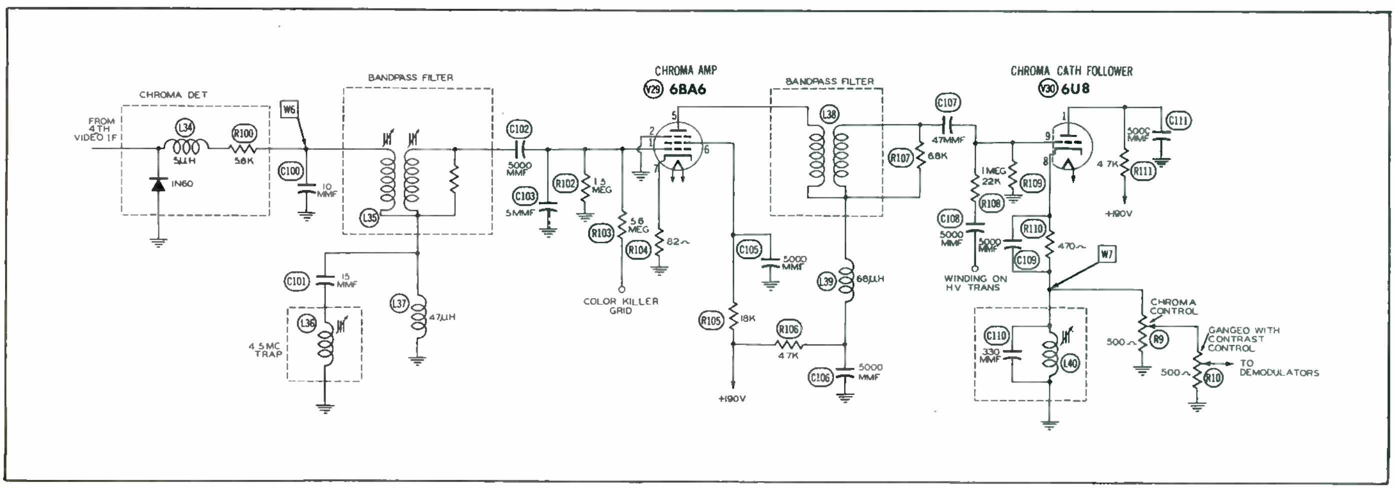

Fig. 6-9. Chroma-Amplifier Circuit in General Electric Model 15CL100 Color Receiver.

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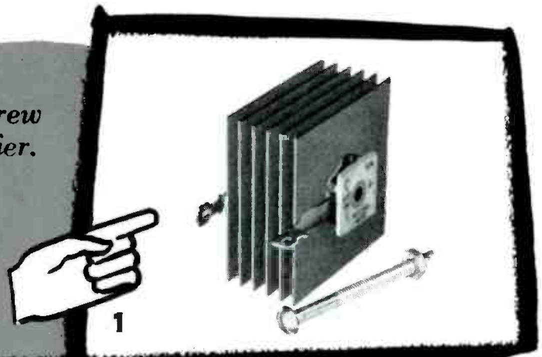

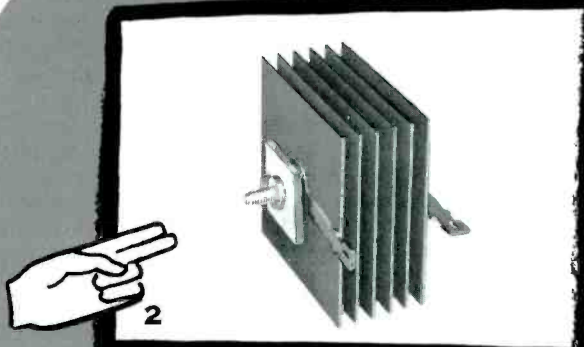

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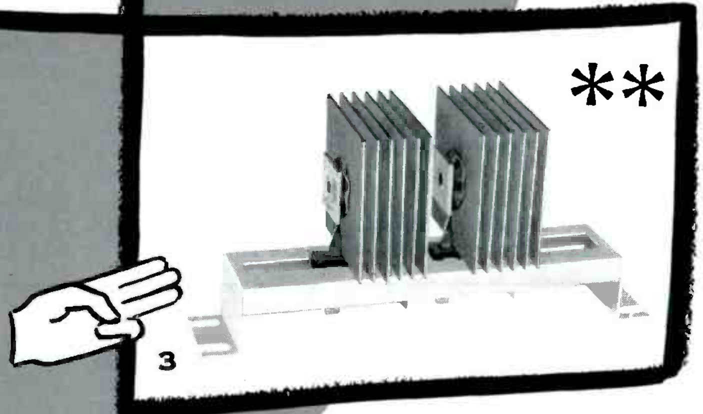

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the use of a 3.58-mc subcarrier. This signal is applied in quadrature to two doubly balanced modulator circuits. Simultaneously, the I color signal is applied to one balanced modulator and the Q color signal is applied to the other. The 3.58-mc subcarrier is cancelled, and the resultant output is the chrominance signal. This is a 3.58-mc component which varies in amplitude and phase.

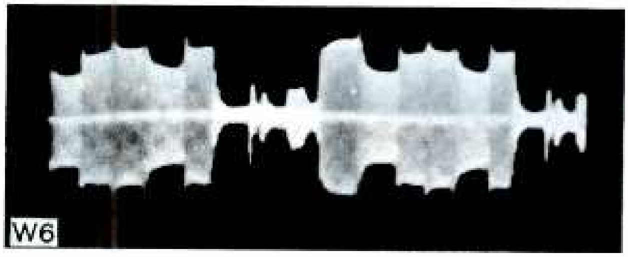


Fig. 6-10. Signal at the Output of the Chroma-Detector Circuit in Fig. 6-9.

Recovery of the color signals in the receiver is accomplished by reversing the modulation process. This requires that a 3.58-mc CW reference signal that is locally generated be applied in quadrature to two demodulator circuits. Accuracy in the demodulation process is attained by regulating this reference signal so that it has a definite phase relationship with the subcarrier. It is the function of the color-sync section to generate the local 3.58-mc reference signal and regulate its frequency and phase.

A block diagram of a typical color-sync section is shown in Fig. 6-12. An oscillator generates a 3.58-mc sine wave which is amplified by the following stage. The output circuit of the amplifier stage provides two 3.58-mc signals having a phase difference of 90 degrees. These are the CW reference signals used in the demodulation process.

The proper frequency and phase of the 3.58-mc oscillator signal is assured by comparing the inphase CW component with a sample of the subcarrier from the transmitter. This sample signal consists of approximately eight cycles at 3.58 megacycles and is placed on the back porch of the horizontal sync pulse. This signal is known as the color burst.

A composite color-picture signal from the burst take-off point is applied to the burst-amplifier stage. The operation of this stage is controlled by the action of the burst-amplifier keying stage which permits the burst amplifier to conduct only during horizontal-retrace time. As a result, the output of this stage contains only the color-burst component.

The color burst is applied to the phase-detector stages where it is compared with the locally generated 3.58-mc reference signal. Any error in the frequency or phase of the reference signal is indicated at the phase-detector section, and a correction voltage is applied to the oscillator control stage. This action causes the control stage to affect the oscillator circuit until it is operating at the proper frequency and the correct phase.

A schematic drawing of a color-sync circuit that operates in the manner just described is shown in Fig. 6-13. This circuit is used in the RCA Victor Model CT-100 color receiver. The triode section V29B of a 6AN8 tube is used in a modified tuned-grid, tuned-plate oscillator circuit. A 3.58-mc crystal is used as the tuned-grid circuit and determines the basic frequency of the oscillator. The output circuit in the cathode can be compared to a tuned-plate circuit since the same current flows through both elements of the tube.

A tap from the tank circuit in the cathode supplies a 3.58-mc CW signal to the gird of the quadrature amplifier V28A. The signal at the input of this stage is shown in Fig. 6-14, waveform W8.

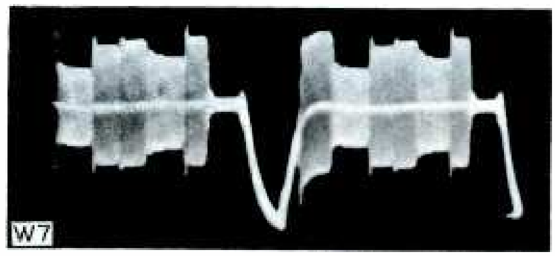


Fig. 6-11. Signal at the Output of Chroma Cathode-Follower Stage in Fig. 6-9.

The oscillator signal is amplified and appears across the primary winding of L45, the quadrature transformer. The secondary windings of this transformer are tuned so that the induced signal in the lower coil is the inphase CW reference signal, and the signal induced in the upper coil is the quadrature CW reference signal. These two 3.58-mc sine waves are used in the demodulation process to recover the I and Q color information from the chrominance signal. Accurate demodulation occurs when the 3.58-mc inphase reference signal is in phase with the I component of the chrominance signal, and the 3.58-mc quadrature reference signal is in phase with the Q component. A sample of the I reference signal is applied to the phase-detector circuit where it is compared to the color-burst signal. Since the I-axis lags the color burst by 57 degrees (see Fig. 6-15), the color-burst phase is delayed by this amount between the burst take-off point and the phase-detector circuit. The hue control functions as a vernier and enables precise adjustment of the phase angle.

Now let us see how the burst signal reaches the phase-detector circuit. A composite color-picture signal from the output of the first video amplifier is coupled to the grid of the burst amplifier V27A through the 3-micromicrofarad capacitor C150. The burst take-off transformer L31, in conjunction with C153 and the hue adjustment, forms a high-impedance circuit at 3.58 megacycles from the grid of the burst amplifier to ground. The phase of the signal applied to this grid can be varied by tuning the hue adjustment through its range.

During scan time, the burst-amplifier keying stage conducts; and a voltage is developed across the cathode

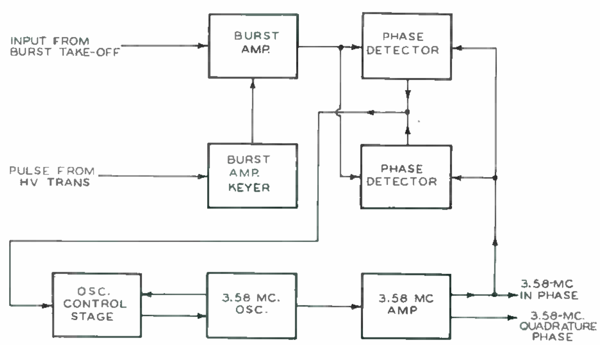


Fig. 6-12. Block Diagram of a Color-Sync Circuit Which Utilizes Phase-Detector and Control-Tube Circuits.

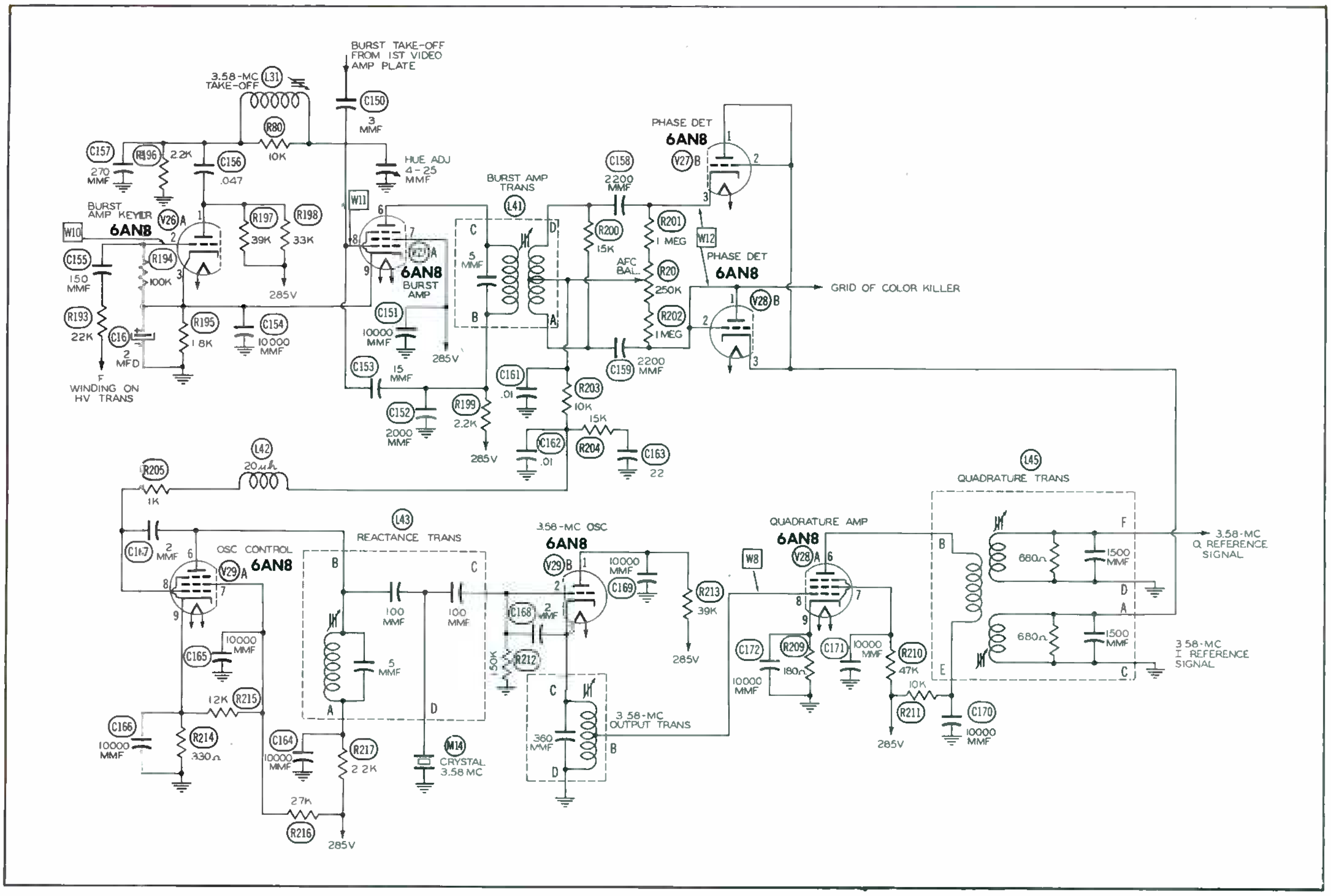


Fig. 6-13. Color-Sync Circuit in RCA Victor Model CT-100.

resistor R195. This results in a positive voltage at the cathode of the burst amplifier, and this voltage is sufficient to hold this stage at cutoff. A winding on the high-voltage transformer is connected to the grid of the keyer stage. This winding provides a negative pulse at the grid of the keyer stage during retrace time. This is shown by the waveform W10 in Fig. 6-16.

The current flow through the keyer stage is reduced considerably because of the negative pulse on the grid. The voltage across R195 does not change appreciably because of the long discharge time of C16; however, the voltage on the keyer-tube plate increases sharply. The resultant positive-voltage pulse is applied to the grid of the burst amplifier V27A through C156.

The pulse at the grid of the burst amplifier occurs at the same time as the color-burst component of the composite color-picture signal. This fact is shown by waveform W11 in Fig. 6-17. (The amplitude of the positive pulse in waveform W11 is very high when compared to the chrominance signal. In order to show the color-burst signal more clearly, an exploded view of this portion of the waveform can be seen in the inset.) The burst amplifier conducts during the period of the positive pulse, and only the color-burst signal is amplified.

The color-burst signal appears across the primary of the burst-amplifier transformer L41 which presents a high impedance at 3.58 megacycles. The secondary

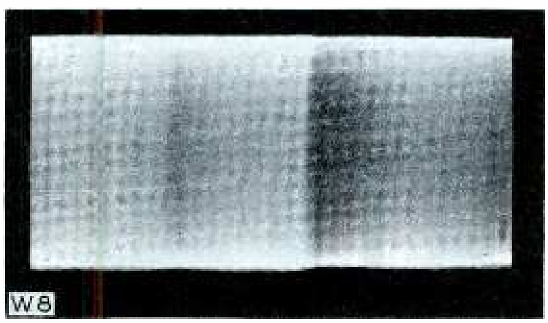


Fig. 6-14. Signal at the Grid of the Quadrature Amplifier in Fig. 6-13.

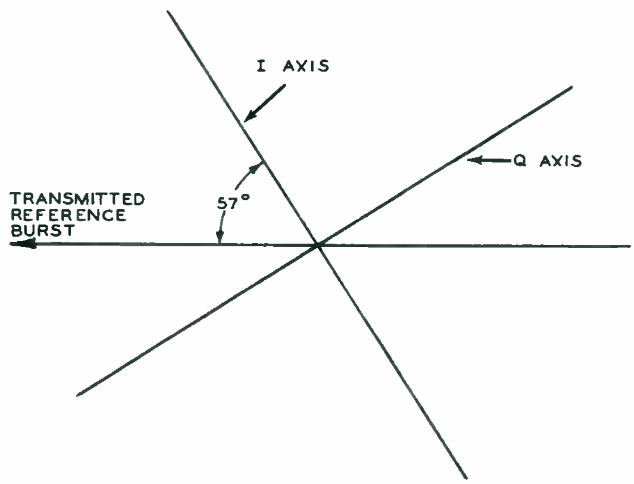
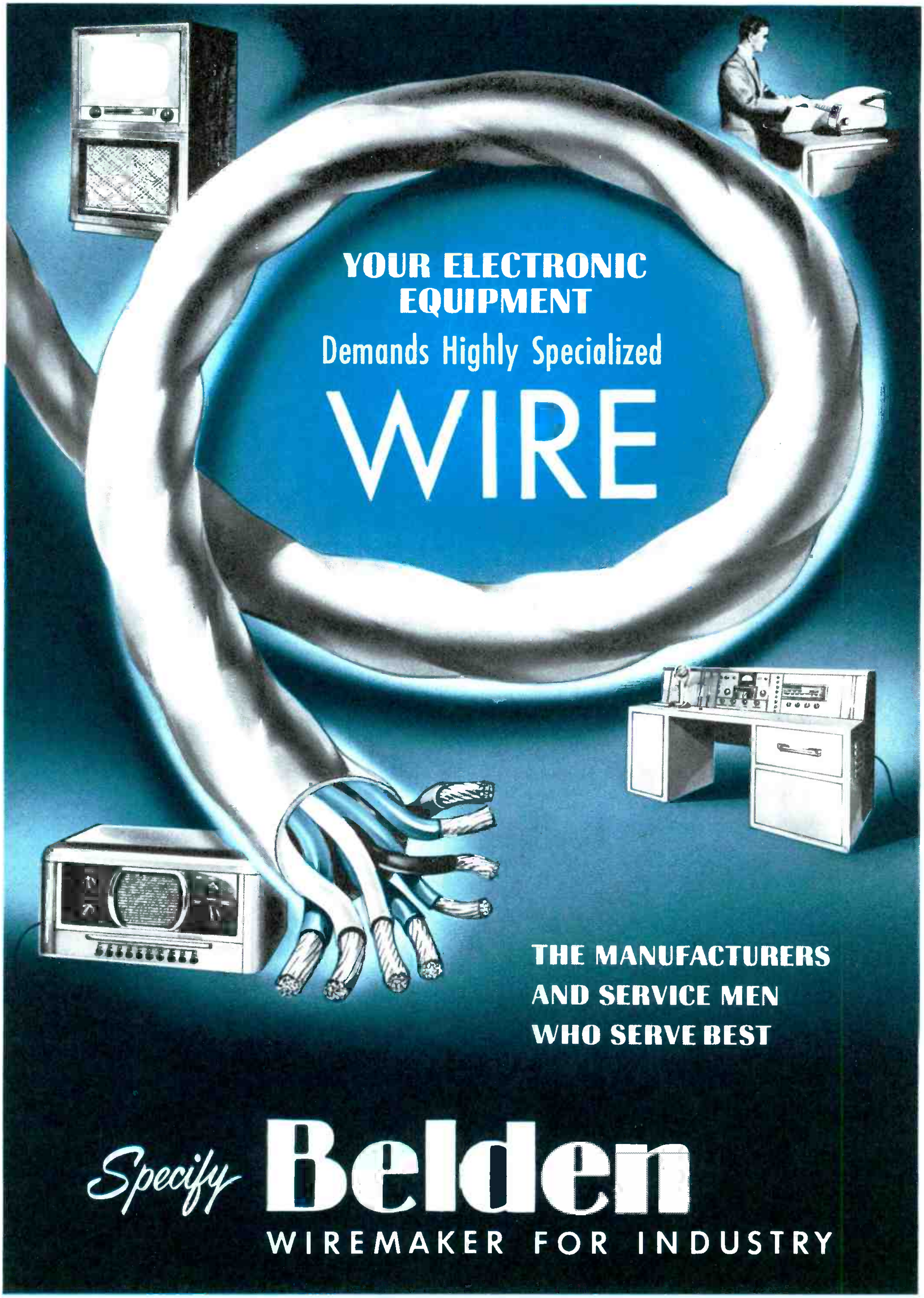


Fig. 6-15. Phase Relationship of the Color Burst and the I-Axis.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winding of L41 is bifilar wound and tightly coupled to the primary. The 15,000-ohm resistor across the secondary lowers the Q of this winding so that the frequency response is flattened. The operation of the entire color-sync section might be impaired if the frequency response of L41 shifted so that a portion of the burst signal occurred on the slope of the curve. The transformer is tuned so that maximum response at the burst-signal frequency occurs at the center of the flat top. Slight changes caused by normal aging of components are not likely to affect the operation of the color-sync circuit.

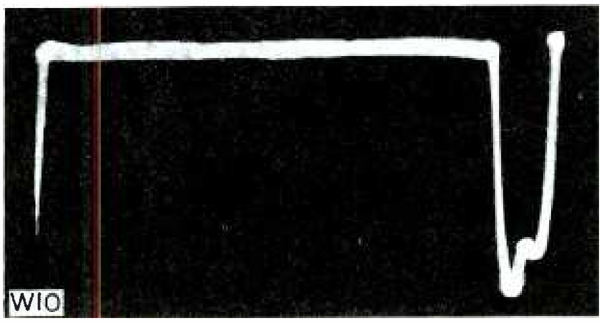


Fig. 6-16. Pulse Applied to the Grid of the Burst-Amplifier-Keying Stage in Fig. 6-13.

Enlargement of Circled Portion

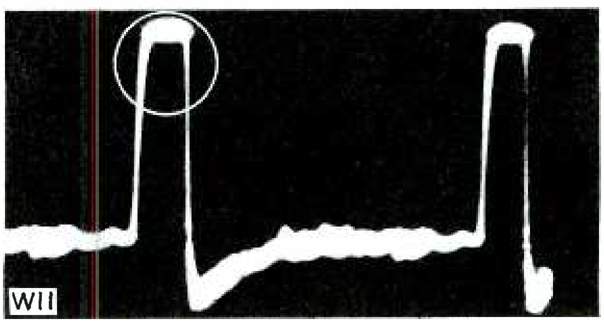


Fig. 6-17. Signal at the Grid of the Burst-Amplifier Stage in Fig. 6-13.

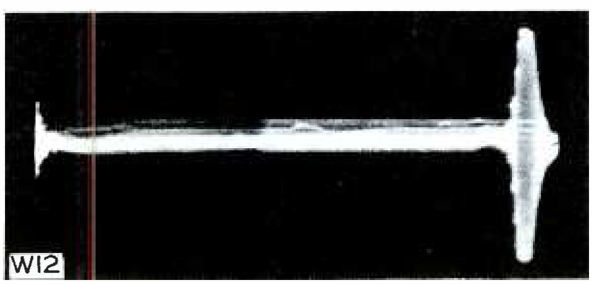


Fig. 6-18. Burst Signal at the Phase-Detector Stage in Fig. 6-13.

The signal at one end of the secondary winding of L41 is 180 degrees out of phase with the signal at the other end. Opposite ends of the secondary are coupled to the detector stages through C158 and C159; thus, the signal at the cathode of the top diode V27B is 180 degrees

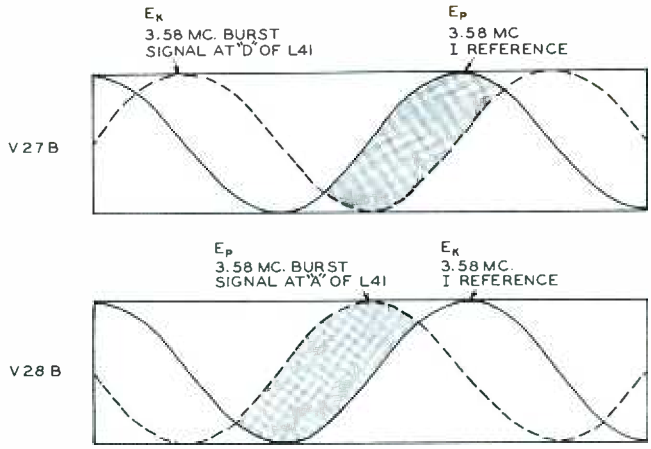


Fig. 6-19. Phase Relationship at the Phase-Detector Stages in Fig. 6-13 When the Chroma-Reference Oscillator Is Operating at the Proper Frequency and Phase.

out of phase with the signal at the plate of the bottom diode V28B. Waveform W12 in Fig. 6-18 shows the color-burst signal present at either of the detector diodes. The instantaneous phase relationship is not evident on the oscilloscope.

When the 3.58-mc oscillator is operating at the correct frequency and has the proper phase, the I reference signal leads the burst signal at the cathode of V27B and lags the burst signal at the plate of V28B by 90 degrees. This phase relationship is shown in Fig. 6-19. Each of the diodes will conduct when the plate voltage E_P exceeds the cathode voltage E_K. The period of conduction of each tube is indicated by the shaded areas, and these periods are seen to be equal.

The center tap at the secondary of L41 is effectively at AC ground, since the impedance of C161 is negligible at 3.58 megacycles. See Fig. 6-13. During the time when V27B conducts, electrons flow from C158 through the diode, through the secondary winding of L45, and from C161 through the top half of the secondary of L41 to C158. This action builds up a charge across C158 so that the voltage at the center tap of L41 is negative with respect to the voltage at pin No. 3 of V27B. When V28B conducts, electrons flow from ground through the secondary of L45, through the diode V28B to one side of C159, and from the other side of C159 through the bottom half of the L41 secondary to C161. The potential across C159 is such that the voltage at the center tap of L41 is positive with respect to pin No. 1 of V28B.

If the phase relationship between the burst signal and the I reference signal is like that shown in Fig. 6-19, the conduction of the diodes will be equal. The resultant charges across C158 and C159 will be equal and opposite,

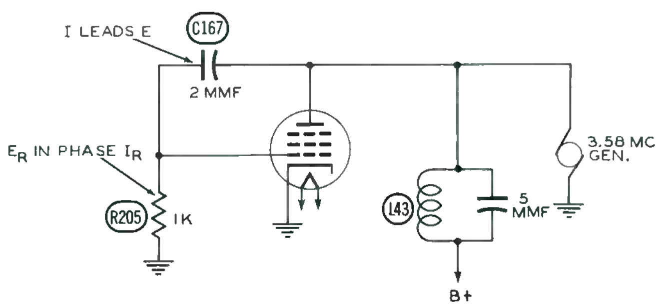


Fig. 6-20. Effective Circuit of Oscillator Control Stage in Fig. 6-13 at 3.58 Megacycles.

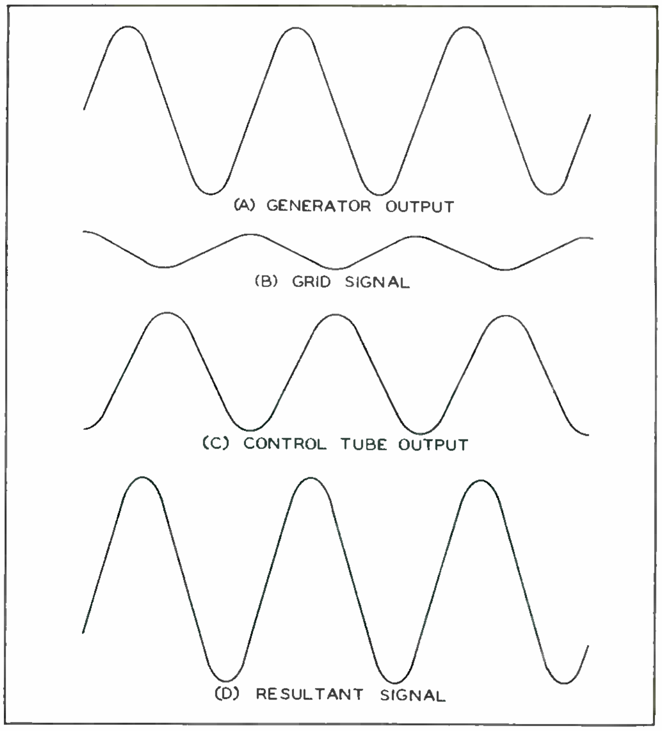


Fig. 6-21. Signals Present in the Control-Tube Circuit. The Resultant Signal Is Developed by the Combination of Signals A and C.

and no difference voltage will appear at the center arm of the balance control R20. If the conduction of V27B is greater than that of V28B, the charge across C158 will exceed the charge across C159, resulting in a positive DC difference voltage at the center tap of the transformer. A negative DC difference voltage would be developed at this point if V28B conducts more heavily than V27B. To illustrate how this difference voltage is developed, let us first consider the case in which the conductions of both diodes are equal. Under these conditions, the voltages across C158 and C159 will be equal, as previously stated. Since the left sides of the two capacitors are connected together through the low-DC resistance of the secondary of L41, a phantom ground or point of zero DC potential exists at the center of the resistance (made up of R201, R20, and R202) across the diodes. The AFC balance control is adjusted during receiver alignment to this zero-potential point for proper balance in the circuit. If the phase of the 3.58-mc oscillator advances, V27B will conduct more heavily than V28B, developing a greater

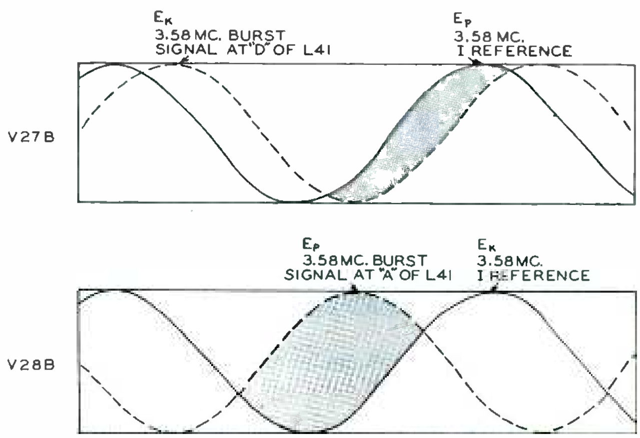


Fig. 6-22. Phase Relationship at the Phase-Detector Stages in Fig. 6-13 When the Phase of the 3.58-Mc Oscillator Is Lagging Normal.

charge on C158 than on C159. The phantom-ground point then shifts downward on R20, resulting in a positive potential at the arm of the AFC balance control. This voltage is of the proper polarity to effect phase correction of the oscillator. Should the phase of the oscillator be retarded, V28B will conduct more than V27B and the phantom-ground point will move up on R20. This places a negative voltage at the arm of R20.

Another way of explaining how the polarity across C161 is reversed is to consider the amounts of conduction of the diodes. If V27B conducts more heavily than V28B, more electrons will flow from the top plate of C161 than will flow into it. Thus, a positive potential will exist. If V28B conducts more than V27B, more electrons will flow into the top plate of C161 than will flow out of it. Thus, a negative potential will be developed. Regardless of which method of explanation is used, it can be seen that a voltage of proper polarity will be developed across C161.

The grid of the control tube V29A has no DC path to ground, and there is no DC current flow through R203, L42, or R205. This means that there will be no DC voltage dropped across these components, and any DC voltage developed at the center arm of R20 will appear at the grid of the control tube.

The bias on this stage is not easily affected by noise pulses. Any noise pulses occurring at retrace time would be amplified by the burst-amplifier stage. The polarity of the resultant voltage could be positive or negative, depending upon the polarity of the noise pulse. C161 responds to this pulse and accordingly charges. C161 will discharge through one of the diodes (through V27B if the charge on C161 is negative and through V28B if the charge is positive) and R203. The discharge current in R203 tends to charge C162 and C163; however, the large value of C163 and the current-limiting action of R204 prevent any appreciable change in the voltage on C163. In this way, the network composed of R204 and C163 forms a sort of noise-immunity circuit.

The schematic of Fig. 6-20 shows the effective circuit of the oscillator control stage at 3.58 megacycles. Consider for the moment that the 3.58-mc signal from the generator is not yet applied across the tube and that its frequency and phase are as shown by Fig. 6-21A. If this signal is then applied across the tube, the 2-mmf

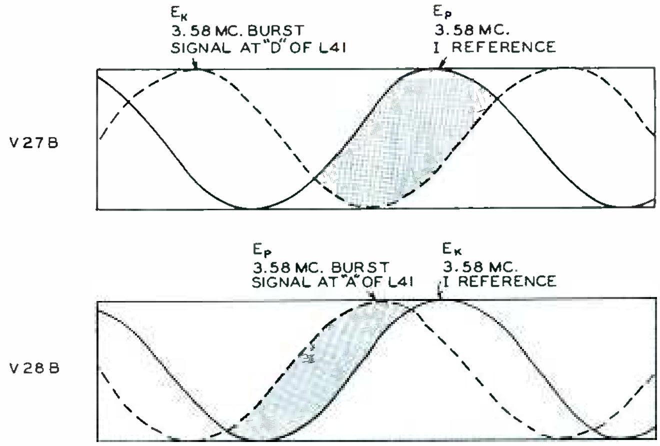


Fig. 6-23. Phase Relationship at the Phase-Detector Stages in Fig. 6-13 When the Phase of the 3.58-Mc Oscillator Is Leading Normal.

capacitor C167 provides high capacitive-reactance coupling from plate to grid. The current in R205 leads by approximately 90 degrees the voltage that is applied from the generator. The voltage developed across R205 is in phase with this current; therefore, it leads the applied voltage by 90 degrees. This is the signal voltage at the grid of the tube and is represented by Fig. 6-21B.

The signal at the grid of the tube is amplified, and the polarity is inverted. The signal output of the tube is represented by the drawing in Fig. 6-21C. It can be seen that the signal C lags the signal A by 90 degrees. Actually, signals A and C do not exist as shown, since the signal at the plate of the control tube is a combination of signals A and C. The phase of this resultant signal is somewhere between the phase of the generator signal and the tube-output signal, favoring the phase of the signal component having the greater amplitude. The signal component supplied by the generator has a constant amplitude; whereas, the amplitude of the signal component supplied by the tube will vary with changes in the bias of the stage.

The signal at the plate of the tube, and formerly represented as signal A, has assumed a phase represented by signal D. Note that signal D lags signal A by almost

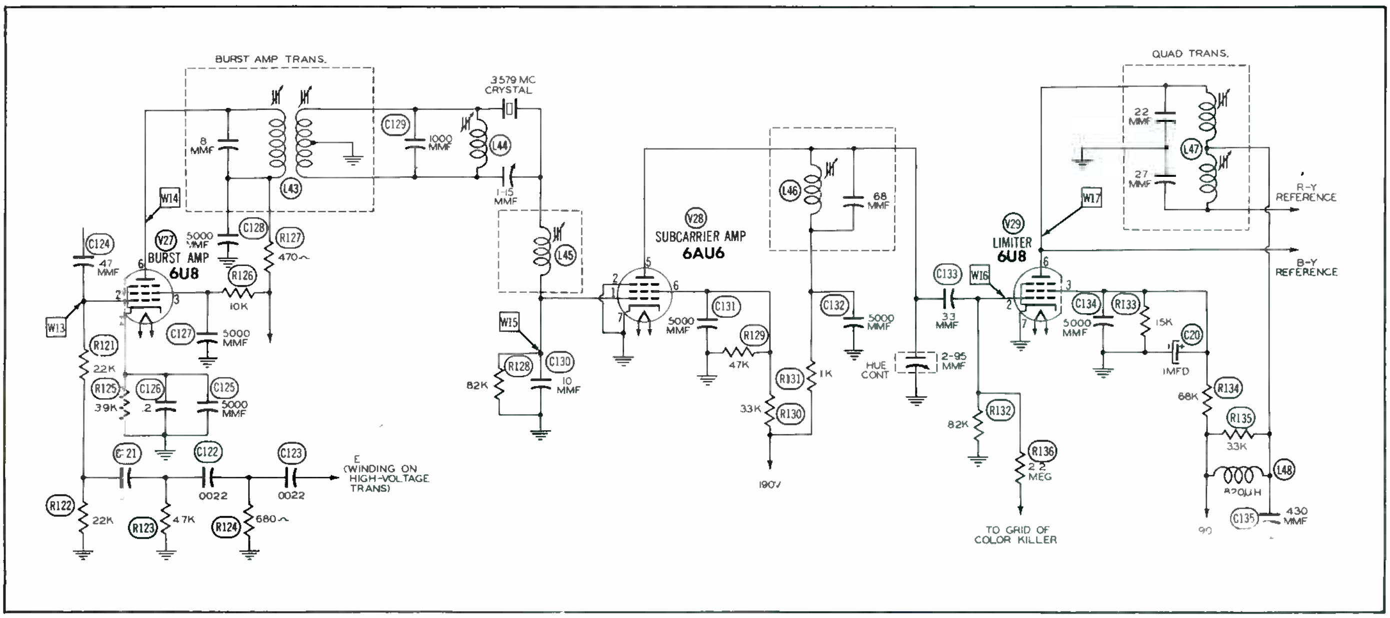
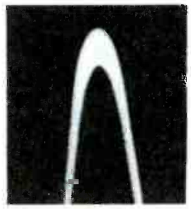


Fig. 6-24. Color-Sync Circuit in General Electric Model 15CL100.

45 degrees; therefore, the phase of the applied signal has changed. Thus, it can be seen that the reactance tube is effective in changing the phase of the 3.58-mc signal. Now let us consider the operation of the complete circuit shown in Fig. 6-13.

The oscillator begins to operate at a frequency which is dependent upon the characteristics of the crystal and upon the capacitive reactance contributed by the reactance tube. A sine wave is obtained from the tuned circuit in the cathode of the oscillator and applied through an amplifier to the quadrature transformer. A sample of the I reference signal is fed to the phase-detector stage where it is compared with the phase of the color-burst signal.



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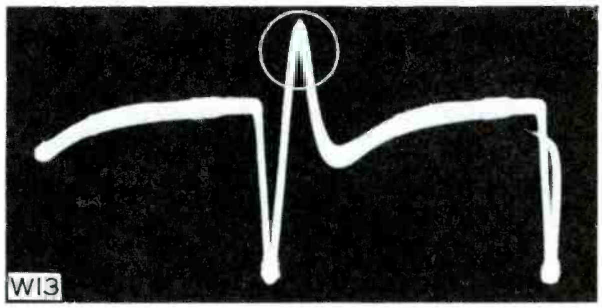

Fig. 6-25. Signal at the Grid of the Burst Amplifier in Fig. 6-24.

Let us assume for the moment that the phase of the oscillator-output signal is lagging normal. This phase delay will be reflected in the phase of the I reference signal, and the voltages at the detector diodes will assume the phase differences shown in Fig. 6-22. It can be seen that V28B will conduct more heavily than V27B. As previously discussed, a negative DC difference voltage is produced, and the bias on the control stage increases. The gain of the control tube is reduced, thereby reducing the capacitance of the reactance tube. This will cause the phase of the oscillator signal to advance. The bias on the control tube will steadily decrease until the phase of the oscillator is in step with that of the color burst.

If the phase of the oscillator signal advances beyond normal, the condition shown by Fig. 6-23 will exist at the detector diodes. A positive DC correction voltage will be developed across C161 because V27B will conduct more heavily than V28B. The gain of the control stage will be increased, and the oscillator phase will be retarded. The conduction of V28B will slowly increase,

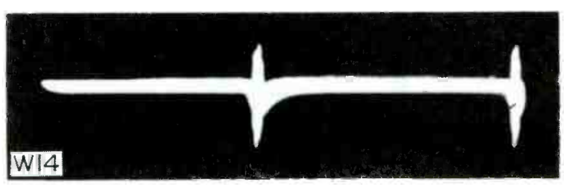

Fig. 6-26. Burst Signal in the Output Circuit of the Burst Amplifier in Fig. 6-24.

and the conduction of V27B will slowly decrease. The positive correction voltage will gradually decrease as the oscillator circuit approaches the proper frequency and phase.

The control stage always has some effect upon the oscillator frequency because the capacitance contributed by the stage is connected in parallel with the crystal. A short time after the circuit is put into operation, a steady-state condition exists. The phase-detector circuit constantly supplies the necessary correction voltage to lock the frequency and phase of the oscillator signal into synchronization with the color-burst signal

The General Electric Model 15CL100 employs a color-sync circuit which differs considerably from the one just discussed. This can be seen in Fig. 6-24. A signal from the output of the chrominance amplifier is applied to the grid of the burst amplifier through a 47-mmf capacitor. The burst-amplifier tube conducts during retrace time and is held at cutoff during scan time because of the charge maintained by C126 in the cathode circuit. A winding on the high-voltage transformer supplies to the grid a positive pulse which is in time coincidence with the color-burst component. This is shown by waveform W13 in Fig. 6-25. This positive pulse causes the tube to conduct, and the burst signal is amplified.

The burst signal appears across the primary of the burst-amplifier transformer L43 which is tuned to resonance at 3.58 megacycles. The burst signal at this point is shown by waveform W14 in Fig. 6-26. This signal is inductively coupled to the crystal ringing circuit and provides the excitation needed to shock this circuit into oscillation. Since the crystal ringing circuit is excited by the burst signal, the correct frequency and phase of the resultant CW signal is assured, and no further synchronizing circuits are necessary.

The CW output (shown by waveform W15 in Fig. 6-27) of the ringing circuit is applied through an amplifier stage. The plate circuit of this stage is tuned to 3.58 megacycles and is shunted by a small variable capacitor labeled "Hue Control." This is a rear-panel control which is used to change the phase of the subcarrier frequency, thus allowing the operator to vary the hue of the reproduced colors to get the most pleasing flesh tones.

The subcarrier signal is applied to a limiter stage. The signal at the grid of this tube is shown by waveform W16 in Fig. 6-28. A limiter stage is necessary because the amplitude of the signal decreases slightly between color-burst excitations. It is mandatory that the reference signal have a constant amplitude as shown by waveform W17 in Fig. 6-29.

A quadrature transformer in the plate circuit of the limiter stage provides an output of two 3.58-mc CW signals. The tuning of the resonant circuits in this transformer causes these two signals to have a phase difference of 90 degrees. These are the CW signals used in the demodulators to recover the color information from the chrominance signal.

Color Killer

The purpose of the color killer in a color receiver is to prevent signal information from getting through the chrominance channel during the time a monochrome signal is being received. This prevents any signal other than the luminance signal from reaching the picture tube. Signal information is prevented from passing through the chrominance channel by employing a color-killer stage to bias to cutoff one or more stages in the chrominance channel.

Shown in Fig. 6-30 is the color-killer circuit used in the RCA Victor Model CT-100 color receiver. This circuit employs one-half of a 6AN8 tube which operates in the following manner. During the time a color signal is being received, the color killer is held at cutoff by a negative potential that is present in the phase-detector circuit. This negative potential is applied to the grid through resistor R206. This negative potential is always present under normal operation during the time color is being received.

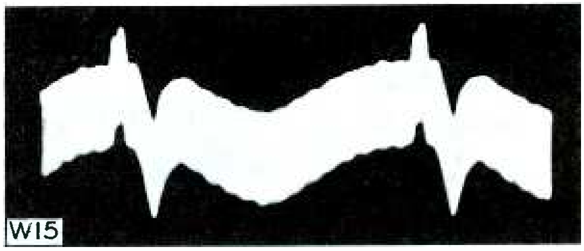

Fig. 6-27. The 3.58-Mc Signal at the Grid of the Subcarrier Amplifier in Fig. 6-24.

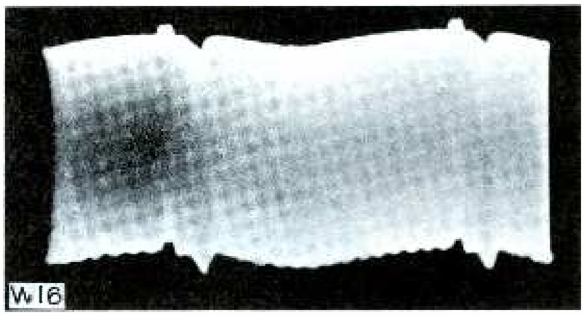

Fig. 6-28. The 3.58-Mc CW Signal at the Grid of the Limiter Stage in Fig. 6-24.

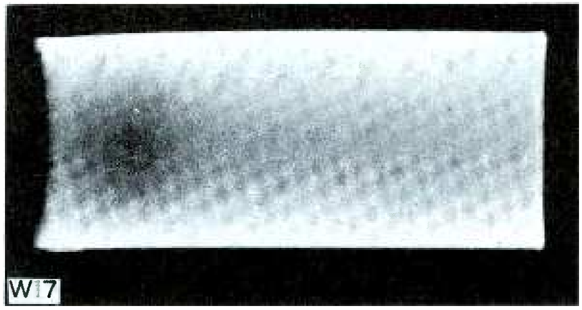

Fig. 6-29. The 3.58-Mc CW Signal Output of the Limiter Stage in Fig. 6-24.

When the color signal ceases and a monochrome signal is being received, a negative potential is not developed by the phase-detector circuit. This allows the bias on the grid of the color killer to increase above the cutoff value and brings the stage into a conducting stage. A positive pulse is applied to the plate from a winding on the high-voltage transformer. With a positive voltage on the plate and with the grid above cutoff potential, the tube conducts. The operation of the color-killer stage is similar to that of a keyed AGC stage. When the color killer conducts during the time of a positive pulse from the transformer winding, plate current flows and charges capacitor C144. When the capacitor discharges, it does so through resistor R208 to ground. This discharging current places across R208 a negative potential which is applied to the grid of the bandpass amplifier through

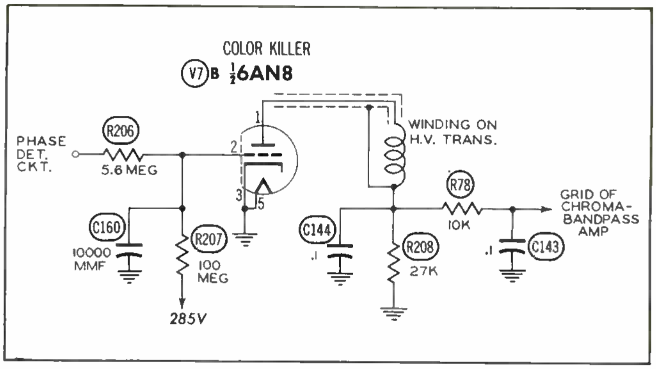

Fig. 6-30. Color-Killer Circuit in RCA Victor Model CT-100.

resistor R78. Resistor R78 and capacitor C143 form a filtering network to remove any ripple that is present in the plate circuit of the color killer. The negative potential is of sufficient amplitude to bias the bandpass amplifier to cutoff. As long as this negative potential is developed, the bandpass amplifier will remain at cutoff.

In the next issue, we will continue the discussion of the color-receiver circuits which have the function of preparing the color information for application to the picture tube.

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.

Questions

1. What is the purpose of the chroma-bandpass amplifier?
2. What is the nature of the signal at the output of the bandpass-amplifier circuit?
3. The burst-amplifier keyer stage in Fig. 6-13 is normally biased to cutoff. True of False?
4. The burst-amplifier stage is normally biased to cutoff. True or False?
5. In the color-sync circuit shown in Fig. 6-13, what corrective action takes place if the phase of the chroma-reference oscillator is too far advanced?
6. If the bias on the oscillator control stage in Fig. 6-13 is increased, will the phase of the oscillator signal be advanced or retarded?
7. Why is a limiter stage used in the color-sync circuit shown in Fig. 6-24?
8. How is the correct frequency and phase of the 3.58-mc reference signal assured in the circuit shown in Fig. 6-24?
9. What is the phase relationship between the two CW reference signals developed in the color-sync circuit?
10. What is the purpose of the color killer?

C. P. OLIPHANT

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VERNE M. RAY

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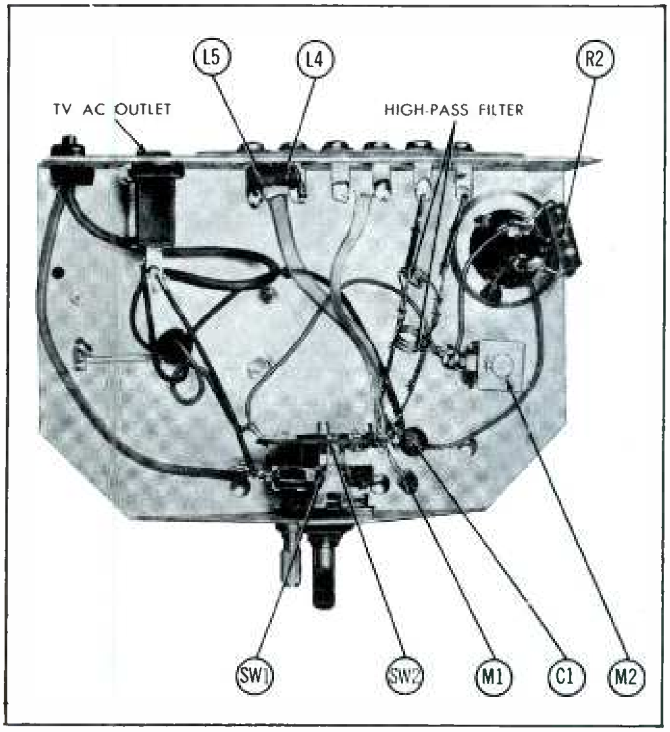


Fig. 8. Bottom Chassis View of Regency Model RC53.

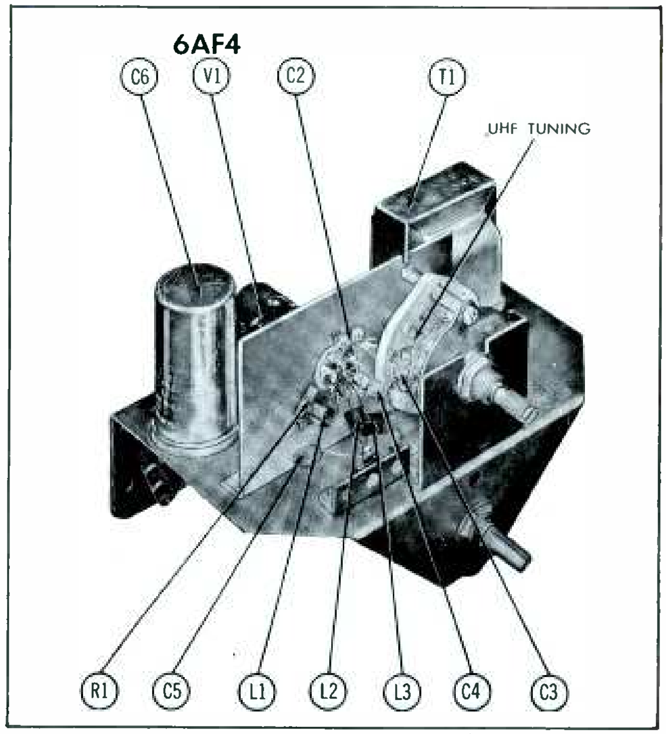


Fig. 9. Top Chassis Components in Regency Model RC53.

which is used in this converter is very similar to the 1N72 type of crystal. The 1N72 may be used for replacement purposes.

Oscillator tuning is accomplished by varying the length of the modified tuned line. The tuned line is actually made up of a modified ceramic wafer switch. See Fig. 9. This modified switch has all detents removed with exception of the stops at the ends. The two silver shoes which are parallel to each other are approximately 330 degrees long and are riveted and soldered together at one end. A terminal contact engages each silver shoe so that when the tuning shaft is rotated, the effective length of the tuned line is changed. This change in the length of the tuned line changes the frequency of the oscillator which is of the modified Colpitts type.

The output signal developed across L4 and L5 is the result of the heterodyne action in the mixer between the incoming signal and the signal from the 6AF4 oscillator which is of a frequency lower than that of the incoming signal.

Since no tuned output stage is employed, any VHF channel from 2 through 13 may be used for conversion.

According to the manufacturer, the oscillator has a long-time frequency stability of approximately 200 kc after a warm-up time of less than five minutes. The noise figure is also reported to be about 16 to 18 db, which closely approximates the crystal-noise figure.

To measure oscillator-injection current, insert a zero to 10-ma meter bypassed by a 1,000-mmf capacitor between the junction of L4 and L5 and the chassis. A reading of .3 to 5 ma over the tuning range of the converter should be obtained.

Voltage and resistance readings should be satisfactory for the solution of any other problems.

STANDARD COIL 82-CHANNEL TUNER

The Standard Coil tuner illustrated in Fig. 11 is an 82-channel,

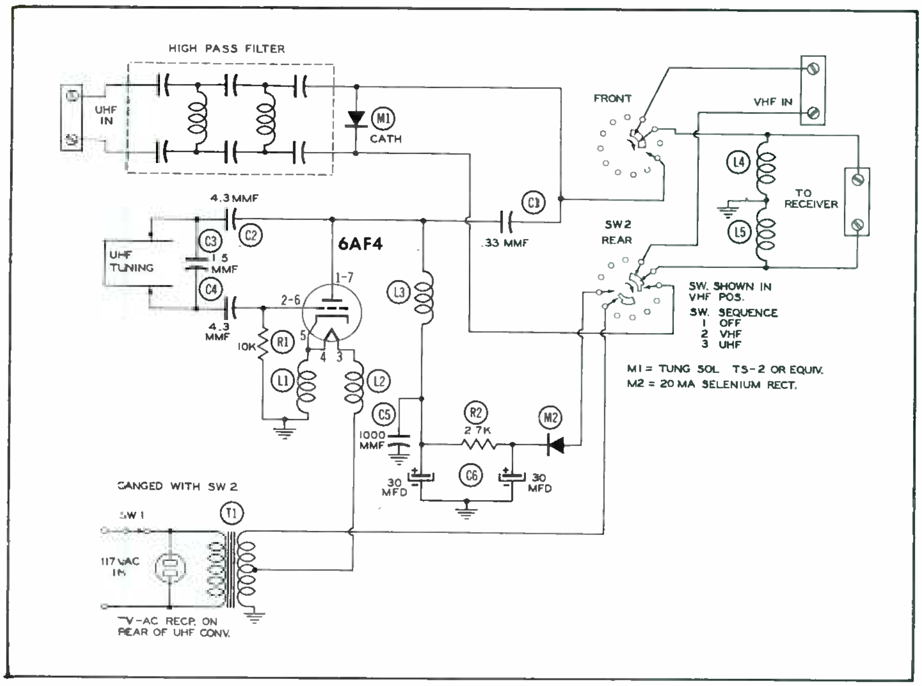


Fig. 10. Schematic of Regency Model RC53.

single-conversion, positive-detent tuner. Fine tuning is provided on all channels.

Close examination reveals that this tuner is actually a combination of two tuners that are tandem connected. The rear or VHF section is available to manufacturers as a separate unit for use as a VHF tuner alone. This VHF unit has been used recently in some makes of color TV receivers.

The VHF section is a conventional Standard Coil cascode tuner with an added "rocking" strip for 41-mc amplification. See Fig. 12. This rocking strip is a cam-operated device that changes the cascode RF amplifier and the pentode mixer in the VHF tuner to 41-mc IF amplifiers when the tuner is operated on UHF. The rocking strip makes contact on the same contacts that serve the VHF drum; and when it does, the VHF drum is electrically disconnected. The cam that operates the rocking strip is located on the rear of the UHF drum. It will be noticed in the figure that the front section of the tuner is the UHF portion and that it contains the components required for UHF reception. These are (1) a local oscillator operating at 41.25 mc above the sound carrier of the tuner station, (2) a preselector circuit, and (3) a mixer.

This tuner has many mechanical and electrical features that are both interesting and unusual. In order that these features may be explained more fully, they will be discussed independently.

Mechanical Features

It will be noticed in Fig. 13 that there are three controls which operate concentrically. The center control B is the VHF-UHF selector and the UHF range selector. The front control A is the VHF channel selector and also functions as the UHF vernier channel selector. The rear control C is the fine-tuning control for both UHF and VHF. The light mask shown in Fig. 13 is used to direct a beam of light at the operating window in control B.

Detent tuning over the entire UHF range is accomplished by the use of a decade system. The tens portion of the decade is made up of the eight individual UHF strips and is actuated by control B. The units portion of the decade is operated by means of control A. This control varies in steps the dielectric between the capacitor plates on the individual UHF strips. The dielectric consists of vanes which are fastened to the

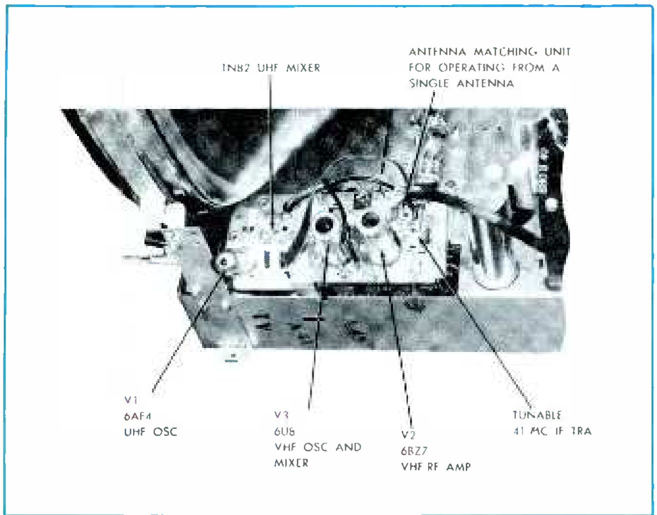


Fig. 11. View of 82-Channel Tuner Mounted on Typical TV Chassis.

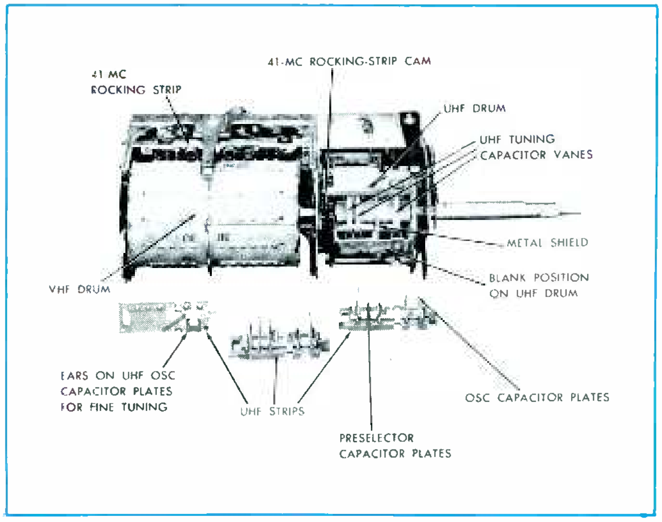


Fig. 12. Bottom View of Tuner Showing Details of VHF and UHF Sections.

same shaft that actuates the VHF drum. Refer to Fig. 12.

There are nine positions on the UHF drum assembly, but there are only eight strips on the drum. One position is left blank for VHF switching purposes. The blank position also provides access from the front of the tuner to adjustment slugs in the VHF oscillator strips. The access hole in the front of the tuner can be seen in Fig. 14.

When control B in Fig. 13 is turned to the VHF position, the cam on the rear of the UHF drum (see Fig. 12) causes the rocking strip to be disengaged and the VHF drum to establish contact. Control A may then be turned to the desired VHF channel. Control C is turned for fine tuning.

When control B is turned so that one of the UHF decade strips is in operating position, the cam on the rear of the UHF drum causes the rocking strip to be connected into the circuit and the VHF drum to be disengaged. This mechanical action changes the RF amplifier and pentode mixer to 41-mc IF amplifiers and at the same time disables the VHF local oscillator by removing its plate voltage. Control A may then be turned to the desired UHF channel in the selected range. Control C is also used for UHF fine tuning. This is accomplished by mechanically connecting the UHF and VHF fine-tuning dielectrics to the same shaft.

On the lowest UHF range (UHF strip marked 10), four VHF stations (10 through 13) and six UHF stations (14 through 19) may be received. This is a function of the cam construction on the rear of the UHF drum. This cam is so constructed that the rocking strip is disconnected for these four VHF channels.

For an illustration, let us suppose that the operator has been viewing a program on UHF channel 14 and desires to change to a program on VHF channel 13. By rotating control A one step in a counterclockwise direction, it will be noted that the number 13 will appear in the UHF-range window. Channel 13 will be received normally in this position because the 41-mc rocking strip, as stated earlier, is disconnected by the cam on the rear of the UHF drum. This same condition will exist for VHF channels 12, 11, and 10. For reception on VHF channels 9 and under, control B must be turned to the VHF operating position.

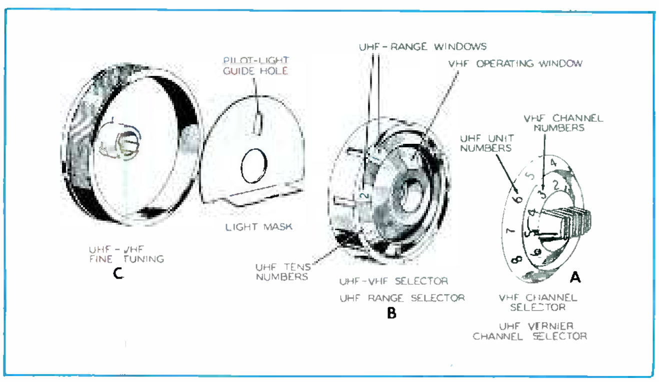


Fig. 13. Exploded View of Knob Assembly for Channel Selector. The UHF and VHF Numbering Systems Are Shown.

In removal of the drum assembly, care should be taken not to damage the UHF range strips. Remove both detent rollers and both retaining springs. Rotate the drum assembly so that the VHF blank on the UHF drum is adjacent to the cam follower that actuates the 41-mc rocking strip. The drum assembly may then be removed without damage to the UHF range strips.

The construction of the VHF fine-tuning mechanism is somewhat unusual and should be mentioned. Fine tuning is accomplished by varying the dielectric between two plates of the fine-tuning capacitor. The edge of the fine-tuning bar can be seen in Fig. 14.

Electrical Features

The VHF portion of this tuner has several interesting circuit features. Among these features is the tunable 41-mc IF trap at the antenna input. This unit may be tuned to attenuate any frequency in the 35- to 48-mc range. The remainder of the 41-mc trap assembly is designed for maximum rejection of IF interference. The circuit of this trap assembly is shown in Fig. 15.

Some of the most interesting features of the UHF portion of this tuner are associated with the channel-changing arrangement. Other UHF tuners usually use either tuned-line, variable capacity, or variable inductance methods of changing channels. This UHF unit uses a combination of methods. The UHF range is selected by changing the preselector and oscillator coils. The individual channels for each range are selected by step changes of capacity to resonate the oscillator and preselector coils. This change of capacity in steps is accomplished by varying the dielec-

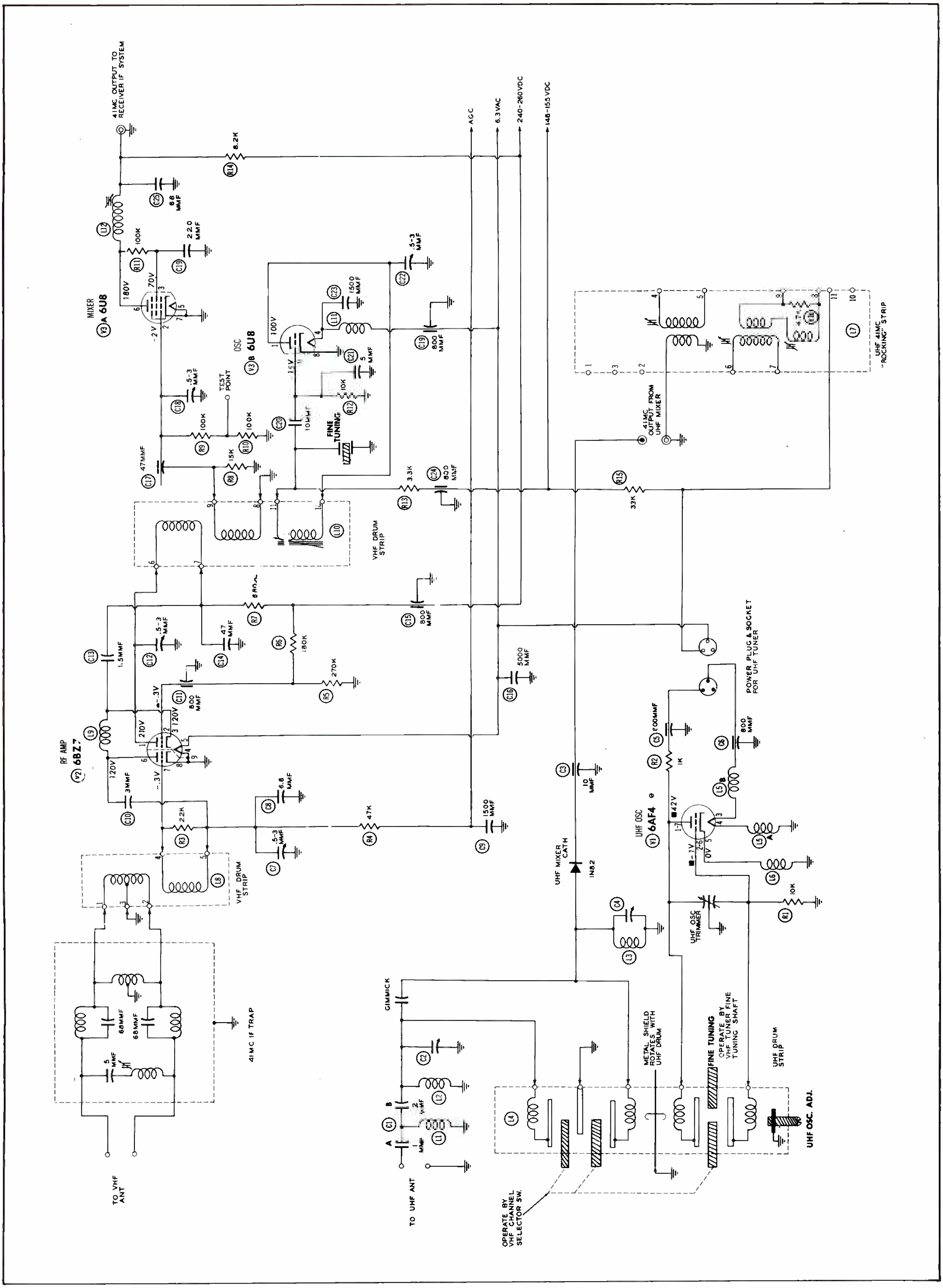


Fig. 14. Schematic Diagram of 82-Channel Tuner.

tric between capacitor plates which are a part of each UHF range strip. The mechanical features of this change have already been discussed.

The UHF range strips are constructed so that each snap of the channel selector produces a 6-mc frequency change over the entire UHF range. Each UHF range strip has an oscillator adjustment screw which may be adjusted for tracking on each strip. The adjustment screws are accessible through the hole in the fine-tuning cam. See Fig. 15.

The input to the preselector is coupled through a high-pass filter which passes only frequencies of 470 mc and over. The output of the preselector is fed to a crystal mixer 1N82 where it is combined with the local-oscillator signal which is 41.25 mc above the sound carrier of the received signal. The resultant 41-mc signal is then coupled to the rear VHF section of the tuner. This section amplifies the signal and passes it on to the IF section of the receiver.

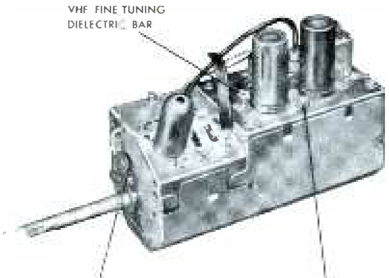


Fig. 15.- Top View of 82-Channel Tuner.

It is interesting to note in Fig. 14 that even in VHF operation, some voltage is applied to the plate of the UHF oscillator tube. This voltage increases the stability of the oscillator when the set is switched from VHF to UHF operation. Since the UHF oscillator tube is kept in a state of partial conduction by this voltage, the initial frequency drift of the oscillator is kept at a minimum.

An oscillator trimmer is provided on some models to compensate for differences in tube characteristics. UHF fine tuning is accomplished by varying the dielectric between extensions on the blades of the oscillator tuning capacitor.

CALVIN C. YOUNG, JR.

Shop Talk

(Continued from page 11)

given as a certain figure. If the same tuned circuit is connected across the output of an amplifier circuit, the resonant frequency is lowered. The reason for the reduction is the additional capacity which the amplifier adds to the tuned circuit. If it is desired that the tuned circuit should regain its original frequency, either some turns of the coil must be removed or the value of the tuning capacitor will have to be decreased.

In the case of an antenna wire, the external circuit is space itself. This space tends to act as an additional capacitance placed across the wire; and to attain the original resonant frequency, the inductance of the wire must be reduced by shortening its length. In addition, nearby physical objects will also have an effect on the wire, necessitating further modification. In equation 4, only the effect of free space was taken into account; and in this sense, the calculations made with this equation were too high.

The general equation 5 applies not only to antenna wires but to any conductor that carries electromagnetic waves. Of particular interest are transmission lines, since the service technician is frequently called upon to provide stubs for removing specific interferences. Typical values of k for popular transmission lines are:

TRANSMISSION LINES	VALUE k
Open parallel-wire	.975
Polyethylene twin-lead, 300-ohm	.93
Polyethylene twin-lead, 150-ohm	.77
Coaxial	.66

These values differ considerably from each other and cause a similar variation in the length of any quarter- or half-wave sections made with them. Furthermore, each of the foregoing values are simply representative or average values for the lines indicated; and within any one group, there could be and generally is a rather appreciable variation.

It is seen then that because of the large number of variables which influence the length of an antenna, any formula is at best only an approximation. Fortunately, in moderate and strong signal areas, the tolerances in antenna length are so very wide that the length could be

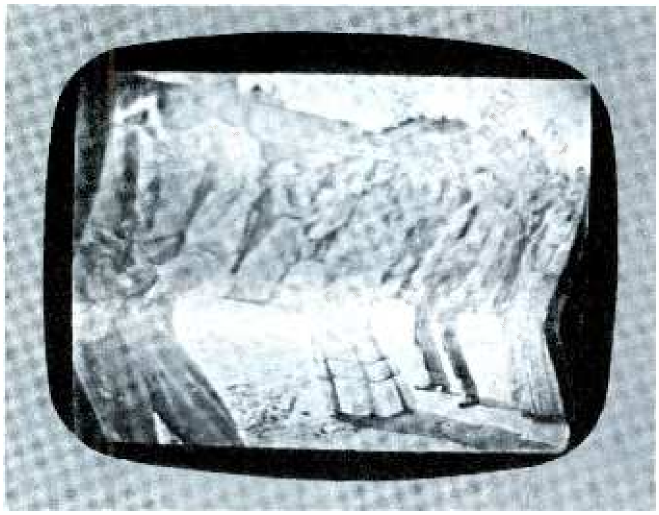


Fig. 1. Example of 60-Cycle Hum Illustrating Ripples at Edge of Picture and Variations in Brightness. (Courtesy of DuMont Service News.)

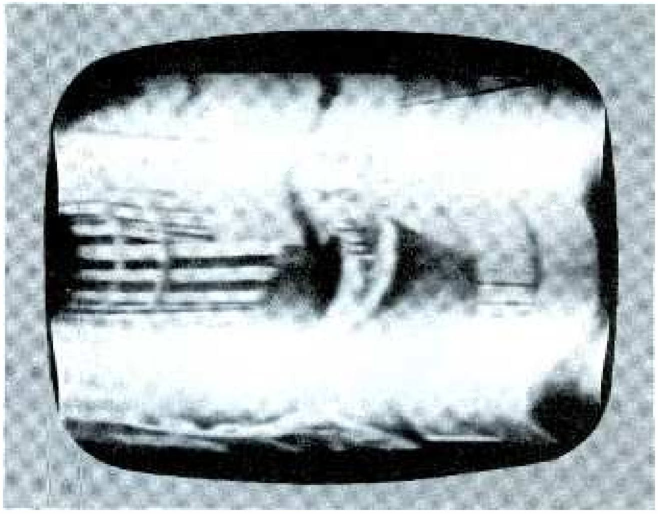


Fig. 2. Example of 120-Cycle Hum Showing Sinusoidal Ripples at Sides of Picture and Two Horizontal Bars. (Courtesy of DuMont Service News.)

varied by as much as 50 per cent or more and the effects could not be noticed on the picture. It is only when the signal level drops below 100 microvolts that the dimensions become critical and that an experimental approach is suggested. That is, take antenna rods that are somewhat shorter than you need and fit them with movable inner sections. Then position the antenna for the best picture possible. Next, disconnect the lead-in line from the receiver, and attach it to a field-strength meter. Then gradually vary the antenna length (via the movable inner rods) until the highest signal reading is obtained.

Of course, in weak signal areas, you want arrays that are more elaborate than a simple dipole; and it is generally better to buy these than to build them yourself. The more elaborate the array, which is to say, the more elements it contains, the better its signal-catching ability. By the same token, however, increasing elaborateness means greater criticalness so far as matching is concerned; and the latter can outweigh the former, sometimes to such an extent that the technician finds he gets better results using a simpler array having less inherent gain.

In addition to mismatching, there are other problems involved in antenna installation. For example, there are the vertical and horizontal directivity patterns of an array to consider. Of the two, it is the horizontal directivity which receives the more attention and rightly so, because it is the one in which we are generally interested; however, in outlying areas far removed from a station, the angle of arrival of the incoming signal may be such that it will be discriminated against by the vertical directivity of the array. As a matter of fact, the more bays an antenna has, the sharper its vertical directivity; and with these structures, reception at locations where the angle of arrival is wrong will be poor in spite of the greater horizontal gain of the array.

All of this leads to the practical suggestion to test each array at a given location to see how well it performs.

REVIEW

From time to time, the technician is called upon to repair television sets which exhibit hum. The hum may be aural or visual, or both. While this is not ordinarily the most difficult type of trouble to locate, finding it can become very complex unless the proper analysis is made. An article designed to acquaint the service technician with an expeditious approach to such problems appeared in the June 1953 issue of the DuMont Service News. The title was "Hum Problems in TV Receivers."

The DuMont Service News is published by the Teleset Service Department of the Allen B. DuMont Laboratories, Inc., 257 Sixteenth Avenue, Paterson, New Jersey.

Hum symptoms in a television receiver can appear in any or all of the three general sections — audio, video, or deflection. In the audio system, hum will make itself known by the sound it produces in the loudspeaker. The hum may possess a frequency of 60 or 120 cycles; and with a little experience, it is possible to distinguish between the two. (As a check on the frequency, take a 1-megohm resistor and connect it between heater and grid of the audio amplifier of another set. The sound produced is 60 cycles, and this may be compared with that heard from the receiver under test.)

Any 60-cycle hum stems from a line carrying the 60-cycle power-line currents. In a receiver, this is usually the filament line. For the 60-cycle voltage to reach the signal path, the most frequent point of entry is via heater-to-cathode leakage in a tube.

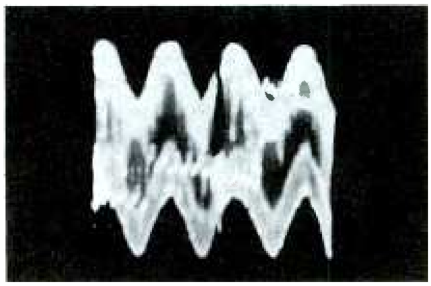
If it is found that the hum is present solely in the sound system, with the picture unaffected, then it is reasonable to assume that the trouble is located in some stage through which only the audio signal passes. This would include the sound IF, the detector, or the audio amplifiers.

A 120-cycle hum is a product of the power supply in which full-wave rectification converts the 60-cycle voltage to 120-cycle voltage. In a receiver that is operating normally, power-supply filters remove the 120-cycle voltage to such an extent that the hum level is low. However, an open filter capacitor could permit enough voltage to remain to make the hum audible.

Since the 120-cycle voltage is associated with the power supply, it is seldom that one finds 120-cycle hum in the audio system without a companion distortion in the picture. If both appear, the filter capacitors can usually be checked by bridging them with a good unit.

Not to be confused with audible hum is sync buzz. This is caused by the incoming sync pulses or by vertical-sweep signals reaching the audio system. Sync buzz has a harsh,

(A) With 60-Cycle Hum.



(B) With 120-Cycle Hum.

Fig. 3. The Appearance of Video Signals.

raspy tone and can be positively identified by removing the signal. The tone should disappear when this is done. If it persists, rotate the vertical hold control. Any corresponding change in buzz tone means that the buzz is due to the vertical-sweep signal.

Let us consider hum indications in the picture. One or more of the following symptoms may be observed.

1. One or two broad bars caused by variation in brightness. One bar is an indication of a 60-cycle voltage; two bars indicate a 120-cycle voltage.

2. A single broad bar in the raster. This will always be accompanied by a similar condition in the picture, although it is possible for the bars to appear in the picture and not affect the raster. This is a significant distinction which will be discussed more fully in a moment.

3. A sinusoidal ripple along the vertical edges of the picture.

4. A sinusoidal ripple at the horizontal edges of the raster. As before, this will always affect the picture, although a ripple may appear at the edges of the picture and not affect the raster.

5. Poor sync stability; also, loss of vertical or horizontal sync.

Illustrations of 60-cycle and 120-cycle hum in the picture are given in Figs. 1 and 2. The 60-cycle voltage produces one cycle of brightness variation from top to bottom in

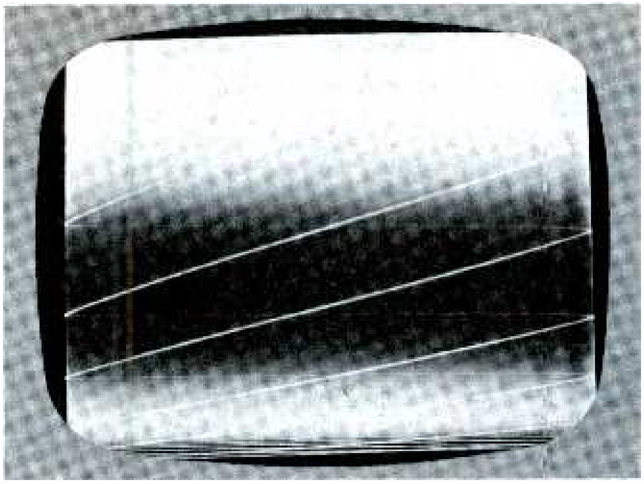


Fig. 4. Hum Bar in Raster Usually Caused by Heater-Cathode Leakage in the Video Amplifier or CRT. (Courtesy of DuMont Service News.)

the picture; a 120-cycle voltage will produce two such brightness cycles. If you turn each illustration on its side, you will see that the 60-cycle picture has one ripple along its edges; whereas, the 120-cycle picture shows double ripple.

The horizontal pulling in the picture reveals that the hum voltage is reaching and affecting the horizontal sync system. Furthermore, the raster edges are straight (as seen in Fig. 1), indicating that the trouble is not arising in the horizontal-deflection system itself. When all these facts are considered together, the only conclusion that the technician can come to is that the AC voltage is combining with the incoming signal at some point along the signal path. This can be verified by removing the signal. The result should be a clean raster such as those in Figs. 1 and 2.

The most common source of this trouble is heater-to-cathode leakage. Check the RF amplifier, mixer, oscillator, and video IF tubes. It is also a good idea to remember that an AC voltage could reach the signal path via the AGC line. A scope will reveal any departure from the normal DC voltage on the AGC line.

The video signal can be scoped at the video second detector. Presence of 60- or 120-cycle voltage will appear as shown in Fig. 3. With a demodulator probe, you could then check the signal back through the video IF system to the point where the hum distortion disappears and in this way pinpoint the tube or stage causing the trouble. The video detector, video amplifiers, and picture tube are not included because of the clean raster when the signal is removed. If the heater-to-cathode leakage is arising in the video detector or subsequent stages, then the raster will show a brightness variation, too. See Fig. 4.

Because of leakage in a stage following sync take-off, it is possible for the hum bar to appear in the picture but for the vertical edges to remain straight. Occasionally, when the hum amplitude is low, it may affect the picture but not the sync. This fact leads to the conclusion that the leakage is occurring beyond the sync take-off point. Check the signal at the video second detector with an oscilloscope, and note whether it contains any hum. This will give you a clue as to the location of the trouble.

If the picture has a sinusoidal bend but the raster is all right and there is no hum bar, the trouble is probably in the horizontal sync or AFC circuits. The clue for this is the absence of the hum bar, indicating that the 60-cycle voltage is not affecting the video signal. The hum must be disturbing the sync pulses, and the horizontal sync and AFC circuits are suspected because of the picture curvature. If the 60-cycle voltage enters the vertical system with sufficient strength, it will cause the vertical hold control to be critical, possibly with the picture flopping over frequently.

There is an alternate situation in which the 60-cycle ripple is present along the vertical edges of the raster, but a hum bar does not appear in the picture. Again, the 60-cycle voltage is not in the signal path; this time it is the raster that is affected, and the prime suspects are the horizontal oscillator and output amplifier. We can eliminate the sync circuits because they do not directly contribute to the formation of the raster. This is a good distinction to keep in mind. In a few cases, it is possible for hum occurring in the AFC circuits or other stages preceding the sweep circuits to reach the sweep circuits and cause raster distortion. This condition can usually be recognized by the fact that the amplitude of the ripple in the raster is much less than the amplitude of the picture ripple.

MILTON S. KIVER

In the Interest of Quicker Servicing

(Continued from page 15)

Another recent service call in which the use of service literature made possible a very simple repair of a receiver that otherwise might have had to be taken to the shop comes to mind. This call was to service a Truetone Model 2D2333A. The complaint from the customer was that the receiver had good sound but no raster. The first check showed that high voltage was available and sufficiently high. The picture-tube filament was lit. Using the voltmeter from the tool kit, the technician measured the voltages at the picture-tube base. This revealed that the voltage on pin No. 11 did not vary with variations of the brightness control. Examination of the schematic also revealed that this voltage was greatly in excess of the 45 volts given on the schematic. In fact, the voltage was in excess of 300 volts. From these indications it was determined that the only possible cause of the trouble was that C68, the

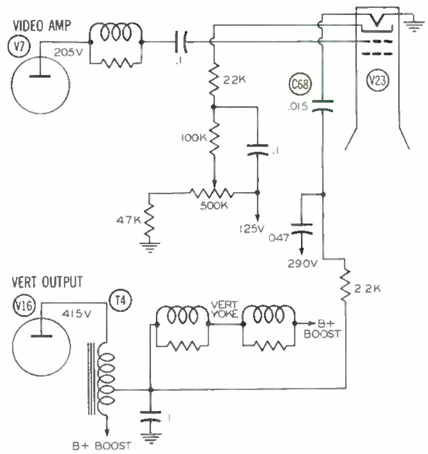


Fig. 2. Schematic of Retrace-Blanking Circuit in Truetone Model 2D2333A Receiver.

.015-mfd 600-volt capacitor that was used to couple the vertical-retrace-blanking signal, had shorted. A schematic diagram of this portion of the receiver is shown in Fig. 2 so that this discussion can be more closely followed. Replacement of the capacitor restored the set to normal operation. This job took almost no time to perform because it eliminated a repair bill for work done in the shop and also eliminated a trip to return the chassis to the customer. The over-all advantages were a saving to the customer with more profit to the service dealer. In addition to this, the customer did not have to do without his receiver; and for that, he was also thankful. Such good will is actually money in the service dealer's pocket eventually.

CHART I

LOCATION OF MODEL AND CHASSIS NUMBERS

MAKE	MODEL NO.	LOCATION	CHASSIS NO.	LOCATION
ADMIRAL	Has 1 or 2 digits, 1 letter, and 2 or 3 more digits; sometimes ends in letter. Examples: 4H115, 21X12, 29X26A.	Tube-placement chart inside cabinet.	Has 2 digits, a letter, and 1 digit. Examples: 20B1, 22Y1.	Stamped on rear apron of chassis.
ANDREA	Has 2, 3, or 4 letters and 2 or 3 digits. Examples: COVK-125, CO-VK15, CO-U15.	Sticker inside cabinet.	Part of model number.	
ARVIN	Has 4 digits and 1, 2, or 3 letters; UHF follows for UHF models. Examples: 5024M, 8213TMA, 8211TM-UHF.	Sticker on back cover of set.	Has letters TE and 3 or 4 digits. Examples: TE330, TE332-4.	Rear apron of chassis.
BENDIX	Newer models have 4 digits. Older have 1 or 2 letters, 2 or 3 digits, and 1 or 2 letters; sometimes 2 digits, 1 letter, and 1 digit. Examples: 2025, KB21C, 21X3.	Back cover on tube-placement chart.		
CAPEHART	Has 1, 2, or 3 digits; 1 or 2 letters; and sometimes 2 or 3 more digits. Examples: 2T20MX, 12F272M. Some older models have 3 digits and sometimes 1 or more letters. Examples: 320BX, 321, 323M.	Sticker on back cover of set.	Has CT or CX and 2 digits; sometimes ends in 2 letters. Examples: CT27, CX33, CX33DX.	Stamped on rear apron of chassis.
CROSLEY	Has 1 or 2 letters, 2 digits, 3 or more letters; sometimes another digit. Examples: DU-21CDM1, EU-17TOB. Some early ones have numbers such as: 9-424B, 11-441MU, 17CDC1.	Sticker on back cover of set.	Usually 3 digits; sometimes 2 digits and 1 letter. Examples: 404, 404-1, 30E, 30E-1.	Stamped on rear apron of chassis.
DuMONT	Uses names such as Andover, Bradford, and Somerset.		Has RA, 3 digits, and 1 letter; sometimes another digit added. Examples: RA-110A, RA-160A1.	Plate on rear apron of chassis and is part of serial number.
EMERSON	Has 3 digits and 1 letter sometimes. Examples: 648B, 650, 784A.	Stamped on back cover of set.	Has 120 plus 3 digits and letter. Sometimes 120 not on chassis. Examples: 120208D, 120182D, 209F, 210D.	Stamped on rear apron of chassis.
FADA	Has 1, 2, or 3 letters and 2, 3, or 4 digits: may have 2 digits, 1 letter, and another digit. Some early models have 3 digits. Examples: H212C, S20T20, UHL2100T, 20C2, 721.	License label on rear apron of chassis.	No chassis number.	
G.E.	Has 2 digits with letter and 1, 2, or 3 more digits. Examples: 21T6, 2T20, 20C107.	Stamped on back of set.	None.	
HALLICRAFTERS	Has 3, 4, or 5 digits. Some early sets had letter T and 2 digits. Examples: 506, 1078, 20823, T60.	Rear cover of set.	Has 1 or 2 letters, 4 digits, and letter. Examples: A1100D, AR1200D.	Rear apron of chassis.
HOFFMAN	Has 1 or 2 digits, letter, and 3 more digits. Sometimes ends in letter. Some early models had 3 digits. Examples: 7B110B, 21M700, 950.	Sticker on rear cover of set.	Has 3 digits, and sometimes letter. Examples 191, 196M.	Stamped on rear apron of chassis.
MAGNAVOX	For more complete information, use the chassis numbers.		Has 2, 3, or 4 letters, 3 digits; may have 2 more letters. Examples: CT214, CMUA410BB, CMU418AA.	Stamped on left side of rear apron of chassis.
MAJESTIC	Has 2 digits, letter, and 1 or 2 digits. Examples: 21T20, 20T8A1. Early models had 3 or 4 digits preceded or followed by a letter. Examples: G-414, 2042C.	Label on back cover of set.	Has a series number of 3 digits. Examples: Series 108, Series 102.	Stamped on rear apron of chassis.
MECK	Has 2 or 3 letters, 3 digits, and 1, 2, or 3 letters. Examples: JM-1717T, XQA-776. Some early models had 3 digits and letter. Example: 619C.	Tube-placement chart on inside of cabinet.	Has 4 digits. Example: 9040.	Tube-placement chart inside of cabinet.
MOTOROLA	Has 1 or 2 digits, 1 or 2 letters, 1 or 2 digits, and sometimes 1 or more letters. Examples: 21F3BD, 20T3. Some recent model numbers preceded by letter usually Y. Example Y24K1. (See chassis number also.)	Sticker on back cover of set.	Has 2 or 3 letters, TS or WTS, and 2 or 3 digits; sometimes ends in 1, 2, or 3 letters. Examples: TS-292AY, WTS-502.	Rear apron of chassis.
MUNTZ	Has 4 digits. Example: 2162. Some late models have 3 digits, 1 letter, 1 digit. Example: 321T3.	Sticker inside cabinet.	Has 2 digits, letter, and 1 digit. Example: 17B3.	Sticker on rear apron of chassis and precedes serial number.
OLYMPIC	Has 2 digits, letter, 2 digits. Example: 17T40. Some early models had 3 digits sometimes preceded by 2 letters. Examples: DX-630, 785.	Inside of cabinet and on sticker on left rear corner of cabinet.	Has 2 letters and 2 digits. Examples: TN-21, TL20.	Stamped on rear apron of chassis.
PACKARD-BELL	Has 4 digits sometimes followed by letters TV. Examples: 2115, 2298-TV.	Sticker on back of cabinet, lower center.	Has 4 or 5 digits. Examples: 2840, 2840-1.	Etched on rear apron of chassis; accompanies serial number.
PHILCO	Has 2 or 3 letters, 4 digits. Examples: A-UT2289, A-T2272. Earlier models had 2 digits, letter, 4 digits. Example: 50T1104. Earliest had 2 digits, dash, 4 digits. Example: 49-1040.	Tube-placement chart on inside of cabinet.	RF chassis consist of 2 digits on early models; letter, 3 digits on late. Examples: 44, R-181. Deflection chassis on early models had letter and 1 digit; late had letter and 3 digits. Examples: D-1, D-181.	Stamped on rear apron of chassis. (Code number identifies major changes on chassis, and it must be known.)
RCA VICTOR	Has 1 or 2 digits, 1 or 2 letters, and 2 or 3 digits. Examples: 6T86, 8TC270, 17T154. Some early models had 3 digits and 2 or 3 letters. Examples: 648PV, 630TCS. Other early models had 1 or 2 letters and 3 digits. Examples: T-100, TA-128.	Tube-placement chart on inside of cabinet.	Has letters KCS, 2 digits, and letter. Example: KCS48A.	Stamped on rear apron of chassis.
RAYTHEON	Has 1 or 2 letters and 4 digits; sometimes ends in letter. Examples: M-1737, RC-1618A.	Stamped on back cover of set.	Has 2 digits, 1 or 2 letters, and 1 or 2 digits. Examples: 16AY28, 21T1.	Stamped on rear apron of chassis.
SENTINEL	Has 1 digit, 1 letter, and 3 more digits. Examples: 1U500. Some early models had 3 digits. Examples: 438, 416.	Tube-placement chart on inside of cabinet or on back cover.	Has series and 2 or 3 letters, or 1 digit and 4 letters. Examples: Series XX, Series XXD, Series 2XD.	Stamped on rear apron of chassis.
SILVERTONE	Has catalog number and 4 digits; sometimes has letter at end. Example: Catalog No. 9130.	Sticker on back cover of cabinet.	Has 3 digits, decimal point, 3 digits; sometimes dash and 1, 2, or 3 more digits. Examples: 478.309, 110.499-2.	Etched on plate of chassis.
SPARTON	Has 4 or 5 digits sometimes followed by 1 or 2 letters. Examples: 4900TV, 10352.	Sticker on back cover of cabinet.	Has 1 or 2 digits, 1 or 2 letters, 2 or 3 digits. Examples: 19TS10, 3TB10, 25D213.	Sticker on rear apron of chassis.
STEWART-WARNER	Has 4 digits sometimes followed by letter. Example: 9202-C. New models have 2 digits, letter, and 4 digits. Example: 21C-9300E.	Stamped on rear left corner of chassis.		
STROMBERG-CARLSON	Has 3 digits and 3 or 4 letters; or 3 digits, 1 letter, 1 or 2 digits, and a letter. Examples: 625CDM, 521C5G. Some early models had 2 letters and 2 or 3 digits. Examples: TC-19, TV-125.	Stamped on rear apron of chassis.		
SYLVANIA	Has 2 or 3 digits, 1 or 2 letters, and maybe 1 or 2 more digits. Examples: 73M-1, 105MU. Some have 3 digits, dash, and 2 more digits. Example: 175-18.	Tube-placement chart on inside of cabinet.	Has 1 digit, dash, 3 digits, dash, sometimes 1 more digit; is part of serial number. Examples: 1-508-2, 1-139.	Rear apron of chassis; is part of serial number.
TRUETONE	Has letter D and 4 digits; or 2D, 4 digits, and 1 letter. Examples: D1994, 2D2312A.	Rear apron of chassis.		
WESTINGHOUSE	Has letter H, 3 digits, sometimes another letter, and 1 or 2 digits. Examples: H-628K16, H-225. (Get chassis number for more positive identification.)	Back cover of cabinet and tube-placement chart on inside of cabinet.	Has letter V, 4 digits, and sometimes 2 or 3 more digits; may end in letter. Examples: V-2132, V2146-05, V2150-94C.	Stamped on rear apron of chassis.
ZENITH	Has letter, 4 digits, and letter. Examples: K1846R, L2259E.	Rear upper rail of cabinet.	Has 2 digits, letter, and 2 more digits. Examples: 19L27, 24H20.	Stamped on rear apron of chassis.

Quicker Servicing

IN THE SHOP

Servicing the Synchroguide AFC Circuit

Because the troubles which occur in horizontal AFC systems can be puzzling, it is felt that a discussion of the servicing problems which are encountered in these systems would be beneficial. A typical synchroguide circuit has been selected; and a few of the problems, their symptoms, and solutions are given in the following material.

The schematic in Fig. 3 is used as a reference. Each problem is taken from the actual servicing records of a bench technician. Waveforms and picture-tube displays were reconstructed and photographed specifically for this article.

Problem No. 1

The picture was very wavy, as may be seen in the photograph of Fig. 4 which was taken directly from the screen of the receiver. This waviness was quickly recognized as the symptom that is well-known as the "pie-crust effect."

The technician knew from past experience that an open component in the cathode circuit of the control tube could produce this effect. Consequently, the following four components were immediately on the suspect list: C3, C4, C5, and R5.

It was a simple matter to find out just which of these components was actually causing the trouble. First, the resistor R5 was checked with the ohmmeter and found to be good. Next, each of the capacitors was replaced one at a time with a substitute. When a substitute was put in the place of C4, the set returned to normal operation.

This was one of those "few and far between" cases in which the symptom points a condemning finger directly at the small circuit that is causing the trouble. Such was not the case with the next problem, however.

Problem No. 2

The receiver had lost horizontal synchronization. The horizontal hold control had some effect upon the picture but could not lock it in.

Tubes in the horizontal-sweep and sync sections had already been checked by substitution, so it was decided to investigate waveforms in the AFC and oscillator stages. These waveforms showed only one thing.

The trouble was not in the AFC circuit. The waveforms in the plate circuit of the oscillator were all distorted, whereas those in the AFC circuit were normal except for the pulses fed back from the oscillator.

All efforts were then directed at the oscillator portion of the circuit. A measurement of all the voltages failed to reveal anything. The next step was to check all the resistances in the circuit. These measurements also failed to turn up anything that could shed light on the trouble. None of the resistances were far enough off tolerance to cause any difficulty.

By this time, the technician was getting very exasperated. Only two things were left to do: to make substitutions for the capacitors and for the synchroguide coil L1. Since the capacitors were the easiest for which to substitute, they were tried first. Luckily, the first one tried was C6 which was the one causing the trouble.

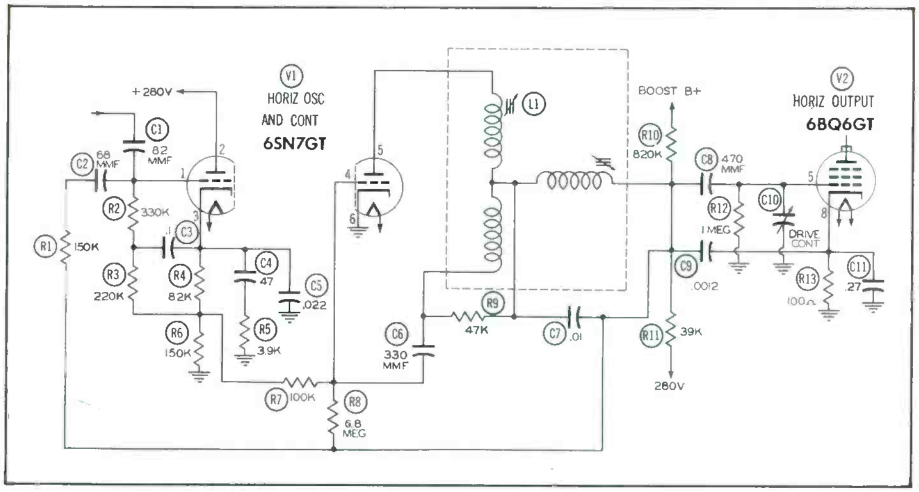


Fig. 3. Schematic of Typical Synchroguide AFC Circuit.

When the replacement was completed, the old capacitor was checked with a capacity bridge to determine what was wrong with it; and it was found to have changed value from 330 mmf to approximately 150 mmf. Such a value change can occur in a mica capacitor as a result of aging; and in this particular application, the value of capacitance is very critical.

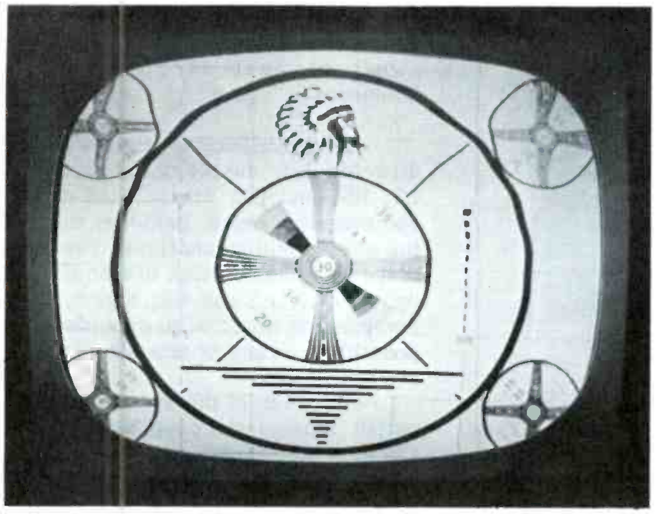


Fig. 4. Pie-Crust Effect in Problem No. 1.

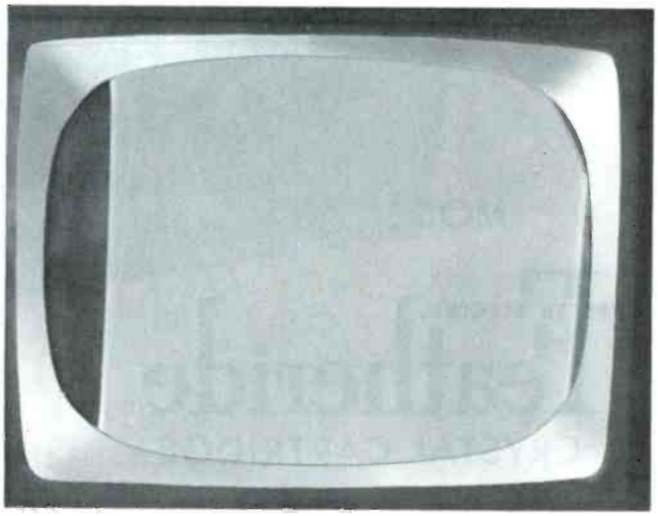


Fig. 5. Blank, Narrow Raster in Problem No. 4.

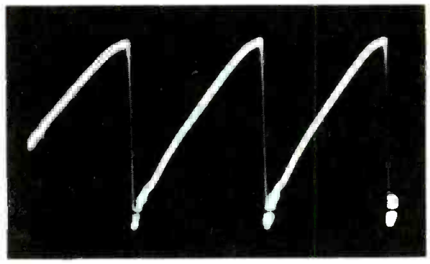


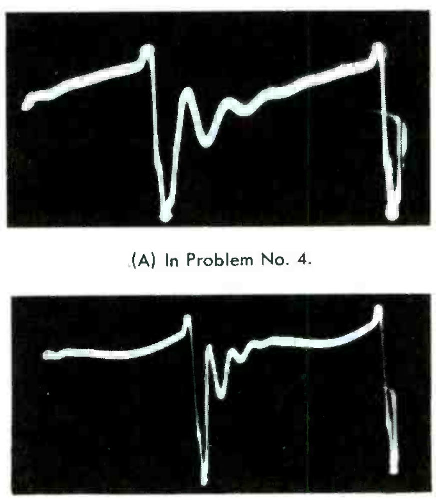
Fig. 6. Normal Drive Voltage on the Grid of the Horizontal-Output Tube.

Problem No. 3

The symptom in this receiver was loss of synchronization accompanied be a dim raster. This combination led the technician to believe that the same trouble that was causing the loss of sync must also be causing the dim raster. This meant that the signal or drive on the grid of the horizontal-output tube was probably reduced considerably from its normal value of voltage. If this was true, then the cause must be somewhere in the wave-shaping network or else some component was loading the oscillator and was reducing the amplitude of the signal as well as changing its frequency.

With this in mind, the technician directed his suspicions toward L1, C7, R9, and C9; since these are the components which perform most of the wave-shaping functions. The shape of the saw-tooth voltage is also affected by R10, R11, and C8; hence, these components were also considered as possible sources of trouble.

A check of the waveform at the output side of the coupling capacitor C8 indicated insufficient drive on the grid of the horizontal-output tube. The signal on the input side of the capacitor was observed next. The difference between the two waveforms showed



(A) In Problem No. 4.

(B) Under Normal Conditions.

Fig. 7. Grid Voltage on the Horizontal Oscillator.

that the usual amount of signal was being dropped across the capacitor. This was an indication that the trouble was not in the capacitor C8 but was ahead of it in the plate circuit of the oscillator.

Resistors R9, R10, and R11 in the plate circuit were then checked and found to be very satisfactory. The next step was to check capacitors C7 and C9 by substitution. C9 was found to be the culprit. It had changed value with age. When checked on a capacitor checker, it measured .0002 mfd instead of .0012 mfd.

This change in capacitance had resulted in a pronounced change in the shape of the drive-voltage waveform. This, in turn, affected the high voltage and produced the dim raster. The distorted drive voltage also caused loss of synchronization, since it was fed back to the AFC tube through R1 and C2.

Problem No. 4

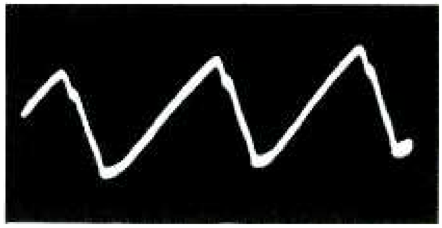
When the set was turned on, the picture appeared for just a few seconds but it was out of synchronization. Then the video faded out and left a blank raster, as shown in Fig. 5. Note in the photograph that the raster is also decreased in width.

The combination of these three symptoms added up to a very misleading conclusion. The reader may be thinking the same thing that the technician thought — low B+, but this was not the case.

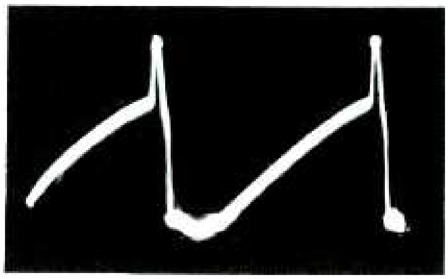
The first thing the technician did was to reach for the VTVM and measure the output voltage of the power supply. He was quite surprised to find that it was up to normal. The next thing he did was to measure the plate voltages on the horizontal-oscillator and video-output tubes, still believing that the trouble was stemming from low voltage. Again, he found that the voltages were normal. By this time, he was ready to buy a new meter. Instead, he checked the meter against another and found that there was nothing wrong with it.

Not being able to find anything by this line of attack, the technician decided to concentrate on one circuit first; and since loss of synchronization was the first symptom that showed up when the set was turned on, the horizontal-sweep section was thought to be as good a place to start as any.

Checking waveforms seemed to be a good idea; therefore, the scope was put into play. First, the scope lead was placed on the grid of the output tube, and the technician found that it looked normal except for its



(A) In Problem No. 4.



(B) Under Normal Conditions.

Fig. 8. Grid Voltage on the AFC Tube.

amplitude. The amplitude was greatly reduced from the 85- or 90-volt signal which is normally fed to this grid. Instead, the amplitude measured 45 volts peak to peak. The signal normally found at this point may be seen in Fig. 6.

The scope lead was moved to the grid of the horizontal oscillator (pin No. 4). The signal at this point was about half the amplitude that it should have been, and it was distorted. Fig. 7A is a photograph of this waveform. Compare it with the one it should have looked like, as may be seen in Fig. 7B.

The probe was next moved to the grid of the AFC tube where the waveform in Fig. 8A was observed. It was also distorted, as can be seen by comparing it with the correct signal shown in Fig. 8B.

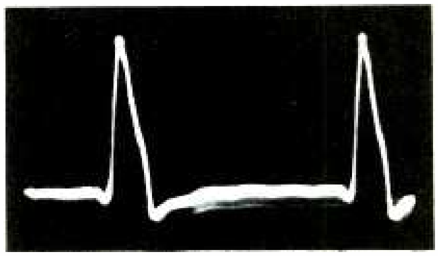
The next waveform checked was on the input side of C1. A pulse was found, but it did not look very much like a horizontal sync pulse. This can be seen by examining Fig. 9B which is the proper pulse and Fig. 9A which is the signal that was found.

Having noted when the set first came on that only horizontal synchronization and not vertical synchronization was lost, the technician decided against going any farther back in the circuit. The next step taken was to check the voltages on the AFC tube. The plate voltage was satisfactory; however, when the grid voltage was measured, it read +8 instead of approximately -20 volts. This could only mean one thing. Either C1 or C2 had become leaky, thereby allowing a positive voltage to be placed on the grid.

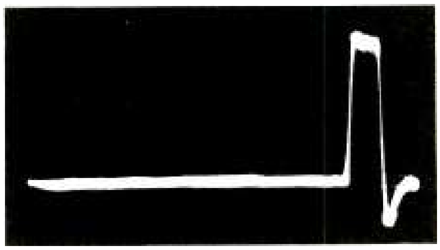
A resistance check with an ohmmeter indicated that C2 was the component that was defective. It measured approximately .5 megohms. When C2 was replaced, the set operated properly.

It might be well to investigate the manner in which a leaky condition in capacitor C2 caused the symptoms that were noted in this receiver. The back of horizontal synchronization was brought about by the inability of the AFC tube to function properly with positive voltage on its grid.

The loss of video after a few seconds of operation was a result of faulty AGC action. The drive voltage on the output tube was too low in amplitude and was not synchronized with the sync pulses of the incoming signal. Consequently, the positive pulses which were fed to the plate of the keyed AGC tube were not of sufficient strength and were not in phase with the sync pulses. The average conduction of the AGC tube was too low, and little or no AGC bias was fed to the RF and IF amplifiers. The result of this chain of events was an overloaded condition in the video IF strip and a loss of the video portion of the signal. The loss did not occur until after a few seconds of operation, because the RF and IF tubes had to warm up completely in order to produce the excessive signal amplitude for an overloaded condition.



(A) In Problem No. 4.



(B) Under Normal Conditions.

Fig. 9. Voltage at the Input Side of Capacitor C1.

The narrowness of the raster caused by the insufficient drive voltage on the grid of the horizontal-output tube.

Other Troubles

The following are a few symptoms and causes which we believe will be of interest to the reader but which we will not discuss in detail at this time; however, these things were tried on the bench to make sure of their validity.

1. SYMPTOM — Loss of sync and very dim raster.
   CAUSES — a. C3 leaky (250K ohms).
   b. R11 increased in value.
2. SYMPTOM — Loss of sync.
   CAUSE — C1 leaky.
3. SYMPTOM — Loss of horiz. sync. causing the frames to roll sideways.
   CAUSE — C5 shorted.

If stable and consistent performance is to be obtained from a synchroguide AGC circuit, the adjustment of the variable components should be checked after any servicing work is done in the circuit. Service literature contains instructions for performing these adjustments.

HENRY A. CARTER and **CALVIN C. YOUNG, JR.**

Notes on Test Equipment

(Continued from page 27)

The channel-selector dial is marked with three separates scales. The outer scale is calibrated on the upper side with UHF channel positions from 14 through 83. The calibration points are midway between the sound-carrier and video-carrier frequencies for each channel. The lower side of this scale is calibrated to indicate the center frequency of the sweep output at any setting.

The oscillator-frequency scale is calibrated to indicate the frequency of the internal oscillator at any setting of the dial.

The reference scale provides a means for resetting the pointer to any position with extreme accuracy. Each one of the 35 scale divisions represents a 5-degree pointer rotation. The scale is calibrated from 0 to 350, and each division can be further divided into tenths by means of a vernier scale. The accuracy of pointer setting is thus one-half of one degree.

The impedance at the VHF input connector is 93 ohms to match the output impedance of most VHF sweep generators. The impedance at the UHF output jack is 300 ohms balanced to ground.

The tube complement consists of the following:

1 6X4 rectifier,

1 6T4 oscillator,

2 6CB6 amplifiers.

The physcial dimensions are: height, 10 1/4 inches; width, 13 inches; and depth, 8 3/4 inches. Weight is 12 1/2 lbs.

Fig. 1. The Jackson Model 711 UHF Television Signal Generator.

The color and finish of the instrument matches other Jackson equipment.

Theory of Operation

The Jackson Model 711 UHF signal generator operates on the superheterodyne principle. A sweep signal from a VHF sweep generator is applied to the VHF input connector of the UHF generator. The center frequency of this signal is set to 43.5 mc. The signal is passed through a wide-band two-stage amplifier and is then applied to a crystal-diode-mixer stage where it is combined with the signal from the local oscillator of the instrument. The local-oscillator frequency varies with the dial setting and may be set over a range of 500 mc to 950 mc. The difference frequency between the local-oscillator signal and the sweep-input signal is a UHF sweep signal for the channel indicated by the dial setting. For example, if the dial pointer is set to UHF channel 50, the local oscillator will operate at 733 mc. This signal beats with the sweep-input signal of 43.5-mc center

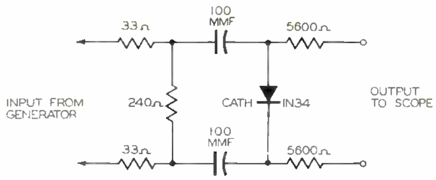


Fig. 2. A Balanced 300-Ohm Detector Circuit.

frequency to produce the 689.5-mc difference frequency which is the center of intelligence of channel 50 (or halfway between the video and sound carriers).

Undesirable beat frequencies of the two signals are attenuated by a two-stage tuned circuit which is tuned by the same knob that tunes the local oscillator, and the output from these stages is coupled to the UHF output jack.

Application

As one example of application, the Model 711 UHF generator was used in viewing the over-all tuner response and the over-all video IF response of a UHF-VHF television receiver. The UHF generator was used in conjunction with the Jackson Model TVG 2 sweep generator and an oscilloscope. As previously mentioned, other sweep generators can be used. If the particular sweep generator used does not also provide a marker, then a marker generator must be provided.

One of the first steps was to set the VHF sweep generator accurately to the 43.5-mc center frequency which is required for the input signal to the UHF generator. This was done according to the procedure given in the following paragraph.

The output of the VHF sweep generator was applied to the input connector of the UHF generator, and the output of the UHF generator was then applied to the input of a sensitive oscilloscope through the balanced-detector circuit shown in Fig. 2. The VHF sweep generator was set as closely as possible to 43.5 mc on the dial. The marker was adjusted to exactly 43.5 mc on the marker dial. With both sweep and marker outputs at maximum and with sweep set at .1-mc width, the sweep tuning was varied slowly about the 43.5-mc position until a beat marker was seen on the base line of the scope response. The sweep tuning was left at the setting which centered the marker on the base line, and the reference scale was noted so that the VHF sweep generator could be set to the same position at any future time.

The same procedure would be followed with any other sweep generator and need only be performed once. By noting the setting on the sweep dial, the sweep generator can be reset to the same position without the necessity of repeating the entire procedure.

The instruction manual accompanying the UHF generator recommends checking the sweep direction by varying the marker setting to a higher frequency. If the marker moves to the left, the operator should keep in mind the fact that the left side of the response curve indicates the higher frequencies. Since, in most alignment setups, the left side of the response curve indicates the lower frequencies, the reversed condition might be confusing. If the VHF sweep generator being used has a sweep-reversal switch, such as that incorporated in the Model TVG 2, this switch should be actuated so that the left side of the response curve indicates the lower frequencies. With the sweep set in this manner, the marker can then be handled exactly as if it

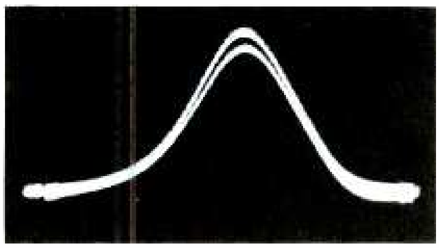


Fig. 3. Over-All UHF-Tuner Response Curve Obtained Through Use of the Model 711 UHF Signal Generator.

were being used to mark a VHF response curve having a center frequency of 43.5 mc.

After the sweep generator was properly adjusted, the UHF output was applied directly to the UHF antenna-input terminals of the receiver. Since the output impedance of the generator and the input impedance of the receiver were both 300 ohms, no matching network was necessary. The sweep width was adjusted to 9 mc, and the tuner response was viewed by connecting the vertical input of the oscilloscope to the wire loop that is the "looker" point on the tuner. This point was at the grid of the second mixer stage; therefore, no detector network was required. (There was a second mixer stage because the UHF tuner operated on the double-conversion principle.) The tuner response appeared as in Fig. 3.

The over-all response of the tuner and video IF stages shown in Fig. 4 was obtained at the output of the video detector. The recommended bias of -3 volts was applied to the video-IF AGC line during this operation. No alignment was made at the time. The experiment was conducted solely to show how the UHF generator could be used to obtain the desired response curves. Any alignment necessary would proceed along recommended lines.

The preceding example should show how the Model 711 UHF generator can be set up with the technician's present equipment as an aid to trouble shooting, servicing, and alignment of UHF circuits.

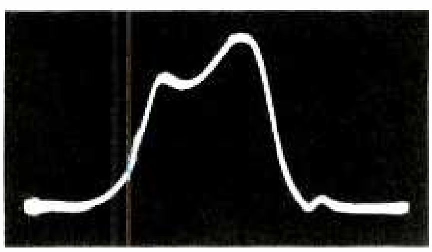


Fig. 4. Over-All Response Curve Obtained Through Use of the Model 711 UHF Signal Generator.

Added Features of the Hickok 655XC Color-Bar Generator

The September issue of the PF INDEX REPORTER carried an item in this column describing the Hickok 655XC color-bar generator and the color-bar signals which it provides. The Hickok Electrical Instrument Company has made some additions to this instrument which now offers a greater range of color bars, although it still retains the same model number as before.

The previous version of this model provided, at one setting of the function selector switch, a 5-bar pattern with the colors presented in the following order: green, yellow, red, magenta, and blue. The newer version provides 7 color bars in the following order: green, yellow, red, magenta, white, cyan, and blue. The bars, in both versions of the instrument, are at 100 per cent saturation. All the other factors of the previous generator have been retained in the improved version.

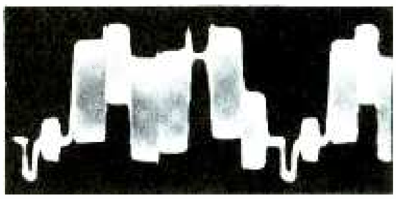


Fig. 5. The 7-Color-Bar Video Signal Provided by the Hickok 655XC Color-Bar Generator.

An oscilloscope display of the new color-bar signal appears in Fig. 5. This signal was taken from the video-output jack of the generator; and the video-polarity switch was in the negative position, resulting in negative-going sync pulses. When the chroma switch is thrown to the OFF position, the waveform appears as in Fig. 6. This represents the luminance component of the color-bar signal. The pulse below the base line at the extreme left of the waveform is the sync pulse. The steps above the base line represent the relative luminance levels of the various color bars. The fifth bar from the left is white with a reference level of 1. Starting from

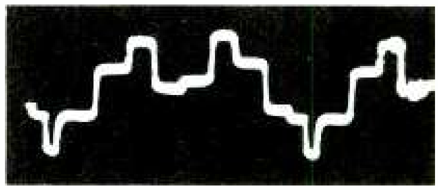


Fig. 6. The Luminance Component of the Signal of Fig. 5.

the left, the relative luminance levels of all the color bars are: green .59, yellow .89, red .30, magenta .41, white 1.0, cyan .70, and blue .11. To the right of blue, the next step (if it can be called a step) is on the base line itself, and therefore it represents zero luminance or black.

With the addition of the cyan and the white bars to the Model 655XC color-bar generator, the list of available colors in the composite color signal is extended to include the three primary colors of red, green, and blue; the three secondary or complementary colors of yellow, magenta, and cyan; plus white, which is a combination of the three primary colors. Black will also be shown on the screen of the receiver if a portion of the raster is visible at the right of the blue bar.

The appearance of the Model 655XC is not changed in the revised version except that a perforated metal cover has been added as protection to the delay network. This network was visible in the illustration in the September article.

Sprague Model KT-1 KWIK-TEST Capacitor Checker

The Sprague Model KT-1 KWIK TEST capacitor checker shown in Fig. 7 is designed to permit checking of capacitors for open, shorted, or

Fig. 7. The Sprague Model KT-1 KWIK-TEST Capacitor Checker.

intermittent conditions without the necessity of disconnecting the capacitor under test from its circuit. Any capacitor within the range of 30 mmf to 2,000 mfd may be checked for these conditions even though it is in parallel with a resistance as low as 60 ohms. Capacitors between .1 mfd and 2,000 mfd may be checked for shorts and intermittent shorts even though in parallel with a resistance as low as 2 ohms.

Thus the technician is spared the necessity of unsoldering and resoldering a suspected capacitor, an operation that is time-consuming and can be damaging to the associated components as well. The Model KT-1 is intended as a supplementary instrument to the Sprague TO-4 capacitor-resistor analyzer which may be used for more extensive tests.

The condition of the capacitor under test is indicated by the opening or closing of the electric-eye tube on the front panel. A table on the front panel of the instrument gives proper interpretations of the capacitor conditions which are indicated by the electric eye.

The instrument is housed in a medium-gray wrinkle-finish steel case 9 inches high by 6 inches wide by 5 1/4 inches deep.

The following types of tubes are used in the KT-1:

2 1626 tubes,
1 1629 tube.

Complete operating instructions, schematics, parts list, and some operating theory are provided in the operating manual furnished with the instrument.

An interesting property of a quarter-wave transmission line is used to check for an open condition in a capacitor. The test lead is in the form of a coaxial transmission line terminated inside the instrument with a pi-network. The network and the coaxial line form a quarter-wave transmission line at about 20 megacycles. This is the frequency of the oscillator in the instrument. This signal is coupled to the transmission line by a pickup loop. The loop is also connected through a crystal-diode rectifier to the grid of the electric-eye tube. When a capacitor is connected to the test clips, the reciprocal of its impedance is reflected back to the sending end — the pickup loop. Thus, the high impedance presented by an open capacitor would be seen as a short at the pickup loop; and no voltage would be developed across the loop. The eye would remain open in this case. With a good capacitor across the test clips, its low impedance at the operating frequency is seen as a high impedance by the pickup loop; and a voltage is developed and applied to the electric eye, causing it to close. The tests which we conducted in our laboratories showed that the results obtained with the instrument were very reliable.

Boland and Boyce High-Voltage Probe

Boland and Boyce Inc., Belleville, N. J., announces a universal high-voltage probe designed for use with any VTVM, multimeter, or voltmeter having a rating of 10,000 ohms per volt or more. Use of the probe permits measurement of voltages up to 30 or 60 kilovolts.

A complete set of plug-in precision resistors is furnished with the probe, together with detailed instructions for matching the probe to any meter of 10,000 ohms per volt or more. One probe can be used with several instruments of different ohm-per-volt ratings merely by unscrewing the probe handle and inserting the proper multiplier resistor.

PAUL C. SMITH

Audio Facts

(Continued from page 29)

ative. Most amplifiers are equipped with fuses that will blow when a filter capacitor breaks down. These fuses will protect the equipment from severe damage.

PREAMPLIFIER

Most of the conditions that can develop in a power amplifier after a period of use can also be encountered in a preamplifier and control unit. Noise, hum, and distortion caused by something that goes wrong in this unit are usually more pronounced because of the low-level circuits used in the preamplifier, equalization, and tone-control sections.

Tubes in the Preamplifier

Microphonic effects, hum, and noise are the usual troubles caused by tubes in the preamplifier. Substitution of a good tube for the suspected one is about the easiest and quickest way to locate and eliminate the trouble. Very careful selection is sometimes required before a suitable tube that is free of noise, hum, and microphonic tendencies can be found for use in the preamplifier stages.

Resistors in the Preamplifier

Resistors are the most common sources of the frying noise which may be heard while the system is being operated at low levels or while no signal is being reproduced. Any resistor can cause noise, but the greatest offenders are the plate-load resistors of the first stages. Special low-noise resistors should be used in these locations if noise is to be reduced to a minimum. The same things that were said about resistors and controls in power amplifiers also apply to the resistors and controls used in preamplifiers.

Capacitors in the Preamplifier

Troubles due to leaky, noisy, shorted, or open capacitors in the preamplifier follow the same general pattern as those found in the capacitors in power amplifiers. Some added effects are possible, especially upon the distortion and the frequency response in the preamplifier.

So far, all of this information has been general with very few definite things emphasized concerning that which can happen to a power amplifier and a preamplifier after they have been used. As mentioned before, these troubles seldom occur in practice. To summarize this discussion up to this point, the major requirements for reconditioning the electronic parts of a high quality audio system are (1) balancing the output stage, (2) replacing defective tubes, and (3) replacing noisy resistors in low-level stages.

To continue with the discussion of the adjustments and trouble shooting that might be required to restore a high quality sound system to normal operation, we encounter a different situation when considering pickups, turntables, and loudspeakers. In many ways, these very important pieces of audio equipment tend to be more mechanical rather than strictly electronic in nature.

PICKUP, STYLUS, AND TURNTABLE

The majority of high quality audio systems installed in homes are used principally to reproduce music from phonograph records. To obtain satisfactory reproduction from records, it is necessary to use a turntable revolving at a correct, constant speed and a properly aligned cartridge operating at the right pressure and equipped with a suitable

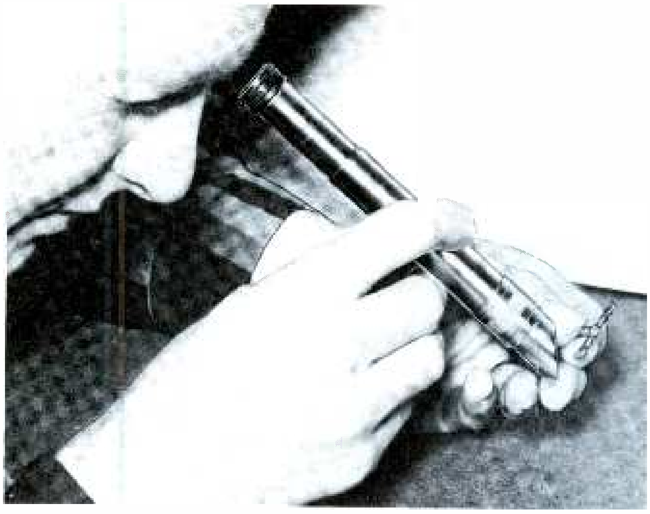


Fig. 1. Examining Stylus With 60-Power Magnifier.

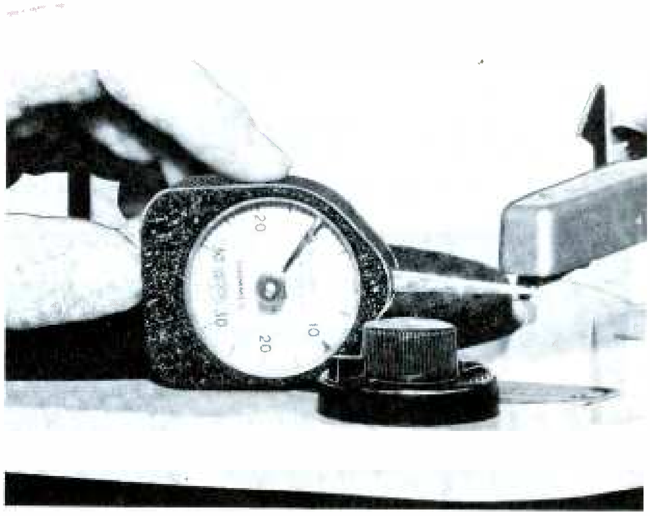


Fig. 2. Checking Stylus Pressure With Dynamometer Gauge.

stylus in good condition. This is a simplified account of what is required, but the procedure that is needed to achieve and maintain the correct adjustments and operating conditions is another story.

Permanent damage can be done to the delicate grooves of the record if the stylus or needle is worn, chipped, or broken. The condition of a worn stylus usually becomes serious enough to damage the record grooves before the distortion and noise caused by its poor condition can be detected in the reproduced sound. In other words, if the listener can tell by the quality of the sound that the stylus is bad, it is already too late to prevent some damage being done to the record.

The best insurance against record wear is to use a diamond stylus and to check its condition at regular intervals with a sufficiently powerful magnifier. Fig. 1 shows a 60-power pocket microscope or magnifier being used to check the tip of a stylus. One with a diamond tip might be considered the cheapest in the long run, because it outwears all other types. It must be remembered, though, that no stylus is permanent. In any case, a worn or damaged stylus should be replaced.

Wear on both the stylus and the record can be excessive if the pickup has not been properly counterbalanced and is bearing down too heavily upon the record. Although stylus pressure is adjusted to some weight between 4 and 8 grams for the average cartridge, this weight is concentrated on a very small area which is the point of contact between the stylus and the record. Consequently, the effect of the weight is greater than might be imagined; and an improper weight adjustment can impair normal operation. Stylus pressure should be checked with a balance or gauge and adjusted to the value recommended by the cartridge manufacturer. The instrument which is used for this check can be a simple balance scale or it can be a more elaborate unit such as the dynamometer shown in Fig. 2.

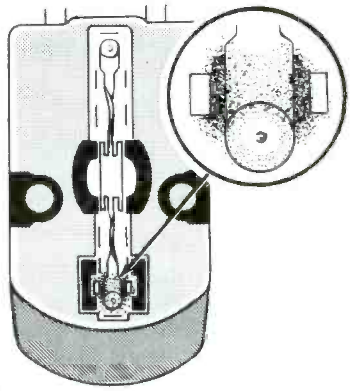


Fig. 3. Dirt or Metal Particles Jamming Gap Between Pole Pieces of Magnetic Cartridge.

Distortion can be caused by dirt or metal particles jammed into the gap between the pole pieces of a magnetic cartridge. This condition is illustrated in Fig. 3. Misalignment of the stylus in relation to the pole pieces can also produce distortion. Fig. 4 shows a condition of vertical misalignment of the stylus, and Fig. 5 is a drawing of a pickup with a stylus that is out of horizontal alignment. In cartridges of the crystal type, distortion can be produced by a damaged or deteriorated crystal. There are test records which are helpful in determining the quality of reproduction from any pickup and stylus.

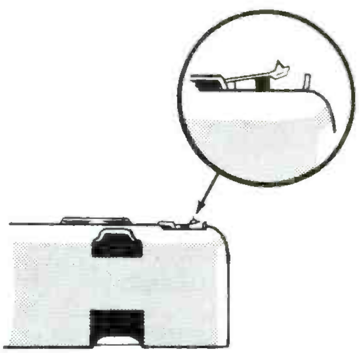


Fig. 4. Stylus Not Aligned Vertically in Magnetic Cartridge.

Turntables may cause a certain amount of rumble in the reproduced sound. The shock mounts should be checked in this case since these mounts can produce rumble if they are out of position or if they have deteriorated from age.

"Wow" is a symptom of unevenness in turntable speed and is often caused by a defective idler wheel or by lack of lubrication in the turntable mechanism. The speed of a turntable can be checked by means of a stroboscopic disc.

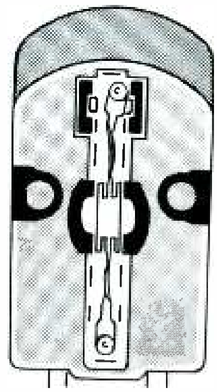


Fig. 5. Stylus Not Aligned Horizontally in Magnetic Cartridge.

The points to check in a record changer are much the same as those for a turntable. In addition there are adjustments which control the setdown point, the tone-arm height during the changing cycle, and other mechanical settings; but in a reconditioning procedure, interest is primarily in those symptoms which can be heard.

LOUDSPEAKER

The loudspeaker and its enclosure should be checked. If the symptom is a loss in low-frequency response, there may be air leaks in the enclosure. Sometimes screws become loosened in the enclosure, and gaps or air leaks develop. Loose screws can also cause rattles. If the symptom is a rattle, check the metal grille. Also check to be sure the speaker is securely fastened to its baffle. A damaged cone in a loudspeaker is a source of rattles and distortion in the reproduced sound. A rubbing voice coil and the presence of dirt or filings in the voice-coil gap can also be sources of troubles in loudspeakers.

When an audio system is reconditioned, the divider network ordinarily does not need attention because the nature of its construction makes it almost trouble free.

ROBERT B. DUNHAM

Dollar & Sense Servicing

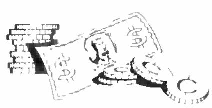
(Continued from page 33)

SETTLING DOWN. Cost of keeping a television set running has settled down to an average of about $20 a year, according to Television Digest. This corresponds to an average of two calls a year, they say. These and other figures and estimates lately are very much in agreement and look as if they'll hold for a few years unless color TV upsets the pattern.

With sets-in-use figures available regularly for any locality (your local TV station will always have this figure at hand), total expectancy of service business for the locality can easily be estimated. Dividing this by the number of service technicians in the locality gives the average per service technician. Are you getting your share?

LOWDOWN. At midyear of 1954, the average factory value of a TV set was $130 as compared to a $140 average for the entire first half of 1954 and a $170 average for all of 1953. Add 45 to 50 per cent as the markup between factory and consumer in 1954 as compared to a maximum of 60 per cent for all of 1953.

For $130 per set today, you can't even buy the parts needed to make up a small batch of TV sets. This is why in Mexico today a TV set costs nearly twice what it does in the United States. Mexican government regulations make it costly or impractical to import assembled American sets. Mexican branches of American firms therefore import the parts for assembly down there and pay a stiff duty on them. Even with wages running around a dollar a day for assembly-line workers, costs are doubled because high prices cut the demand for sets and keep production runs down to around 150 per month; and as a result, costs are high. "Ring around the rosy!"



GUNLESS PICTURE TUBES. Some time back, this column announced progress of research on picture tubes thin enough to hang on a wall. These used wire grids at right angles to activate an electroluminescent phosphor between the grid lines.

GE broke the veil of secrecy first to release a photograph showing their concept of what the TV set of the future will look like. It's essentially just a transistor-filled tray with the new tube as its cover. The tube lifts up and props at the optimum angle for viewing. Sound comes from rows of tiny electrostatic speakers at the top and bottom of the tube. The tube has no electron gun and not even a vacuum.

Next to admit by implication that work on such a tube was progressing behind locked doors of laboratories came RCA. At a Chicago speech, David Sarnoff spoke about a tubeless TV set which is based on electroluminescence and which can have a screen of any desired size on the wall. A small cable runs from this to a cigar-box-size set that can be placed anywhere in the room. Other such screens can be placed anywhere in the house and hooked to the same set.

We know of at least one more firm working on this type of tube; but so far, they haven't seen fit to swap secrecy for publicity, so their secret shall be kept.

FALL CLEANUP. Look around the shop and home; make a list of the old sets, test instruments, tools, and other things you haven't touched in the last six months; figure out the lowest prices you'd take to get rid of each item; then put an ad in the classified section of your local paper. You'll be surprised at how people respond to bargains, whether they need the things or not -- and so will your wife when you present her with the proceeds as a token of your esteem for her cooking and housekeeping.

ULTRASONIC DENTAL DRILL. Silent, painless drilling of teeth with an ultrasonic-powered bit driven by a vacuum-tube generator is a long way from the hand-cranked egg-beater drills of Civil War days; but already, teeth of dogs have been successfully drilled with this new tool at the United States Naval Hospital.

When ultrasonic dental drills are in general use, service technicians will become a lot better acquainted with the dentists in town — on the basis of a two-way flow of money.

POWER DRAIN. In 1953, for every ten electrons that spun the watt-hour meters in residential and rural areas, one was headed for a TV set. An electron may be the next thing to nothing, but that ten per cent of "nothing" has forced power companies throughout the nation to add huge new generators and build new plants in that same ratio. Thus has TV stimulated business in other industries.

EXECUTIVE PRIORITY. Newest in intercoms is one with a master station having a switch that allows the top man to break in and override any conversation. In recognition of the rights of workers, however, a signal light comes on at each substation to warn everyone when the boss cuts in to listen. The manufacturer is Dukane Corp., 135th and Indiana Streets, St. Charles, Illinois.

INDUSTRIAL SPYING. Engineers of one firm were watching a demonstration of a new magnetic-tape recorder by another firm and reported that there was no gap in the recording head. As a result, orders went out to develop a gapless head of their own. They did it; and only then did they discover that the demonstrated recorder actually did have a gap, though admittedly it was very small and unobtrusive. As a result of this inaccurate spying, however, the industry may soon have a recording head with no discontinuities whatsoever to cause wear on tape.

WATER TORTURE. In the presence of newsmen, DuMont quality-control manager Nick De Falco took a standard TV set off his production line, hauled it to the nearby Passaic River bridge, and heaved it over the rail. The set made a nice splash as it sank but bobbed right up again, since the evacuated picture tube acted like a life preserver. After allowing the set to drift downstream a while, they fished it out; took it back to the plant; dried it out; and plugged it in. The picture was still perfect — good selling point for flood-fearful customers along the Mississippi, Ohio, Rio Grande, or any other rivers that occasionally flood.

FROM 78 TO 45. Disk jockeys in some 2,000 radio stations are now receiving free promotional records in 45-rpm size from all major companies in place of the former 78-rpm records. Advantages claimed for 45's are that they are cheaper to produce for giveaway, provide better fidelity, and decrease space needed for storage at radio stations. About half of the record industry's $225,000,000 annual sales volume is now 45 rpm, according to RCA president Frank Folsom.

GLASS CAPACITORS. Though automatic production machinery is now turning out glass capacitors comparable in quality to micas, the glass units still cost about two and a half times as much as mica units. This means that you won't be seeing the new capacitors in sets for some time yet. Military people are delighted with Corning's new capacitor development, however, because the higher cost is to them insignificant in relation to making this country independent of foreign sources of mica in wartime.

VISIONPHONE. For industrial use, Kalbfell Laboratories, Inc., of San Diego have come out with a combination telephone handset, TV receiver, and Vidicon camera setup. When you get your party, his image appears on one half of the screen and yours appears on the other half — assuming, of course, that both stations are equally equipped and are interconnected by an 8-mc coaxial cable or a microwave link.

Suggested applications are for interplant conferences, main offices to branches, quick preliminary interviews with callers who might be pests, customer and signature identification in banks, and — eventually perhaps — seeing your blind date before committing yourself to an evening with her.

AGE TEST. Getting old is when you no longer want those things you couldn't afford when you were young. Or is it that you are getting smart enough to realize that the things weren't so important after all?

JOHN MARKUS

UHF Servicing

(Continued from page 5)

to such a degree that realignment may be necessary. This effect will be more apparent on converters and tuners of the detent type. In tuners and converters of the continuously variable types, the tuning range is usually sufficient so that tube changes may not necessitate realignment of the tuner or converter. These statements were confirmed by tests conducted in our laboratory where several representative types of converters and tuners were used. A photograph of the test setup used in the tests is shown in Fig. 1A. Figs. 1B and 1C are the block diagrams of the actual hookups used in compiling the values shown in Chart I which gives the results of changing the oscillator tube in one tuner.

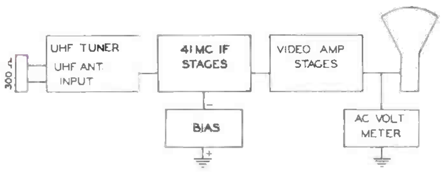


Fig. 1B. Block Diagram of Test Setup Before Applying Signal.

After each tube substitution, it was necessary to adjust the range slug in each tuning strip in order to cover the channels each range strip was designed to cover.

The condition governing the test used in obtaining the values shown in Chart I are as follows:

1. The UHF antenna terminals were terminated with a 300-ohm resistor.

2. The gain of the test receiver was set at maximum.

3. The AGC was clamped to limit noise at the driven element of the picture tube to 20 volts peak to peak. This corresponds to a 3.3-volt AC reading on VTVM. See Fig. 1B.

4. The 300-ohm termination resistor was removed, and the calibrated signal at 30 per cent modulation was applied to the UHF antenna-input terminals. A Measurements Corporation Model 84-TV signal generator

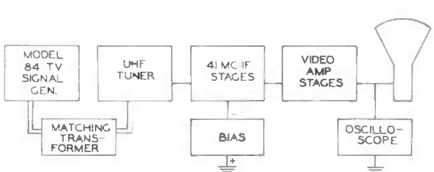


Fig. 1C. Block Diagram of Test Setup With Signal Applied.

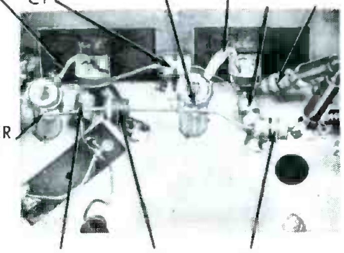


Fig. 2. View of UHF Tuner Showing Critical Placement of Components.

was used as a signal source. See Fig. 1C.

5. The output of the signal generator was adjusted to give 20 volts peak-to-peak signal at the driven element of the picture tube.

The values shown in Chart I represent the various levels of generator output required to produce a signal of 20 volts peak to peak at the driven element of the picture tube.

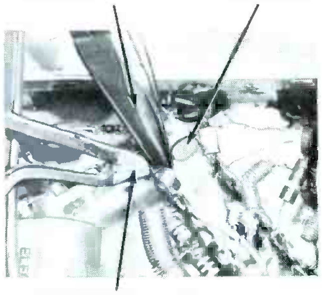


Fig. 3A. Method of Protecting Crystals When Soldering.

The circuit will in many cases be disturbed to the extent that realignment may be necessary when replacing such components as soldered-in crystals, capacitors, or resistors.

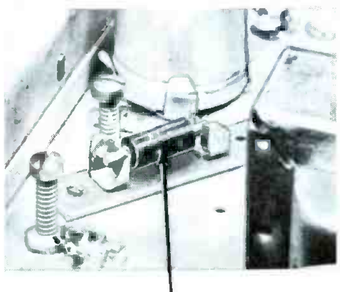


Fig. 3B. One Type of Crystal Mounting.

CHART I

INPUT SIGNAL LEVELS REQUIRED TO PRODUCE 20-VOLT PEAK-TO-PEAK VIDEO SIGNAL

Tubes	Input Signal Levels in Microvolts			
	Channel 14	Channel 37	Channel 60	Channel 83
Original	90	140	70	80
1	90	120	70	75
2	90	120	70	75
3	90	120	70	150
4	90	120	70	75
5	90	120	70	90
6	90	130	70	90
7	90	140	70	90
8	90	140	70	220
9	90	150	80	220
10	90	120	75	170
11	90	120	75	220
12	90	150	90	Dead

Notice the layout of parts in Fig. 2. The changing of the capacitors C1, C4, C5, or C6 usually results in a disturbance of L1 or L2. No matter how small this disturbance, some frequency change will result. The amount of change will vary depending upon the service technician's care in replacing the components.

If either C2 or C3 were changed, the amount of solder on the solder joints indicated in Fig. 2 may be different and thus change the capacity of the circuit to such a degree that realignment might be required.

It should also be noted that some of the components shown in Fig. 2 have very short leads and that any change in lead length or component placement may result in extreme changes in converter operation.

The mixer stages of some UHF converters use crystals which have been soldered into the circuit. In these cases, the replacement of a crystal calls for a procedure which assures that the crystal will not be subjected to excessive heat. In Fig. 3A, the proper method of soldering a new crystal into place is shown. The long-nosed pliers are used to grip the lead between the point being soldered and the crystal. This dissipates the heat and prevents crystal damage. Fig. 3B and 3C show the two conventional methods of mounting crystals. The crystal shown in Fig. 3B is mounted in a clip on the top of the converter chassis. With the crystal mounted in this fashion, it is easier to check the crystal by substitution. The crystal shown in Fig. 3C is of the soldered-in type. Notice how one lead has been left long and extends near the local oscillator. This functions as a gimmick coupling which provides oscillator voltage to the crystal mixer. The replacement of the crystal will make it necessary to adjust this coupling in order to obtain sufficient crystal current.

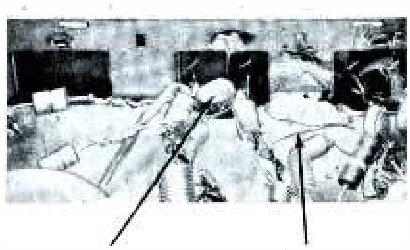


Fig. 3C. Crystal Soldered Into Circuit of UHF Tuner.

It can be seen from the foregoing discussion that replacement of components of the UHF converter is somewhat more involved than the replacement of corresponding components in a VHF tuner and will in some cases require the use of expensive test equipment. In many cases, however, high quality VHF test equipment has been found to perform satisfactorily for UHF servicing.

CALVIN C. YOUNG, JR.

Magnetic Recording

(Continued from page 13)

most professional and amateur sound recordists, the first part of this discussion will center upon them. In that way, they can serve as the basic example of magnetic recorders and as a reference point for comparison when other types are brought into the discussion.

For example, tape and wire recorders have much in common but do differ in certain details. Each type possesses certain advantages when compared with the other. A wire recorder uses a small (about .004 inch in diameter) stainless-steel recording wire instead of the plastic or paper tape used by a tape recorder. Consequently, the recording head on a wire recorder differs in dimensions and physical design when compared with a tape-recorder head because of the physical characteristics of the recording wire and the tape. Of course, there are many other differences such as the mechanical arrangements required to handle the wire or tape.

Tape

The tape is the medium upon which the program material is recorded. The tape can be played back upon the recorder on which it was recorded or played back on another suitable machine.

Tape has been made (in fact, it is still being made) of paper, but plastic is now used almost universally because of its strength and durability. Various widths serve for certain specialized purposes; but for sound recording, a width of 1/4 inch is standard and a thickness of about .0015 inch is most commonly used.

During manufacture, an iron oxide (which can be magnetized) is mixed with a binding material and applied to one side of the tape in a thin layer about .0006-inch thick. This coating is the active portion of the tape upon which the signal is recorded because it can be magnetized in the manner in which iron and some other materials can be magnetized. It is important that the individual particles of iron oxide be very small and evenly distributed on the surface of the tape because of the effect these conditions can have upon the frequency response and noise characteristics of that particular brand or type of tape. The surfaces of the coating and of the paper or plastic base must be uniform and smooth, because roughness and nonuniformity will show up as noise and inconsistencies in the

Fig. 4. Combination Erase, Record, and Playback Head Used on Federal (F-M-E) Model 37-B Tape Recorder.

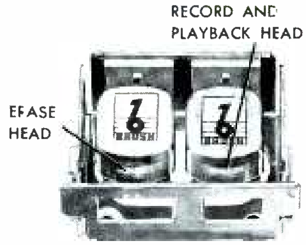


Fig. 6. Erase Head and Record-Playback Head Used on TDC130 Tape Recorder.

final recording. More will be said about this later, because so many of these effects are interactive and must be mentioned when other characteristics and features are discussed.

Most coatings containing some form of iron oxide are red; although in a few cases, they are black. The red coating accounts for the familiar reddish-brown color so characteristic of most tapes, since the plastic base is transparent and has no color.

Recording Heads

Some examples of heads used on magnetic recorders are shown in the title illustration of this article. From left to right, the first four are types used on tape recorders. The fifth one is a combination record, playback, and erase head used on wire recorders. Figs. 4, 5, 6, and 7 are photographs of heads shown mounted in position on current-model recorders. The basic construction and some of the important features of a recording head, which is a typical example of those used on most tape recorders, are shown in the drawing in Fig. 8.

The coil through which the modulating signal flows is wound around the core to produce an electromagnet. The core is shaped in such a way that the poles of the magnet leave a very narrow gap between them in the center of the face of the head. It is very important that the gap, which is usually filled with a nonmagnetic material such as beryllium copper, should be very narrow and should lie perpendicular to the direction of movement of the tape. The face of the head is made as smooth as possible, because the coated surface of the tape must make actual contact at the gap at all times as the tape moves across the face of the head during recording. The reason for constant contact is to insure a uniform frequency response and a constant reference level at the gap. These requirements will be mentioned in a later issue when the electronic circuits and characteristics of magnetic recorders are discussed. The methods of maintaining constant contact and pressure on the tape will be explained when the mechanical (transport) section is covered.

No permanent magnets, such as are found in magnetic headphones and loudspeakers, are used in a recording head since no magnetic force is desired other than that produced by the signal and bias current flowing through the coil during recording. In fact, care must be taken to make sure the head does not become permanently magnetized by accident or overload.

When recording is in progress, the magnetic force developed at the gap in the face of the head varies with the modulation of the signal flowing through the coil. As the tape moves across the gap, it is magnetized along its length into a series of small magnets each of which varies in length and strength in accordance with the modulating signal as shown in Fig. 9. This method of impressing the signal on the tape by passing it over the gap is known as longitudinal magnetization and is used in practically all present-day magnetic recorders.

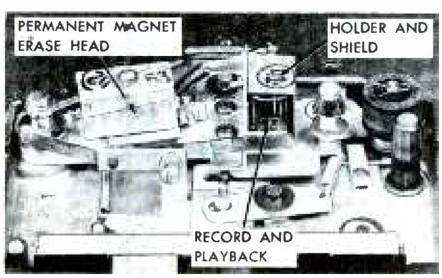


Fig. 5. Permanent-Magnet Erase Head and Record-Playback Head Used on Wilcox-Gay Model 4A10 Tape Recorder.

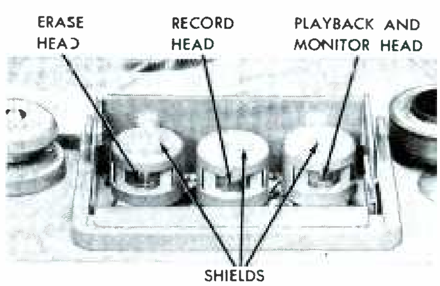


Fig. 7. Erase Head, Record Head, and Playback-Monitor Head Used on Ampex Model 600 Tape Recorder.

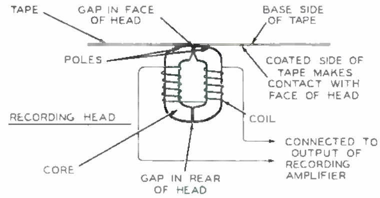


Fig. 8. Drawing Showing Basic Details of Tape-Recording Head and Tape.

Playback

The varying magnetization along the length of the tape is the signal recorded there by the recording head. This magnetization is permanent and will remain until the tape is deliberately or accidentally erased or demagnetized.

Playing back the tape by passing it over the face of a playback head is the reverse of the recording procedure but does not remove the signal recorded upon the tape. This means that the tape can be played back over and over again as often as desired.

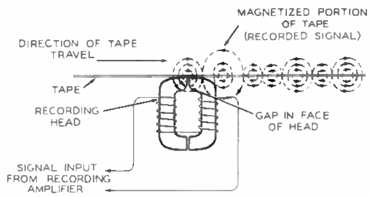


Fig. 9. Drawing Showing Details of How a Signal Is Recorded on Tape.

A playback head is very similar to a recording head. In fact, in most of the medium- and lower-priced recorders, the record head is used as the playback head during that mode of operation. The only difference is in the way it is used in the circuit. A playback head is connected into the circuit in such a manner that any signal generated in the head itself will be fed into the circuit and amplified.

When the tape upon which the recording has been made is moved across the gap of the playback head, the magnetized areas on it will cause a signal to be generated in the coil because of the moving magnetic field. If the tape is moved over the playback head at the same speed as when the signal was recorded upon it, the signal generated in the playback head will be a reproduction of the original recorded signal.

This has been a very simplified account of how magnetic recording is accomplished, but it does give some basic facts that will serve as a foundation for easier understanding of discussions which will be presented in subsequent issues.

ROBERT B. DUNHAM

"I believe all your troubles would vanish, Mrs. Kosgriff, if you'd simply get a JENSEN NEEDLE!"

From Split-Sound to Intercarrier

(Continued from page 31)

suming. It is not a difficult job if planned properly, and the whole task should not take more than three-quarters of an hour.

The price of the components usually required for the conversion is rather small. There are only three components which are ordinarily needed: a 4.5-mc take-off trap, a 4.5-mc sound IF transformer, and a 4.5-mc discriminator or ratio-detector transformer. Some sets may require that a small capacitor be changed to one of a smaller value at the point of take-off.

Sound-conversion jobs can be neat; odd components need not be used in most cases. The 4.5-mc sound-circuit components can be obtained in a variety of shapes and sizes to correspond with the original parts. The job can be so well done that a change is scarcely noticeable. Another advantage in using coils and transformers which are of the same type as the originals is that the mounting is simplified. For instance, if small cans were used in the original layout, it would take time to mount large cans because new mounting holes would have to be drilled. Moreover, there may not even be room available for the large cans.

Most problems can be avoided through good planning. Before starting a job of conversion, examine the circuit well and make a list of the components that will be required. Measure the transformer cans on the original components. Then select suitable components from the parts catalogs.

The photograph in Fig. 1 shows a portion of a chassis after it had been converted to intercarrier sound. The set is a Radio Craftsmen Model RC200 television receiver which has already had the front end converted to a Standard Coil tuner so that UHF strips could be used. This set is a good example to show how easy some sets are to convert from split-sound to intercarrier operation. There were no complications to mar the job or to slow it up.

First, the sound IF transformer cans were measured and found to be 3/4 by 3/4 by 2 inches high. Next, the parts catalogs were consulted, and it was found that most coil manufacturers produced components in cans of this size. Then, the schematic was studied closely to see just what

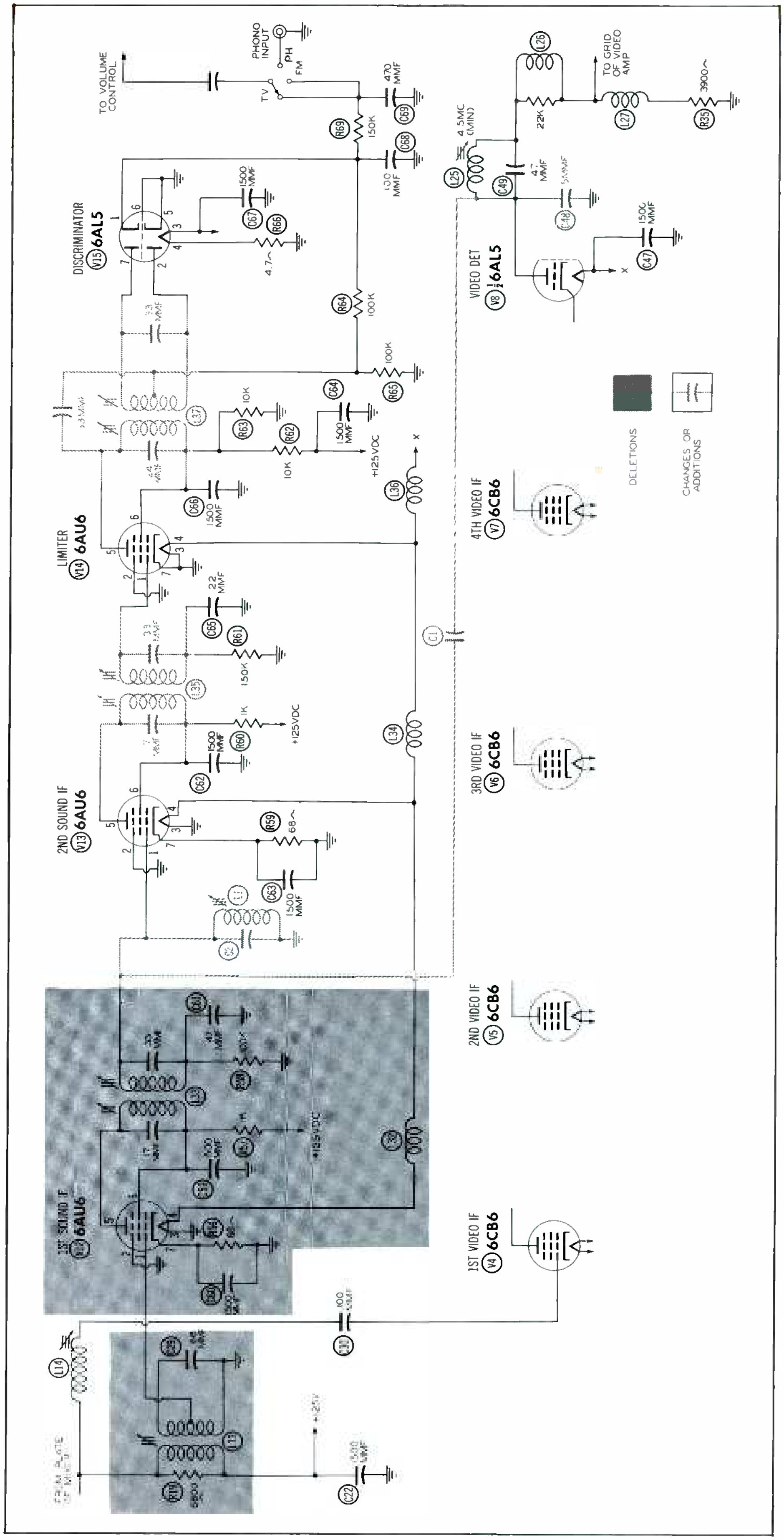


Fig. 2. Partial Schematic Showing Conversion Changes in the Radio Craftsmen Model RC200.

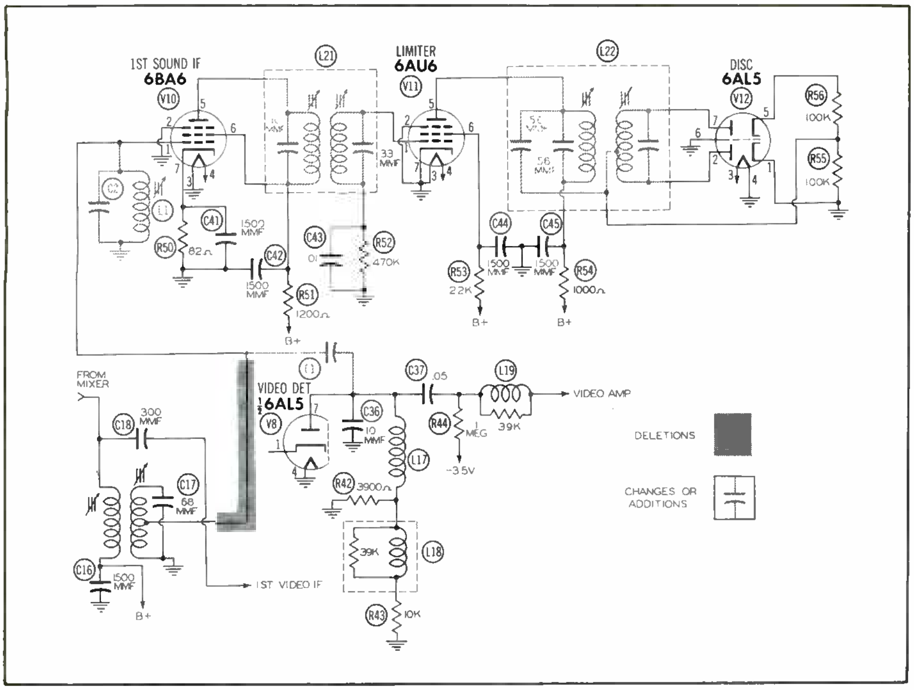


Fig. 3. Partial Schematic Showing Conversion Changes in the Olympic Model 922L.

components and connections would be needed.

It was decided that the first sound IF stage could be eliminated because the signal received some amplification while passing through the video IF strip. See the schematic of the set in Fig. 2. Eliminating this stage provided a very good spot in which to mount the 4.5-mc sound take-off trap. By removing the first sound IF transformer and then reaming the center hole larger to 5/16 inch, the take-off trap could be mounted in place of the transformer. This placed the coil adjacent to the sound IF amplifier. In Fig. 1, an AGC clamper can be seen in the place originally occupied by the first sound IF amplifier. This clamper had been placed under the chassis when the tuner conversion had been made at which time the necessity for a clamper had arisen. The removal of the first sound IF amplifier provided an ideal place to relocate the tube so that replacement could be made without removing the chassis.

Chart I is a list of 4.5-mc components from the products of three parts manufacturers. Any of these could have been used in the sound conversion of the Radio Craftsmen receiver. Merit Coil and Transformer Corporation units were used in this case because they were on hand. A 3.2-mmf coupling capacitor C1 was used to couple the signal from the video-detector circuit to the sound take-off trap. The partial schematic in Fig. 2 shows the changes, deletions, and additions made in the Radio Craftsmen receiver in order to bring about intercarrier operation.

After the conversion was completed, alignment was performed according to the customary methods used with intercarrier receivers.

The sound from the set was very good, but it was found that a slight loss of high-frequency response in the picture had occurred. This loss was attributed to shunting capacity that resulted from the addition of coupling capacitor C1 and the sound trap. As a compensating measure, capacitor C48 was changed from 10 mmf to 5 mmf.

UHF strips were tried in the tuner with very satisfactory results. The slight drift in local-oscillator frequency could only be detected by the use of instruments; it was not noticeable in the sound.

Another case of a sound conversion can be recounted. This second set was an Olympic Model 922L, and a partial schematic of it may be seen in Fig. 3. Note that this set used only one sound IF stage and one limiter, and therefore both stages were retained in the conversion. All other considerations were the same as those for the Radio Craftsmen receiver.

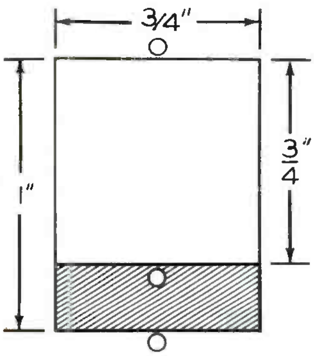


Fig. 4. Enlargement of Mounting Hole for New Sound IF Transformer.

Let us consider the components chosen for the conversion. It was decided that a transformer with a different size than the original would be tried in one of the stages. The original interstage transformer was small (7/8 by 7/8 by 2 inches), and the 4.5-mc replacement unit was large (1 1/8 by 1 1/8 by 2 1/8 inches). The sketch in Fig. 4 shows what had to be done to facilitate the mounting of the larger transformer shield. The small square represents the size of the chassis hole for the original can. The shaded portion represents that which was filed out to take the larger shield. Note that the filing was done on only one end so that only one new mounting hole was required.

Chart II lists the parts which were available for the conversion of the Olympic receiver.

HENRY A. CARTER

STATUS OF TV BROADCAST OPERATIONS

SUPPLEMENT NO. 2

The total numbers of operating stations, construction permits granted, stations that have reverted to CP status, and stations that have discontinued operations are shown in the first chart. These figures are up to date as of September 25, 1954.

OPERATING STATIONS	CONSTRUCTION PERMITS	REVERTED FROM OPERATING TO CP STATUS	DISCONTINUED OPERATIONS
Total 408	Total 198	Total 18	Total 12
Commercial 281 VHF 120 UHF	Commercial 65 VHF 107 UHF	Commercial 2 VHF 15 UHF	Commercial 6 VHF 6 UHF
Educational 4 VHF 3 UHF	Educational 11 VHF 15 UHF	Educational 0 VHF 1 UHF	

The following charts show the construction permits and stations which have come on the air during the period between April 11 and September 25. A third chart lists the stations that have discontinued operations and the construction permits that have been relinquished.

When combined with the data presented in the February and June 1954 issues of the PF INDEX, this supplemental data presents a complete picture of the status of TV broadcast operations in the United States (including Alaska, Hawaii, and Puerto Rico).

CONSTRUCTION PERMITS GRANTED FROM APRIL 11 THROUGH SEPTEMBER 25, 1954

ALABAMA
Dothan
WTVY Ch. 9
*Mobile
WKAB-TV Ch. 48
Mount Cheaha
WEDM Ch. 7#

ARIZONA
Phoenix
KTVK Ch. 3

ARKANSAS
Ft. Smith
KNAC-TV Ch. 5

CALIFORNIA
*Fresno
KBID-TV Ch. 53
*Los Angeles
KTHE Ch. 28#
San Jose
KQXI Ch. 11

FLORIDA
Daytona Beach
WMFJ-TV Ch. 2
Tampa
WFLA-TV Ch. 8
WTVT Ch. 13

INDIANA
Notre Dame
- - - Ch. 46
*Princeton
WRAY-TV Ch. 52

KENTUCKY
Lexington
WLEX-TV Ch. 18
*Louisville
WKLO-TV Ch. 21

LOUISIANA
*Monroe
EFAZ Ch. 43

MICHIGAN
*Battle Creek
WBKZ-TV Ch. 64
Detroit
WJLB-TV Ch. 50
WTVS Ch. 56#
Flint
WJRT Ch. 12
Grand Rapids
- - - Ch. 23

MINNESOTA
*Duluth
WFTV Ch. 38
Minneapolis
KEYD-TV Ch. 9

MISSISSIPPI
Columbus
WCBI-TV Ch. 4
*Meridian
WCOC-TV Ch. 30

MISSOURI
Jefferson City
KRCG Ch. 13
St. Louis
KWK-TV Ch. 4

MONTANA
*Butte
KOPR-TV Ch. 4

NEBRASKA
Scottsbluff
- - - Ch. 10

NEVADA
Henderson
KLRJ-TV Ch. 2

NEW JERSEY
*Atlantic City
WFPG-TV Ch. 46

NEW YORK
WYNC-TV Ch. 31

NORTH CAROLINA
Fayetteville
WFLB-TV Ch. 18

OHIO
Mansfield
WTVG Ch. 36

OKLAHOMA
Ardmore
KVSO-TV Ch. 12
Tulsa
KVOO-TV Ch. 2
KOED-TV Ch. 11#

OREGON
Portland
KLOR Ch. 12

PENNSYLVANIA
*Chambersburg
WCHA-TV Ch. 46
*Pittsburgh
WKJF-TV Ch. 53

TEXAS
Beaumont
- - - Ch. 6
Big Spring
KBST-TV Ch. 4
Ft. Worth
- - - Ch. 11
*Houston
KNUZ-TV Ch. 39
San Antonio
KCOR-TV Ch. 41

WEST VIRGINIA
Huntington
- - - Ch. 13
Oak Hill
WOAY-TV Ch. 4

WISCONSIN
Milwaukee
WTVW Ch. 12
Wausau
WSAU-TV Ch. 7

* Reverted from Operating Status to CP Status

Educational.

STATIONS NOW ON THE AIR FROM APRIL 11 THROUGH SEPTEMBER 25, 1954

ALABAMA
- Decatur
  - WMSL-TV Ch. 23

CALIFORNIA
- Stockton
  - KOVR Ch. 13

COLORADO
- Grand Junction
  - KFXJ-TV Ch. 5

CONNECTICUT
- Hartford
  - WGTH-TV Ch. 18

FLORIDA
- Orlando
  - WDBO-TV Ch. 6
- Palm Beach
  - WJNO-TV Ch. 5

INDIANA
- Indianapolis
  - WISH-TV Ch. 8
- Terre Haute
  - WTHI-TV Ch. 10
- Waterloo-Ft.Wayne
  - WINT Ch. 15

IOWA
- Des Moines
  - WHO-TV Ch. 13
- Mason City
  - KGLO-TV Ch. 3
- Sioux City
  - KTIV Ch. 4

LOUISIANA
- Alexandria
  - KALB-TV Ch. 5
- Lake Charles
  - KPLC-TV Ch. 7

MAINE
- Bangor
  - WTWO Ch. 2
- Poland Spring
  - WMTW Ch. 8
- Portland
  - WGAN-TV Ch. 13

MARYLAND
- Salisbury
  - WBOC-TV Ch. 16

MICHIGAN
- Traverse City
  - WPBN-TV Ch. 7

MISSOURI
- Joplin
  - KSWM-TV Ch. 12
- Sedalia
  - KDRO-TV Ch. 6
- St. Louis
  - KETC Ch. 9#
  - KWK-TV Ch. 4

MONTANA
- Missoula
  - KGVO-TV Ch. 13

NEW YORK
- Buffalo
  - WGR-TV Ch. 2
- Kingston
  - WKYN-TV Ch. 66

NORTH CAROLINA
- Asheville
  - WLOS-TV Ch. 13
- Durham
  - WTVD Ch. 11

NORTH DAKOTA
- Valley City
  - KXJB-TV Ch. 4

OHIO
- Cincinnati
  - WCET Ch. 48#

OKLAHOMA
- Ada
  - KTEN Ch. 10
- Enid
  - KGEO-TV Ch. 5
- Muskogee
  - KTVX Ch. 8

PENNSYLVANIA
- Erie
  - WSEE Ch. 35
- Harrisburg
  - WCMB-TV Ch. 27

SOUTH CAROLINA
- Charleston
  - WUSN-TV Ch. 2

TENNESSEE
- Chattanooga
  - WDEF-TV Ch. 12
- Nashville
  - WLAC-TV Ch. 5

TEXAS
- Corpus Christi
  - KVDO-TV Ch. 22
- Weslaco
  - KRGV-TV Ch. 5

UTAH
- Salt Lake City
  - KUTV Ch. 2

VERMONT
- Montpelier
  - WMVT Ch. 3

VIRGINIA
- Newport News
  - WACH-TV Ch. 33

WEST VIRGINIA
- Charleston
  - WCHS-TV Ch. 8

WISCONSIN
- La Crosse
  - WKBT Ch. 8
- Marinette
  - WMBV-TV Ch. 11

Educational.

CP'S RELINQUISHED AND STATIONS DISCONTINUING OPERATIONS FROM APRIL 11 THROUGH SEPTEMBER 25, 1954

<u>Relinquished</u>

ALABAMA
- Birmingham
  - WSGN-TV Ch. 42

CALIFORNIA
- Merced
  - KMER Ch. 34

CONNECTICUT
- Bridgeport
  - WSJL Ch. 49

ILLINOIS
- Champaign
  - WCUI Ch. 21

INDIANA
- Indianapolis
  - WJRE Ch. 26

KENTUCKY
- Paducah
  - WTLK Ch. 43

LOUISIANA
- New Orleans
  - WTLO Ch. 20

MASSACHUSETTS
- Boston
  - WBOS-TV Ch. 50
- Lawrence
  - WGLM Ch. 72
- New Bedford
  - WTEV-TV Ch. 28

MASS. (Cont.)
- Pittsfield
  - WBEC-TV Ch. 64

MISSISSIPPI
- Columbus
  - WCBI-TV Ch. 28

MISSOURI
- Cape Girardeau
  - KGMO-TV Ch. 18

NEW JERSEY
- New Brunswick
  - WDHN Ch. 47
- Trenton
  - WTTM-TV Ch. 41

NEW YORK
- Jamestown
  - WJTN-TV Ch. 58
- Utica
  - WFRB Ch. 19

NORTH CAROLINA
- Goldsboro
  - WTVX Ch. 34
- Greensboro
  - WCOG-TV Ch. 57

PENNSYLVANIA
- Philadelphia
  - WIP-TV Ch. 29

SOUTH CAROLINA
- Aiken
  - WAKN-TV Ch. 54
- Greenwood
  - WCRS-TV Ch. 21

S. CAROLINA (Cont.)
- Spartanburg
  - WSCV Ch. 17

SOUTH DAKOTA
- Rapid City
  - KTLV Ch. 7

TENNESSEE
- Chattanooga
  - WOUC Ch. 49

TEXAS
- Fort Worth
  - KTCO Ch. 20
- Lufkin
  - KTRE-TV Ch. 9
- Marshall
  - KMSL Ch. 16

WEST VIRGINIA
- Beckley
  - WBEY Ch. 21

WYOMING
- Casper
  - KSPR-TV Ch. 2

<u>Discontinuing Operations</u>

ALABAMA
- *Mobile
  - WKAB-TV Ch. 48

ARIZONA
- Phoenix
  - KOY-TV Ch. 10 (merged with KOOL-TV)

CALIFORNIA
- *Fresno
  - KBID-TV Ch. 53
- *Los Angeles
  - KTHE Ch. 28#

COLORADO
- Pueblo
  - KDZA-TV Ch. 3

INDIANA
- *Princeton
  - WRAY-TV Ch. 52

KENTUCY
- *Louisville
  - WKLO-TV Ch. 21

LOUISIANA
- *Monroe
  - KFAZ Ch. 43

MICHIGAN
- *Battle Creek
  - WBKZ-TV Ch. 64
- Flint
  - WTAC-TV Ch. 16

MINNESOTA
- *Duluth
  - WFTV Ch. 38

MISSISSIPPI
- *Meridian
  - WCOC-TV Ch. 30

MISSOURI
- Kansas City
  - KMBC-TV Ch. 9 (merged with WHB-TV)
- St. Louis
  - KSTM-TV Ch. 36

MONTANA
- *Butte
  - KOPR-TV Ch. 4

NEW JERSEY
- *Atlantic City
  - WFPG-TV Ch. 46

NEW YORK
- Elmira
  - WECT Ch. 18

PENNSYLVANIA
- *Chambersburg
  - WCHA-TV Ch. 46
- *Pittsburgh
  - WKJF-TV Ch. 53

TEXAS
- *Houston
  - KNUZ-TV Ch. 39

* Reverted to CP Status.

Educational.

PF REPORTER

+ More or Less −

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While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this Index.

If we are fortunate, this column will be substituted at the last minute, long after the rest of this issue has gone to press. The cause for substitution is what we feel may well be an important portent to our industry; namely, the announcement of the release of a fully transistorized production model commercial radio receiver.

The following material describing the equipment has been excerpted from an announcement letter of the Regency division of Industrial Development Engineering Associates, Inc. (I.D.E.A.):

"REGENCY INTRODUCES FIRST TRANSISTOR RADIO FOR CONSUMER USE, MODEL TR-1

"Indianapolis, Indiana, October 18: A revolutionary pocket radio — the first in the history of the electronics industry to use transistors instead of tubes — is now in production by Regency of Indianapolis.

"Credit for the perfection of the unique pocket radio goes to Regency, a division of Industrial Development Engineering Associates, Inc. (I.D.E.A.), 7900 Pendleton Pike, whose president, Edward C. Tudor, today announced the availability of the unit November 1.

"The Regency pocket radio, Model TR-1, measures 3"x 5"x 1-1/4", and weighs less than 12 ounces. It will be priced at $49.95, and will be introduced simultaneously in two markets — New York and Los Angeles — in time for Christmas shopping.

"TECHNICAL INFORMATION ON THE REGENCY TR-1 POCKET RADIO

"Since the announcement of the development of the transistor some 4-1/2 years ago by Bell Laboratories, there has been a great deal of speculation as to when a transistorized radio would be available, since the pocket radio is such an obvious application. While several manufacturers have produced working models of such a radio, none has done so commercially, largely because of the prohibitive cost of the six to eight transistors previously required.

"The success of the Regency unit is due, in large measure, to a high-performance, low-cost transistor developed by Texas Instruments Incorporated, of Dallas. Texas Instruments, the first to produce a high-temperature silicon transistor in commercial quantity, is now also the first to mass produce a low-cost, high-gain, high frequency germanium transistor.

"This transistor is known as a grown junction n-p-n type, and its performance is illustrated in the Regency pocket radio wherein power gains of 34 decibels and 40 decibels are achieved in the intermediate-frequency and audio stages, respectively. Such figures have previously only been attainable in the laboratory.

"The effectiveness of the TI n-p-n transistors is pointed up in the Regency set wherein outstanding performance is obtained through the use of only four transistors in the entire radio, almost half the number hitherto used in laboratory models. The Regency model uses one transistor as a combination mixer-oscillator, two as intermediate-frequency amplifier, and one as an audio amplifier. A germanium diode is employed as a detector."

The letter further covers the important contribution made by many component manufacturers to the development of the diminutive receiver assembly, and indicates that the final construction is a semi-automatic process using the newest printed wiring and dip-soldering techniques.

Application of the transistor to the general radio, television, and electronic fields has been anticipated, or even anxiously awaited. This is the first public announcement of such application that we have seen, and we do believe that it is highly significant of developments to come.

J.R.R.

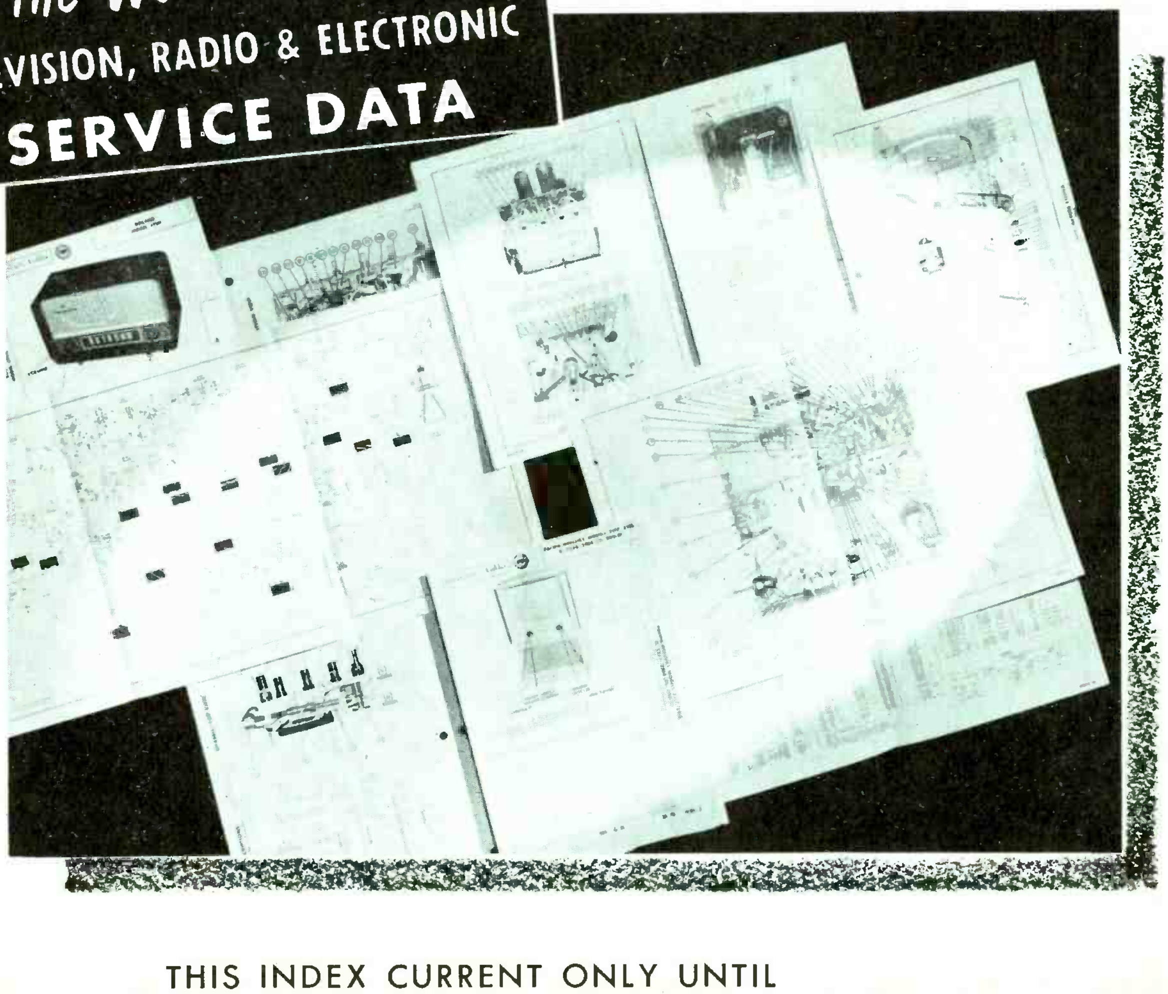
Cumulative Index No. 47

COVERING PHOTOFACT FOLDER SETS 1 THRU 257

NOV.-DEC. 1954

PHOTOFACT FOLDERS

the World's Finest
TELEVISION, RADIO & ELECTRONIC
SERVICE DATA



THIS INDEX CURRENT ONLY UNTIL
JANUARY 15th, 1955

Cumulative Index to PHOTOFACT FOLDERS

No. 47 · Covering Folder Sets Nos. 1 through 257 · World's Finest Electronic Service Data

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.

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321AX (Ch. CT-27) (Ch. Series CX-33DX) Tel. Rec. (See Ch. CT-27—Set 160-2)
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332B, M (Ch. C-286, C-204) (Ch. Series CX-33) Tel. Rec. (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set 112-3)
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NOTE: PCB denotes Production Change Bulletin

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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)
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A-T1816, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T1816 (Code 129) (Ch. 81A, D-81) Tel. Rec. 227–10
A-T1817, HM (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T1818 (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-T1856, HM, L, W (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T1856W (Code 129) (Ch. 81A, D-81) Tel. Rec. 227–10
A-T1858 (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-T2230, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T2230 (Code 129) (Ch. 81A, D-81) Tel. Rec. 227–10
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A-T2233 (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-T2234 (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)
A-T2262HM (Code 123) (Ch. 81, H-1 H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T2266, 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-T2271HM (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-T2272, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T2272 (Code 129) (Ch. 81A, D-81) Tel. Rec. 227–10

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A-T2274, W (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T2274S (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-T2275S (Code 129) (Ch. 81A, D-81) Tel. Rec. 227–10
A-T2277, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T2277S (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-T2279 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T2280 (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-T2281 (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-T2288, HM (Code 123) (Ch. 81, H-1, H-1A) Tel Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
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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)
A-UT1816, L (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-UT1817 (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-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)

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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)
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18BU3002 (Code 140) (Ch. R-191U, D-191) Tel. Rec. 231–12

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18BU3000, HM, L (Code 130) (Ch. R-181U, D-181) Tel. Rec. **227**–10
18BU3000W (Code 130) (Ch. R-181U, D-181) Tel. Rec. (See Model 18BU3000—Set 227-10)
18BU3002, L (Code 140) (Ch. R-191U, D-191) Tel. Rec. **231**–12
18BU3004 (Code 150) (Ch. R-201, D-201) Tel. Rec. **241**–11
22B4000 (Code 130) (Ch. R-181, D-181) Tel. Rec. **227**–10
22B4000X, XD (Code 130) (Ch. R-181, D-181) Tel. Rec. (See Model 18B3000—Set 227-10)
22B4001, E, L (Code 130) (Ch. R-181, D-181) Tel. Rec. (See Model 18B3000—Set 227-10)
22B4002 (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4002G (Code 140) (Ch. R-191, D-191) Tel. Rec. (See Model 18B3002—Set 231-12)
22B4002L (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4003 (Code 130) (Ch. R-181, D-181) Tel. Rec. See Model 18B3000—Set 227-10)
22B4004 (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4005, L (Code 140) (Ch. R-191, D-191) Tel. Rec. (See Model 18B3002—Set 231-12)
22B4007, L (Code 140) (Ch. R-191, D-191) Tel. Rec. (See Model 18B3002—Set 231-12)
22B4008, 22B4009 (Code 150) (Ch. R-201, D-201) Tel. Rec. **241**–11
22B4100 (Code 130) (Ch. R-181, D-181) Tel. Rec. **227**–10
22B4100A (Code 130) (Ch. R-181, D-181 Tel. Rec. (See Model 18B3000—Set 227-10)
22B4100L (Code 130) (Ch. R-181, D-181) Tel. Rec. **227**–10
22B4100X (Code 130) (Ch. R-181, D-181) Tel. Rec. (See Model 18B3000—Set 227-10)
22B4101 (Code 130) (Ch. R-181, D-181) Tel. Rec. **227**–10
22B4102, L (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4103, L (Code 130) (Ch. R-181, D-181) Tel. Rec. (See Model 18B3000—Set 227-10)
22B4104, L (Code 130) (Ch. R-181, D-181) Tel. Rec. (See Model 18B3000—Set 227-10)
22B4106 (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4107, L (Code 140) (Ch. R-191, D-191) Tel. Rec. (See Model 18B3002—Set 231-12)
22B4108 (Code 150) (Ch. R-201, D-201) Tel. Rec. **241**–11
22B4109HM (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4110, L (Code 150) (Ch. R-201, D-201) Tel. Rec. **241**–11
22B4112, L (Code 140) (Ch. R-191, D-191) Tel. Rec. (See Model 18B3002—Set 231-12)
22B4150 (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4150L (Code 140) (Ch. R-191, D-191) Tel. Rec. (See Model 18B3002—Set 231-12)
22B4301 (Code 130) (Ch. R-181, D-181) Tel. Rec. **227**–10
22B4302 (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4303 (Code 130) (Ch. R-181) D-181) Tel. Rec. **227**–10
22B4304 (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4306, L (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4307HM (Code 140) (Ch. R-191, D-191) Tel. Rec. **231**–12
22B4308 (Code 150) (Ch. R-201, D-201) Tel. Rec. **241**–11
22BU4000 (Code 130) (Ch. R-181U, D-181) Tel. Rec. **227**–10
22BU4000X, XD (Code 130) (Ch. R-181, D-181) Tel. Rec. (See Model 18BU3000—Set 227-10)
22BU4001, E, L (Code 130) (Ch. R-181, D-181) Tel. Rec. (See Model 18BU3000—Set 227-10)
22BU4002 (Code 140) (Ch. R-191U, D-191) Tel. Rec. **231**–12
22BU4002L (Code 140) (Ch. R-191U, D-191) Tel. Rec. (See Model 18BU3002—Set 231-12)
22BU4003 (Code 130) (Ch. R-181, D-181 Tel. Rec. (See Model 18B3000—Set 227-10)
22BU4004 (Code 140) (Ch. R-191U, D-191 Tel. Rec. **231**–12
22BU4008, 22BU4009 (Code 150) (Ch. R-201, D-201) Tel. Rec. **241**–11
22BU4100 (Code 130) (Ch. R-181U, D-181 Tel. Rec. **227**–10
22BU4100A (Code 130) (Ch. R-181U, D-181) Tel. Rec. (See Model 22BU3000—Set 227-10)
22BU4100L (Code 140) (Ch. R-181U, D-181) Tel. Rec. **227**–10
22BU4100X (Code 130) (Ch. R-181U, D-181) Tel. Rec. (See Model 22BU3000—Set 227-10)
22BU4101 (Code 130) (Ch. R-181U, D-181 Tel. Rec. **227**–10
22BU4102, L (Code 140) (Ch. R-191U, D-191) Tel. Rec. **231**–12
22BU4103, L (Code 130) (Ch. R-181, D-181) Tel. Rec. (See Model 18B3000—Set 227-10)
22BU4105, L (Code 130) (Ch. R-181U, D-181) Tel. Rec. (See Model 18BU3000—Set 227-10)
22BU4106 (Code 140) (Ch. R-191U, D-191) Tel. Rec. **231**–12
22BU4108 (Code 150) (Ch. R-201, D-201) Tel. Rec. **241**–11
22BU4109HM (Code 140) (Ch. R-191U, D-191) Tel. Rec. **231**–12

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22BU4110, L (Code 150) (Ch. R-201, D-201) Tel. Rec. **241**–11
22BU4150, L (Code 140) (Ch. R-191U, D-191) Tel. Rec. (See Model 18BU3002—Set 231-12)
22BU4302 (Code 140) (Ch. R-191U, D-191) Tel. Rec. **231**–12
22BU4303 (Code 130) (Ch. R-181U, D-181) Tel. Rec. **227**–10
22BU4304 (Code 140) (Ch. R-191U, D-191) Tel. Rec. **231**–12
22BU4306, L (Code 140) (Ch. R-191U, D-191) Tel. Rec. ...**231**–12
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46-1203 ...... **6**–23
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48-1266 ...... **39**–15
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48-1284 ...... **45**–20
48-1286 ...... **51**–15
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49-1040 (Code 121) Tel. Rec. **91A**–10
49-1040 (Code 123) Tel. Rec. **92**—5
49-1075 (Codes 121 and 122) Tel. Rec. **93A**–11
49-1076 (Code 122) Tel. Rec. **93A**–11
49-1076 (Code 123), 49-1077 (Code 122) Tel. Rec. ... **92**—5
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49-1150 (Codes 121 and 123) Tel. Rec. ...... **70**—6
49-1150 (Codes 122, 124) Tel. Rec. ...... **92**—5
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49-1175 (Codes 122, 124) Tel. Rec. ...... **92**—5
49-1240 (Codes 121, 123) Tel. Rec. **93A**–11
49-1240 (Code 124) Tel. Rec. **92**—5
49-1275 (Code 121) Tel. Rec. **93A**–11
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49-1475 (Codes 121A, B, 123A, B, 123T A, B) Tel. Rec. ...... **77**—8
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50-T1104 (Code 123) Tel. Rec. (Also see PCB 29—Set 154-1) ...... **114**—9
50-T1400, 50-T1401, 50-T1402 (Code 121) Tel. Rec. (Also see PCB 29—Set 154-1).... **114**—9
50-T1403, 50-T1404 (Codes 121 and 122) Tel. Rec. (See PCB 29—Set 154-1 and Model 50-T1104—Set 114-9)
50-T1403 (Code 125), 50-T1404, 50-T1406 (Codes 123, 124, 125) Tel. Rec. ...... **115**—8
50-T1406 (Codes 121 and 122) Tel. Rec. (See PCB 29—Set 154-1 and Model 50-T1104—Set 114-9)
50-T1430 (Code 121) Tel. Rec. (Also see PCB 29—Set 154-1). **114**—9
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50-T1432 (Code 124) Tel. Rec. ...... **115**—8
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51-PT1207, 51-PT1208 Tel. Rec. **136**–12
51-PT1234 Tel. Rec. **136**–12
51-PT1282 Tel. Rec. **136**–12
51-T1443B, L, M, X, XL (Code 121) (Ch. 31, A1) Tel. Rec... **125**–10
51-T1443P, PM, PL, PW (Code 121) (Ch. 3P1, AP1 and Radio Ch. RT-4) Tel. Rec. **123**–11
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51-T1604 (Code 121) (Ch. C, L) Tel. Rec. (See PCB 20—Set 134-1 and Model 50-T1600—Set 110-10)
51-T1604 (Code 122) (Ch. B, L) Tel. Rec. (See PCB 20—Set 134-1 and Model 50-T1600—Set 110-10)
51-T1606 (Codes 121 and 122) Tel. Rec. (See PCB 20—Set 134-1 and Model 50-T1600—Set 110-10)
51-T1606 (Code 131) Tel. Rec. (See Model 50-T1600, Code 121—Set 91A-10)
51-T1606 (Code 132) Tel. Rec. [For Defl. Ch. see Model 50-T1600 (Code 121)—Set 91A-10, for RF Ch. see Model 50-T1600 (Code 122)—Set 110-10]
51-T1607 (Code 121) (Ch. 33, C1) Tel. Rec. ...... **138**—7
51-T1607 (Code 122) (Ch. 32, C1) Tel. Rec. ...... **138**—7
51-T1634 (Code 121) (Ch. C, L) Tel. Rec. (See PCB 20—Set 134-1 and Model 50-T1600—Set 110-10)
51-T1634 (Code 122) (Ch. B, J) Tel. Rec. (See PCB 20—Set 134-1 and Model 50-T1600—Set 110-10)
51-T1634 (Code 123) (Ch. 33, C1) Tel. Rec. ...... **138**—7
51-T1634 (Code 124) (Ch. 32, C1) Tel. Rec. ...... **138**—7
51-T1800 Code 121) (Ch. 33, C2) Tel. Rec. **148**–13
51-T1800 (Code 122) (Ch. 32, C2) Tel. Rec. **148**–13
51-T1830 (Code 121) (Ch. 33, C2) Tel. Rec. **148**–13

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51-T1832 (Code 121) (Ch. 33, C2) Tel. Rec. **148**–13
51-T1833 (Code 121) (Ch. 3P1, CP1) Tel. Rec. **135**–10
51-T1834 (Code 121) (Ch. 33, C2) Tel. Rec. **148**–13
51-T1835 (Code 121) (Ch. 3R2, CR3) Tel. Rec. **135**–10
51-T1836 (Code 123) (Ch. 34, C3) Tel. Rec. **148**–13
51-T1836 (Code 125) (Ch. 33, C2) Tel. Rec. **148**–13
51-T1838 (Code 124) (Ch. 3R2, CR3) Tel. Rec. **135**–10
51-T1870 (Code 121) (Ch. 3P1, CP1) Tel. Rec. **135**–10
51-T1871 (Code 121) (Ch. 3P1, CP1) Tel. Rec. **135**–10
51-T1871 (Code 122) (Ch. 35, CP1) Tel. Rec. **135**–10
51-T1872 (Code 121) (Ch. 3P1, CP1 and Radio Ch. RT-4) Tel. Rec. **135**–10
51-T1872 (Code 122) (Ch. 35, CP1 and Radio Ch. RT-4) Tel. Rec. **135**–10
51-T1874 (Code 121) (Ch. 3P1, CP1 and Radio Ch. RT-4) Tel. Rec. **135**–10
51-T1875 (Code 121) (Ch. 3P1, CP1 and Radio Ch. RT-2) Tel. Rec. (For TV Ch. see Set 135-10, for Radio Ch. see Model 51-T2102—Set 132-10)
51-T1876 (Code 121) (Ch. 3P1, CP1 and Radio Ch. RT-4) Tel. Rec. **135**–10
51-T2102 (Code 122) (Ch. 35, F2) Tel. Rec. **132**–10
51-T2130 (Code 121) (Ch. 35, F2) Tel. Rec. **132**–10
51-T2132 (Code 121) (Ch. 35, F2) Tel. Rec. **132**–10
51-T2133 Code 121) (Ch. 3R2, FR2) Tel. Rec. **132**–10
51-T2134 (Code 124) (Ch. 35, F2) Tel. Rec. **132**–10
51-T2136 (Code 124) (Ch. 35, F2) Tel. Rec. **132**–10
51-T2138 (Code 124) (Ch. 3R2, FR2) Tel. Rec. **132**–10
51-T2170 (Code 121) (Ch. 35, F2 and Radio Ch. RT-4) (For TV Ch. see Model 51-T2102—Set 132-10, for Radio Ch. see Model 51-T1833—Set 135-10)
51-T2175, 51-T2176 (Code 124) (Ch. 35, F-2 and Radio Ch. RT-2) Tel. Rec. **132**–10
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52-T1610 (Code 122) (Ch. 32, C1) Tel. Rec. (See Model 51-T1601, Code 122—Set 138-7)
52-T1612 (Code 122) (Ch. 32, C1) Tel. Rec. (See Model 51-T1601, Code 122—Set 138-7)
52-T1802 (Code 123) (Ch. 37, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1802 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ...... **179**—9
52-T1804 (Code 122) (Ch. 32, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1804 (Code 123) (Ch. 37, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1808 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1808 (Code 122) (Ch. 33, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1810M (Code 122) (Ch. 33, C2) Tel. Rec. **148**–13
52-T1810L, M (Code 123) (Ch. 37, C2) Tel. Rec. **148**–13
52-T1812 (Code 122) (Ch. 33, C2) Tel. Rec. **148**–13
52-T1812 (Code 123) (Ch. 37, C2) Tel. Rec. **148**–13
52-T1820 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1821, 52-T1822 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1).... **179**—9
52-T1831 (Code 122) (Ch. 33, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1839 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1839 (Code 122) (Ch. 33, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1839 (Code 123) (Ch. 37, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1840 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1840 (Code 122) (Ch. 33, C2) Tel. Rec. **148**–13
52-T1840 (Code 123) (Ch. 37, C2) Tel. Rec. **148**–13
52-T1841L (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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52-T1841L (Code 123) (Ch. 37, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1842 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1842 (Code 122) (Ch. 33, C2) Tel. Rec. **148**–13
52-T1842 (Code 123) (Ch. 37, C2) Tel. Rec. **148**–13
52-T1842L (Code 124) (Ch. 33, C2) Tel. Rec. (See Model 52-T1842—Set 148-13)
52-T1844 (Code 121) (Ch. 41- D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1844 (Code 122) (Ch. 33, C2) Tel. Rec. **148**–13
52-T1844 (Code 123) (Ch. 37, C2) Tel. Rec. **148**–13
52-T1844 (Code 124) (Ch. 33, C2) Tel. Rec. **148**–13
52-T1845 (Ch. 3R2, CR2) (Code 124) Tel. Rec. (See Model 51-T1833—Set 135-10)
52-T1850 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1850-W (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ...... **179**—9
52-T1882 (Code 121) (Ch. 44, D4, D4A) Tel. Rec. (Also see PCB 57—Set 191-1) ...... **181**—9
52-T1882, W (Code 122) (Ch. 35, CP1 and Radio Ch. RT-4) Tel. Rec. (For TV Ch. see Model 51-T2102—Set 132-10, for Radio Ch. see Model 51-T1833—Set 135-10)
52-T1883 (Code 121) (Ch. 44, D4, D4A) Tel. Rec. (Also see PCB 57—Set 191-1) ...... **181**—9
52-T2106, 52-T2108, 52-T2110 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (Also see PCB 56—Set 190-1) ...... **171**—9
52-T2110 (Code 122) (Ch. 35, F2) Tel. Rec. (See Model 51-T2102—Set 132-10)
52-T2120 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 57—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2120 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 190-1) ...... **179**—9
52-T2122, L (Code 121) (Ch. 41, D1, D1A) Tel .Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2140 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (Also see PCB 56—Set 190-1) ...... **171**—9
52-T2142 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
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
52-T2252 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 57—Set 191-1) ...... **181**—9
52-T2252 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ...... **179**—9
52-T2253 (Code 121) (Ch. 44, D4, D4A) Tel. Rec. (Also see PCB 57—Set 191-1) ...... **181**—9
52-T2254 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
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)

NOTE: PCB denotes **Production Change Bulletin**

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52-T2259 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2282, 52-T2283 (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)
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53-T1824 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) .... **179**—9
53-T1825 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... **201**—7
53-T1825 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) .... **179**—9
53-T1826 (Code 123) (Ch 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... **201**—7
53-T1826 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) .... **179**—9
53-T1827, -F, -HM (Code 126) (Ch. 91, J-1) Tel. Rec. (See PCB 66—Set 203-1 and Model 53-T1853—Set 185-10)
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)
53-T1852L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also See PCB 83—Set 224-1) .... **201**—7
53-T1852L (Code 124) (Ch. 71, G-1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
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
53-T2125, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ... **201**—7
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)
53-T2183 (Code 125) (Ch. 44, G-4 and Radio Ch. RT-9) Tel. Rec. (TV Ch. only) **196**-11
53-T2225, L (Codes 123 and 133) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... **201**—7
53-T2226 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... **201**—7
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

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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)
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)

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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 **P**roduction **C**hange **B**ulletin

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NOTE: PCB denotes **P**roduction **C**hange **B**ulletin

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H-659T17 (Ch. V-2204-1) Tel. Rec. (Also see PCB 42—Set 176-1) ... **154**–15

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H-660C17, H-661C17 (Ch. V-2203-1 and Radio Ch. V-2180-3) Tel. Rec. (Also see PCB 46—Set 180-1) ... **157**–12
H-662K20 (Ch. V-2201-1) Tel. Rec. (Also see PCB 42—Set 176-1) ... **154**–15
H-663T17 (Ch. V-2192-2) Tel. Rec. (See PCB 28—Set 150-1 and Model H-639T17—Set 133-15)
H-663T17 (Ch. V-2204) Tel. Rec. (Also see PCB 42—Set 177-1) ... **154**–15
H-664K17 (Ch. V-2200-1) Tel. Rec. (Also see PCB 42—Set 176-1) ... **154**–15
H-665T16 (Ch. V-2206-1) Tel. Rec. (See PCB 42—Set 176-1 and Model H-648T20—Set 154-15)
H-667T17, H-668T17 (Ch. V-2216) Tel. Rec. (Also see PCB 40—Set 172-1) ... **167**–15
H-673K21 (Ch. V-2217-1) Tel. Rec. (See Model H-667T17—Set 167-15)
H-676T21 (Ch. V-2217-1) Tel. Rec. (See Model H-667T17—Set 167-15)
H-678K17, H-679K17 (Ch. V-2216-1, -2, -3) Tel. Rec. (Also see PCB 40—Set 172-1, PCB 45—Set 179-1 and PCB 52—Set 186-1) ... **167**—15
H-681T17 (Ch. V-2215-1) Tel. Rec. (See PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-688K24 (Ch. V-2219-1) (Also see PCB 52—Set 186-1) ... **174**–14
H-689T16 (Ch. V-2214-1) (See PCB 40—Set 172-1, PCB 58—Set 192-1 and Model H-667T17—Set 167-15)
H-690K21, H-691K21 (Ch. V-2217-1) Tel. Rec. (See Model H-667T17—Set 167-15)
H-692T21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-695K21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-699K17 (Ch. V-2216-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-700T17, H701T17 (Ch. V-2216-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-667-T17—Set 167-15)
H-701K21 (Ch. V-2217-2) Tel. Rec. (See PCB 43—Set 177-1 and Model H-667T17—Set 167-15)
H-702K17, H-703K17 (Ch. V-2216-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-767T17—Set 167-15)
H-704T17 (Ch. V-2216-2) Tel. Rec. (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 51—Set 185-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-704T17 (Ch. V-2216-4, -5) Tel. Rec. ... **202**—10
H-705K17 (Ch. V-2216-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-706T16 (Ch. V-2207-1) Tel. Rec. ... **193**–12
H-708T20 (Ch. V-2220-1, -3, -11) Tel. Rec. ... **193**–12
H-710T21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-710T21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-711T21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 40—Set 172-1, FCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-711T21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-713K21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-714K21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-714K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-715K21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-715K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-718K20 (Ch. V-2220-2) Tel. Rec. ... **193**–12
H-720K21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-720K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-721K21 Ch. V-2217-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-721K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10

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H-722K21 (Ch. V-2217-2, -3) Tel. Rec. (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set 167-15)
H-722K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-723K21 (Ch. V-2217-5) Tel. Rec. ... **202**–10
H-724T20, H-725T20 (Ch. V2220-2) Tel. Rec. ... **193**–12
H-730C21 (Ch. V-2218-1 and Radio Ch. V-2180-9, -10) Tel. Rec. ... **190**–16
H-730C21 (Ch. V-2218-2 and Radio Ch. V-2180-9, -10) Tel. Rec. (Also see PCB 59—Set 193-1 and PCB 68—Set 205-1) ... **190**–16
H-730C21 (Ch. V-2218-11 and Radio Ch. V-2180-9, -10) Tel. Rec. (Also see PCB 59—Set 193-1) ... **190**–16
H-732C21 (Ch. V-2218-1 and Radio Ch. V-2180-9, -10) Tel. Rec. ... **190**–16
H-732C21 (Ch. V-2218-11 and Radio Ch. V-2180-9, -10) Tel. Rec. (Also see PCB 59—Set 193-1) ... **190**–16
H-733C21 (Ch. V-2218-1 and Radio Ch. V-2180-9, -10) Tel. Rec. ... **190**–16
H-733C21 (Ch. V-2218-11 and Radio Ch. V-2180-9, -10) Tel. Rec. (Also see PCB 59—Set 193-1) ... **190**–16
H-736T17 (Ch. V-2227-1) Tel. Rec. (Also See PCB 89—Set 233-1) ... **214**–10
H-737T17 (Ch. V-2216-5) Tel. Rec. ... **202**–10
H-737T17 (Ch. V-2232-2) Tel. Rec. ... **212**—9
H-738T17 (Ch. V-2227-1) Tel. Rec. (Also See PCB 89—Set 233-1) ... **214**–10
H-739T17, H-739TU17 (Ch. V-2227-2) Tel. Rec. ... **214**–10
H-740T21, H-742K21, H-743K21 (Ch. V-2233-1) Tel. Rec. (Also See Prod. Chge. Bul. 99—Set 244-1) ... **212**—9
H-746K21, H-746KU21, H-747K21, H-747KU21 (Ch. V-2233-4) Tel. Rec. ... **215**–16
H-750T21 (Ch. V-2233-3) Tel. Rec. ... **212**—9
H-751T21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-751T21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-752T21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-752T21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-753K21 (Ch. V-2233-3) Tel. Rec. ... **212**—9
H-754K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-754K21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-755K21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-756K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-756K21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-757K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-757K21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-758K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-758K21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-759K21 (Ch. V-2217-4, -5) Tel. Rec. ... **202**–10
H-759K21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-760T21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-760TU21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-761T21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-761TU21 (Ch. V-2233-2) Tel. Rec. ... **212**—9
H-769T21 (Ch. V-2263-12, -14) Tel. ... **253**–17
H-769TU21 (Ch. V-2273-122) Tel. ... **253**–17
H-770T21A (Ch. V-2263-12) Tel. ... **253**–17
H-770TU21A (Ch. V-2273-122) Tel. ... **253**–17
H-771T21A (Ch. V-2263-12) Tel. ... **253**–17
H-771TU21A (Ch. V-2273-122) Tel. ... **253**–17
H-786K21 (Ch. V-2263-12) Tel. ... **253**–17
H-786KU21 (Ch. V-2273-122) Tel. ... **253**–17
H-787K21 (Ch. V-2263-12) Tel. ... **253**–17
H-787KU21 (Ch. V-2273-122) Tel. ... **253**–17
H-795T27, H-795TU27 (Ch. V-2250-1) Tel. Rec. (Also See PCB 105—Set 252-1) ... **241**–12
H-798T17 (Ch. V-2260-12, -14) Tel. Rec. ... **255**–17
H-798TU17 (Ch. V-2270-122, -124) Tel. Rec. ... **255**–17
H-799T17 (Ch. V-2260-12, -14) Tel. Rec. ... **255**–17
H-799TU17 (Ch. V-2270-122, -124) Tel. Rec. ... **255**–17
H-802 (Ch. V-11900-1, -2, -3, -4, -5, V-11213) Tel. UHF Conv. ... **209**–13
H-815T24, H-815TU24 (Ch. V-2250-1, -4) Tel. Rec. (Also See PCB 105—Set 252-1) ... **241**–12
H-817K24, H-817KU24 (Ch. V-2250-1, -4) Tel. Rec. (Also See PCB 105—Set 252-1) ... **241**–12

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H-822K21 (Ch. V-2263-12) Tel. Rec. ... **253**–17
H-822KU21 (Ch. V-2273-122) Tel. Rec. ... **253**–17
H-823K21 (Ch. V-2263-12) Tel. Rec. ... **253**–17
H-823KU21 (Ch. V-2273-122) Tel. Rec. ... **253**–17
H-827T21 (Ch. V-2263-12, -13, -14, -15) Tel. Rec. ... **253**–17
H-827TU21 (Ch. V-2273-122, -134) Tel. Rec. ... **253**–17
H-828T21 (Ch. V-2263-12, -13, -14, -15) Tel. Rec. ... **253**–17
H-828TU21 (Ch. V-2273-122, -134) Tel. Rec. ... **253**–17
H-829T21 (Ch. V-2263-12, -13, -14, -15) Tel. Rec. ... **253**–17
H-829TU21 (Ch. V-2273-122, -134) Tel. Rec. ... **253**–17
H-830K21 (Ch. V-2263-11, -12, -13, -14) Tel. Rec. ... **253**–17
H-830KU21 (Ch. V-2273-111, -122, -124, -132, -134) Tel. Rec. ... **253**–17
H-831K21 (Ch. V-2263-11, -12, -13, -14) Tel. Rec. ... **253**–17
H-831KU21 (Ch. V-2273-111, -122, -124, -132, -134) Tel. Rec. ... **253**–17
H-834K21 (Ch. V-2263-22) Tel. Rec. ... **253**–17
H-834KU21 (Ch. V-2273-222) Tel. Rec. ... **253**–17
H-835K21 (Ch. V-2263-22) Tel. Rec. ... **253**–17
H-835KU21 (Ch. V-2273-222) Tel. Rec. ... **253**–17
H-836T21 (Ch. V-2263-35) Tel. Rec. ... **253**–17
H-836TU21 (Ch. V-2273-322) Tel. Rec. ... **253**–17
H-838K21 (Ch. V-2263-15) Tel. Rec. ... **253**–17
H-838K21A (Ch. V-2263-15) Tel. Rec. (See Model H-769T21—Set 253-17)
H-838KU21 (Ch. V-2273-122) Tel. Rec. ... **253**–17
H-838KU21A (Ch. V-2273-124) Tel. Rec. (See Model H-769TU21—Set 253-17)
H-839K21 (Ch. V-2263-15) Tel. Rec. ... **253**–17
H-839KU21 (Ch. V-2273-122) Tel. Rec. ... **253**–17
H-863T21A (Ch. V-2263-35) Tel. Rec. (See Model H-769T21—Set 253-17)
H-863TU21A (Ch. V-2273-324) Tel. Rec. (See Model H-769TU21—Set 253-17)
H-864T21A (Ch. V-2263-35) Tel. Rec. (See Model H-769T21—Set 253-17)
H-864TU21A (Ch. V-2273-324) Tel. Rec. (See Model H-769TU21—Set 253-17)
H-865T21A (Ch. V-2263-35) Tel. Rec. (See Model H-769T21—Set 253-17)
H-865TU21A (Ch. V-2273-324) Tel. Rec. (See Model H-769TU21—Set 253-17)
H-866T21A (Ch. V-2263-35) Tel. Rec. (See Model H-769T21—Set 253-17)
H-866TU21A (Ch. V-2273-324) Tel. Rec. (See Model H-769TU21—Set 253-17)
H-873T21A (Ch. V-2263-35) Tel. Rec. (See Model H-769T21—Set 253-17)
H-873TU21A (Ch. V-2273-234) Tel. Rec. (See Model H-769TU21—Set 253-17)
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Ch. V-2103-3 (See Model H-214)
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Ch. V-2128-2 (See Model H-202)
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Ch. V-2149-2 (See Model H-231)
Ch. V-2149-3 (See Model H-603C-12)
Ch. V-2150-01, V-2150-02 (See Model H-223)
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Ch. V-2150-136 (See Model H-610T12)
Ch. V-2150-146 (See Model H-613K16)
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Ch. V-2157, U (See Model H-318T5)
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Ch. V-2172 (See Model H-626T16)
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Ch. V-2180-3 (See Model H-660C17)
Ch. V-2180-5 (See Model H-357C10)
Ch. V-2180-8 (See Model H-370T7)
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Ch. V-2202-2 (See Model H-653K24)
Ch. V-2203-1 (See Model H-660C17)
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Ch. V-2214-1 (See Model H-689T16)
Ch. V-2215-1 (See Model H-681T17)
Ch. V-2216-1 (See Model H-667T17)
Ch. V-2216-2, -3 (See Model H-678K17)
Ch. V-2216-4, -5 (See Model H-704T17)
Ch. V-2217-1 (See Model H-673K21)
Ch. V-2217-2, -3 (See Model H-692T21)
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Ch. V-2220-1 (See Model H-708T20)
Ch. V-2220-2 (See Model H-718K20)
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Ch. V-2227-2 (See Model H-739T17)
Ch. V-2232-2 (See Model H-737T17)
Ch. V-2233-1 (See Model H-704T21)
Ch. V-2233-2 (See Model H-751T21)
Ch. V-2233-3 (See Model H-750T21)
Ch. V-2233-4 (See Model H-746K21)
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Ch. V-2273-222 (See Model H-834KU21)
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Ch. V-2273-324 (See Model H-833TU21A)
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WILCOX-GAY
(Also see Majestic)
(Also see Recordio)

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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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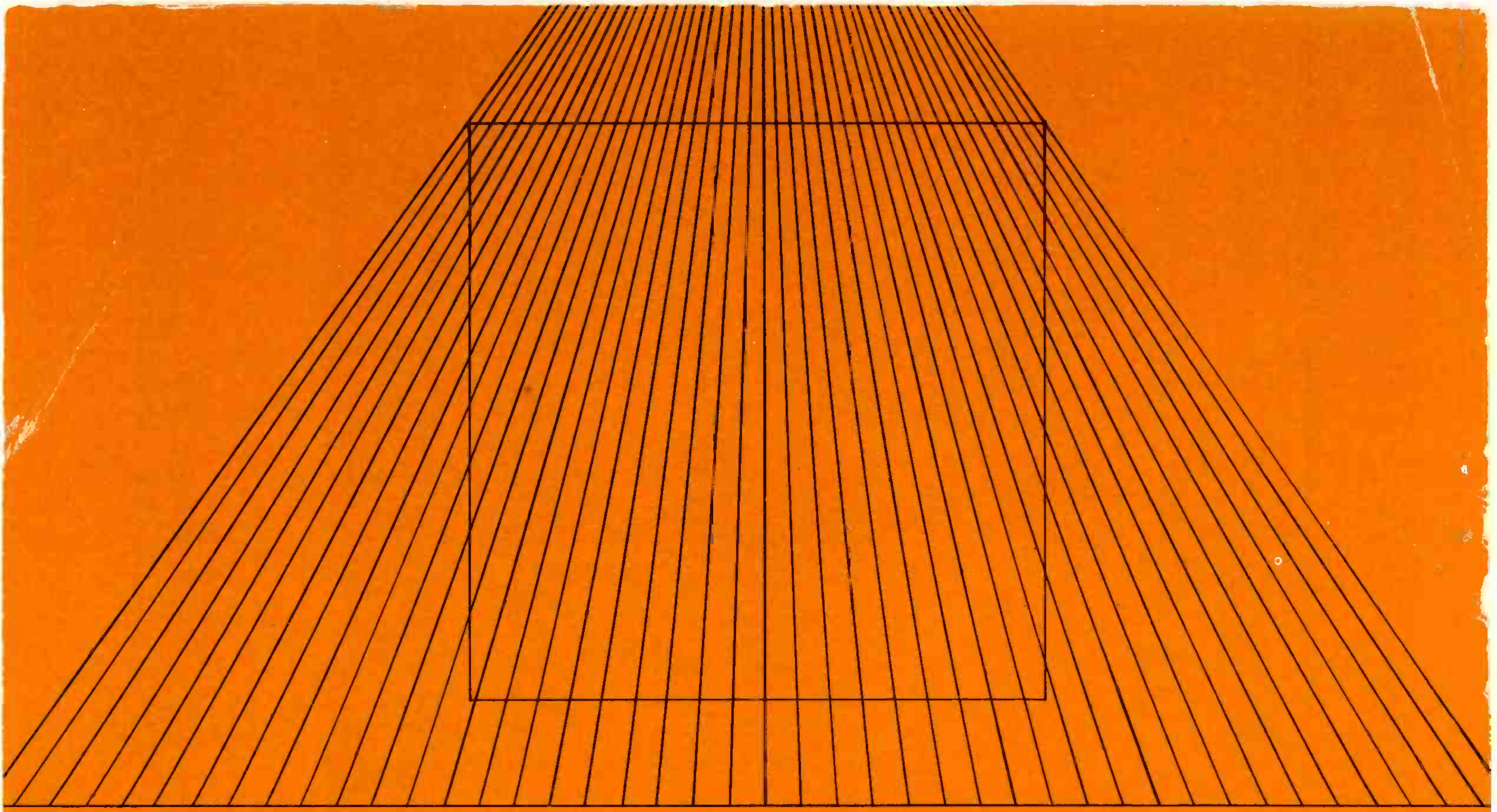

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